AGENCY REVIEW DRAFT MAY 2024

City of Port Townsend

City of Port Townsend

GENERAL SEWER PLAN

PREPARED BY RH2 ENGINEERING

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City of Port Townsend General Sewer Plan

AGENCY REVIEW DRAFT
MAY 2024

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CERTIFICATION

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E | Executive Summary E-1
PURPOSE OF THE PLAN E-1
SUMMARY OF KEY ELEMENTS E-1
Sewer Service Area, Land Use, and Population E-1
Existing Facilities and Discharge Regulations E-2
Existing Wastewater Flow and Loading E-6
Inflow and Infiltration E-8
Peaking Factors E-8
Projected Wastewater Flow E-9
Projected Wastewater Quality E-10
Policies and Design Criteria E-12
Operation and Maintenance E-13
Summary of Improvements E-13
1 | Introduction 1-1
SEWER SYSTEM OWNERSHIP AND MANAGEMENT 1-1
OVERVIEW OF EXISTING SYSTEM 1-1
AUTHORIZATION AND PURPOSE 1-2
PREVIOUS PLANNING EFFORTS 1-3
SUMMARY OF PLAN CONTENTS 1-3
LIST OF ABBREVIATIONS 1-3
2 | Sewer System Description and Discharge Regulations 2-1
INTRODUCTION 2-1
SEWER SERVICE AREA 2-1
History 2-1
Geology 2-2
Topography 2-2
Climate 2-3
Water Bodies and Floodplains 2-3
City Limits, Urban Growth Area, and Sewer Service Area Boundary 2-4
EXISTING SEWER FACILITIES 2-5
Sewer Drainage Basins 2-5
Gravity Sewer Collection Piping 2-6
Force Mains 2-8
Lift Stations 2-9
Low Pressure Sewer Systems 2-12
Wastewater Treatment and Disposal Facilities 2-14
DISCHARGE AND DISPOSAL REGULATIONS AND PERMITS 2-15
WWTF NPDES Permit and Regulations 2-15
Future City NPDES Permit Effluent Limits (Outfall No. 001) Changes 2-16

Other Regulations and Required Permits 2-17
ADJACENT SEWER SYSTEMS 2-23
CITY OF PORT TOWNSEND AND ADJACENT WATER SYSTEMS 2-23
City of Port Townsend 2-23
Adjacent Water Systems 2-26
3 | Land Use and Population 3-1
INTRODUCTION 3-1
COMPATIBILITY WITH OTHER PLANS AND POLICIES 3-1
Growth Management Act 3-1
Port Townsend Comprehensive Plan 3-2
Jefferson County County-wide Planning Policies 3-2
Jefferson County Comprehensive Plan 3-3
LAND USE 3-3
POPULATION 3-5
Household Trends 3-5
Historical and Future City Population 3-5
Sewer System Population 3-7
Distribution of Population Assumptions 3-8
4 | Flow and Loading Analyses 4-1
INTRODUCTION 4-1
SEWER SERVICE CONNECTIONS AND RESIDENTIAL POPULATION 4-1
Sewer Service Connections 4-1
Sewer Service Population 4-2
EXISTING WASTEWATER FLOW AND LOADING 4-3
Wastewater Flow 4-3
Wastewater Loading 4-4
INFLOW AND INFILTRATION 4-6
Inflow 4-6
Infiltration 4-7
PROJECTED WASTEWATER FLOW AND LOADING 4-7
Peaking Factors 4-8
Projected Wastewater Flow Rates 4-9
Historical Wastewater Flow by Basin 4-12
Projected Wastewater Flow by Basin 4-13
Lift Station Hydraulic Capacity Analyses 4-14
Projected Wastewater Loading Capacity 4-15
SUMMARY 4-22
5 | Policies and Collection System Design Criteria 5-1
INTRODUCTION 5-1

REGULATIONS 5-2
National Pollutant Discharge Elimination System Permit 5-2
Other Regulations and Required Permits 5-2
CUSTOMER SERVICE POLICIES 5-2
Existing Sewer Service and Connection 5-2
Proposed Sewer Service and Connection Policies 5-3
Septic System Policies 5-4
COLLECTION SYSTEM POLICIES AND DESIGN CRITERIA 5-5
Sanitary Sewer Design Criteria 5-5
Gravity Sewer Design Criteria 5-5
Design Flow Rates 5-6
Separation Between Sanitary Sewer and Other Utilities 5-6
Design Period 5-6
Force Main Design Criteria 5-7
Low Pressure Sewer Design Criteria 5-7
Side Sewer Design Criteria 5-7
LIFT STATION POLICIES AND DESIGN CRITERIA 5-7
OPERATIONAL POLICIES 5-8
Facilities Maintenance 5-8
Collection System Maintenance 5-8
Temporary and Emergency Services 5-9
Reliabilities 5-9
ORGANIZATIONAL POLICIES 5-9
Staffing 5-9
FINANCIAL POLICIES 5-10
General 5-10
Connection Charges 5-12
6 | Sewer Collection System Evaluation 6-1
INTRODUCTION 6-1
COLLECTION SYSTEM ANALYSIS 6-1
Hydraulic Model 6-1
Hydraulic Analyses Results 6-2
Other Existing Gravity Collection System Deficiencies 6-8
LIFT STATION ANALYSIS 6-10
Lift Station Capacity 6-10
7 | Existing Treatment Facilities Assessment 7-1
BACKGROUND 7-1
History and Introduction 7-1
System Overview 7-1

Historical WWTF Performance 7-2
WWTF EXISTING PROCESS UNITS EVALUATION 7-4
Introduction 7-4
Influent Pump Station 7-4
Headworks 7-5
Activated Sludge System 7-7
Sludge Holding, Dewatering, and Disposal 7-10
Odor Control System 7-11
Electrical and SCADA Existing Systems Evaluation 7-12
COMPOST FACILITY EXISTING SYSTEMS EVALUATION 7-15
Overview 7-15
Condition Assessment 7-17
Summary of Major Findings 7-18
TREATMENT FACILITIES ASSESSMENT CONCLUSION 7-18
8 | Treatment Facilities Analysis 8-1
INTRODUCTION 8-1
MAJOR CONSIDERATIONS FOR WWTF IMPROVEMENTS 8-1
Growth in Flow and Loading 8-1
Regulatory Changes – Nitrogen Reduction 8-2
WWTF Site Footprint 8-3
Age and Condition 8-5
APPROACH TO WWTF ANALYSES 8-5
ACTIVATED SLUDGE SYSTEM 8-6
Existing Activated Sludge System 8-6
Screening of Nitrogen Treatment Options 8-10
Improvements to the Existing Oxidation Ditch System 8-14
Replacement of the Existing Oxidation Ditch System 8-17
Activated Sludge System Recommendations 8-20
PRELIMINARY TREATMENT 8-22
Summary of Analysis 8-22
Recommendations 8-23
EFFLUENT DISINFECTION 8-24
Summary of Analysis 8-24
Recommendations 8-25
OUTFALL 8-25
TERTIARY TREATMENT – WATER REUSE/RECLAMATION 8-26
SOLIDS HANDLING 8-28
On-Site WWTF Solids Handling System 8-28
Off-Site Compost Facility 8-30

ELECTRICAL AND CONTROLS 8-31
REFERENCES 8-33
9 | Operations and Maintenance 9-1
INTRODUCTION 9-1
NORMAL OPERATIONS 9-1
City Personnel 9-1
Personnel Responsibilities 9-2
Certification of Personnel 9-3
Available Equipment 9-4
Routine Operations 9-4
Continuity of Service 9-5
Routine Wastewater Quality Sampling 9-5
EMERGENCY OPERATIONS 9-5
Capabilities 9-5
PREVENTIVE MAINTENANCE 9-7
Wastewater Division 9-7
STAFFING 9-9
Current Staff 9-9
Proposed Staffing 9-9
10 | Capital Improvement Plan 10-1
INTRODUCTION 10-1
DESCRIPTION OF IMPROVEMENTS 10-2
5-Year System Improvements 10-2
6- to 10-Year System Improvements 10-9
11- to 20-Year System Improvements (Long-Term Planning Capital Improvements) 10-10
Planning Improvements 10-13
ESTIMATING COSTS OF IMPROVEMENTS 10-13
PRIORITIZING IMPROVEMENTS 10-15
SCHEDULE OF IMPROVEMENTS 10-15
Future Project Cost Adjustments 10-15
11 | Financial Analysis 11-1
INTRODUCTION 11-1
FINANCIAL HISTORY 11-1
CAPITAL FUNDING RESOURCES 11-3
Grant and Low-Cost Loan Programs 11-3
System Development Charges (SDCs) 11-3
Bonds 11-5
CURRENT REVENUE 11-5
Financial Policies 11-6

Revenue Requirement.....11-12
CURRENT AND PROJECTED SEWER RATES.....11-13
Utility Rate Affordability Analysis.....11-14
CONCLUSION.....11-20

TABLES

Table ES-1 Land Use Inside Future Wastewater Service Area.....E-2
Table ES-2 2021 City Sewer System Data.....E-3
Table ES-3 Gravity Sewer Collection Piping Inventory – Diameter.....E-3
Table ES-4 Force Main Inventory – Diameter.....E-4
Table ES-5 Lift Station Characteristics.....E-4
Table ES-6 WWTF Permitted Flow and Loading Design Criteria.....E-5
Table ES-7 SWDP SBR Effluent Limits.....E-6
Table ES-8 SWDP Wetland Effluent Limits.....E-6
Table ES-9 Historical WWTF Influent Flow Summary.....E-7
Table ES-10 Historical WWTF Influent BOD_5 Loading Summary.....E-7
Table ES-11 Historical WWTF Influent TSS Loading Summary.....E-7
Table ES-12 WWTF Peaking Factor Summary for Flows.....E-9
Table ES-13 WWTF Peaking Factor Summary for Loadings.....E-9
Table ES-14 Total Projected WWTF Flow including Special Study Area Expansion.....E-10
Table ES-15 Total Projected WWTF BOD_5 Loading including Special Study Area Expansion.....E-11
Table ES-16 Total Projected WWTF Influent TSS Loading including Special Study Area Expansion.....E-12
Table ES-17 Proposed CIP Implementation Schedule.....E-15
Table 1-1 2021 City Sewer System Data.....1-2
Table 1-2 Abbreviations.....1-4
Table 2-1 Gravity Sewer Collection Piping Inventory – Diameter.....2-7
Table 2-2 Gravity Sewer Collection Piping Inventory – Material.....2-7
Table 2-3 Gravity Sewer Collection Piping Inventory – Installation Year.....2-8
Table 2-4 Force Main Inventory – Diameter.....2-8
Table 2-5 Force Main Inventory – Material.....2-9
Table 2-6 Force Main Inventory – Installation Year.....2-9
Table 2-7 Lift Station Characteristics.....2-10
Table 2-8 WWTF Permitted Flow and Loading Design Criteria.....2-16
Table 2-9 NPDES Permit Effluent Limits.....2-16
Table 2-10 Comparison of City NPDES Permit and PSNGP Monitoring Requirements for WWTF Influent.....2-20
Table 2-11 Comparison of City NPDES Permit and PSNGP Monitoring Requirements for WWTF Effluent.....2-20
Table 2-12 Compost Facility Flow and Loading Design Criteria.....2-22
Table 2-13 State Waste Discharge Permit SBR Effluent Limits.....2-22
Table 2-14 State Waste Discharge Permit Wetland Effluent Limits.....2-22
Table 2-15 Booster Pump Station Facilities Summary.....2-25
Table 2-16 Storage Facilities Summary.....2-25
Table 3-1 Land Use Inside Future Wastewater Service Area.....3-4
Table 3-2 Population Trends within the City Limits.....3-5
Table 3-3 Population Projections.....3-6

Table 4-1 Historical Sewer Connections Summary 4-2
Table 4-2 Historical Sewer Service Population 4-3
Table 4-3 Historical WWTF Influent Flow Summary 4-4
Table 4-4 Historical WWTF Influent BOD_5 Loading Summary 4-5
Table 4-5 Historical WWTF Influent TSS Loading Summary...4-5
Table 4-6 Peaking Factor Summary for Flows...4-8
Table 4-7 Peaking Factor Summary for Loadings...4-9
Table 4-8 Projected WWTF Influent Flow for Sewer System Population Within City Limits 4-10
Table 4-9 Projected WWTF Influent Flow for Sewer System Special Study Area Expansion..................4-11
Table 4-10 Total Projected WWTF Flow including Special Study Area Expansion 4-12
Table 4-11 Historical AAF and PHF Rates by Lift Station...4-13
Table 4-12 Existing and Projected AAF and PHF Rates by Basin 4-14
Table 4-13 Current AAF and PHF Rates and Remaining Capacity by Lift Station.................................4-14
Table 4-14 Projected WWTF Influent BOD_5 Loading for Sewer System Population Within City Limits..4-16
Table 4-15 Projected WWTF Influent BOD_5 Loading for Sewer System Special Study Area Expansion .4-17
Table 4-16 Total Projected WWTF BOD_5 Loading including Special Study Area Expansion 4-18
Table 4-17 Projected WWTF Influent TSS Loading for Sewer System Population Within City Limits.....4-19
Table 4-18 Projected WWTF Influent TSS Loading for Sewer System Special Study Area Expansion 4-20
Table 4-19 Total Projected WWTF TSS Loading including Special Study Area Expansion 4-21
Table 4-20 Summary of Existing and Projected Flow and Loading at the WWTF 4-22
Table 7-1 WWTF Performance Based on NPDES Permit Effluent Limits (2019-2022)............................7-3
Table 7-2 Monthly Nitrogen Sampling Results 7-3
Table 8-1 Projected Influent Flow and Loading 8-2
Table 8-2 Original Oxidation Ditch Design Criteria 8-6
Table 8-3 Original Facility Design Flow and Load...8-7
Table 8-4 Predicted Clarifier SLR for Existing Activated Sludge System at MLSS 2,800 mg/L 8-8
Table 8-5 Preliminary Treatment Design Criteria from 1990 Project 8-23
Table 8-6 Disinfection System Design Criteria from 1990 Project...8-24
Table 8-7 Aerobic Holding Tank Design Criteria from 1990 Project 8-29
Table 8-8 Dewatering System Design Criteria from 1990 Project 8-29
Table 9-1 Personnel Certification..9-3
Table 9-2 Wastewater Division Equipment List 9-4
Table 9-3 Utility and Agency Contacts 9-6
Table 10-1 Gravity Sewer Pipe Unit Costs for Open-Cut Construction..10-14
Table 10-2 Gravity Sewer Pipe Unit Costs for Cured-in-Place Pipe..10-14
Table 10-3 Proposed CIP Implentation Schedule...10-17
Table 11-1 Summary of Historical Financial Performance ($000s) 11-2
Table 11-2 Sewer SDC Calculation 11-4
Table 11-3 Capital Cost Forecast..11-9
Table 11-4 Capital Funding Strategy 11-11
Table 11-5 Projected Financial Performance and Revenue Requirements ($000s) 11-13
Table 11-6 Sewer Rate Forecast...11-14
Table 11-7 Combined Utility Bill Forecast..11-15
Table 11-8 Monthly Utility Bill as a Percentage of Median Household Income 11-16
Table 11-9 Rate Affordability Assessment Based on HM and AR_{20}...11-18

Table 11-10 Summary of Rate Burden Evaluation Based on EPA Methodology 11-19
Table 11-11 Rate Burden Assessment Based on EPA Methodology 11-20

CHARTS

Chart 3-1 Population Projections 3-7
Chart 4-1 2021 Sewer Service Connections by Customer Class 4-2

FIGURES

Figure 2-1 Existing Sewer System
Figure 2-2 Sewer Drainage Basins
Figure 2-3 Sewer Drainage Basins Schematic
Figure 2-4 Pipe Material
Figure 2-5A Known Pipe Age
Figure 2-5B Assumed Pipe Age
Figure 2-6 Wastewater Treatment Facilities in Vicinity
Figure 2-7 Existing Sewer and Water System
Figure 3-1 Existing Land Use Map
Figure 3-2 Possible Service Area Expansion
Figure 3-3 Allocation of Future Population by Planning Area
Figure 6-1 CIP SM1
Figure 6-2 CIP SM2
Figure 6-3 CIPs SM3 and SM4
Figure 6-4 CIP SM5
Figure 6-5 CIP SM6
Figure 6-6 CIP SM7
Figure 6-7 CIP SM10
Figure 6-8 Washington Sewer Street with Cracks
Figure 6-9 CIP SM9
Figure 7-1 Existing WWTF Overall Site Plan
Figure 7-2 Existing WWTF Process Schematic
Figure 7-3 Existing Compost Facility Overall Site Plan
Figure 7-4 Existing Compost Facility Process Schematic
Figure 8-1 WWTF and Surrounding Parcels
Figure 8-2 WWTF Site Aerial
Figure 8-3 Existing Oxidation Ditch Configuration
Figure 8-4 Current Operation of Existing Oxidation Ditch with Aerator at Low Speed
Figure 8-5 Conceptual Conversion of Existing Oxidation Ditches to MLE Configuration
Figure 8-6 Conceptual Conversion of Existing Oxidation Ditches to Cyclic Operation
Figure 8-7 Sea Level Rise Projects for 17% Probability of Exceedance including Storm Surge
Figure 8-8 WWTF and Surrounding Parcels
Figure 8-9 Adjacent Parcel Acquisition Considerations
Figure 8-10 Basic Configuration of Expanded WWTF
Figure 8-11 Approximate Outfall Configuration
Figure 9-1 Wastewater Division Organization Chart
Figure 10-1 Capital Improvement Plan Map Collection System

APPENDICES

Appendix A – 2019 Stormwater Management Plan
Appendix B – 2012 Mill Road Pump Station and Force Main Predesign Report by CH2M HILL
Appendix C – NPDES Permit
Appendix D – PSNGP
Appendix E – State Waste Discharge Permit
Appendix F – SEPA Checklist/DNS and SERP/Affirmed Determination
Appendix G – City Wastewater Engineering Standards
Appendix H – 2016 to 2021 WWTF Influent Flow and Loading Summaries
Appendix I – Hydraulic Model Data
Appendix J – Mill Site Lift Station Sizing Analysis
Appendix K – 2022 City of Port Townsend Sea Level Rise and Coastal Flooding Risk Assessment
Appendix L – 2019 Port Townsend Condition Assessment Summary Report by Jacobs
Appendix M – City Resolutions and Ordinances
Appendix N – Funding Program Summary
Appendix O – Port Townsend Sewer Rate Model
Appendix P – Agency Review Correspondence

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E | EXECUTIVE SUMMARY

PURPOSE OF THE PLAN

The City of Port Townsend's (City) sewer system is a major infrastructure, most of which is invisible to the customers it serves. The sewer system requires qualified staff to operate and maintain an ongoing capital improvement plan to replace old components to meet the requirements mandated by federal and state laws. The primary purpose of the City's General Sewer Plan (GSP) is to identify and schedule sewer system improvements that correct existing deficiencies and ensure a safe and reliable sewer system for current and future customers. This GSP has been prepared in accordance with Washington Administrative Code (WAC) 173-240-050.

SUMMARY OF KEY ELEMENTS

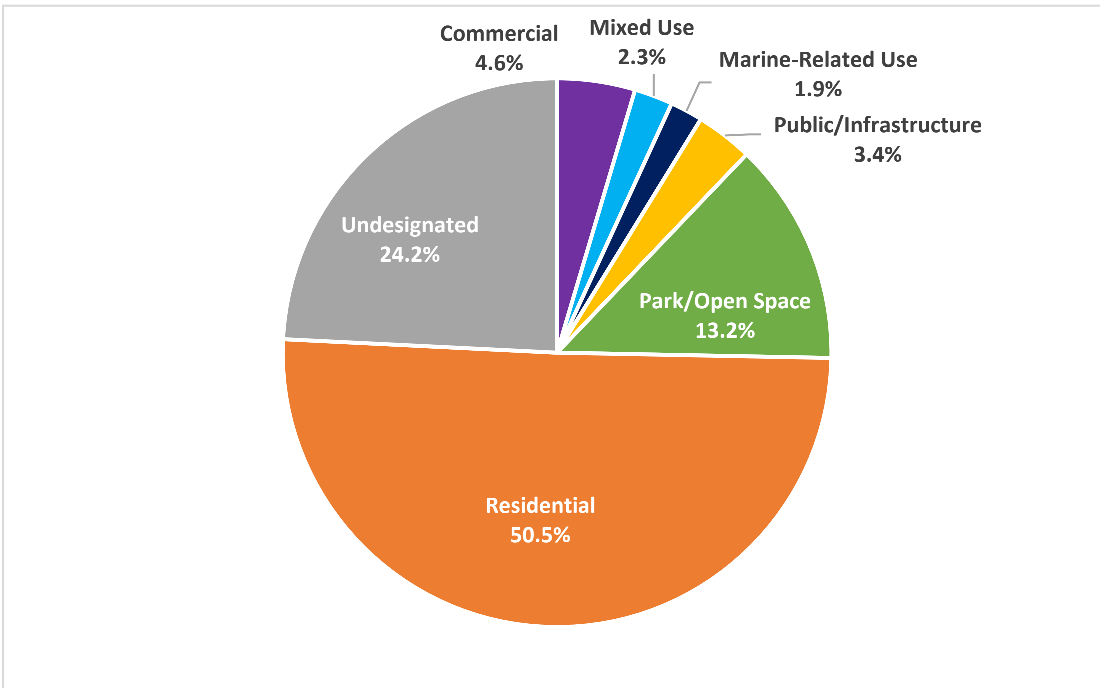
Sewer Service Area, Land Use, and Population

The City limits coincide with the Urban Growth Area (UGA) boundary, and encompass an area of approximately 7.4 square miles. Approximately 50 percent of the land within the City's future wastewater service area is designated for residential use, while the remaining land is designated for other uses such as open space/parks, commercial use, public/infrastructure use, and other land uses. **Table ES-1** presents the land uses within the future wastewater service area. **Chapter 3** provides more information regarding the population projections and designated land use within the City's planning area.

The City's 2021 population was 10,220 people, which is expected to grow to 13,300 people by 2043. The City's residential areas largely are comprised of single-family homes, with approximately 75 percent of the housing units being single-family residences. The 2021 sewer service population is estimated at approximately 9,829 people. The City's sewer system population is expected to grow to 12,720 people in 2033 and to 15,242 people by 2043. The residential population estimate is based on an average single-family household size of 1.9 persons per household in the City.

Table ES-1
Land Use Inside Future Wastewater Service Area

Land Use Type	Acres	% of Total
Commercial	205	4.6%
Mixed Use	101	2.3%
Marine-Related Use	86	1.9%
Public/Infrastructure	150	3.4%
Park/Open Space	588	13.2%
Residential	2,254	50.5%
Undesignated	1,081	24.2%
Total	**4,466**	**100.0%**



Existing Facilities and Discharge Regulations

The City's sewer system includes a gravity collection and conveyance system, seven wastewater lift stations, force mains, the wastewater treatment facility (WWTF), a Compost Facility, and an outfall. A summary of the sewer system characteristics is provided in **Table ES-2**. **Chapter 2** describes the City's gravity collection and conveyance system, lift station, and general WWTF characteristics.

Table ES-2
2021 City Sewer System Data

Description	Data
City Population	10,220
Number of Properties on Septic Systems	211
Sewer System Population	9,829
Total Connections	4,710
Sewer Planning Area - UGA (Square Miles)	7.4
Average Gallons per Capita per Day (gpcd)	85
Average Annual Flow (MGD)	0.84
Maximum Month Average Flow (MGD)	1.02
Maximum Day Flow (MGD)	2.18
Number of Lift Stations	7
Total Length of Gravity Main (Miles)	75.2
Length of 8-inch-diameter Gravity Main (Miles)	45.3
Total Length of Force Main (Miles)	2.2
WWTF Permitted Maximum Month Average Flow (MGD)	2.05

gpcd = gallons per capita per day

Gravity Sewer Collection Piping

The City's existing sewer service area is comprised of 14 sewer drainage basins. Approximately 75.2 miles of gravity sewer piping, ranging in size from 6 to 30 inches, serves the City's sewer system customers. As shown in **Table ES-3**, most of the sewer pipe (approximately 60 percent) within the sewer service area is 8-inch diameter.

Table ES-3
Gravity Sewer Collection Piping Inventory – Diameter

Diameter (inches)	Total Length (feet)	Total Length (Miles)	% of System
6 and smaller	100,808	19.09	25.4%
8	239,222	45.31	60.2%
10	20,188	3.82	5.1%
12	10,131	1.92	2.6%
14	1,963	0.37	0.5%
15	80	0.02	0.0%
16	3,462	0.66	0.9%
18	6,974	1.32	1.8%
22	1,376	0.26	0.3%
24	179	0.03	0.0%
30	6,471	1.23	1.6%
Unknown	6,222	1.18	1.6%
Total	**397,077**	**75.20**	**100.0%**

The City also has 2.2 miles of force mains. A summary of the force mains by diameter is provided in **Table ES-4**.

Table ES-4
Force Main Inventory – Diameter

Diameter (inches)	Total Length (feet)	Total Length (Miles)	% of System
4	1,718	0.33	15.1%
6	4,333	0.82	38.0%
10	2,706	0.51	23.8%
12	2,179	0.41	19.1%
16	381	0.07	3.3%
Unknown	78	0.01	0.7%
Total	**11,395**	**2.16**	**100.0%**

Lift Stations

The City currently owns, operates, and maintains seven wastewater lift stations. The characteristics of the lift stations are summarized in **Table ES-5**.

Table ES-5
Lift Station Characteristics

	Lift Station					Pumps			
Lift Station Name	**Year Constructed**	**Force Main Diameter (inches)**	**No. of Pumps**	**Type**	**Manufacturer**	**Horsepower (hp)**	**TDH (feet)**	**Design Capacity (gpm)**	**Design Firm Capacity (gpm)**
Gaines Street Lift Station	1967 - Constructed 2022 - Upgrade	6	3	Submersible	Flygt	60	107	1,050 1,050 1,050	2,100
Monroe Street Lift Station	1965 - Constructed 2008 - Upgrade	10	3	Dry Pit	Chicago	15		600 600 600	1,200
Port Lift Station	1967	6	2	Submersible	Cornell	5		200 200	200
31st Street Lift Station	1996	4	2	Submersible	Gorman-Rupp	3		100 100	100
Island Vista Lift Station	1985 - Constructed 2004 - Upgrade	4	2	Submersible	Flygt	6.5	100	100 100	100
Point Hudson Lift Station	1975 - Constructed 1988 - Upgrade	4	2	Submersible	Peabody Barnes	1.5		150 150	150
Hamilton Heights Lift Station	1997	6	2	Submersible	FairBanks Morse	10	58	250 250	250

Wastewater Treatment and Disposal Facilities

The City's WWTF is located just west of Fort Worden in the North Beach neighborhood. The WWTF originally was constructed in 1967 and provided primary treatment and disinfection using chlorine gas. The WWTF was expanded in 1993 to provide secondary treatment.

Raw wastewater enters the WWTF from two gravity sewers, and an influent pump station lifts the wastewater to the headworks. Within the headworks, a bar screen removes rags and floating debris, and then a grit classifier settles out the sand and heavy materials. The flow rate of the screened and de-gritted influent is measured in a Parshall flume and the liquid then flows to the oxidation ditches. In the oxidation ditches, surface mixers stir air into the liquid, promoting the growth of microbiological cultures that consume the biochemical oxygen demand in the mixture and form a solution known as mixed liquor. The mixed liquor flows to the secondary clarifier, where the biological solids settle out. The clarified effluent flows to the chlorination basins, where it is chlorinated using liquid sodium hypochlorite. The biological solids (liquid sludge) produced during secondary clarification are pumped to the small aerobic digesters for a short stabilization period. The liquid sludge is then pumped to the control building, where it is blended with polymer and dewatered using a belt filter press.

Descriptions of processes and further details of the WWTF are presented in **Chapter 7**.

NPDES Regulations and City Permit

The City has a National Pollutant Discharge Elimination System (NPDES) Permit issued by the Washington State Department of Ecology (Ecology). The permit includes effluent limits for treated water discharged to the City's outfall in the Strait of Juan de Fuca in Puget Sound. In addition, the permit includes facility flow and loading design criteria for the WWTF as shown in **Table ES-6**.

Table ES-6
WWTF Permitted Flow and Loading Design Criteria

Parameter	Design Quantity
Maximum Month Design Flow (MMDF)	2.05 MGD
Annual Average Flow	1.44 MGD
BOD_5 Influent Loading for Maximum Month	3,754 ppd
TSS Influent Loading for Maximum Month	4,568 ppd
Design Population	12,000

MGD = million gallons per day

ppd = pounds per day

Compost Facility and Solids Handling

The Compost Facility has been successfully operating since 1993. Dewatered biosolids, dewatered septage, and ground yard waste are composted to produce a product used for soil conditioning. The City's Compost Facility is covered under the general permit to produce Class A biosolids as defined in the federal 40 CFR 503 regulations and is covered under a State Waste Discharge Permit (SWDP). The SWDP effluent limits for the sequencing batch reactor (SBR) and wetlands are shown in **Tables ES-7** and **ES-8**.

Table ES-7
SWDP SBR Effluent Limits

Parameter	Average Monthly	Average Weekly
BOD_5	30 mg/L 1 ppd 85% removal of influent BOD_5	45 mg/L 1.5 ppd
TSS	30 mg/L 1 ppd 85% removal of influent TSS	45 mg/L 1.5 ppd
Parameter	**Minimum**	**Maximum**
pH	6.0 standard units	9.0 standard units

Table ES-8
SWDP Wetland Effluent Limits

Parameter	Monthly Geometric Mean	7-Day Geometric Mean
Fecal Coliform	200 col/100 mL	400 col/10 mL
Parameter	**Average Monthly**	**Average Weekly**
Total Residual Chlorine	0.5 mg/L	0.75 mg/L
Effluent Limits: Wetland Effluent		
Parameter	**Average Monthly**	**Average Weekly**
Nitrate	10 mg/L as N	-

Existing Wastewater Flow and Loading

Flow and load values in a sewer system are used to determine the size of gravity collection piping, lift station facilities, and force main piping, and the size and type of treatment facilities needed. This information also is used to develop the sewer service provider's NPDES Permit, which is required by Ecology. **Chapter 4** presents the historical and projected WWTF flow and loading rates.

The total influent flow to the WWTF is made up of wastewater flow from primarily residential customers but also includes flow from a number of commercial, hospitality, and retail businesses, schools, and the Jefferson Healthcare Medical Center. The historical 2016 through 2021 influent average annual flow (AAF), maximum month average flow (MMF), and maximum day flow (MDF) (including infiltration and inflow) is summarized in **Table ES-9**. The 2021 AAF was 0.84 million gallons per day (MGD).

Table ES-9
Historical WWTF Influent Flow Summary

Year	Sewer System Population	AAF (MGD)	AAF per Capita (gpcd)	MMF (MGD)	MDF (MGD)	PHF (MGD)	Percent of NPDES Permit Max. Month Limit[1]	Peaking Factors MMF/AAF	MDF/AAF	PHF/AAF
2016	9,414	0.85	91	1.07	1.99	--	52%	1.26	2.33	--
2017	9,480	0.84	88	0.92	1.39	2.79	45%	1.10	1.66	3.33
2018	9,559	0.87	91	1.16	1.82	3.06	57%	1.33	2.09	3.52
2019	9,669	0.78	81	0.87	1.12	2.35	43%	1.11	1.43	2.99
2020	9,757	0.80	82	1.15	2.37	3.34	56%	1.43	2.96	4.17
2021	9,829	0.84	85	1.02	2.18	---	50%	1.22	2.60	---
2016 to 2019 Average[2]		**0.84**	**88**	**1.01**	**1.58**	**2.74**	**--**	**1.20**	**1.88**	**3.28**
2016 to 2019 Max.[2]		**0.87**	**91**	**1.16**	**1.99**	**3.06**	**--**	**1.33**	**2.33**	**3.52**

1 = The City's WWTF is permitted for a maximum month average influent flow of 2.05 MGD.
2 = 2020 and 2021 values are not included in the historical averages and maximums due to the COVID pandemic.

Table ES-10 summarizes the historical 5-day biochemical oxygen demand (BOD_5), and **Table ES-11** summarizes the historical total suspended solids (TSS) loadings for 2016 through 2021 in pounds per day (ppd) and pounds per capita per day (ppcd).

Table ES-10
Historical WWTF Influent BOD_5 Loading Summary

Year	Sewer System Population	Average Annual BOD_5 (mg/L)	Average Annual BOD_5 (ppd)	Average Annual BOD_5 (ppcd)	Max. Month BOD_5 (mg/L)	Max. Month BOD_5 (ppd)	Percent of NPDES Permit Max. Month Limit[1]	BOD_5 Max. Month Average/Average Annual Peaking Factor
2016	9,414	332	2,242	0.24	405	2,442	65%	1.09
2017	9,480	329	2,289	0.24	364	2,538	68%	1.11
2018	9,559	363	2,509	0.26	454	2,968	79%	1.18
2019	9,669	400	2,591	0.27	437	2,718	72%	1.05
2020	9,757	336	2,147	0.22	374	2,422	65%	1.13
2021	9,829	334	2,221	0.23	393	2,500	67%	1.13
2016 to 2019 Average[2]		**356**	**2,408**	**0.25**	**415**	**2,667**	**---**	**1.11**
2016 to 2019 Max.[2]		**400**	**2,591**	**0.27**	**454**	**2,968**	**---**	**1.18**

1 = The City's WWTF is permitted for a maximum month BOD_5 influent loading of 3,754 ppd.
2 = 2020 and 2021 values are not included in the historical averages and maximums due to the COVID pandemic.

Table ES-11
Historical WWTF Influent TSS Loading Summary

Year	Sewer System Population	Average Annual TSS (mg/L)	Average Annual TSS (ppd)	Average Annual TSS (ppcd)	Max. Month TSS (mg/L)	Max. Month TSS (ppd)	Percent of NPDES Permit Max. Month Limit[1]	TSS Max. Month Average/Average Annual Peaking Factor
2016	9,414	331	2,240	0.24	388	2,458	54%	1.10
2017	9,480	329	2,291	0.24	367	2,564	56%	1.12
2018	9,559	359	2,493	0.26	431	2,799	61%	1.12
2019	9,669	376	2,437	0.25	417	2,686	59%	1.10
2020	9,757	341	2,188	0.22	386	2,725	60%	1.25
2021	9,829	322	2,146	0.22	390	2,481	54%	1.16
2016 to 2019 Average[2]		**349**	**2,365**	**0.25**	**401**	**2,627**	**---**	**1.11**
2016 to 2019 Max.[2]		**376**	**2,493**	**0.26**	**431**	**2,799**	**---**	**1.12**

1 = The City's WWTF is permitted for a maximum month TSS influent loading of 4,568 ppd.
2 = 2020 and 2021 values are not included in the historical averages and maximums due to the COVID pandemic.

Inflow and Infiltration

Inflow and infiltration is the combination of groundwater and surface water that enters the sewer system. The U.S. Environmental Protection Agency (EPA) published a report in May 1985, *Infiltration/Inflow, I/I Analysis and Project Certification,* that developed guidelines to help determine what amount of inflow and infiltration (I/I) is considered to be excessive and what amount can be cost-effectively removed.

Inflow is considered to be non-excessive if the average daily flow during periods of heavy rainfall or spring thaw does not exceed 275 gallons per capita per day (gpcd). The peak recorded flow data in the 6 years of data analyzed for the City was 2.37 MGD. This peak inflow event equates to 243 gpcd, which is below the EPA's maximum guideline of 275 gpcd. The City did not experience any peak inflow events above the EPA's maximum inflow criterion. The City should continue to monitor inflow throughout the system, particularly in areas over 50 years old that previously may have been combined collection systems.

The determination of non-excessive infiltration was based on the national average for dry weather flow of 120 gpcd. In order for the amount of infiltration to be considered non-excessive, the average daily flow must be less than 120 gpcd. The peak dry weather flow period in the last 6 years (2016 through 2021) of record for the City, occurring after a few consecutive days of rain, was the 5-day period from January 22 through January 26, 2016. This period also was directly preceded by heavy rains, and yielded an average flow of 1.20 MGD, equating to 128 gpcd. The second highest peak dry weather flow period occurred in February 2018 and yielded an average flow of 124 gpcd. The third highest peak dry weather flow period occurred during a 14-day period in February 2020, resulting in an average flow of 121 gpcd. All three events are slightly above the EPA's maximum infiltration criterion; therefore, the amount of infiltration is considered excessive. The City should continue to monitor infiltration throughout the system.

Peaking Factors

Projected flows are used to analyze how well the existing sewer system will perform in the future and determine improvements required to maintain or improve system function. Peaking factors are needed to establish projected flow scenarios for the sewer system, which are then applied to future flow rates. **Table ES-12** shows a summary of peaking factors for flows at the City's WWTF for the 2016 through 2021 period.

Table ES-12
WWTF Peaking Factor Summary for Flows

Flow	
Max. Month Average Flow/Average Annual Flow (MMF/AAF)	1.33
Max. Day Flow/Average Annual Flow (MDF/AAF)[1]	2.83
Peak Hour Flow/Average Annual Flow (PHF/AAF)[1]	4.00
BOD_5	
Max. Month Average/Average Annual Loading	1.18
TSS	
Max. Month Average/Average Annual Loading	1.12

1 = The MDF and PHF for 2016 through 2021 both occurred in 2020 during the COVID pandemic. 2020 had a lower than typical AAF, so the PHF/AAF and MDF/AAF peaking factors were estimated with the PHF and MDF from this year divided by the average AAF for 2016 through 2019.

Peaking factors also are developed to determine maximum month average BOD_5 and TSS loading projections, as shown in **Table ES-13**. These loading peaking factors are the average historic maximum month to average annual loadings from 2016 to 2019. Data obtained during the COVID pandemic (2020 and 2021) may not represent normal flow and load conditions.

Table ES-13
WWTF Peaking Factor Summary for Loadings

Year	BOD_5 Max. Month Average/Average Annual Peaking Factor	TSS Max. Month Average/Average Annual Peaking Factor
2016	1.09	1.10
2017	1.11	1.12
2018	1.18	1.12
2019	1.05	1.10
2020	1.13	1.25
2021	1.13	1.16
Average[1]	**1.11**	**1.11**

1 = The peaking factors used for projections are the averages of the peaking factors from 2016 to 2019. 2020 and 2021 values are not included in these averages due to the COVID pandemic.

Projected Wastewater Flow

The City's sewer system is projected to add a total of 5,683 additional persons by 2043 using 2018 as the base year. **Table ES-14** provides a summary of the projected flows for the WWTF. According to these projections, the WWTF will not exceed the NPDES permit maximum month limit capacity during the 20-year planning period. However, the City should evaluate the WWTF for upgrades when the average MMF exceeds 85 percent of the NPDES Permit limit. According to these projections (based on flow), the City should prepare for WWTF upgrades by 2038.

Table ES-14
Total Projected WWTF Flow including Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected AAF[1] (MGD)	Projected MMF[2] (MGD)	Percent of NPDES Permit Max. Month Limit[3]	Projected MDF[4] (MGD)	Projected PHF[5] (MGD)	Projected PHF with Inflow Reduction[6] (MGD)
2018 (Baseline)	**9,559**	**0.87**	**1.16**	**57%**	**1.82**	**3.06**	**--**
2019	9,669	0.78	0.87	43%	1.12	2.35	--
2020	9,757	0.80	1.15	56%	2.37	3.34	--
2021	9,829	0.84	1.02	50%	2.18	---	--
2022	9,981	0.91	1.21	59%	2.57	3.63	--
2023	10,134	0.92	1.23	60%	2.61	3.69	--
2024	10,289	0.94	1.25	61%	2.65	3.75	--
2025	10,553	0.96	1.29	63%	2.73	3.87	--
2026	10,819	0.99	1.32	65%	2.81	4.00	--
2027	11,086	1.02	1.36	66%	2.89	4.13	--
2028	11,354	1.05	1.40	68%	2.97	4.26	--
2029	11,624	1.08	1.44	70%	3.05	4.39	--
2030	11,896	1.11	1.47	72%	3.13	4.52	--
2031	12,169	1.13	1.51	74%	3.21	4.65	--
2032	12,444	1.16	1.55	76%	3.29	4.78	--
2033 (+ 10 years)	**12,720**	**1.19**	**1.59**	**78%**	**3.38**	**4.91**	**4.50**
2034	12,927	1.21	1.62	79%	3.44	5.01	4.59
2035	13,140	1.24	1.65	80%	3.50	5.10	4.69
2036	13,361	1.26	1.68	82%	3.56	5.20	4.79
2037	13,603	1.28	1.71	83%	3.64	5.31	4.90
2038	13,853	1.31	1.75	85%	3.71	5.42	5.01
2039	14,111	1.34	1.78	87%	3.79	5.54	5.13
2040	14,379	1.36	1.82	89%	3.86	5.66	5.25
2041	14,656	1.39	1.86	91%	3.95	5.79	5.38
2042	14,944	1.42	1.90	93%	4.03	5.92	5.51
2043 (+ 20 years)	**15,242**	**1.46**	**1.94**	**95%**	**4.12**	**6.06**	**5.65**
Buildout	**25,806**	**2.39**	**3.19**	**156%**	**6.77**	**9.82**	**9.40**

1 = Total projected AAF was estimated by adding City limit and sewer system expansion flows together.
2 = Total projected MMF was estimated by adding City limit and sewer system expansion flows together.
3 = The City's WWTF is permitted for a maxium month average influent flow of 2.05 MGD.
4 = Total projected MDF was estimated by adding City limit and sewer system expansion flows together.
5 = Total projected PHF was estimated by adding City limit and sewer system expansion flows together.
6 = Projected PHFs with inflow reduction were estimated by reducing projected PHFs after 2032 by 288 (0.41 MGD) to account for the removal of inflow estimated to be contributed by catch basins connected to the City's sewer system along Lawrence Street.

Projected Wastewater Quality

Projected BOD_5 and TSS loadings are presented in **Tables ES-15** and **ES-16**. According to these projections, the WWTF will exceed the NPDES Permit maximum month limit capacity for BOD_5 during the 20-year planning period. However, the City should prepare the WWTF for upgrades when the maximum month average BOD_5 load exceeds 85 percent of the NPDES permit limit. According to these projections (based on BOD load), the City should begin planning and preparing for WWTF upgrades by 2027. Near-term upgrades will be completed to enable the City to reach 100-percent capacity. However, the WWTF will not exceed the NPDES Permit maximum month limit capacity for TSS during the 20-year planning period. The City should prepare the WWTF for upgrades when the maximum month average TSS load exceeds 85 percent of the NPDES Permit limit. According to these projections, the City should prepare for WWTF upgrades for TSS by 2041. Capital improvement plan projects for WWTF upgrades are included in **Chapter 10**.

Table ES-15
Total Projected WWTF BOD_5 Loading including Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected Average Annual BOD_5 (ppd)[1]	Projected Max. Month Average BOD_5 (ppd)[2]	Percent of NPDES Permit Max. Month Limit[3]
2018	9,559	2,509	2,968	79%
2019 (Baseline)	**9,669**	**2,591**	**2,718**	**72%**
2020	9,757	2,147	2,422	65%
2021	9,829	2,221	2,500	67%
2022	9,981	2,654	2,939	78%
2023	10,134	2,684	2,973	79%
2024	10,289	2,715	3,007	80%
2025	10,553	2,768	3,066	82%
2026	10,819	2,821	3,125	83%
2027	11,086	2,875	3,184	85%
2028	11,354	2,928	3,243	86%
2029	11,624	2,982	3,303	88%
2030	11,896	3,037	3,363	90%
2031	12,169	3,091	3,424	91%
2032	12,444	3,146	3,485	93%
2033 (+ 10 years)	**12,720**	**3,202**	**3,546**	**94%**
2034	12,927	3,243	3,592	96%
2035	13,140	3,286	3,639	97%
2036	13,361	3,330	3,688	98%
2037	13,603	3,378	3,741	100%
2038	13,853	3,428	3,797	101%
2039	14,111	3,480	3,854	103%
2040	14,379	3,533	3,913	104%
2041	14,656	3,589	3,975	106%
2042	14,944	3,646	4,039	108%
2043 (+ 20 years)	**15,242**	**3,706**	**4,105**	**109%**
Buildout	**25,806**	**5,819**	**6,445**	**172%**

1 = Projected average annual BOD_5 loadings were estimated by adding City limit and sewer system expansion loadings together.
2 = Projected maximum month average BOD_5 loadings were estimated by adding City limit and sewer system expansion loadings together.
3 = The City's WWTF is permitted for a maximum month average influent BOD_5 loading of 3,754 ppd.

Table ES-16
Total Projected WWTF Influent TSS Loading including Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected Average Annual TSS (ppd)[1]	Projected Max. Month Average TSS (ppd)[2]	Percent of NPDES Permit Max. Month Limit[3]
2018 (Baseline)	**9,559**	**2,493**	**2,799**	**61%**
2019	9,669	2,437	2,686	59%
2020	9,757	2,188	2,725	60%
2021	9,829	2,146	2,481	54%
2022	9,981	2,577	2,862	63%
2023	10,134	2,608	2,896	63%
2024	10,289	2,639	2,930	64%
2025	10,553	2,692	2,989	65%
2026	10,819	2,745	3,048	67%
2027	11,086	2,798	3,107	68%
2028	11,354	2,852	3,167	69%
2029	11,624	2,906	3,227	71%
2030	11,896	2,960	3,287	72%
2031	12,169	3,015	3,347	73%
2032	12,444	3,070	3,408	75%
2033 (+ 10 years)	**12,720**	**3,125**	**3,470**	**76%**
2034	12,927	3,167	3,516	77%
2035	13,140	3,209	3,563	78%
2036	13,361	3,253	3,612	79%
2037	13,603	3,302	3,666	80%
2038	13,853	3,352	3,721	81%
2039	14,111	3,403	3,779	83%
2040	14,379	3,457	3,838	84%
2041	14,656	3,513	3,900	85%
2042	14,944	3,570	3,964	87%
2043 (+ 20 years)	**15,242**	**3,630**	**4,030**	**88%**
Buildout	**25,806**	**5,742**	**6,376**	**140%**

1 = Projected average annual TSS loadings were estimated by adding City limit and sewer system expansion loadings together.
2 = Projected maximum month average TSS loadings were estimated by adding City limit and sewer system expansion loadings together.
3 = The City's WWTF is permitted for a maximum month average influent TSS loading of 4,568 ppd.

Policies and Design Criteria

The City operates and plans sewer service for the City and associated sewer service area residents and businesses according to the design criteria, laws, and policies that originate from the EPA and Ecology.

These laws, design criteria, and policies guide the City's operation and maintenance of the sewer system on a daily basis, as well as the City's plan for growth and improvements. The overall objective is to ensure that the City provides high quality sewer service at a fair and reasonable cost to its customers. They also set the standards the City must meet to ensure that the sewer system is adequate to meet existing and future flows. The collection system's ability to handle these flows is detailed in **Chapter 6**, and the recommended improvements are identified in **Chapter 10**. The City Council adopts regulations and policies. The City's policies cannot be less stringent or in conflict with those established by federal and state governments. The City's policies take the form of ordinances, memoranda, and operational procedures, many of which are summarized in **Chapter 5**.

The City will maintain an updated GSP that is coordinated with the Land Use Element of the City's *Comprehensive Plan*, so that new development will be located where sufficient sewer system capacity exists or can be efficiently and logically extended.

Operation and Maintenance

Chapter 9 addresses the operation and maintenance (O&M) staff for the City's WWTF and collection system. Currently, there are approximately 8 personnel funded and assigned to the O&M of the City's sewer system.

The collection system and WWTF will continue to expand with population growth, and the City will need additional staff to continue maintaining the gravity sewers, force mains, and lift stations. For O&M needs, the City recommends a total of 2.6 full-time employees (FTEs) for the wastewater collections. The City also has requested and is planning to add 1.0 FTE for the WWTF and Compost Facility. This results in a total of approximately 10 FTEs for the O&M of the City's sewer system.

Summary of Improvements

A general description of improvements and an overview of the deficiencies they will resolve are presented in **Chapter 10**. Some of the improvements are necessary to resolve existing system deficiencies. The sewer system improvements were identified from the results of the collection system evaluation presented in **Chapter 6** and the WWTF and Compost Facility evaluation presented in **Chapters 7** and **8**. The sewer system improvements were sized to meet the system's projected 2043 demand conditions.

Collection system improvements to accommodate new growth are not shown in detail in this CIP. It is assumed that most of the new growth will occur at or near the Mill site. This CIP includes a lift station to allow development of the Mill site and conveyance for the new lift station's discharge throughout the existing collection system.

It is intended that this GSP contain an inclusive list of recommended system improvements; however, additional projects may need to be added or removed from the list as growth occurs or conditions change. The City will evaluate the capacity of the wastewater collection system, WWTF, and Compost Facility as growth occurs and as development permits are received.

Project costs for the proposed improvements were estimated based on costs of similar recently constructed sewer projects around the Puget Sound area and are presented in 2023 dollars. The cost estimates include the estimated construction costs and indirect costs. The existing system improvements were prioritized by the City based on a perceived need for the improvement to be completed prior to projects with fewer deficiencies or less risk of damage due to failure of the system. A general schedule has been established for planning purposes; the schedule should be modified based on City preferences, budget, or as development fluctuates. In addition, the City retains the flexibility to reschedule, expand, or reduce the projects presented in **Table ES-17** when new information becomes available for review and analysis.

Table ES-17
Proposed CIP Implementation Schedule

CIP No.	Project Description	Length (LF)	Estimated Cost (2023 $)	2024	2025	2026	2027	2028	6-10 years	11-20 years
	Sewer Main Improvements									
SM1	Sims Way Crossing and Wilson Street Realignment	786	$1,212,000	$100K	$606K	$506K				
SM2	Howard Street and S Park Avenue	1,079	$1,578,000						$1,578K	
SM3	Sims Way, 3rd Street, and Gise Street	796	$1,186,000						$1,186K	
SM4	Holcomb Street	531	$819,000						$819K	
SM5	Howard Street, S Park Avenue, and McPherson Street	1,685	$2,463,000							$2,463K
SM6	West Sims Way and 3rd Street	1,149	$1,679,000							$1,679K
SM7	Future Interceptor Upsizing	3,785	$6,722,000							$6,722K
SM8	Sewer System Defect Investigation and Repair	--	$3,300,000	$150K	$350K	$350K	$350K	$350K	$1,750K	
SM9	Lawrence Street Combined Sewer Separation*	1,800	$2,826,000		$500K	$1,163K	$1,163K			
SM10	Suitcase Pipe Replacement on Washington Street	303	$399,000		$399K					
SM11	Long-Term Sewer System Investigation and Refurbishment**	--	$56,000,000							$56,000K**
SM12	Water Street Sewer Replacement	1,600	$2,100,000	$2,100K						
Total - Sewer Main Improvements			**$80,284,000**	**$2,350K**	**$1,855K**	**$2,019K**	**$1,513K**	**$350K**	**$5,333K**	**$66,864K**
	Lift Station Improvements									
WW1	Existing Monroe Street Lift Station Improvements		$5,000,000					$500K	$4,500K	
WW2	Sewer Camera Van, Video Camera and Tractor, Recording Software and Hardware, and Staff Training		$300,000	$300K						
WW3	General Lift Station Improvements		$1,000,000	$50K	$50K	$50K	$50K	$50K	$250K	$500K
WW4	Mill Lift Station		$6,300,000	$1,100K	$3,200K	$2,000K				
Total - Lift Station Improvements			**$12,600,000**	**$1,450K**	**$3,250K**	**$2,050K**	**$50K**	**$550K**	**$4,750K**	**$500K**
	Wastewater Treatment Facility Improvements									
F1	Influent Pump Station and Odor Control Improvements		$2,120,000	$300K	$1,820K					
F2	Headworks Rehabilitation		$1,200,000						$1,200K	
F3	Clarifier No. 1 Improvements		$1,250,000						$1,250K	
F4	Clarifier No. 2 Improvements		$1,250,000						$1,250K	
F5	Non-Potable Water Pump Replacements (City to Install)		$120,000	$60K		$60K				
F6	SCADA Upgrades		$1,140,000		$150K	$990K				
F7	Electrical Upgrades		$630,000			$630K				
F8	Near-Term Oxidation Ditch Improvements		$2,940,000		$100K			$400K	$2,440K	
F9	Outfall Upgrades		$4,000,000	$500K	$600K	$2,900K				
F10	On-Site Solids Handling Improvements		$3,000,000						$3,000K	
F11	Land Acquisition for WWTF Expansion		$2,000,000		$2,000K					
F12	Long-Term WWTF Expansion (Budgetary Estimate)		$30,000,000							$30,000K
Total - Facility Improvements			**$49,650,000**	**$860K**	**$4,670K**	**$4,580K**	**$0K**	**$400K**	**$9,140K**	**$30,000K**
	Compost Facility and Solids Handling Improvements									
C1	Solids Handling Influent Screening and Grit Removal		$890,000			$160K	$365K	$365K		
C2	Solids Handling Tank Replacement and Mechanical Upgrades		$700,000		$150K	$130K	$130K	$130K	$160K	
C3	Compost Screen Replacement		$460,000	$460K						
C4	Compost Case Loader Replacement		$390,000		$390K					
C5	Compost Blowers Replacements		$80,000	$19K	$19K	$19K	$23K			
C6	Compost Facility Infrastructure Upgrades		$410,000		$15K					$395K
C7	6-inch Hydrant Line		$670,000		$100K	$285K	$285K			
C8	Office with Dedicated Lunchroom		$300,000		$300K					
Total - Facility Improvements			**$3,900,000**	**$479K**	**$974K**	**$594K**	**$803K**	**$495K**	**$160K**	**$395K**
	Miscellaneous and Planning Improvements									
M1	Arc Flash Analysis		$90,000		$90K					
M2	Public Works Shop - Sewer Collection Share		$2,850,000		$100K				$2,750K	
M3	General Sewer Plan Update		$250,000							$250K
M4	Downtown Restrooms		$250,000		$250K					
Total - Miscellaneous Improvements			**$3,440,000**	**$0K**	**$440K**	**$0K**	**$0K**	**$0K**	**$2,750K**	**$250K**
Total Estimated Project Costs of City-funded Improvements			**$149,874,000**	**$5,139K**	**$11,189K**	**$9,243K**	**$2,366K**	**$1,795K**	**$22,133K**	**$98,009K**

*50% cost shown in the CIP table. It is assumed an additional 50% will be paid by the Road and Storm Drainage departments.

**Costs are budgetary for pipe replacement of unknown materials. As the City video inspects the system and updates condition, this is subject to change. Rate analysis only includes anticipated grants to reduce City expenditure to $21 million.

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1 | INTRODUCTION

SEWER SYSTEM OWNERSHIP AND MANAGEMENT

The City of Port Townsend (City), located in Jefferson County (County), is a municipal corporation that provides wastewater collection and treatment, among other municipal services. The City owns, operates, and maintains the sewer system. Ownership information, including the owner's authorized representative, is as follows.

Physical Address:
250 Madison Street, Suite 2R
Port Townsend, WA 98368

Authorized Representative Name and Phone Number: City Manager, John Mauro, (360) 349-5043

Operation and management of the sewer system is provided by the wastewater division of the City's Public Works Department with the following contacts:

- City Public Works Director, Steve King, (360) 379-5090
- Wastewater Treatment and Compost Operations Manager, Bliss Morris, (360) 344-3043
- Streets and Collection Operations Manager, Brian Reid, (360) 385-3197

OVERVIEW OF EXISTING SYSTEM

The City's sewer system is comprised of a wastewater treatment facility (WWTF), 7 sewer lift stations, and approximately 77.4 miles of gravity and force main pipes. The City also owns and operates a Compost Facility for solids from the WWTF, and septage receiving station and separate WWTF at the Compost Facility. The City provided wastewater collection and treatment to an estimated 9,829 people in 2021, compared to the City's population of 10,220. Currently, 206 properties within the City limits are using on-site septic systems. As of 2021, the City's number of wastewater service customer connections was approximately 4,710. The City's sewer planning area is the same as its Urban Growth Area (UGA).

The main WWTF consists of an Influent Pump Station (IPS), headworks, oxidation ditches, secondary clarifiers, and chlorine contact basins. Waste sludge is captured in the aerobic sludge holding tanks and hauled to the City's Compost Facility. The WWTF is permitted for a maximum month average flow (MMF) of 2.05 million gallons per day (MGD). The Compost Facility produces a Class A biosolids product for local beneficial use and handles some of the County's septage in a sequencing batch reactor with disinfection and disposal to constructed wetlands and infiltration.

A summary of the City's sewer system data is provided in **Table 1-1**.

Table 1-1
2021 City Sewer System Data

Description	Data
City Population	10,220
Number of Properties on Septic Systems	211
Sewer System Population	9,829
Total Connections	4,710
Sewer Planning Area - UGA (Square Miles)	7.4
Average Gallons per Capita per Day (gpcd)	85
Average Annual Flow (MGD)	0.84
Maximum Month Average Flow (MGD)	1.02
Maximum Day Flow (MGD)	2.18
Number of Lift Stations	7
Total Length of Gravity Main (Miles)	75.2
Length of 8-inch-diameter Gravity Main (Miles)	45.3
Total Length of Force Main (Miles)	2.2
WWTF Permitted Maximum Month Average Flow (MGD)	2.05

gpcd = gallons per capita per day

AUTHORIZATION AND PURPOSE

The City authorized RH2 Engineering, Inc., (RH2) to prepare a General Sewer Plan (GSP) in accordance with Washington Administrative Code (WAC) 173-240-050. The previous *Wastewater Comprehensive Plan* was prepared by CH2MHILL for the City in 1999 and was approved by the Washington State Department of Ecology (Ecology) in 2000. In addition, a *Wastewater Facilities Plan* was completed in 2000 by Gray & Osborne, Inc., to address Ecology comments on the *Wastewater Comprehensive Plan* and focus on major system components with a capital program.

The purpose of this updated GSP is as follows:

- To update the City's GSP for consistency with the future population and employment growth projections from the City's Planning and Community Development Department.
- To evaluate existing sewer flow and loading data and project future flows and loadings.
- To analyze the existing sewer system to determine if it meets minimum requirements mandated by Ecology and the City's own policies and design criteria.
- To determine the overall reliability and vulnerability of the existing wastewater lift stations.
- To evaluate the existing WWTF to determine if the treatment facility meets the City's National Pollutant Discharge Elimination System Permit requirements.
- To identify sewer system collection improvements that will resolve existing system deficiencies and accommodate future needs of the system.

- To identify WWTF improvements that will resolve existing system deficiencies and accommodate future wastewater treatment needs.
- To prepare a schedule of improvements that meets the goals of the City's financial program.

PREVIOUS PLANNING EFFORTS

The following documents provide a history of the planning efforts involving the City's sewer system.

1999 *Wastewater Comprehensive Plan*

2000 *Wastewater Facilities Plan*

2009 *Southwest Sewer Basin Study*

2012 *Mill Road Pump Station and Force Main Predesign Report*

2019 *Port Townsend Condition Assessment Summary Report*

SUMMARY OF PLAN CONTENTS

A brief summary of the content of the chapters in this GSP is as follows:

- **Chapter 1** introduces the reader to the City's sewer system, the objectives of the GSP, and the GSP organization.
- **Chapter 2** presents the sewer service area and describes the existing sewer system.
- **Chapter 3** presents related plans, land use, and population characteristics.
- **Chapter 4** identifies existing wastewater flow and loading rates and projects future flow and loading rates.
- **Chapter 5** presents the City's operational policies and design criteria.
- **Chapter 6** discusses the wastewater collection system analyses and deficiencies.
- **Chapter 7** discusses the existing WWTF and Compost Facility analyses and deficiencies.
- **Chapter 8** evaluates future improvement needs for the WWTF and Compost Facility to address existing and projected deficiencies.
- **Chapter 9** discusses the City's operations and maintenance program.
- **Chapter 10** presents the proposed Capital Improvement Plan (CIP), including wastewater collection system, WWTF, and Compost Facility improvements, their estimated costs, and a schedule for implementation.
- **Chapter 11** summarizes the financial status of the sewer utility and presents a plan for funding the sewer improvements.

LIST OF ABBREVIATIONS

The abbreviations listed in **Table 1-2** are used throughout this GSP.

Table 1-2
Abbreviations

Abbreviation	Description
AACE	Association of Cost Engineers
AAF	average annual flow
AC	asbestos cement
AKART	all known, available, and reasonable treatment
BOD_5	5-day biochemical oxygen demand
CI	cast iron
CIP	Capital Improvement Plan
CIPP	cured-in-place pipe
City	City of Port Townsend
County	Jefferson County
CWA	Clean Water Act
DI	ductile iron
DMR	Daily Monitoring Report
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FRP	fiberglass reinforced plastic
FTE	full-time staff equivalents
GMA	Growth Management Act
gpcd	gallons per capita per day
GSP	General Sewer Plan
HDPE	high-density polyethylene
IFAS	integrated fixed film activated sludge
I/I	Inflow and Infiltration
IPS	Influent Pump Station
LAMIRD	local area of more intense rural development
lf	linear feet
LID	Local Improvement District
MABR	membrane aeration biofilm reactors
MCC	Motor Control Center
MDF	maximum day flow
MG	million gallons
MGD	million gallons per day
mg/L	milligrams per liter
MLE	Modified Ludzach-Ettinger
MLSS	mixed liquor suspended solids
MMDF	maximum month design flow
MMF	maximum month average flow

Table 1-2
Abbreviations (Continued)

Abbreviation	Description
MOB	mobile organic biofilm
MUTCD	Manual on Uniform Traffic Control Devices
NES	National Electrical Code
NOP	Nitrogen Optimization Plan
NPDES	National Pollutant Discharge Elimination System
NPW	non-potable water
OFM	Office of Financial Management
O&M	operations and maintenance
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PHF	peak hour flow
ppcd	pounds per capita per day
ppd	pounds per day
psi	pounds per square inch
PSNGP	Puget Sound Nutrient General Permit
PTMC	Port Townsend Municipal Code
PVC	polyvinyl chloride
RAS	return activated sludge
RCW	Revised Code of Washington
RH2	RH2 Engineering, Inc.
SBR	sequencing batch reactor
SCADA	supervisory control and data acquisition
SEPA	State Environmental Policy Act
SLR	solids loading rate
SRT	solids retention time
SVI	sludge volume index
SWDP	State Waste Discharge Permit
TIN	total inorganic nitrogen
TSS	total suspended solids
UGA	Urban Growth Area
VC	vitrified clay
VFD	variable frequency drive
WAC	Washington Administrative Code
WAS	waste activated sludge
WISHA	Washington Industrial Safety and Health Act
WWTF	wastewater treatment facility

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2 | SEWER SYSTEM DESCRIPTION AND DISCHARGE REGULATIONS

INTRODUCTION

This chapter describes the City of Port Townsend's (City) sewer service area, wastewater collection and treatment system, lift stations, and discharge and disposal regulations and permits. Included in this chapter is a brief overview of the City's topography, geology, and climate to provide a better understanding of the physical characteristics of the City. A brief description of the City's water system facilities also is presented.

Analysis of the existing sewer system is presented in **Chapter 4**. The results of the evaluation and analyses of the existing sewer system are presented in **Chapter 6**. Evaluation of the existing treatment facilities is presented in **Chapter 7**. Improvements to address treatment facility deficiencies are presented in **Chapter 8**.

SEWER SERVICE AREA

History

The City's sewer system was originally constructed as combined wastewater and stormwater sewers serving each small drainage area. There was no requirement for treatment of this combined sewage, so there were many outfalls to Port Townsend Bay and Admiralty Inlet.

In the 1960s, the City responded to new Washington State requirements to provide primary treatment for all combined sewage. Interceptors, lift stations, and the City's first wastewater treatment facility were constructed and placed in service, and the existing outfall was extended in 1967.

In the early 1970s, the Federal Government established new standards requiring higher levels of treatment for municipal wastewater. For most cities, including Port Townsend, these higher standards meant that additional (secondary) treatment facilities would be required.

In 1976, the City completed a Wastewater Facilities Plan under the guidelines issued by the U.S. Environmental Protection Agency. The plan evaluated the requirements to upgrade the facility to secondary treatment and was approved by the Washington State Department of Ecology (Ecology). The plan recommended adding sludge dewatering facilities and an oxidation ditch for secondary treatment and conversion to secondary clarifiers. Upon completion of the plan, the City applied for funding from Ecology to implement the plan. Ecology did not assist the City with funding at that time; therefore, no improvements were made.

In 1982 and 1983, the City prepared and submitted an Application for Modification of Secondary Treatment Requirements for Discharge into Marine Waters, as allowed under Section 301(h) of the Clean Water Act. The waiver of secondary treatment was denied by state and federal agencies.

The City later entered into a consent agreement with Ecology to have secondary treatment facilities operational by 1993. In 1987, engineering for upgrading the wastewater treatment facility (WWTF) to secondary treatment began. In 1989 and 1990, several permit issues surfaced and a citizens group filed an action against the City to stop construction. The City and the citizens group worked cooperatively to resolve the permit issues through design changes. The City commenced construction, and the new secondary wastewater treatment facility was installed at the same site as the original plant. The new facility began service in July of 1993.

The City originally disposed of the biosolids produced by the WWTF at the Jefferson County (County) landfill until 1991 when the landfill was closed. Biosolids were then hauled to Bremerton as an interim biosolids disposal method. The City explored a number of alternative methods for disposal of the generated biosolids and septage, ranging from forest application and incineration to lime and kiln dust stabilization. After a detailed analysis and substantial public involvement, composting was chosen as the preferred approach to biosolids management. The Compost Facility has been successfully operating since 1993. Dewatered biosolids, dewatered septage, and yard waste are composted to produce a product used for soil conditioning. The finished compost meets federal 40 CFR 503 regulations for a class A product and is thus allowed for unrestricted use.

The City has been growing steadily since the original interceptors, lift stations, and WWTF were constructed in 1967. Since that time, improvements to the collection system have consisted of regular maintenance and repair activities at the lift stations and expansion of the collection system to serve unsewered areas. Most of the collection system improvements identified in the 2000 *Wastewater Facilities Plan* have been completed. The work performed over the last 20 years was funded through loan and grant contributions, along with sewer rates. **Figure 2-1** shows the extents of the sewer collection system.

Geology

The soils in the Port Townsend area are primarily of the Clallam-Hoypus-Dick association, which are composed of gravel, loam, and sand. These soils vary from 20 to 60 inches in depth, and most areas are well drained. Compact gravelly sand and glacial till underlie these soils. Till is a deposit of unsorted material that has been densely compacted under the weight of a glacier. The City's service area has undergone repeated glacial advances and retreats until as recently as 10,000 years ago. Glacial till is relatively impermeable and is the cause of many on-site septic system problems over the years. There are many small, isolated areas across the City where the glacial till is exposed and the soils are poorly drained. Drainage in these areas is problematic with many perched, wet areas that further complicate the application of on-site septic systems.

Topography

Figure 2-2 shows the topography and natural drainage basins with the City limits. The City has several high hills and steep bluffs, and elevations range from sea level to just over 300 feet. The undulating topography creates many isolated areas of low spots. These areas can be challenging to sewer with gravity mains, but in general, the large amount of relief over the City allows many sewers to be placed at steeper than minimum grades, reducing required sewer sizes and the required time for wastewater to get to the treatment facility. Unfortunately, there are several areas that drain naturally to local low points away from the WWTF, where lift stations already exist or may be necessary in the future to provide sewer service to those areas.

Climate

The northern end of the Quimper Peninsula, where the City is located, does not typically receive heavy precipitation common in other parts of the Olympic Peninsula and Puget Sound lowlands. The City lies in the rain shadow of the Olympic Mountains. As a result, the City receives relatively little precipitation in the summer months when prevailing winds are from the west. The majority of the City's annual precipitation occurs in the winter months when most weather patterns pass over the City from the south. The City's average annual minimum and maximum precipitation are approximately 12 inches and 27 inches, respectively. Average daily minimum and maximum precipitation ranges from approximately 0.4 to 0.8 inches per day, respectively.

Sea Level Rise

The City and the County joined forces to develop a Climate Action Committee. This committee has worked diligently to develop several reports and studies associated with the following:

- Modeling County carbon dioxide equivalent emissions with the goal of reducing and measuring greenhouse gas emissions produced in the County overtime.
- Addressing the need to adapt to climate change in terms of impacts to weather patterns and the hydrology of the area.
- Addressing the impacts of Sea Level Rise and developing forecasting tools to assess the impacts of Sea Level Rise on City infrastructure.

The City of Port Townsend Sea Level Rise and Coastal Flooding Risk Assessment (2022, City of Port Townsend and Cascadia Consulting Group) (**Appendix K**) incorporates the best available science and information concerning climate change, and specifically Sea Level Rise, on the City's sewer infrastructure. In particular, Sea Level Rise will impact the City's WWTF, three sewer lift stations, and the City's collection system over the next 100 years. Infrastructure planning for these facilities incorporates this understanding, with the long-term goal of moving or transitioning sewer facilities to become more resilient to Sea Level Rise. The City already has experienced impacts of king tides, with one of the largest king tides occurring on December 27, 2022. This king tide event flooded a portion of the Port of Port Townsend Boat Haven Marina boat yard and contributed to the collapse of an asbestos cement (AC) gravity sewer pipe, which settled due to a high water table caused by the king tide and the backup of water into the storm system directly above the AC pipe. None of the City's lift stations incurred damage, but this event illustrates how close the City is to experiencing the effects of Sea Level Rise combined with a king tide event.

Water Bodies and Floodplains

The City is bounded by the Salish Sea with Port Townsend Bay to the south, Admiralty Inlet to the east, and the Strait of Juan de Fuca to the north. The natural drainage basins within the sewer service area drain primarily to the sea, Kah Tai Lagoon, or Chinese Gardens Lagoon.

These natural drainage basins are shown in a figure from the City's 2019 *Stormwater Management Plan* in **Appendix A**. Both the Kah Tai and the Chinese Gardens Lagoons are somewhat tidally influenced through pipe connections to the Salish Sea. There are no rivers or streams located within the City limits, although there are a number of small, natural ponds or depressions throughout the area, as well as several wetlands. The City's 2019 *Stormwater Management Plan* addresses how surface water is dealt with within the City. A map of the existing stormwater facilities is presented in **Appendix A**.

A small portion of the City is located within the 100-year floodplain along its marine shorelines, including the Port of Port Townsend's Point Hudson and Boat Haven, Kah Tai Lagoon, and the Lincoln Beach area. Furthermore, there are several small wetlands and riparian areas throughout the City. These sensitive areas and steep slopes limit the buildable area.

Given the City is surrounded by the Salish Sea, the City coordinates with the County Marine Resources Council and the City's Climate Action Committee concerning sewer project impacts to the Salish Sea and/or the impacts of the sea on the operations and development of the sewer system.

City Limits, Urban Growth Area, and Sewer Service Area Boundary

The sewer service area coincides with the Urban Growth Area (UGA) boundary, which is also the City limits, and encompasses an area of approximately 7.4 square miles. The majority of the developed area within the City limits is currently served by the City's existing sewer system. Within the sewer service area, approximately 5 percent of residences are served by privately owned and operated on-site sewage systems (i.e. septic tanks with drain fields). Currently, 211 properties within the City limits are on on-site systems. The City's sewer planning area (i.e. future sewer service area) includes the City's UGA (**Figure 2-1**).

The Glen Cove area directly adjacent and southwest of the City limits has been designated as a Special Study Area for possible future inclusion in the City's service area. The primary basis for allowing this area to be incorporated into the City sewer service area is based on the following factors:

1. The Glen Cove industrial area is a Type 3 Local Area of More Intense Rural Development (LAMIRD) intended for light industrial and limited commercial use that could benefit from the presence of sewer. Currently, all uses in this area are required to have an on-site septic system, which may be limiting industrial activities and potentially resulting in environmental degradation. LAMIRDs are permitted to be served by sanitary sewer per the Growth Management Act (Washington Administrative Code (WAC) 365-196-425(6)(c), Rural Element).
2. In this area, the Port Townsend Paper Mill currently has an industrial waste treatment system and a domestic waste treatment system, both of which discharge to Port Townsend Bay. The City may consider allowing the domestic system to connect to the City's sewer system for the environmental benefit of eliminating a discharge to Port Townsend Bay. This option would need to be approved by Ecology and the Department of Commerce before executing a sewer service agreement for the Paper Mill.

3. Through a UGA expansion or swap in cooperation with the County. Based on existing, more intense development patterns, the Glen Cove Area may be deemed a key area to serve existing and future uses to support the local economy given the lack of industrially zoned properties and the need for housing within the City. An additional 20-acre parcel directly adjacent to the City is owned by the County and is serving as a homeless shelter. This parcel serves key public needs of providing for the poor and infirm. Sewer service to this property may be of great benefit to the community and may serve as a basis for a UGA expansion.
4. A portion of the area within the Glen Cove drainage basin is already in the City limits and does not have access to sewer without the installation of a sewer lift station. Therefore, locating a sewer lift station in an appropriate area that keeps options open will allow the City to make sewer service available for unsewered areas within the City limits while allowing Factors 1 through 3 above to be considered.

All four of these factors involve the City and County working closely together to evaluate impacts of sewer extension. The purpose of the Special Study Area is to document the sewer basin planning process performed in 2012 as outlined in the *Mill Road Pump Station and Force Main Predesign Report* (**Appendix B**). The City has funding to site a lift station in the Mill Road area to serve the current UGA. Siting of this lift station, which could serve as described above, is an important consideration for this Special Study Area to guide public investment of approximately $4 million.

This General Sewer Plan (GSP) will address service needs in the Glen Cove Area and account for Glen Cove's possible future inclusion in the UGA.

EXISTING SEWER FACILITIES

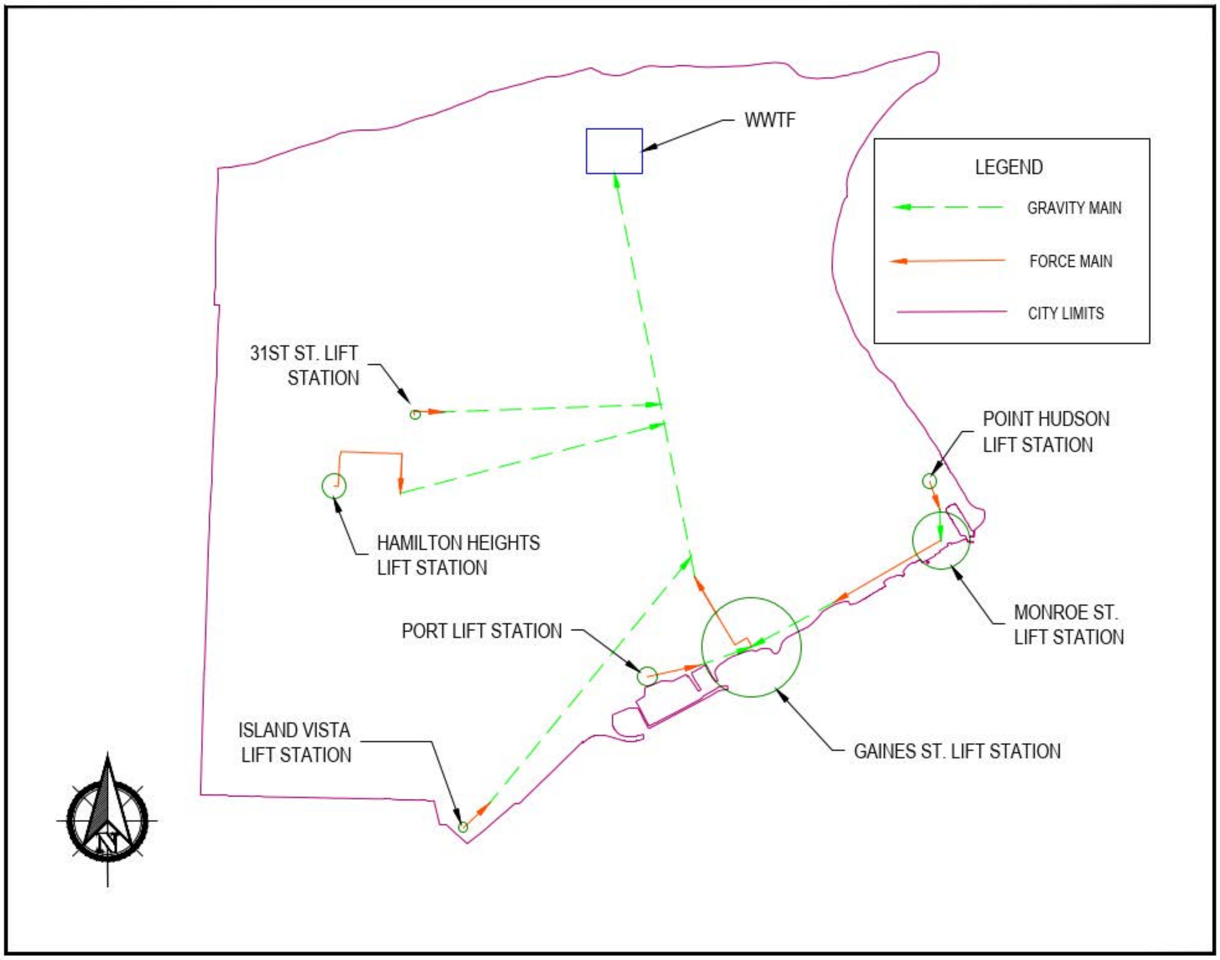
The City owns, operates, and maintains the wastewater system, which includes a gravity collection and conveyance system, seven wastewater lift stations, force mains, a WWTF, and an outfall.

Sewer Drainage Basins

The City's existing sewer service area is comprised of 14 sewer drainage basins that flow by gravity to the 7 lift stations and WWTF, as shown in **Figure 2-2**.

The wastewater from the eastern part of the City is conveyed by the Point Hudson Lift Station and the Monroe Lift Station, where flow is then conveyed to the Gaines Street Lift Station before traveling by gravity main to the City's WWTF. In other words, all of the sewer flow from uptown, downtown, and the eastern shoreline is routed through the Gaines Street Lift Station. Southern flows from the Port Lift Station also are conveyed to the Gaines Street Lift Station before reaching the City's WWTF. Wastewater from the western portion of the City is conveyed to the Hamilton Heights Lift Station and the 31st Street Lift Station, which both then route wastewater flows by gravity to the WWTF. A small portion of wastewater in the southwestern portion of the City is sent to the Island Vista Lift Station, where it then flows by gravity to the WWTF. All other wastewater collected in the City flows via gravity to the WWTF, where it is pumped to the outfall. **Figure 2-3** shows a schematic representation of the general location and flow path for each of the primary sewer drainage basins.

Figure 2-3
Sewer Drainage Basins Schematic



Gravity Sewer Collection Piping

The City has 75.2 miles of gravity sewer piping, including collection sewers and interceptors and treated effluent sewers from the WWTF. A majority of the system is 8-inch-diameter gravity main, totaling 45.3 miles. The predominant material used in the system, accounting for approximately 54 percent of gravity piping, is polyvinyl chloride (PVC).

Approximately 72 percent of the gravity sewer's installation year is unknown. Assumptions of pipe ages based upon the material were made in an effort to determine the general age of the collection system piping. AC was a popular material in sewer pipe construction between the years of 1950 and 1970. A median installation year of 1960 was assumed for AC pipe where the actual year is unknown. Both cast iron (CI) and vitrified clay (VC) were materials used primarily before the 1950s. Ductile iron (DI) and high-density polyethylene (HDPE) use rises in popularity in 1980 and is still used in present day, although largely for deep sewer pipe construction. A median installation year of 2000 was assumed for DI and HDPE pipe where the actual year is unknown. Reinforced concrete pipe (RCP) is another older material where the use ranged from 1940 to 1960. A median installation year of 1950 was assumed for RCP pipe where the actual year is unknown.

Table 2-1 summarizes the sewer system pipe by diameter, **Table 2-2** summarizes the pipe by material, and **Table 2-3** summarizes the pipe by installation year. **Figure 2-1** illustrates pipe sizes and locations, and **Figure 2-4** illustrates pipe material. **Figure 2-5(a)** illustrates the pipe installation year with the known information. **Figure 2-5(b)** illustrates the assumed pipe installation year based upon known information and pipe material, as described previously.

Table 2-1
Gravity Sewer Collection Piping Inventory – Diameter

Diameter (inches)	Total Length (feet)	Total Length (Miles)	% of System
6 and smaller	100,808	19.09	25.4%
8	239,222	45.31	60.2%
10	20,188	3.82	5.1%
12	10,131	1.92	2.6%
14	1,963	0.37	0.5%
15	80	0.02	0.0%
16	3,462	0.66	0.9%
18	6,974	1.32	1.8%
22	1,376	0.26	0.3%
24	179	0.03	0.0%
30	6,471	1.23	1.6%
Unknown	6,222	1.18	1.6%
Total	**397,077**	**75.20**	**100.0%**

Table 2-2
Gravity Sewer Collection Piping Inventory – Material

Material	Total Length (feet)	Total Length (Miles)	% of System
AC	35,170	6.66	8.9%
CI	617	0.12	0.2%
DI	310	0.06	0.1%
HDPE	4,838	0.92	1.2%
PVC	214,161	40.56	53.9%
RCP	75,643	14.33	19.0%
VC	59,984	11.36	15.1%
Unknown	6,353	1.20	1.6%
Total	**397,077**	**75.20**	**100.0%**

Table 2-3
Gravity Sewer Collection Piping Inventory – Installation Year

Installation Year	Total Length (feet)	Total Length (Miles)	% of System	Total Assumed Length (feet)	Total Assumed Length (Miles)	% of System
Before 1950s	--	--	--	60,502	11.46	15.2%
1950s	--	--	--	74,267	14.07	18.7%
1960s	706	0.13	0.2%	34,023	6.44	8.6%
1970s	1,940	0.37	0.5%	1,940	0.37	0.5%
1980s	10,692	2.02	2.7%	10,692	2.02	2.7%
1990s	30,163	5.71	7.6%	30,163	5.71	7.6%
2000s	51,995	9.85	13.1%	166,646	31.56	42.0%
2010s	14,082	2.67	3.5%	14,082	2.67	3.5%
2020s	269	0.05	0.1%	269	0.05	0.1%
Unknown	287,229	54.40	72.3%	4,492	0.85	1.1%
Total	**397,077**	**75.20**	**100.0%**	**397,077**	**75.20**	**100.0%**

Force Mains

The City has approximately 2.2 miles of force mains. **Table 2-4** summarizes the force mains by diameter, **Table 2-5** summarizes the force mains by material, and **Table 2-6** summarizes the force mains by installation year. **Figure 2-1** illustrates the force main locations.

Approximately 41 percent of the force main installation years are unknown. Assumptions of the pipe ages based upon the material were made in an effort to determine the general age of the collection system piping.

Table 2-4
Force Main Inventory – Diameter

Diameter (inches)	Total Length (feet)	Total Length (Miles)	% of System
4	1,718	0.33	15.1%
6	4,333	0.82	38.0%
10	2,706	0.51	23.8%
12	2,179	0.41	19.1%
16	381	0.07	3.3%
Unknown	78	0.01	0.7%
Total	**11,395**	**2.16**	**100.0%**

Table 2-5
Force Main Inventory – Material

Material	Total Length (feet)	Total Length (Miles)	% of System
CI	6,259	1.19	54.9%
HDPE	381	0.07	3.3%
PVC	4,745	0.90	41.6%
Unknown	11	0.00	0.1%
Total	**11,395**	**2.16**	**100.0%**

Table 2-6
Force Main Inventory – Installation Year

Installation Year	Total Length (feet)	Total Length (Miles)	% of System	Total Assumed Length (feet)	Total Assumed Length (Miles)	% of System
Before 1950s	--	--	--	2,706	0.51	23.8%
1950s	--	--	--	0	0.00	0.0%
1960s	2,179	0.41	19%	2,179	0.41	19.1%
1970s	1,374	0.26	12%	1,374	0.26	12.1%
1980s	0	0.00	0%	0	0.00	0.0%
1990s	3,610	0.68	32%	3,610	0.68	31.7%
2000s	0	0.00	0%	1,515	0.29	13.3%
2010s	0	0.00	0%	0	0.00	0.0%
2020s	0	0.00	0%	0	0.00	0.0%
Unknown	4,232	0.80	37%	11	0.00	0.1%
Total	**11,395**	**2.16**	**100%**	**11,395**	**2.16**	**100.0%**

Lift Stations

The City currently owns, operates, and maintains seven wastewater lift stations. The characteristics of the lift stations are summarized in **Table 2-7**, and a description of each lift station follows.

Table 2-7
Lift Station Characteristics

	Lift Station					Pumps			
Lift Station Name	**Year Constructed**	**Force Main Diameter (inches)**	**No. of Pumps**	**Type**	**Manufacturer**	**Horsepower (hp)**	**TDH (feet)**	**Design Capacity (gpm)**	**Design Firm Capacity (gpm)**
Gaines Street Lift Station	1967 - Constructed 2022 - Upgrade	6	3	Submersible	Flygt	60	107	1,050 1,050 1,050	2,100
Monroe Street Lift Station	1965 - Constructed 2008 - Upgrade	10	3	Dry Pit	Chicago	15		600 600 600	1,200
Port Lift Station	1967	6	2	Submersible	Cornell	5		200 200	200
31st Street Lift Station	1996	4	2	Submersible	Gorman-Rupp	3		100 100	100
Island Vista Lift Station	1985 - Constructed 2004 - Upgrade	4	2	Submersible	Flygt	6.5	100	100 100	100
Point Hudson Lift Station	1975 - Constructed 1988 - Upgrade	4	2	Submersible	Peabody Barnes	1.5		150 150	150
Hamilton Heights Lift Station	1997	6	2	Submersible	FairBanks Morse	10	58	250 250	250

Gaines Street Lift Station

The Gaines Street Lift Station was originally constructed in 1967, and the pumps were upgraded in 2022. The station is located at 201 Gaines Street and is equipped with three 60 horsepower (hp) Flygt submersible pumps. The station has a firm design capacity of 2,100 gallons per minute (gpm) and is a conventional wet well/dry well station. The Gaines Street Lift Station collects wastewater from its sewer basin along with wastewater from the Port, Monroe Street, and Port Hudson Lift Stations in the southeastern portion of the system and conveys it through the gravity collection system to the WWTF. Back-up power is provided by a generator. The lift station is connected by radio communication to the City's supervisory control and data acquisition (SCADA) system.

Gaines Street Lift Station

Monroe Street Lift Station

The Monroe Street Lift Station, last upgraded in 2008, pumps wastewater from the gravity collection system to the Gaines Street Lift Station. The Monroe Street Lift Station is equipped with three 15 hp Chicago dry pit pumps that discharge into a 10-inch-diameter force main. The lift station is connected by radio communication to the City's SCADA system. The lift station has a hookup for a temporary generator, and response time is less than 30 minutes to connect power. The City is alerted when power is out by the SCADA system, and this is the first lift station responded to.

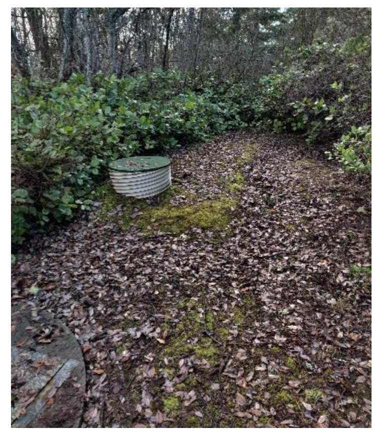
Monroe Street Lift Station

Port Lift Station

Port Lift Station

The Port Lift Station is located in the Port Townsend Boat Haven Marina. Constructed in 1967, this submersible station is equipped with two 5 hp Cornell pumps and has a design firm pumping capacity of 200 gpm. All wastewater from the Port Lift Station is pumped to the Gaines Street Lift Station through a 6-inch-diameter force main before being conveyed to the WWTF. The lift station is connected by radio communication to the City's SCADA system. The lift station has a hookup for a temporary generator, and staff generally have around 60 minutes to connect power. The City is alerted when power is out by the SCADA system, and this is the second lift station responded to.

31st Street Lift Station



31st Street Lift Station

The 31st Street Lift Station was constructed in 1996 and is located at 1920 31st Street. This submersible lift station is equipped with two 3 hp Gorman-Rupp submersible pumps that discharge into a 4-inch-diameter force main. The design capacity of the 31st Street Lift Station is 100 gpm. Wastewater from the lift station mostly consists of infiltration and inflow and is conveyed via gravity mains to the City's WWTF. The lift station is connected by radio to the City's SCADA system. The 31st Street Lift Station has a hookup for a temporary generator. The City is alerted when power is out by the SCADA system, and operators generally pump this out once or twice in 24 hours.

Island Vista Lift Station

Island Vista Lift Station

The Island Vista Lift Station is located at 112 Vista Boulevard, was constructed in 1985, and was upgraded in 2004. This submersible station collects wastewater and pumps it through the gravity collection system to the WWTF. The lift station consists of two Flygt submersible pumps that are each 6.5 hp with 100 gpm capacity. The lift station is connected by radio to the City's SCADA system. This lift station has a hookup for a temporary generator. The City is alerted when power is out by the SCADA system, and operators generally pump this out once or twice in 24 hours.

Point Hudson Lift Station

Originally constructed in 1967, the Point Hudson Lift Station was most recently upgraded in 1988. The Point Hudson Lift Station collects wastewater that is conveyed to the Monroe Street Lift Station before flowing to the Gaines Street Lift Station and ultimately, the City's WWTF. This submersible lift station has two 1.5 hp Peabody Barnes pumps that have a capacity of 150 gpm each. This lift station is not connected to the City's SCADA system. The Point Hudson Lift Station has a hookup for a temporary generator. The City is alerted when power is out by the SCADA system, and operators generally pump this out once or twice in 24 hours.

Point Hudson Lift Station

Hamilton Heights Lift Station

The Hamilton Heights Lift Station is located near 2500 Howard Street and was constructed in 1997. This submersible lift station consists of two 10 hp FairBanks Morse pumps and has a design capacity of 250 gpm. Wastewater from this lift station is conveyed through a 6-inch force main before flowing by gravity main to the City's WWTF. The lift station is connected by radio to the City's SCADA system. The Hamilton Heights Lift Station has a permanent backup generator.

Hamilton Heights Lift Station

Low Pressure Sewer Systems

The City has permitted a small number of low pressure sewers over the last 20 years. Low pressure sewers consist of a private single pump lift station located at a residential structure with a small force main that ultimately connects to gravity sewer. Often, multiple private pumps will discharge into a shared private force main as illustrated in the schematic that follows.

Low Pressure Sewer System Schematic. Image credit: Environmental One website.

Historically, the City has only allowed low pressure sewers if they were entirely privately maintained, including the force main. The City generally discouraged this approach to sewer service as technology was still under scrutiny and private ownership of pump stations was considered problematic due to pump failures and the inability to quickly fix the problem. Failure of private pumps also leads to sewer overflows. Many cities have not taken on ownership of these private pumps due to the massive impact on city maintenance costs given the pumps were considered unreliable.

The technology and reliability of low pressure sewer pump systems has improved considerably and now failures of the pump systems are rare. Many municipalities are now embracing the application of low pressure sewers in areas that are hard to serve due to undulating topography where gravity sewer is not feasible.

This GSP suggests there are areas within the City that would benefit greatly from the installation of low pressure sewer pump systems. Recommended standards for low pressure sewers are included in **Chapter 5**.

Wastewater Treatment and Disposal Facilities

Existing System

The City's WWTF is located just west of Fort Worden in the North Beach neighborhood. The WWTF was originally constructed in 1967 and provided only primary treatment and disinfection using chlorine gas. The facility was expanded in 1993 to provide secondary treatment.

WWTF Oxidation Ditches

Raw wastewater enters the WWTF from two gravity sewers, and an influent pump station lifts the wastewater to the headworks. Within the headworks, a bar screen removes rags and floating debris, and then a grit classifier settles out the sand and heavy materials. The flow rate of the screened and de-gritted influent is measured in a Parshall flume and the liquid then flows to the oxidation ditches. In the oxidation ditches, surface mixers stir air into the liquid, promoting the growth of microbiological cultures that consume the biochemical oxygen demand (BOD) in the mixture and form a solution known as mixed liquor. The mixed liquor flows to the secondary clarifier, where the biological solids settle out. The clarified effluent flows to the chlorination basins, where it is chlorinated using liquid sodium hypochlorite. Effluent is retained in the chlorine contact chambers for at least 20 minutes to ensure complete disinfection.

WWTF Chlorine Pumping Room

The biological solids (liquid sludge) produced during secondary clarification are pumped to the small aerobic digesters for a short stabilization period. The liquid sludge is then pumped to the control building, where it is blended with polymer and dewatered using a belt filter press.

Treated Wastewater Discharge and Solids Handling

Wastewater from the City's sewer system is processed at the WWTF, resulting in treated water and digested sludge. The treated effluent is dechlorinated using liquid sodium bisulfite and discharged to the Strait of Juan de Fuca via a 2,300-foot-long, 18-inch-diameter pipeline and outfall ending 700 feet offshore.

The dewatered sludge is loaded into a truck and hauled to the City's Compost Facility at the Jefferson County Waste Management Facility site. Sludge from the WWTF is composted at the facility in combination with dewatered septage, yard waste, and other wood wastes. Liquids from the process and a portion of the County's septage hauling are treated in a sequencing batch reactor and constructed wetlands and discharged to infiltration basins for additional treatment and ultimate disposal.

DISCHARGE AND DISPOSAL REGULATIONS AND PERMITS

WWTF NPDES Permit and Regulations

Wastewater flow and loading into the City's WWTF and treated plant effluent water discharged to the Strait of Juan de Fuca in Puget Sound are regulated through the City's National Pollutant Discharge Elimination System (NPDES) Permit.

The federal Clean Water Act (CWA, 1972, and later modifications, 1977, 1981, and 1987) established water quality goals for the navigable (surface) waters of the United States: "The objective of the CWA is the restoration and maintenance of the chemical, physical, and biological integrity of the country's water." The CWA grants individual authority to each state to define the water quality standards (within the limits set by the water quality goals) within its jurisdiction and enforce them. Water quality standards for surface waters in Washington State have been established (Chapter 173-201A WAC) and are enforced by Ecology (Chapter 90.48 Revised Code of Washington (RCW)). The purpose of the water quality standards is to provide "public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife." Each surface water in the state is identified as fresh water or marine water and designated for one or more uses, which then determines the specific water quality standards that apply to that water.

The state also has established a permit program for implementation of the NPDES Permit Program created by the CWA. The program requires a discharge permit for any point source, such as a domestic wastewater treatment plant, and discharge of pollutants to surface waters of the state for the purpose of maintaining the water quality standards. Each permit is renewed on roughly a 5-year cycle. The permit and accompanying fact sheet include information on discharge limits, monitoring schedules, and general and special conditions that apply to the applicable point source.

The City's current NPDES Permit (Permit No. WA0037052) has an effective date of December 1, 2015, and expired on November 30, 2020. The WWTF continues to operate under this permit as Ecology is currently reviewing and has not issued a revised NPDES permit since the expiration date. Copies of the permit and accompanying fact sheet are included as **Appendix C**.

Facility Design Criteria

The permitted facility flow and loading design criteria for the WWTF are included in **Table 2-8**.

Table 2-8

WWTF Permitted Flow and Loading Design Criteria

Parameter	Design Quantity
Maximum Month Design Flow (MMDF)	2.05 MGD
Annual Average Flow	1.44 MGD
BOD_5 Influent Loading for Maximum Month	3,754 ppd
TSS Influent Loading for Maximum Month	4,568 ppd
Design Population	12,000

MGD = million gallons per day

ppd = pounds per day

Effluent Limits

Treated plant effluent water is discharged to the Strait of Juan de Fuca through a piped outfall, which is designated as Outfall No. 001 in the NPDES Permit. The effluent limits for Outfall No. 001 are summarized in **Table 2-9**.

Table 2-9

NPDES Permit Effluent Limits

Parameter	Average Monthly	Average Weekly
Biochemical Oxygen Demand (5-Day) (BOD_5)	30 mg/L 513 ppd 85% removal of influent BOD_5	45 mg/L 769 ppd
Total Suspended Solids (TSS)	30 mg/L 513 ppd 85% removal of influent TSS	45 mg/L 769 ppd
Total Residual Chlorine	0.5 mg/L	0.75 mg/L
Parameter	**Minimum**	**Maximum**
pH	6.0 standard units	9.0 standard units
Parameter	**Monthly Geometric Mean**	**Weekly Geometric Mean**
Fecal Coliform Bacteria	200/100 mL	400/100 mL

mg/L = milligrams per liter

mL = milliliters

Future City NPDES Permit Effluent Limits (Outfall No. 001) Changes

Ecology can change water quality standards or NPDES Permit effluent limits (the latter for the purpose of maintaining water quality standards). Known future changes to water quality standards and NPDES Permit effluent limits that are applicable to Outfall No. 001 at the WWTF are summarized in this section.

Bacterial Indicator Effluent Limits

The receiving water of the Strait of Juan de Fuca at Outfall No. 001 is designated for Primary Contact Recreational Use (WAC 173-201A-612, Table 612). To protect water contact recreation in marine water, such as the receiving water, bacterial indicator criteria (standards) are defined (WAC 173-201A-210(3)(b)). Ecology is reviewing adding an *E. coli* standard in future permits.

The *E. coli* and fecal coliform bacterial indicator criteria are both defined in the current version of WAC 173-201A-210(3)(b).

The City's NPDES Permit has a fecal coliform bacteria effluent limit for Outfall No. 001. An *E. coli* bacteria effluent limit for Outfall No. 001 will be evaluated and further monitoring will be required when the permit is renewed. As Ecology continues to review, the current fecal coliform bacteria effluent limit will remain effective.

Other Regulations and Required Permits

WWTF Puget Sound Nutrient General Permit

Section 303(d) of the CWA establishes a process to identify and clean up surface waters that do not meet the applicable water quality standards. Every few years, Ecology performs a water quality assessment using collected data to determine whether water quality of the surface waters meets the standards. Based on the assessment, each surface water is placed into one of five categories that describes the status of the water quality and ranges from meeting the standards (Category 1) to impaired (i.e. polluted) and requiring a water improvement project (Category 5). Surface waters placed into Category 5 are listed on the state's 303(d) list of polluted waters, which is named after the referenced section of the CWA.

At certain times of the year, dissolved oxygen levels in a large number of locations throughout Puget Sound do not meet the applicable water quality standards, and in many other locations show evidence of not meeting the standards in the future. The surface waters within Puget Sound that are not meeting the dissolved oxygen standards are listed in the state's 303(d) list. Ecology initiated the Puget Sound Nutrient Reduction Project (Project) in the spring of 2017 to address the problem of human sources of nutrients contributing to the low and decreasing dissolved oxygen levels throughout Puget Sound. As a result of modeling, Ecology believes discharges of nutrients to Puget Sound from domestic wastewater treatment plants are significantly contributing to the problem. The goal of the Project is to develop a nutrient source reduction strategy, which includes reducing nutrient levels discharged from domestic wastewater treatment plants.

Ecology has been utilizing a model of Puget Sound to understand the problem and simulate potential improvements. Ecology has identified nitrogen as the limiting nutrient, with inorganic nitrogen, consisting of nitrate-nitrite and ammonia, as the "biologically available" form. Ecology is performing additional modeling for optimization scenarios; however, results from completed modeling are being used to determine effluent nitrogen permit limits for domestic wastewater treatment plants with outfalls to Puget Sound (identified as marine sources), which includes the City's WWTF. Individual NPDES permits for the same treatment plants will continue independently of, but in conjunction with, the general permit and may be modified as necessary to include facility-specific nutrient-related requirements.

In January 2021, Ecology released a preliminary draft of the Puget Sound Nutrient General Permit (PSNGP) for public comment. The public comment period ended on March 15, 2021, and Ecology has proceeded with developing a formal version, which became effective January 1, 2022, and expires December 31, 2026. Copies of the final PSNGP and accompanying fact sheet are included as **Appendix D**. The following descriptions summarize the final PSNGP, including anticipated permit limits specific to the City's WWTF.

Notice of Intent

The City has filed a Notice of Intent for coverage under the PSNGP and will submit Discharge Monitoring Reports (DMRs) as required by the permit and as discussed as follows.

Nitrogen Optimization Requirements

The City must submit an annual Nitrogen Optimization Plan (NOP) to Ecology no later than March 31, 2026, as defined in the PSNGP. Optimization refers to short-term actions (low-cost controls and process changes) focused on improving existing performance. Optimization processes do not include large scale capital investments. The City must begin optimization immediately upon coverage under the PSNGP.

The NOP must include the following components:

1. Treatment Process Performance Assessment

   Assess the nitrogen removal potential of the current treatment process and have the ability to evaluate optimization strategies prior to implementation.

   a. Evaluation. Develop a treatment process assessment method for the purposes of evaluating optimization approaches during the permit term. This will include an evaluation of current (pre-optimization) process performance to determine the empirical Total Inorganic Nitrogen (TIN) removal rate for the WWTF. The assessment must include an evaluation of possible optimization strategies at the WWTF prior to and after implementation. Determine the optimization goal for the WWTF and develop a list of optimization strategies capable of achieving the optimization goal for the WWTF. Update this list as necessary to continuously maintain a selection of strategies for achieving each optimization goal identified. Any optimization strategy may be excluded from the initial selection if it is found to exceed a reasonable implementation cost or timeframe. Documentation must be provided that includes an explanation of the rationale and financial criteria used for the exclusion determination.

   b. Initial Selection. Identify the optimization strategy selected for implementation. Document the expected percentage of TIN removal (or the expected reduction in effluent load) for the optimization strategy prior to implementation.

2. Optimization Implementation

   The City must document implementation of the selected optimization strategy, which includes the following:

   a. Strategy Implementation. Describe how the selected strategy was implemented during the reporting period, initial implementation costs, length of time to implement (including start date), anticipated and unanticipated challenges, and impacts to the overall treatment performance due to optimization process changes.

b. Load Evaluation. The City must review effluent data collected during the reporting period to determine whether TIN loads are increasing. This includes using all accredited monitoring data to determine the WWTF's annual average TIN concentration and load for each year during the reporting period. The City also must determine the WWTF's TIN removal rate at the end of each year and compare it with the pre-optimization rate previously identified.

c. Strategy Assessment. The City must quantify the results of the implemented strategy and compare them to the expected percentage of TIN removal previously identified. If the TIN loading increased, apply adaptive management, and re-evaluate the optimization strategies and the resulting performance to identify the reason. From this, select a new optimization strategy or revise the implementation for better performance. Document any updates to the implementation schedule and overall plan.

3. Influent Nitrogen Reduction Measures/Source Control

The City must investigate opportunities to reduce influent TIN loads from septage handling practices, commercial, dense residential, and industrial sources and submit documentation with the Annual Report. This includes the following:

a. Review non-residential sources of nitrogen and identify any possible pretreatment opportunities.

b. Identify strategies for reducing TIN from new multi-family/dense residential developments and commercial buildings.

AKART Analysis

Under the PSNGP, all permittees classified as Small Loaders must prepare and submit an approvable all known, available, and reasonable treatment (AKART) analysis to Ecology for the purposes of evaluating reasonable treatment alternatives capable of reducing TIN. Permittees that maintain an annual TIN average of less than 10 milligrams per liter (mg/L) and do not document an increase in load through their DMRs are excluded from this requirement and do not have to submit this analysis.

Monitoring Requirements

The PSNGP will create additional monitoring requirements for the City. These requirements do not replace any requirements stipulated in the City's NPDES Permit. The City will need to comply with both permits separately. Recorded monitoring data should be submitted monthly on the electronic DMR form provided by Ecology within the Water Quality Permitting Portal. The City may use the monitoring locations identified in the NPDES Permit to collect samples for the PSNGP, but must still prepare two separate monthly DMR submittals (one for each permit). Samples must be representative of the flow and characteristics of the discharge, and sampling is not required outside of normal working hours or during unsafe conditions. For each sample taken, the City must record the sample date and time, location, method of sampling, and individual who performed the sampling. The City must use appropriate flow measurement and methods consistent with accepted scientific practices, including proper installation, calibration, and maintenance of all measurement devices. A summary of the anticipated monitoring requirements under the PSNGP and a comparison to the City's NPDES Permit can be found in **Tables 2-10** and **2-11**.

Table 2-10

Comparison of City NPDES Permit and PSNGP Monitoring Requirements for WWTF Influent

Parameter	Units and Specification	Minimum Sampling Frequency (NPDES)	Minimum Sampling Frequency (PSNGP)	Sample Type
Flow	MGD	Continuous	-	Metered/Recorded
BOD_5	mg/L	1/week	-	24-Hour Composite
BOD_5	ppd	1/week	-	Calculated
TSS	mg/L	1/week	-	24-Hour Composite
TSS	ppd	1/week	-	Calculated
$CBOD_5$	mg/L	-	2/month	24-Hour Composite
Total Ammonia	mg/L as N	-	2/month	24-Hour Composite
Nitrate plus Nitrite	mg/L as N	-	1/month	24-Hour Composite
Total Kjeldahl Nitrogen	mg/L as N	-	1/month	24-Hour Composite

Table 2-11

Comparison of City NPDES Permit and PSNGP Monitoring Requirements for WWTF Effluent

Parameter	Units and Specification	Minimum Sampling Frequency (NPDES)	Minimum Sampling Frequency (PSNGP)	Sample Type
Flow	MGD	-	2/month	Metered/Recorded
BOD_5	mg/L	1/week	-	24-Hour Composite
BOD_5	ppd	1/week	-	Calculated
BOD_5	% removal	1/week	-	Calculated
TSS	mg/L	1/week	-	24-Hour Composite
TSS	ppd	1/week	-	Calculated
TSS	% removal	1/week	-	Calculated
Chlorine (Total Residual)	mg/L	1/week	-	Grab
Fecal Coliform	#/100 ml	1/week	-	Grab
pH	Standard Units	1/day	-	Grab
$CBOD_5$	mg/L	-	2/month	24-Hour Composite
Total Organic Carbon	mg/L	-	1/quarter	24-Hour Composite
Total Ammonia	mg/L as N	-	2/month	24-Hour Composite
Nitrate plus Nitrite	mg/L as N	-	2/month	24-Hour Composite
Total Kjeldahl Nitrogen	mg/L as N	-	1/month	24-Hour Composite
Total Inorganic Nitrogen (TIN)	mg/L as N	-	2/month	Calculated
TIN	ppd	-	2/month	Calculated
Average Monthly TIN	lbs	-	1/month	Calculated
Annual TIN, year to date	lbs	-	1/month	Calculated

The City must submit monthly monitoring data using Ecology's WQWebDMR program by the 15^{th} day of the following month. Any pollutant monitoring data collected more frequently than the permit stipulates must be used in calculations and submitted in the DMR.

After 12 months of monitoring, the City may request a reduction in sampling frequency from Ecology if it can demonstrate that the distribution of concentrations can be accurately represented with a lower sampling frequency.

Additional Requirements

The City must retain records of monitoring information or documentation pertaining to permit requirements for a minimum of 5 years following termination of permit coverage. If the City is unable to comply with the conditions of the permit, it must notify Ecology within 24 hours and submit a written report to Ecology via the WQWebPortal within 5 days describing the noncompliance event and duration, and how steps will be taken to correct it. The City must keep the following documentation onsite or within reasonable access to the site: Permit Coverage Letter, PSNGP, DMRs, and attachments to the NOP.

Compost Facility Regulations for Biosolids

Chapter 173-308 WAC is the basis for the state-wide biosolids management program. Facilities that are subject to the permit program apply for coverage under the existing state-wide general permit. The state biosolids program regulates facilities that produce, treat, or land apply sewage sludge or biosolids for beneficial use. The City's Compost Facility is covered under the general permit to produce Class A biosolids as defined in the federal 40 CFR 503 regulations.

Biosolids quality is measured using three parameters: pathogen reduction, vector attraction reduction, and pollutant concentration. Pathogen reduction uses accepted treatment processes or requires measurement of pathogen concentration to determine compliance. To receive classification as Class A, biosolids must go through a rigorous process called a Process to Further Reduce Pathogens. This reduces pathogens below detectable limits. Operators must test all Class A biosolids for pathogens and indicator organisms.

Vector attraction is related to odor control and can be thought of as the appeal that the biosolids present to organisms (e.g., flies) that may transmit pathogens, if pathogens were present in the biosolids. Reduction of vector attraction can be achieved through lime stabilization, reducing volatile solids content, or physical mixing processes.

Pollutant concentration refers to the pollutant limits established in WAC 173-308-160. This sets a ceiling concentration limit for each pollutant, meaning the maximum allowable concentration in biosolids. It also lists the pollutant concentration limit, which is lower than the ceiling limit. Biosolids with pollutants above the pollutant concentration limit are subject to cumulative loading limits on application sites.

The City's existing solids handling system is discussed in **Chapter 7**. Proposed solids handling improvements are discussed in **Chapter 8**.

Compost Facility State Waste Discharge Permit

The City's Compost Facility contains a Sequencing Batch Reactor (SBR) that treats liquids from the composting process and also a portion of the County's septage hauling and discharges to constructed wetlands and then infiltration basins for further treatment and disposal. The Compost Facility's WWTF is covered under the State Waste Discharge Permit (SWDP), which regulates the flow and loading of the SBR and adjacent wetlands. The City's current SWDP (Permit No. ST 6127) has an effective date of July 1, 2019, and expires on June 30, 2024. Copies of the permit and accompanying fact sheet are included as **Appendix E**.

Facility Design Criteria

The permitted flow and loading design criteria for the Compost Facility are included in **Table 2-12**.

Table 2-12

Compost Facility Flow and Loading Design Criteria

Parameter	Design Quantity
Maximum Month Design Flow (MMDF)	4,000 gpd
Daly Maximum Flow	6,200 gpd

gpd = gallons per day

Effluent Limits

SBR effluent water is discharged to infiltration basins, designated as wetlands in the SWDP, west of the Compost Facility. The effluent limits for the SBR and wetland influent and effluent are summarized in **Tables 2-13** and **2-14**.

Table 2-13

State Waste Discharge Permit SBR Effluent Limits

Parameter	Average Monthly	Average Weekly
BOD_5	30 mg/L 1 ppd 85% removal of influent BOD_5	45 mg/L 1.5 ppd
TSS	30 mg/L 1 ppd 85% removal of influent TSS	45 mg/L 1.5 ppd
Parameter	**Minimum**	**Maximum**
pH	6.0 standard units	9.0 standard units

Table 2-14

State Waste Discharge Permit Wetland Effluent Limits

Effluent Limits: Wetland Influent		
Parameter	**Monthly Geometric Mean**	**7-Day Geometric Mean**
Fecal Coliform	200 col/100 mL	400 col/10 mL
Parameter	**Average Monthly**	**Average Weekly**
Total Residual Chlorine	0.5 mg/L	0.75 mg/L
Effluent Limits: Wetland Effluent		
Parameter	**Average Monthly**	**Average Weekly**
Nitrate	10 mg/L as N	-

ADJACENT SEWER SYSTEMS

There are no municipal sewer service systems adjacent to the City. The closest wastewater treatment plant to the City is the Port Townsend Paper Corporation just south of the City limits.

The surrounding areas of unincorporated Jefferson County do not have sewer service, and wastewater is managed with on-site septic systems, community drain fields, or alternative sewage treatment technologies. However, the County is in the process of constructing a sewer plant and collection system in Hadlock that will allow for conversion of existing septic systems to public sewer and growth of housing and businesses within the Hadlock UGA.

Figure 2-6 shows the wastewater treatment facilities within 20 miles of the City.

CITY OF PORT TOWNSEND AND ADJACENT WATER SYSTEMS

City of Port Townsend

The City's existing retail water service area, which covers an area of approximately 11.2 square miles, is shown on **Figure 2-7** The existing retail service area includes the current City limits and adjacent lands to the west and south of the City limits.

This section provides a brief description of the existing water system and the current operation of the facilities. The water service area, facilities, and supply sources are shown in **Figure 2-7**. Water is supplied to the City's system by the Big Quilcene and Little Quilcene Rivers.

The City's wastewater facilities are all separated from major drinking water facilities for the City and adjacent drinking water purveyors. As a result of this separation, the City's wastewater facilities are unlikely to conflict with or impact the drinking water facilities or supplies for the City or neighboring purveyors.

Pressure Zones

The City divides the water system into two different pressure zones, the "High Zone" and the "Low Zone." Prior to 1998, the City was served from a single pressure zone (the Low Zone). Service pressures ranged from above 130 pounds per square inch (psi) near the shoreline of Puget Sound to less than 20 psi at the higher elevations within the service area. To increase system pressures, the City installed a new, taller storage tank, which provides higher service pressures in areas of the City with higher elevations, creating the initial phase of the High Zone. The High Zone serves areas generally above 210 feet of elevation, resulting in a typical High Zone pressure range of 35 psi to 70 psi (although there are localized areas over 70 psi). The City expanded the extent of the High Zone to adjacent northwest areas of similarly higher elevation in 2004 to ensure service pressures in that area were maintained above the Washington State Department of Health minimum criterion of 30 psi. The revised Low Zone pressure range is typically from about 50 psi to above 130 psi, but there are localized areas under 50 psi.

Supply Facilities

Introduction

The City water system is supplied by surface water from the Big Quilcene and Little Quilcene Rivers, which are located approximately 30 and 20 miles south of the City, respectively. The diversions at the Little Quilcene and Big Quilcene Rivers provide flow to Lords Lake and to City Lake, which are both man-made impoundments. The headwaters of each river originate within the Olympic National Forest and Olympic National Park. The U.S. Forest Service manages most of the municipal watershed and the City has a good working relationship with them. The Big Quilcene River is the primary water supply for the City. Water from the Little Quilcene River diversion is used to fill Lords Lake, which has a capacity of approximately 500 million gallons (MG). Lords Lake also can be filled from the Big Quilcene Diversion. The City's surface water supplies are high quality and generally very low in turbidity. When the Big and Little Quilcene Rivers experience high turbidity events, the City and the Port Townsend Paper Corporation use water stored in Lords Lake or City Lake. The entire system operates by gravity from both of the diversions, to Lords Lake, City Lake, and the City. City Lake functions as a raw water equalizing reservoir with approximately 140 MG of storage.

Water Treatment

Prior to treatment, water from City Lake flows through two sets of mesh screen, which prevents objects larger than $^{3}/_{32}$ inch from entering the Olympic Gravity Water System pipeline below City Lake. The new water treatment facility (WTF), completed in 2017, is located adjacent to the City's existing water storage tanks. The WTF has the following features:

- Raw water flow and pressure control valves.
- Mechanical micro-screens for removing algae and larger-sized sediment.
- Pressure ultrafiltration membranes for the removal of microbial pathogens (*Giardia* and *cryptosporidium*), sediment, and semi-colloidal particles.
- Sodium hypochlorite feed to provide primary disinfection and a chlorine residual in the finished water throughout the distribution system.
- Potassium permanganate injection system for treatment of algal toxins in the event toxins are detected in the raw water supply.
- Automated control system.
- Standby power generator.

Pump Station Facilities

The City's water system has two booster pump station (BPS) facilities. The Morgan Hill BPS, constructed in 2004, has two domestic flow pumps (one service, one standby), three high flow pumps (two service, one standby), and emergency power (**Table 2-15**). The BPS serves a closed distribution system with 2,000 gallons of storage via a hydro-pneumatic tank on top of the hill. The second BPS is located at the WTF and pumps water into the High Zone and 1 MG Standpipe reservoir.

Table 2-15

Booster Pump Station Facilities Summary

Facility	Year Constructed	Description/Size	Capacity
Morgan Hill BPS	2004	Domestic Flow Pumps High Flow Pumps	(2) 100 gpm (3) 550 gpm
WTF BPS	2017	Domestic Flow Pumps Low Flow Pump[1]	(2) 2,100 gpm (1) 450 gpm

1. Used to boost Low Zone pressure to serve the High Zone when the 1 MG Standpipe is offline for service.

Storage Facilities

The City's water system has two facilities that provide storage to the water system (**Table 2-16**). A 37-foot-tall, 160-foot-diameter 5 MG prestressed concrete reservoir serves the City's low elevation zone, and an 84-foot-tall, 47-foot-diameter 1 MG steel standpipe serves the City's high elevation zone. Both reservoirs have baffles to increase the contact time (CT) in the reservoir in order to meet CT requirements.

Table 2-16

Storage Facilities Summary

Facility	Year Constructed	Description/Size	Capacity	Construction Materials
5 MG Reservoir	2017	37 Feet Tall 160 Feet Diameter	5 MG	Concrete
1 MG Standpipe	1994	84 Feet Tall 47 Feet Diameter	1 MG	Steel

Distribution and Transmission System

The City's water system contains approximately 110 miles of water main ranging in size from 2 inches to 36 inches. Most of the water main (approximately 33 percent) within the system is 6 inches in diameter or less. Approximately 56 percent of the distribution system is constructed of AC pipe. The majority of the remainder of the piping system is constructed of PVC pipe. The City has complied with water quality testing requirements for asbestos in the water system, demonstrating that concentrations are below state and federal standards.

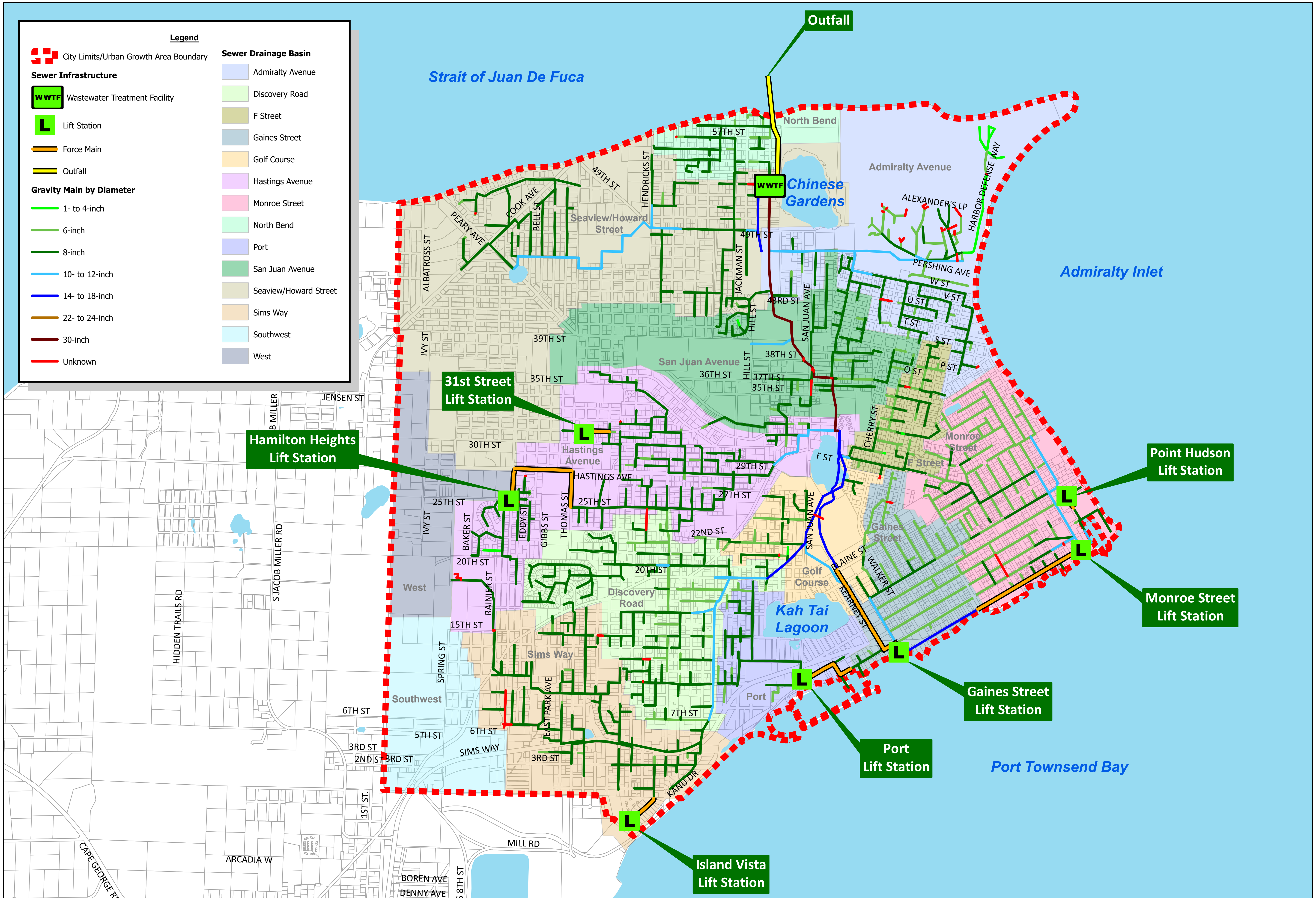
Water System Interties

Water system interties are physical connections between two adjacent water systems. Interties normally are separated by a closed isolation valve or control valve. Emergency supply interties provide water from one system to another during emergency situations only. An emergency situation may occur when a water system loses its main source of supply or a major transmission main, or during firefighting situations, and is unable to provide a sufficient quantity of water to its customers. Normal supply interties provide water from one system to another during non-emergency situations and are typically supplying water at all times.

The City does not have any interties with any adjacent water systems.

Adjacent Water Systems

The City's water service area is shown in **Figure 2-7**. Three water systems share a boundary with the City: Deaner Line, Jamie Kozelisky, and Quimper (Jefferson County Public Utility District (PUD) No.1). Other purveyors located on the Quimper Peninsula, but not sharing a boundary with the City, include Jefferson County PUD No. 1 Vandecar, Cape George, and Jefferson County PUD No. 1 Valiani.



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Vicinity Map

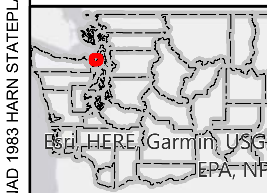


Figure 2-1
Existing Sewer System
City of Port Townsend General Sewer Plan

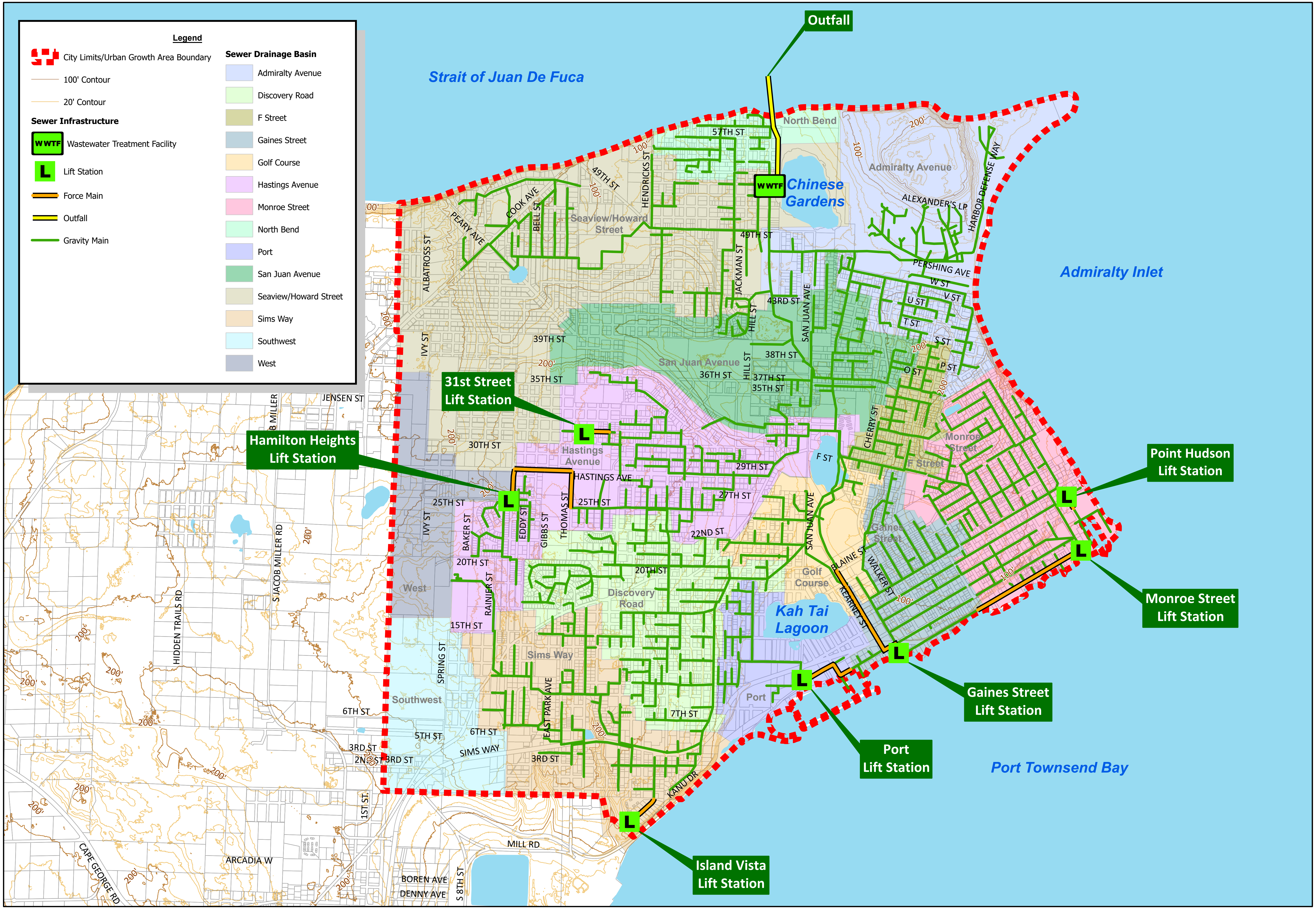
1 inch : 2,000 Feet

0 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

NORTH

\\CORP.RH2.COM\PROJECTS\PROJECT\DATA\TWNSD\21-0226\GIS\2022 GSP UPDATE\2022 GSP UPDATE.APRX BY: LMOJARAB PLOT DATE: JAN 13, 2023 COORDINATE SYSTEM: NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET



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Vicinity Map

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COORDINATE SYSTEM: NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

BY: LMOJARAB PLOT DATE: JAN 25, 2023

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Figure 2-2
Sewer Drainage Basins
City of Port Townsend
General Sewer Plan

City of Port Townsend

1 inch : 2,000 Feet

0 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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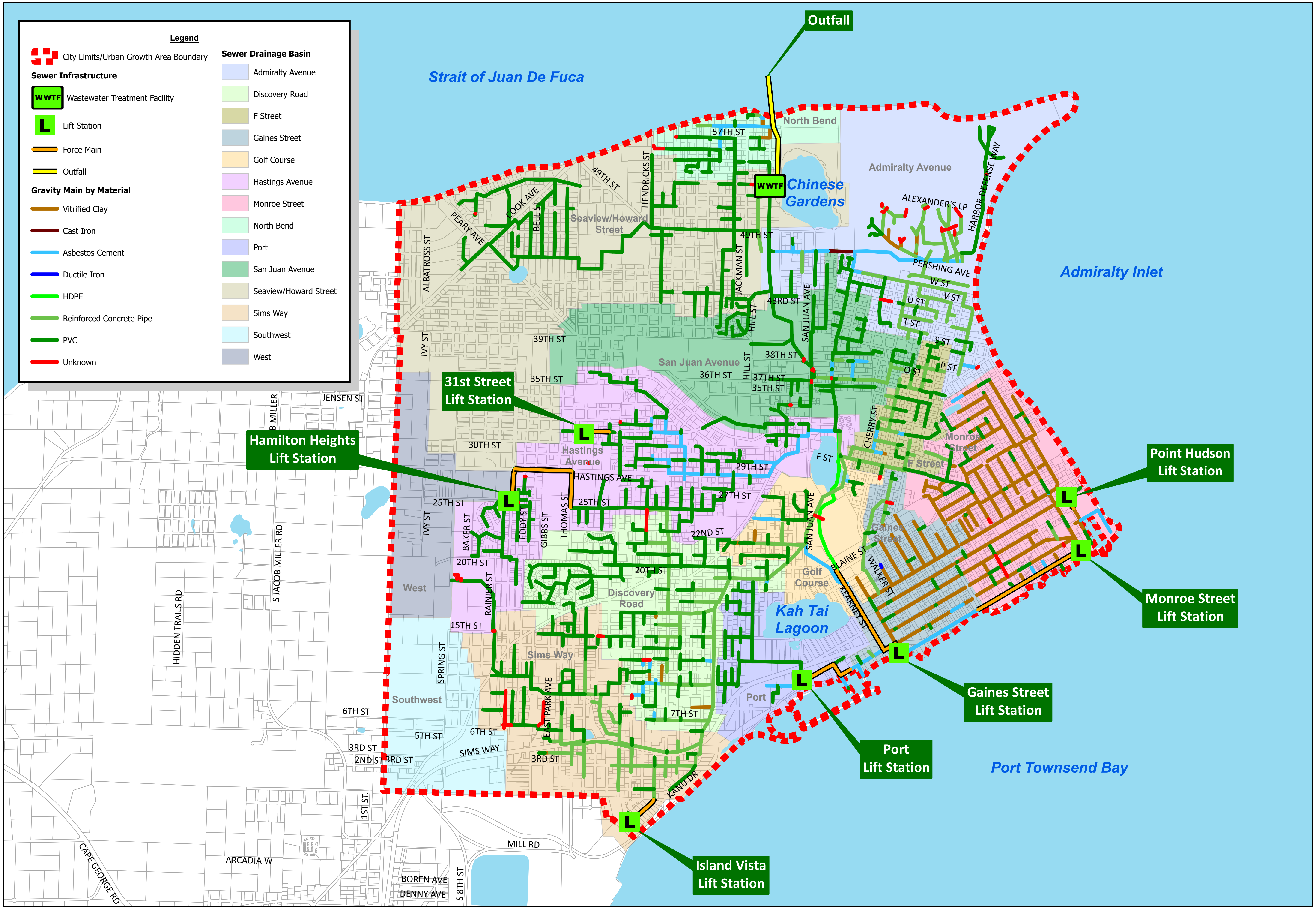
NORTH



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Vicinity Map

Esri, HERE, Garmin, USGS, EPA

Figure 2-4
Pipe Material
City of Port Townsend General Sewer Plan

City of Port Townsend

1 inch : 2,000 Feet

0 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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NORTH

COORDINATE SYSTEM: NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET PLOT DATE: JAN 13, 2023 BY: LMOJARAB

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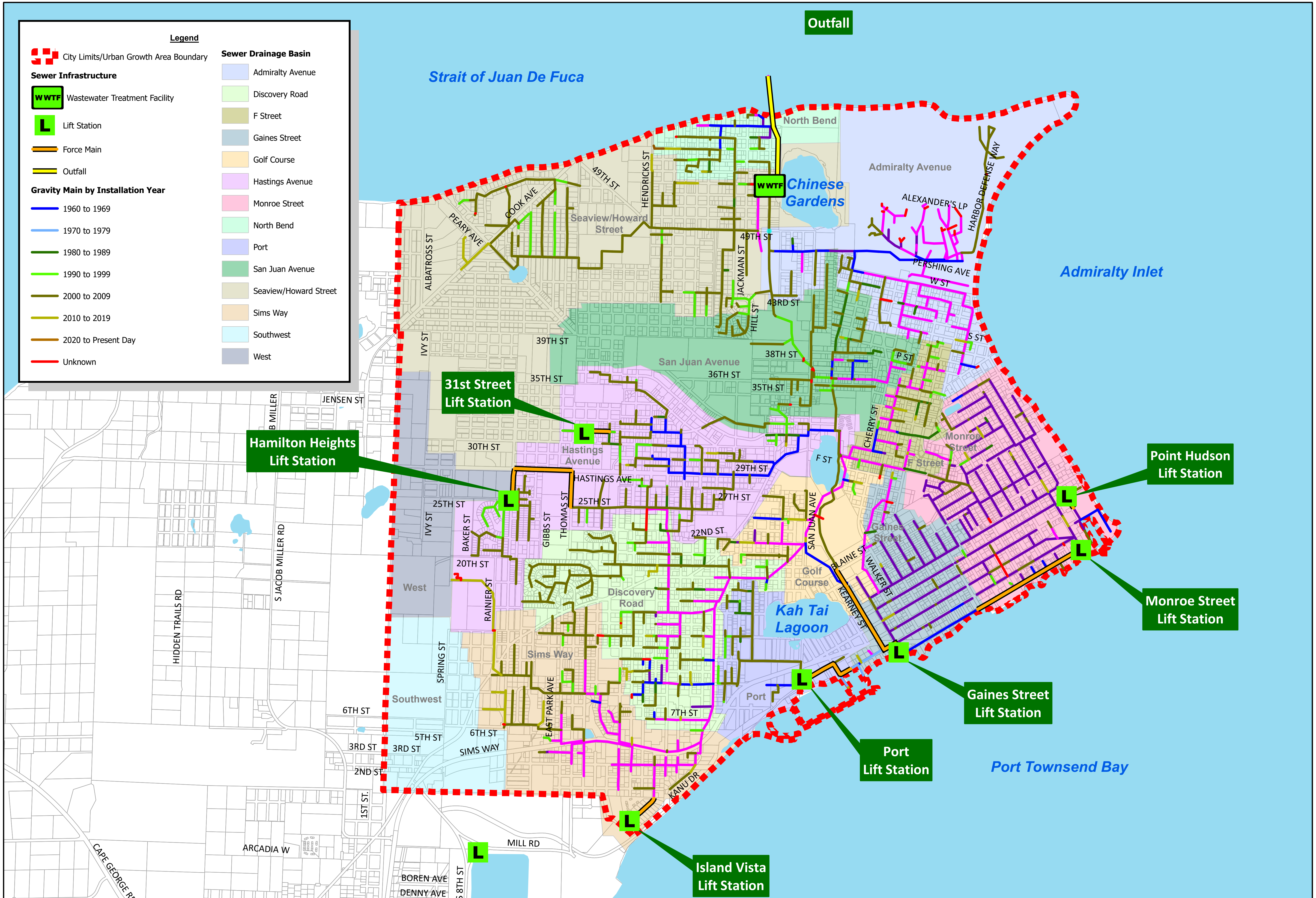

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Vicinity Map

Figure 2-5(a)
Known Pipe Age

City of Port Townsend General Sewer Plan

COORDINATE SYSTEM: NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

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City of Port Townsend

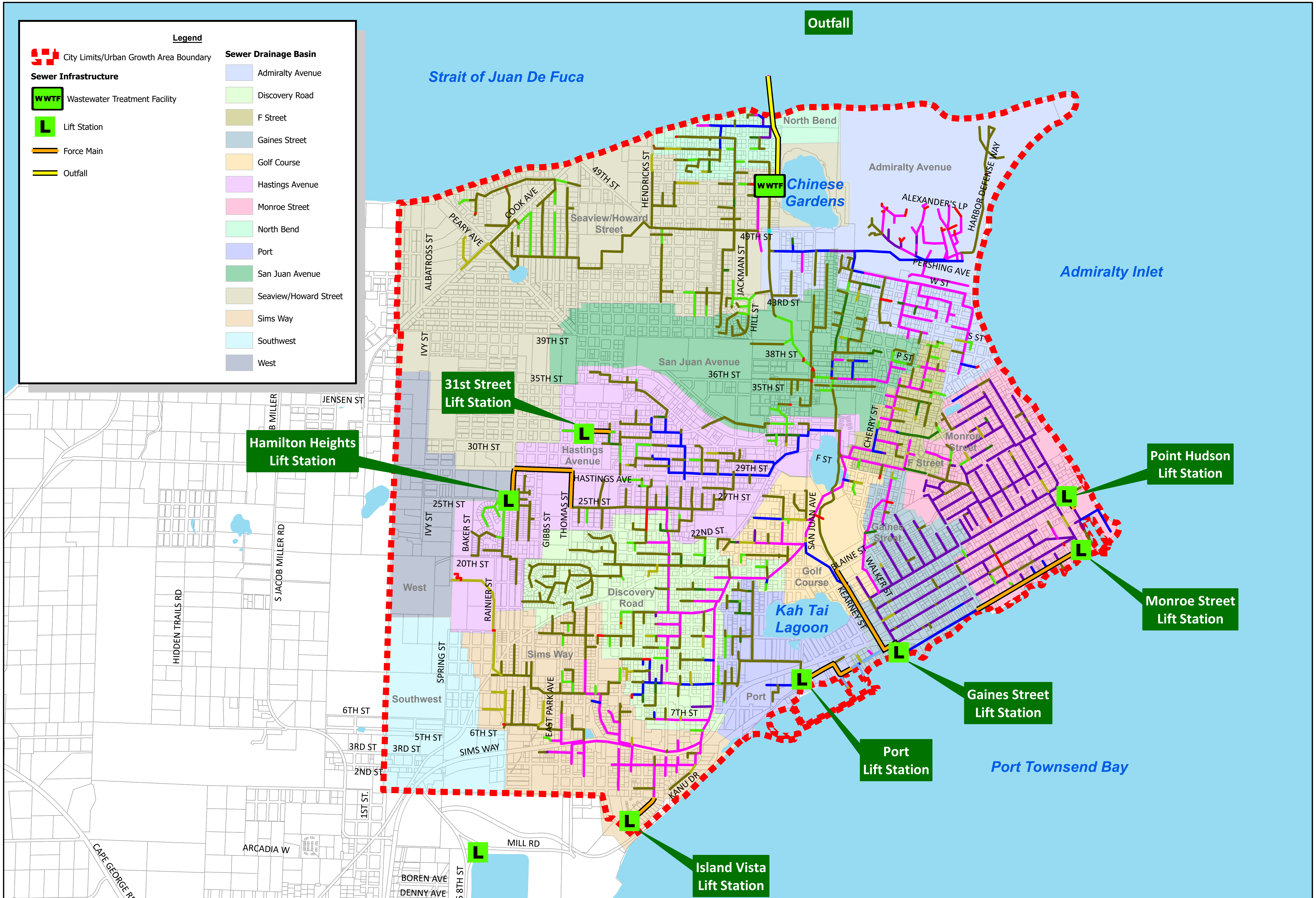
1 inch : 2,000 Feet

0 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

RH2

NORTH



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Vicinity Map

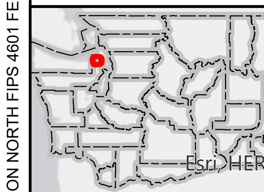

Figure 2-5(b)
Assumed Pipe Age
City of Port Townsend General Sewer Plan

City of Port Townsend

1 inch : 2,000 Feet

0 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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NORTH

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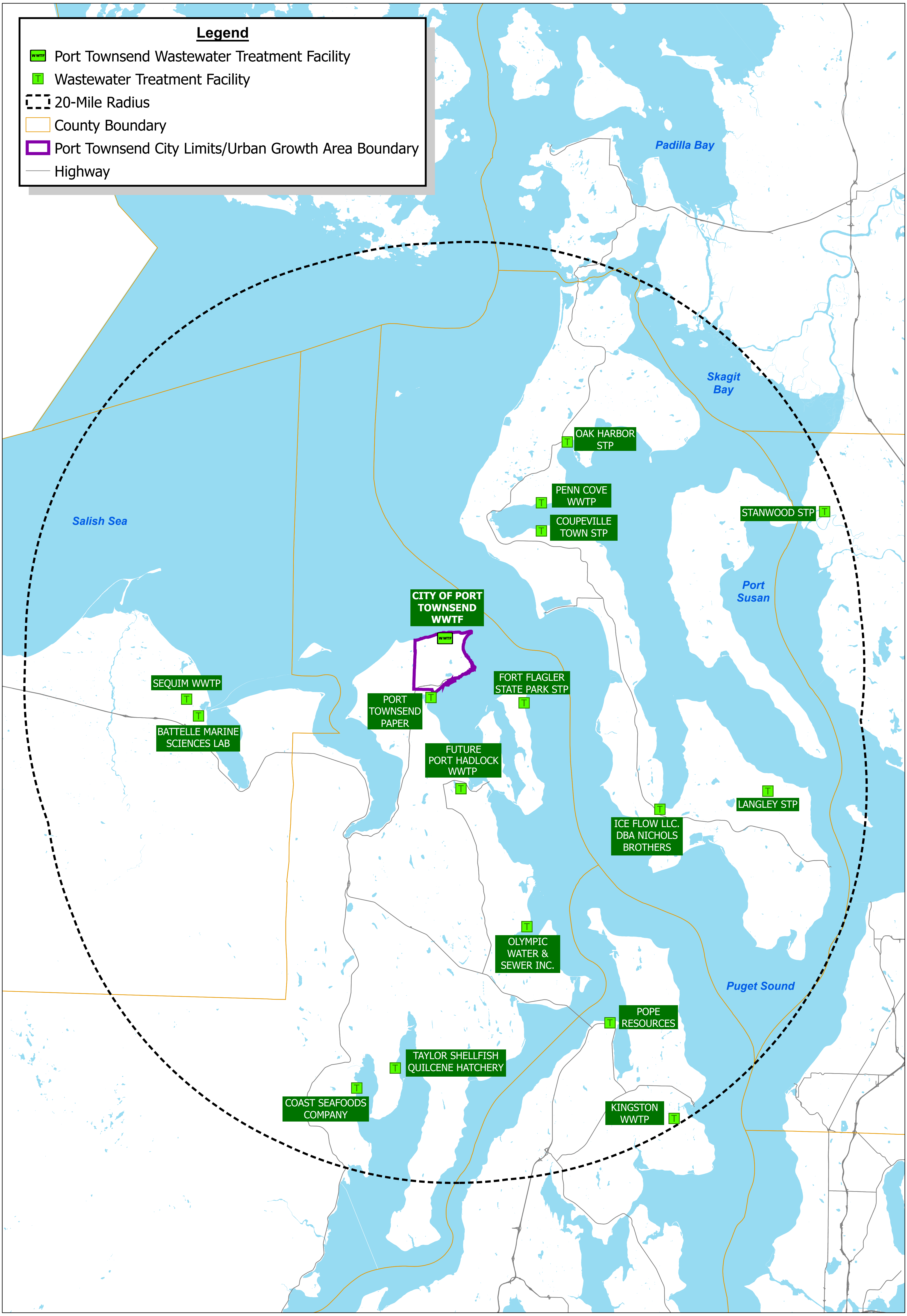

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NORTH

1 inch : 12,000 Feet

0 12,000 24,000 Feet

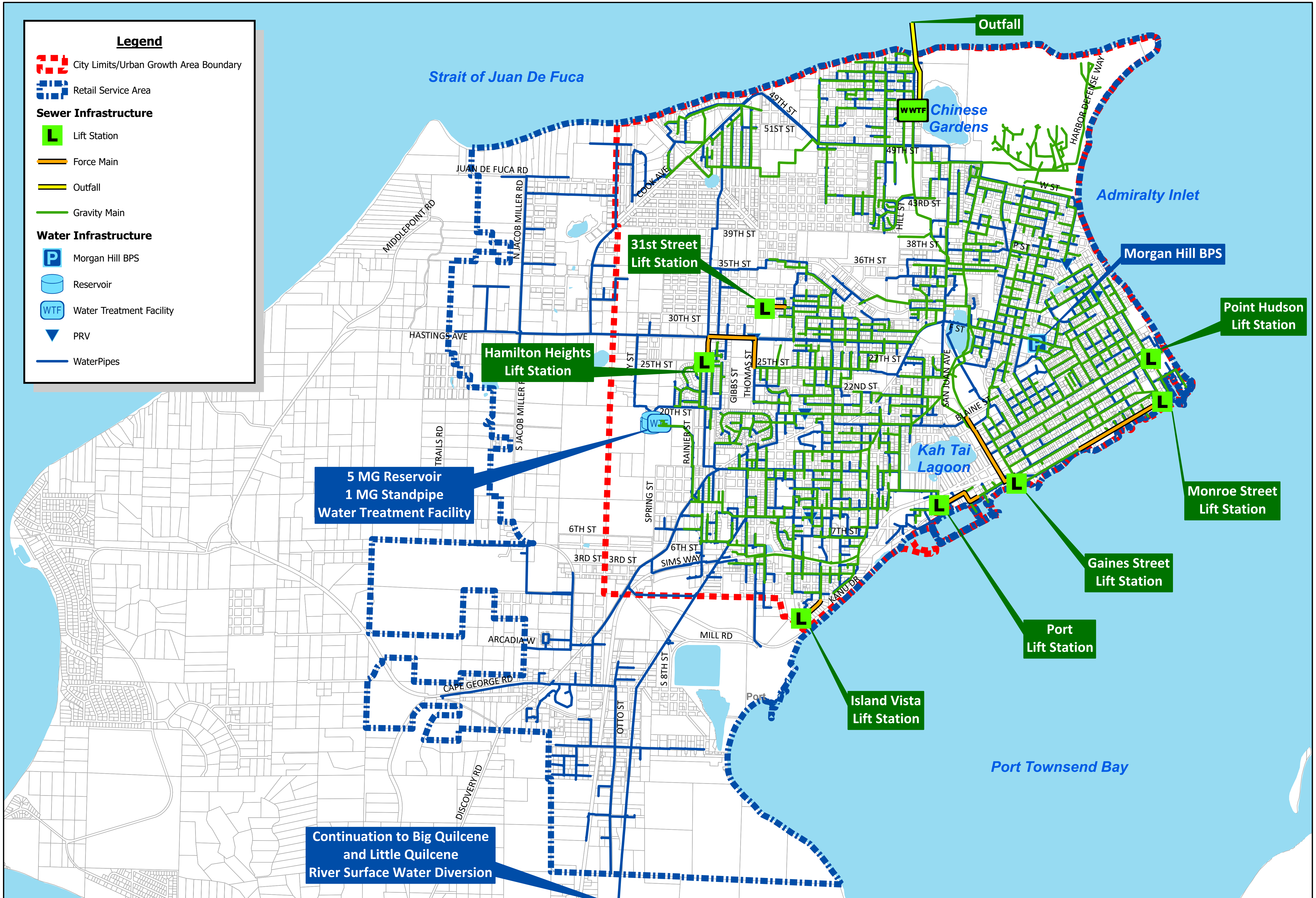
DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

City of Port Townsend

Figure 2-6
WW Treatment Facilities in Vicinity
City of Port Townsend
General Sewer Plan

Vicinity Map

Esri, HERE, Garmin, USGS, EPA, NPS



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Vicinity Map

Figure 2-7
Existing Sewer and Water System
City of Port Townsend
General Sewer Plan

City of Port Townsend

1 inch : 2,500 Feet

0 1,250 2,500 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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3 | LAND USE AND POPULATION

INTRODUCTION

The State of Washington Growth Management Act (GMA) requires, among other things, consistency between land use and utility plans and their implementation. This chapter demonstrates the compatibility of the City of Port Townsend's (City) General Sewer Plan (GSP) with other plans, identifies the designated land uses within the existing and future service area, and presents population projections within the City's planning area.

COMPATIBILITY WITH OTHER PLANS AND POLICIES

To ensure that the GSP is consistent with the land use policies that guide it and other related plans, the following planning documents were examined.

- State of Washington Growth Management Act
- *Port Townsend Comprehensive Plan*
- Jefferson County County-wide Planning Policies
- *Jefferson County Comprehensive Plan*

Growth Management Act

The State of Washington GMA of 1990 (and its multiple amendments) defined four goals relevant to this GSP:

1. Growth should be in urban areas;
2. There should be consistency between land use and utility plans and their implementation;
3. There should be concurrency of growth with public facilities and services; and
4. Critical areas should be designated and protected.

Urban Growth Area

The GMA requires that Jefferson County (County) designate an Urban Growth Area (UGA) where most future urban growth and development will be directed. The Countywide UGA is defined in the *Jefferson County Comprehensive Plan* and encompasses the area where this urban growth and development is projected to occur over the 20-year planning period. The current Jefferson County UGA boundaries in the vicinity of the City are shown on **Figure 3-1**.

Consistency

The GMA requires planning consistency from two perspectives. First, it requires the consistency of plans between jurisdictions. This means that plans and policies of the City and County must be consistent per Revised Code of Washington (RCW) 36.70A.100. Second, the GMA requires that the implementation of the GSP be consistent with comprehensive plans (RCW 36.70A.120).

Concurrency

Concurrency means that adequate public facilities and services be provided at the time that growth occurs. For example, growth should not occur where schools, roads, and other public facilities are overloaded. To achieve this objective, the GMA directs growth to areas already served or readily served by public facilities and services (RCW 36.70A.110). It also requires that when public facilities and services cannot be maintained at an acceptable level of service, the new development should be prohibited (RCW 36.70A.110).

Critical Areas

The GMA requires that critical areas be designated and protected. Critical areas include aquifer recharge areas, wetlands, frequently flooded areas, streams, wildlife habitat, landslide hazard areas, seismic hazard areas, and steep slopes. The City has adopted development regulations identifying and protecting critical areas as required. The State Environmental Policy Act (SEPA) Checklist in **Appendix F** addresses other environmental concerns.

Port Townsend Comprehensive Plan

The *Port Townsend Comprehensive Plan* was last adopted in 2016. The plan was developed to describe the City's vision for the 20-year planning period and to provide goals and policies for achieving the vision, as well as to meet the requirements of the GMA.

The Land Use Element of the City's *Comprehensive Plan* is the City's vision of how growth and development should occur over a 20-year horizon. While the Land Use Element goals and policies set forth general standards for locating land uses, the Land Use Map (Figure 4-1) indicates geographically where current and future land uses may be appropriate. The Land Use Map is a blueprint for the development of an area. The City's existing land use is shown in **Figure 3-1**.

The Land Use Element considers the general location of land uses, as well as the appropriate intensity and density of land uses given the current development trends of the City. The Transportation, Utilities, and Capital Facilities Elements ensure that new development will be served adequately without compromising adopted levels of service, which is consistent with the principal of concurrency as defined in the GMA.

Jefferson County County-wide Planning Policies

Jefferson County and the City adopted a joint resolution establishing the County-wide Planning Policies on December 21, 1992. The policies are intended to ensure that County and City comprehensive plans are consistent in accordance with the GMA. The County-wide Planning Policies are organized into policies related to UGAs, development and urban services, siting of public facilities, County-wide transportation facilities, affordable housing, economic development and employment, and rural areas. All the City's functional plans are required to be consistent with the County-wide Planning Policies.

Jefferson County Comprehensive Plan

The current version of the *Jefferson County Comprehensive Plan* was last updated in 2018. Chapters include the following.

- Land Use
- Natural Resources
- Housing
- Open Space, Parks & Recreation, Historic & Cultural Preservation
- Environment
- Transportation
- Economic Development
- Capital Facilities & Utilities

The County's plan is focused on ten framework goals, as follows.

I. Preserving Rural Character
II. Sustainable and Suitable Growth Patterns
III. Enhancement of the Rural Economy
IV. Housing Variety and Affordability
V. Allocation of Land to Meet Anticipated Needs
VI. Environmental Consideration
VII. Mobility
VIII. Active and Healthy Living
IX. Continuous and Ongoing Public Involvement
X. Compliant with GMA

The *Jefferson County Comprehensive Plan* guides development and designates land use in unincorporated Jefferson County. County Land Use inside the City's future wastewater service area (which includes the City's UGA) is shown in **Figure 3-1**; the *Jefferson County Comprehensive Plan* can be referenced for County Land Use outside the City's future wastewater service area.

LAND USE

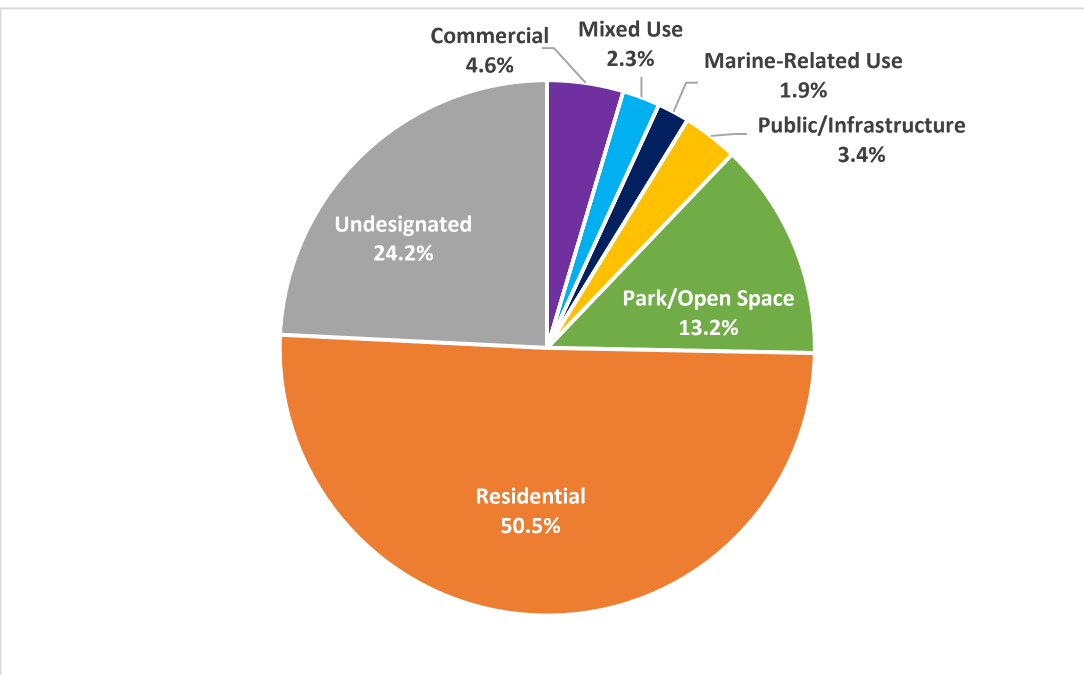
The wastewater service area includes the City limits, which is also the City's UGA boundary, for a total of approximately 7.0 square miles. The Land Use Map, as shown in **Figure 3-1**, guides development and can be used to forecast future wastewater flows and loadings. Land use outside the City is designated by the County, as shown in **Figure 3-1**.

Approximately 50.5 percent of the area within the City's future wastewater service area is designated for residential use, as indicated in **Table 3-1**. Approximately 13.2 percent of the future wastewater service area is designated for open space/parks; approximately 4.6 percent is designated for commercial use; approximately 3.4 percent is designated for public/infrastructure use; and approximately 28.3 percent is designated for other land uses or is undesignated. One key factor to the City's land use is the extensive amount of land that is designated as public right-of-way. Approximately 50 percent of the City's land area is public right-of-way, leaving nearly half the land undevelopable. This is a result of the pre-platted nature of the City and the 200-foot by 200-foot block pattern. This factor will be a key item of discussion in the next *Comprehensive Plan* update and impacts the amount of land generating demand on the utility systems.

Table 3-1

Land Use Inside Future Wastewater Service Area

Land Use Type	Acres	% of Total
Commercial	205	4.6%
Mixed Use	101	2.3%
Marine-Related Use	86	1.9%
Public/Infrastructure	150	3.4%
Park/Open Space	588	13.2%
Residential	2,254	50.5%
Undesignated	1,081	24.2%
Total	**4,466**	**100.0%**



POPULATION

Household Trends

The City's residential areas are largely comprised of single-family residences. The City's 2016 *Comprehensive Plan* estimated that there were over 5,300 housing units in the City. Of these, approximately 4,006 housing units (75.2 percent) were single-family residences, approximately 1,101 housing units (20.7 percent) were multi-family residences, and 219 housing units (4.1 percent) were other types of residences such as mobile homes, boats, and RVs. The City's average household size is estimated to be 1.90 persons per household based on the 2020 U.S. Census Bureau data.

Historical and Future City Population

The City has experienced steady population growth since 2000. The population of the City has increased by approximately 23 percent over the last 20 years. **Table 3-2** illustrates the historical population growth since 1995. The historical population shown in **Table 3-2** represents the population within the City limits. The sources of the historical population numbers are the decennial census and Office of Financial Management (OFM) intercensal estimates.

Table 3-2

Population Trends within the City Limits

Year	City Population
1995	8,165
2000	8,334
2001	8,441
2004	8,543
2007	8,945
2010	9,113
2011	9,240
2012	9,299
2013	9,320
2014	9,504
2015	9,579
2016	9,805
2017	9,871
2018	9,950
2019	10,060
2020	10,148
2021	10,220

Projected future population growth within the City Limits, shown in **Table 3-3** and **Chart 3-1**, is based on current projections from the City's 2016 *Port Townsend Comprehensive Plan*. The City is projected to have a population of 13,300 people in 2043. The buildout population shown in **Table 3-3** is based on data from the City's previous GSP.

The City is currently discussing an expansion to its sewer service area. **Chapter 2** describes factors to consider in serving a Special Study Area and the expansion that would result. The expansion of the service area is dependent on coordination with the County, the Department of Commerce, and the Department of Ecology to ensure compliance with the GMA. The Special Study Area expansion will extend service to two new sewer basins already inside the City limits and could serve the Glen Cove Local Area of More Intense Rural Development (LAMIRD) just outside the City limits. The Special Study Area boundary is approximately shown in **Figure 3-2**. For the purposes of estimating demand on the sewer system, an equivalent population for the industrial area was estimated. The additional population outside of the City limits this expansion would introduce to the sewer service area is included in **Table 3-3** under the assumption the expansion would start in 2025. Note, the actual population growth would be considerably less given business customers do not necessarily add more population to the City.

Table 3-3

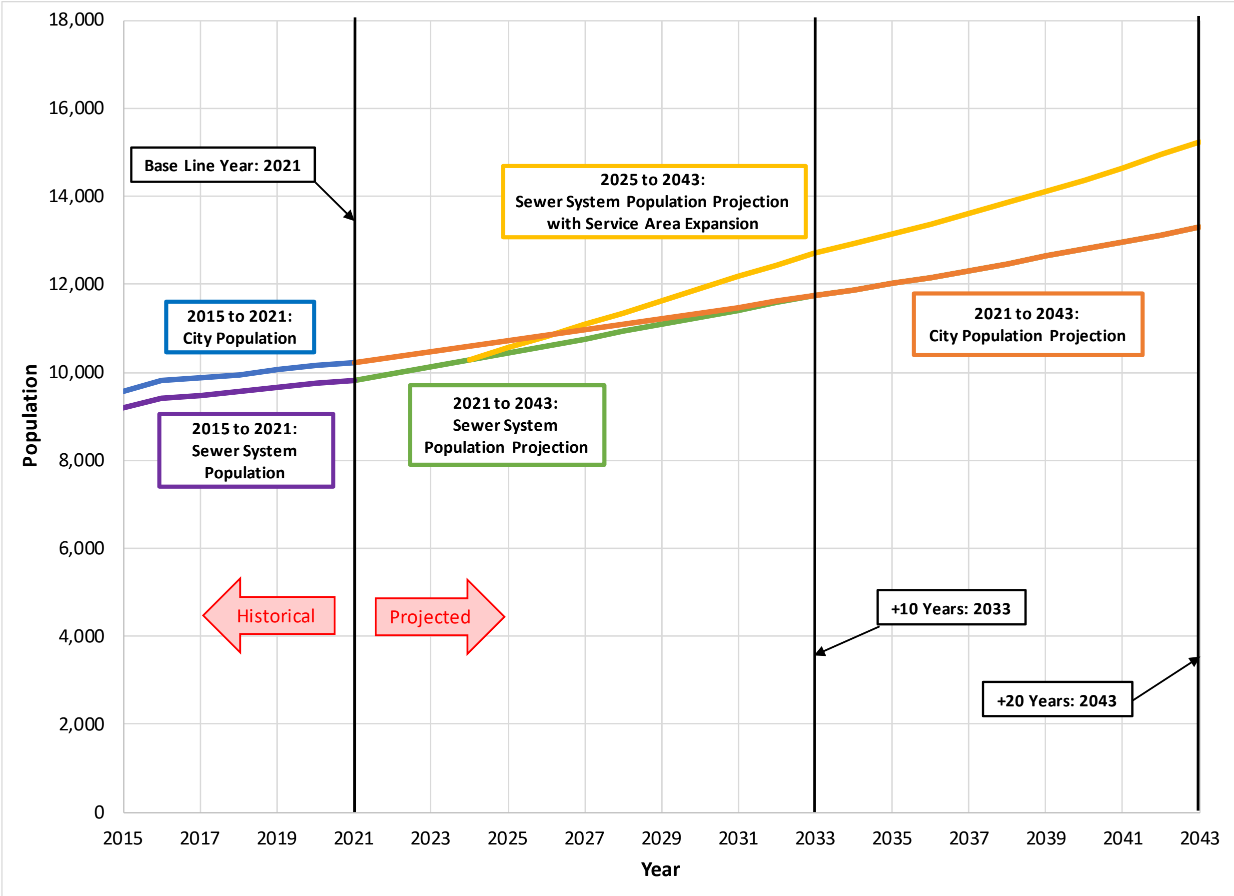
Population Projections

Year	City Population	City Sewer System Population	Population Served by Septic Systems	Sewer Service Expansion Equivalent Population[1]	Sewer System Population with Expansion
2015	9,579	9,188	391	--	--
2016	9,805	9,414	391	--	--
2017	9,871	9,480	391	--	--
2018	9,950	9,559	391	--	--
2019	10,060	9,669	391	--	--
2020	10,148	9,757	391	--	--
2021	10,220	9,829	391	--	--
2022	10,339	9,981	359	--	--
2023	10,460	10,134	326	--	--
2024	10,582	10,289	294	0	10,289
2025	10,706	10,445	261	108	10,553
2026	10,831	10,603	228	216	10,819
2027	10,958	10,762	196	324	11,086
2028	11,086	10,923	163	432	11,354
2029	11,215	11,085	130	540	11,624
2030	11,346	11,248	98	648	11,896
2031	11,479	11,413	65	755	12,169
2032	11,613	11,580	33	863	12,444
2033 (+10 years)	**11,748**	**11,748**	**0**	**971**	**12,720**
2034	11,886	11,886	0	1,041	12,927
2035	12,025	12,025	0	1,116	13,140
2036	12,165	12,165	0	1,196	13,361
2037	12,321	12,321	0	1,282	13,603
2038	12,479	12,479	0	1,374	13,853
2039	12,639	12,639	0	1,472	14,111
2040	12,801	12,801	0	1,578	14,379
2041	12,965	12,965	0	1,691	14,656
2042	13,132	13,132	0	1,812	14,944
2043 (+20 years)	**13,300**	**13,300**	**0**	**1,943**	**15,242**
Buildout	**23,035**	**23,035**	**0**	**2,771**	**25,973**

1 = Equivalent population is shown based upon the projected flow and is representative of the growth in terms of population.

Chart 3-1

Population Projections



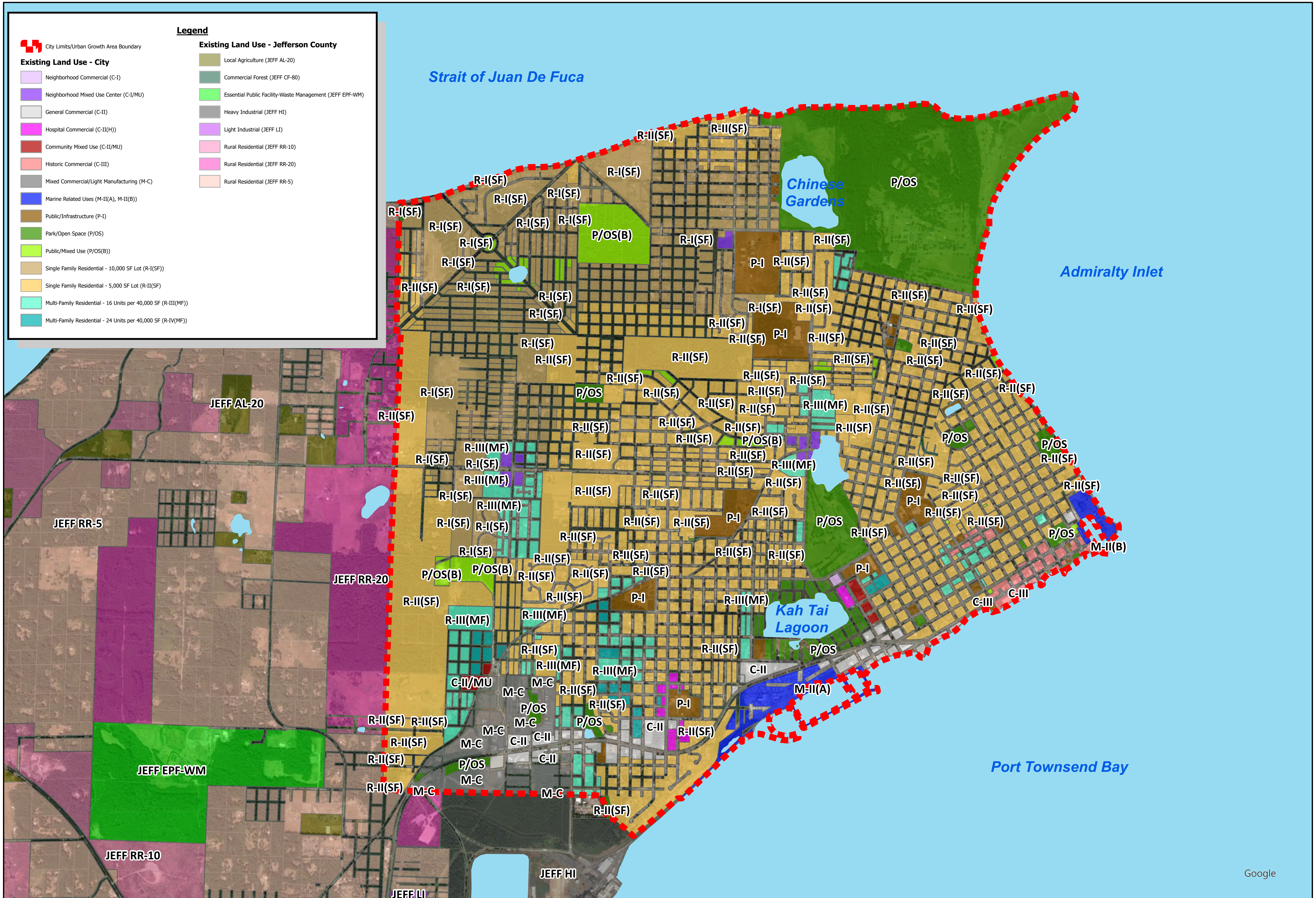
Sewer System Population

The actual number of people served by the City's wastewater system is different than the population of the City limits. The City currently provides sewer service to the entire population within the City limits, except for 206 residential properties that currently are unsewered. The unsewered population and the sewer system population inside the City limits was calculated by multiplying the estimated number of connections by the average household size for the City. As shown in **Table 3-3**, the estimated population served by the sewer system in 2021 was 9,829.

Sewer system population projections through 2043 are shown in **Table 3-3**. It was assumed that by 2033, the current unsewered properties in the City limits would be connected to the City's wastewater system. The wastewater system is expected to provide service to approximately 15,242 people in 2043.

Distribution of Population Assumptions

City planning staff made an estimate of where future growth might occur within the existing sewer service area as shown in the map in **Figure 3-3**. This population forecast was used to allocate future flows in the sewer hydraulic model for the 5-year, 6- to 10-year, and 11- to 20-year design horizons. Flow contributions from the Special Study Area expansion to the Glen Cove Area to be served by the proposed Mill Lift Station are in addition to these allocations.



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Vicinity Map

Figure 3-1
Existing Land Use
City of Port Townsend
General Sewer Plan

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City of Port Townsend

1 inch : 2,000 Feet

0 500 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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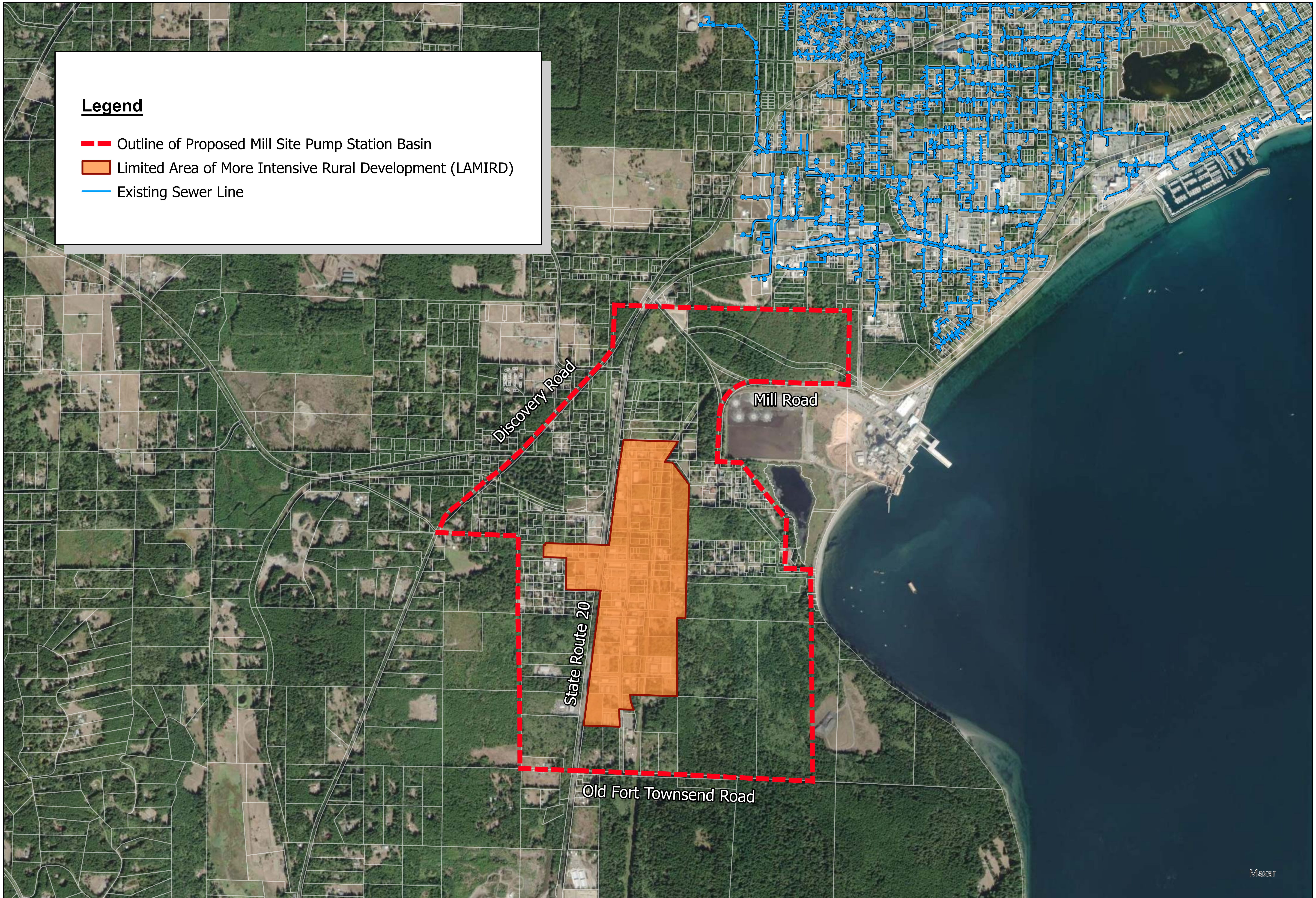
NORTH



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Vicinity Map

Figure 3-2
Possible Service Area Expansion
City of Port Townsend
General Sewer Plan

City of Port Townsend

1 Inch: 1,500 Feet

0 750 1,500 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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NORTH

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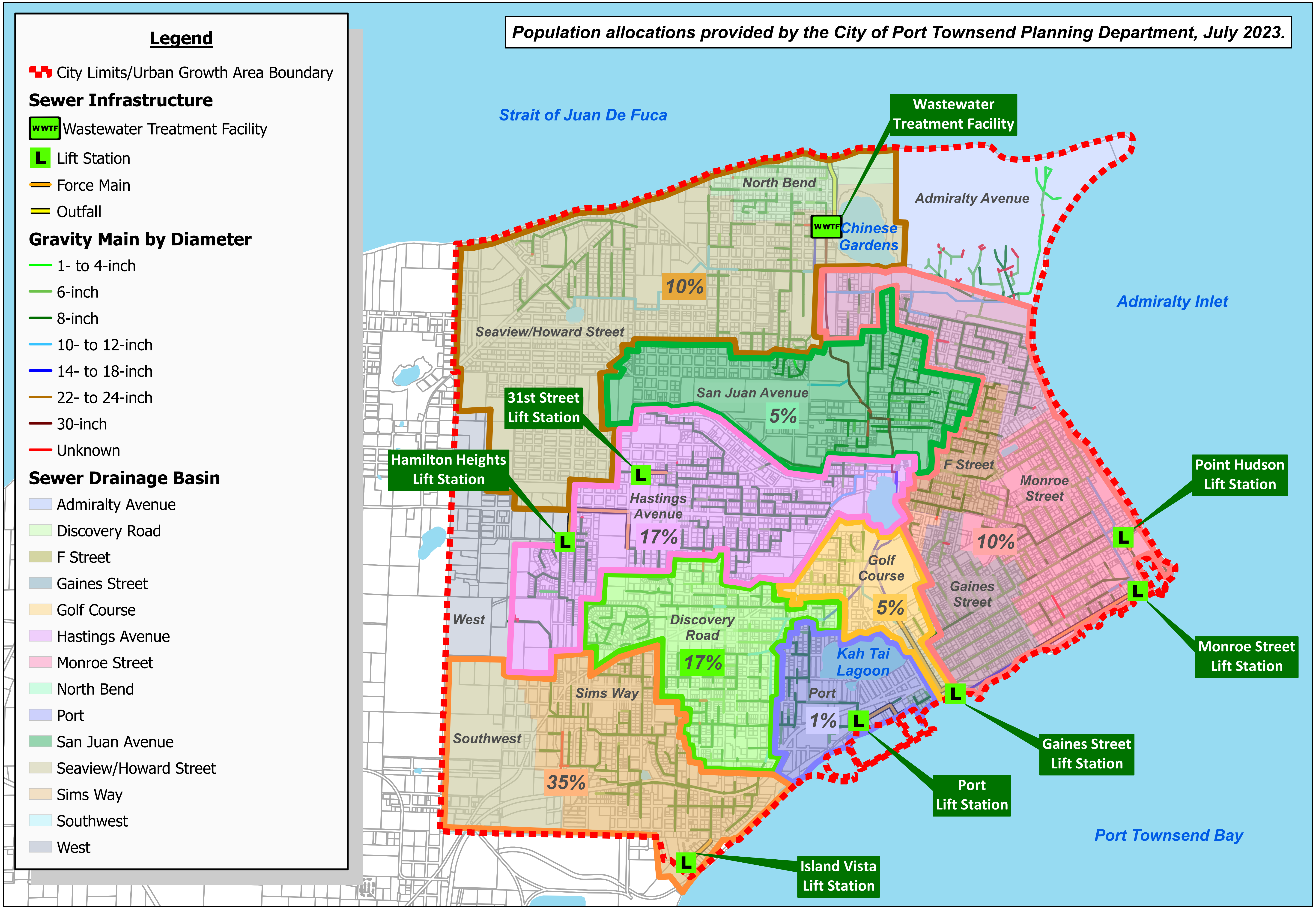

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Vicinity Map

Esri, HERE, Garmin, USGS, EPA, NPS

Figure 3-3

Allocation of Future Population by Planning Area

City of Port Townsend General Sewer Plan

City of Port Townsend

1 inch : 2,000 Feet

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DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

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4 | FLOW AND LOADING ANALYSES

INTRODUCTION

A detailed analysis of flow and loading is crucial to the planning efforts of a sewer service provider. When analyzing a sewer system, the first step is to identify current flow and load values to determine if the existing system can provide adequate service to its existing customers under the most crucial conditions in accordance with federal and state laws. A projected sewer system analysis identifies projected flow and load values to determine where the system will need to be improved to satisfy projected growth while continuing to meet federal and state laws.

Flow and load values in a sewer system are used to determine the size of gravity collection piping, lift station facilities, and force main piping, as well as the size and type of treatment facilities needed. This information also is used to develop the sewer service provider's National Pollutant Discharge Elimination System (NPDES) waste discharge permit, which is required by the Washington State Department of Ecology (Ecology). Several different flow scenarios were analyzed for the City of Port Townsend's (City) sewer system and are addressed in this chapter, including average annual flow (AAF), maximum month average flow (MMF), maximum day flow (MDF), peak hour flow (PHF), and projected flows. The City's wastewater treatment facility (WWTF) loading, inflow and infiltration (I/I), and peaking factors also are presented.

System design criteria and standards have been developed to ensure that a consistent minimum level of service is maintained throughout the City's sewer system and to facilitate planning, design, and construction of sewer system projects. A copy of the City's *Engineering Design Standards Manual* is included in **Appendix G**. Design requirements for sewer systems are available in Ecology's *Criteria for Sewage Works Design* (commonly known as the "Orange Book").

SEWER SERVICE CONNECTIONS AND RESIDENTIAL POPULATION

Sewer Service Connections

Table 4-1 presents the City's historical sewer service connections for 2015 through 2021. As of 2021, there were approximately 4,710 sewer service connections throughout the City's sewer system. Of these connections, 4,265 were residential services and 445 were commercial/government services. A breakdown of the sewer service connections by customer class is shown in **Chart 4-1**.

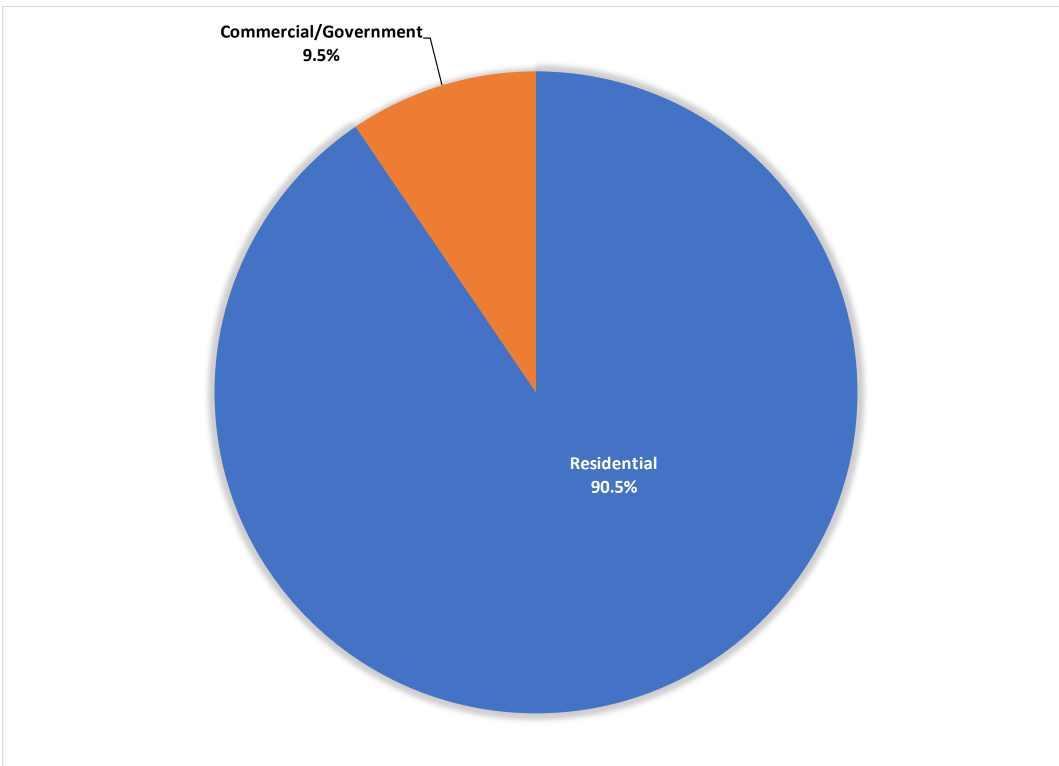
Table 4-1

Historical Sewer Connections Summary

Year	Residential Sewer Accounts	Commercial/Government Sewer Accounts	Total Sewer Accounts
2015	4,048	425	4,473
2016	4,041	429	4,470
2017	4,103	434	4,537
2018	4,145	436	4,581
2019	4,196	444	4,640
2020	4,238	444	4,682
2021	4,265	445	4,710

Chart 4-1

2021 Sewer Service Connections by Customer Class



Sewer Service Population

As presented in **Chapter 3**, the City's 2021 sewer service area population is estimated to be 9,829 people. This estimate is based on the City's population of 10,220 for 2021, and an average household size of 1.90 for areas in the City limits multiplied by 206 unsewered residential properties in the City limits. The average household size for areas in the City limits is based on the City's *Comprehensive Plan*, which was amended in 2016. **Table 4-2** presents the City's historical sewer population for 2015 through 2021.

Table 4-2

Historical Sewer Service Population

Year	City Population	Sewer System Population
2015	9,579	9,188
2016	9,805	9,414
2017	9,871	9,480
2018	9,950	9,559
2019	10,060	9,669
2020	10,148	9,757
2021	10,220	9,829

The City's wastewater collection planning area includes the entire Urban Growth Area (UGA). There are parcels within the City limits that are served by on-site septic systems. Once these systems fail, City code requires that the homeowners connect to the City's municipal wastewater system if the parcel is located within 500 feet of the wastewater collection system. It is assumed for this General Sewer Plan (GSP) that all of these parcels in the City limits will be connected to the City's wastewater collection system by 2033, and the sewer service population will be the same as the UGA population by 2043. This will ensure that the City has the infrastructure in place to serve the entire UGA population.

EXISTING WASTEWATER FLOW AND LOADING

Wastewater Flow

The total influent flow to the WWTF is made up of untreated flow from primarily residential customers, but also includes flow from a number of commercial, hospitality, and retail businesses, schools, and the Jefferson Healthcare Medical Center. The City's existing collection system flow rates were estimated using the WWTF discharge monitoring reports and lift station run time data for the 2016 through 2021 period. The City's sewer collection system drainage basins are shown in **Figure 2-1**.

The City's discharge monitoring reports have been reviewed and analyzed to determine current wastewater characteristics and influent loadings. **Table 4-3** summarizes the historical WWTF AAFs, MMFs, MDFs (including I/I), and PHFs on an annual basis for the 2016 through 2021 period.

Table 4-3

Historical WWTF Influent Flow Summary

Year	Sewer System Population	AAF (MGD)	AAF per Capita (gpcd)	MMF (MGD)	MDF (MGD)	PHF (MGD)	Percent of NPDES Permit Max. Month Limit[1]	Peaking Factors		
								MMF/AAF	MDF/AAF	PHF/AAF
2016	9,414	0.85	91	1.07	1.99	--	52%	1.26	2.33	--
2017	9,480	0.84	88	0.92	1.39	2.79	45%	1.10	1.66	3.33
2018	9,559	0.87	91	1.16	1.82	3.06	57%	1.33	2.09	3.52
2019	9,669	0.78	81	0.87	1.12	2.35	43%	1.11	1.43	2.99
2020	9,757	0.80	82	1.15	2.37	3.34	56%	1.43	2.96	4.17
2021	9,829	0.84	85	1.02	2.18	---	50%	1.22	2.60	---
2016 to 2019 Average[2]		**0.84**	**88**	**1.01**	**1.58**	**2.74**	--	**1.20**	**1.88**	**3.28**
2016 to 2019 Max.[2]		**0.87**	**91**	**1.16**	**1.99**	**3.06**	--	**1.33**	**2.33**	**3.52**

1 = The City's WWTF is permitted for a maximum month average influent flow of 2.05 MGD.
2 = 2020 and 2021 values are not included in the historical averages and maximums due to the COVID pandemic.

The monthly average and maximum influent wastewater flows recorded on the WWTF's discharge monitoring reports for the 2016 through 2021 period are summarized in **Appendix H**. Data from 2020 and 2021 were not included in the historical averages and maximums in **Table 4-3** due to probable shifts in typical wastewater patterns due to the COVID pandemic.

In the 2016 to 2019 period, the average annual flow for the WWTF is 0.84 million gallons per day (MGD), with the highest AAF of 0.87 MGD occurring in 2018. The AAF for 2016 through 2018 has remained at or above the 4-year average. In 2019, the AAF dropped to 0.78 MGD. The MDF for the WWTF has varied from year to year over the same 4-year period, with the lowest MDF of 1.12 MGD occurring in 2019, and the highest MDF of 1.99 MGD occurring in 2016.

The WWTF is currently permitted for a MMF of 2.05 MGD. The City's NPDES permit stipulates that the City shall submit a plan and schedule for continuing to maintain capacity when the flow reaches 85 percent of the permitted flow for 3 consecutive months; 85 percent of the permitted flow is approximately 1.74 MGD. As **Table 4-3** and **Appendix H** show, this limit has not been exceeded in the 2016 through 2019 period. The highest MMF of 1.16 MGD (57 percent of the permitted flow) occurred in 2018. A significant increase in the MMF occurred from 2017 to 2018; however, the MMF dropped again in 2019 to flows similar to 2017.

Wastewater Loading

The City's discharge monitoring reports have been reviewed and analyzed to determine current wastewater characteristics and influent loadings. The 2016 through 2021 historical average annual and maximum month average 5-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) loadings in pounds per day (ppd) and pounds per capita per day (ppcd) are summarized in **Tables 4-4** and **4-5**, respectively.

Table 4-4

Historical WWTF Influent BOD_5 Loading Summary

Year	Sewer System Population	Average Annual BOD_5 (mg/L)	Average Annual BOD_5 (ppd)	Average Annual BOD_5 (ppcd)	Max. Month BOD_5 (mg/L)	Max. Month BOD_5 (ppd)	Percent of NPDES Permit Max. Month Limit[1]	BOD_5 Max. Month Average/Average Annual Peaking Factor
2016	9,414	332	2,242	0.24	405	2,442	65%	1.09
2017	9,480	329	2,289	0.24	364	2,538	68%	1.11
2018	9,559	363	2,509	0.26	454	2,968	79%	1.18
2019	9,669	400	2,591	0.27	437	2,718	72%	1.05
2020	9,757	336	2,147	0.22	374	2,422	65%	1.13
2021	9,829	334	2,221	0.23	393	2,500	67%	1.13
2016 to 2019 Average[2]		**356**	**2,408**	**0.25**	**415**	**2,667**	---	**1.11**
2016 to 2019 Max.[2]		**400**	**2,591**	**0.27**	**454**	**2,968**	---	**1.18**

1 = The City's WWTF is permitted for a maximum month BOD_5 influent loading of 3,754 ppd.
2 = 2020 and 2021 values are not included in the historical averages and maximums due to the COVID pandemic.

Table 4-5

Historical WWTF Influent TSS Loading Summary

Year	Sewer System Population	Average Annual TSS (mg/L)	Average Annual TSS (ppd)	Average Annual TSS (ppcd)	Max. Month TSS (mg/L)	Max. Month TSS (ppd)	Percent of NPDES Permit Max. Month Limit[1]	TSS Max. Month Average/Average Annual Peaking Factor
2016	9,414	331	2,240	0.24	388	2,458	54%	1.10
2017	9,480	329	2,291	0.24	367	2,564	56%	1.12
2018	9,559	359	2,493	0.26	431	2,799	61%	1.12
2019	9,669	376	2,437	0.25	417	2,686	59%	1.10
2020	9,757	341	2,188	0.22	386	2,725	60%	1.25
2021	9,829	322	2,146	0.22	390	2,481	54%	1.16
2016 to 2019 Average[2]		**349**	**2,365**	**0.25**	**401**	**2,627**	---	**1.11**
2016 to 2019 Max.[2]		**376**	**2,493**	**0.26**	**431**	**2,799**	---	**1.12**

1 = The City's WWTF is permitted for a maximum month TSS influent loading of 4,568 ppd.
2 = 2020 and 2021 values are not included in the historical averages and maximums due to the COVID pandemic.

The average annual and maximum month average BOD_5 and TSS loadings in **Tables 4-4** and **4-5** were estimated from 2016 through 2019 data. Data from 2020 and 2021 are not included in the historical averages due to the COVID pandemic. The monthly average and maximum influent loadings recorded at the WWTF for the 2016 through 2019 period are summarized in **Appendix H**.

In the 2016 through 2019 period, the average annual influent BOD_5 loading has increased overall; however, there have been fluctuations throughout that time period with both significant increases and decreases from year to year. The average annual influent BOD_5 and TSS loadings significantly increased from 2017 to 2018. Average annual BOD_5 and TSS loadings were relatively consistent in 2016 and 2017, before increasing in 2018. As **Tables 4-4** and **4-5** show, the average annual BOD_5 and TSS loading are relatively similar.

The WWTF currently has a permitted capacity for BOD_5 influent maximum month average loading of 3,754 ppd and a TSS influent maximum month average loading of 4,568 ppd. The City's NPDES permit stipulates that the City shall submit a plan and schedule for continuing to maintain capacity when the loading reaches 85 percent of the permitted loading for

3 consecutive months; 85 percent of the permitted loading is 3,191 ppd for BOD_5 and 3,883 ppd for TSS.

As **Tables 4-4** and **4-5** show, the BOD_5 and TSS influent limits have not been exceeded in the 2016 through 2019 time period. The highest maximum month average BOD_5 loading of 2,968 ppd (79 percent of the permitted BOD_5 loading) and the highest maximum month average TSS loading of 2,799 ppd (61 percent of the permitted TSS loading) both occurred in 2018.

INFLOW AND INFILTRATION

I/I is the combination of groundwater and surface water that enters the sewer system. Infiltration is groundwater entering the sewer system through defects in the sewer system infrastructure, such as fractured pipes and leaking maintenance holes and pipe joints. Inflow is surface water that enters the sewer system from sources such as roof and street drains and leaky maintenance hole covers.

A sanitary sewer system must be able to carry the domestic wastewater generated by utility customers and the extraneous I/I that is a part of every sewer collection system. Excessive I/I in the sewer collection system can lead to serious issues within the collection system that may include wastewater system backups and overflows, accelerating the structural deficiencies of the collection system. Excessive I/I also can inflate capacity requirements of the proposed collection and treatment system infrastructure.

Reducing I/I in a sewer collection system can reduce the risk of sanitary sewer overflows and the cost of treating wastewater. By reducing or eliminating I/I sources, the extraneous water that previously occupied the conveyance and treatment system can now be occupied by sewage flows. This leads to delaying conveyance and treatment projects that were needed because of the extraneous I/I water.

The U.S. Environmental Protection Agency (EPA) published a report in May 1985, *Infiltration/Inflow, I/I Analysis and Project Certification*, which developed guidelines to help determine what amount of I/I is considered to be excessive and what amount can be cost-effectively removed. The report established I/I flow rates that are considered normal or acceptable based on surveys and statistical evaluations of data from hundreds of cities across the nation.

Precipitation and temperature data were compiled from the National Oceanic and Atmospheric Administration's (NOAA) website for weather stations in and near the City.

Inflow

The EPA report gives guidelines for determining whether inflow can be classified as non-excessive. Inflow is considered to be non-excessive if the average daily flow during periods of heavy rainfall or spring thaw (i.e. any event that creates surface ponding and surface runoff) does not exceed 275 gallons per capita per day (gpcd). The peak recorded daily flow in the 6 years analyzed for the City (2016 through 2021) was 2.37 MGD, which occurred on February 5, 2020. Per the weather data obtained from NOAA, this day was recorded as having

0.95 inches of precipitation. This peak inflow event equates to a 243 gpcd flow rate, which is below the EPA's maximum of 275 gpcd. The second peak recorded daily flow was 2.36 MGD, which occurred on the following day, February 6, 2020. This day was recorded as having 0.4 inches of precipitation. This peak inflow event equates to a 242 gpcd flow rate, which does not exceed the EPA maximum. The third highest recorded daily flow was 2.18 MGD, which occurred on January 4, 2021. This day was recorded as having 0.64 inches of precipitation and a peak inflow equating to 222 gpcd, which is below the EPA's inflow guideline.

All three peaks are below the EPA's maximum inflow criterion and are considered non-excessive. The City should continue to monitor inflow throughout the system, particularly in areas over 50 years old that previously may have been combined collection systems.

Infiltration

The EPA's guideline for determination of non-excessive infiltration was based on the national average for dry weather flow of 120 gpcd. In order for the amount of infiltration to be considered non-excessive, the average daily flow must be less than 120 gpcd (i.e. a 7- to 14-day average measured during periods of seasonal high groundwater). Although it can be difficult to discern between inflow and infiltration, peak inflow will generally occur immediately during or just after a significant rain event, while peak infiltration will occur during the high groundwater period that follows prolonged precipitation events.

The peak dry weather flow period in the last 6 years (2016 through 2021) of record for the City, occurring after a few consecutive days of rain, was the 5-day period from January 22, through January 26, 2016. This period also was directly preceded by heavy rains, and yielded an average flow of 1.20 MGD, equating to 128 gpcd. The second highest peak dry weather flow period occurred during a 13-day period from February 4, through February 16, 2018. This period was preceded by moderate rainfall and yielded an average flow of 124 gpcd. The third highest peak dry weather flow period occurred during a 14-day period from February 7, through February 21, 2020. This period directly followed a period of heavy rainfall and yielded an average flow of 121 gpcd. All three events are slightly above the EPA's maximum infiltration criterion; therefore, the amount of infiltration is considered excessive. The City should continue to monitor infiltration throughout the system.

Any I/I studies that are conducted in the future should follow the guidelines defined in Chapter C-1 of Ecology's *Criteria for Sewage Works Design* (commonly known as the "Orange Book"). Emphasis should be placed on older sections of the City with concrete, vitrified clay, and asbestos cement mains or in areas suspected of being combined sewers. Lawrence Street is believed to convey both storm and sanitary sewer. **Chapter 10** discusses remediation of this defect..

PROJECTED WASTEWATER FLOW AND LOADING

The City's sewer system is projected to add a total of 5,850 additional persons by 2043, using 2018 as the base year. This increase in population includes the sewer system expansion as discussed in **Chapter 3**.

Peaking Factors

Once existing flow rates are measured and defined, projected flow rates can be developed. Projected flows are used to analyze how well the existing system will perform in the future and determine improvements required to maintain or improve system function. In order to establish projected flow scenarios for a sewer system, peaking factors need to be determined for the existing system, which can then be applied to projected flow rates. Peaking factors are the ratio of higher flows, such as MDF to AAF.

A maximum peak hour flow of 3.34 MGD, based on the highest PHF from the flow data analyzed for this GSP, occurred in 2020 during the COVID pandemic. The AAF for 2020 was lower than typical so the peaking factors were estimated by finding the ratio of the 2020 PHF to the 2016 to 2019 average AAF, establishing a PHF/AAF of 4.00 for the WWTF. **Table 4-6** shows a summary of the peaking factors for flows at the City's WWTF for the 2016 through 2021 period.

Table 4-6

Peaking Factor Summary for Flows

Flow	
Max. Month Average Flow/Average Annual Flow (MMF/AAF)	1.33
Max. Day Flow/Average Annual Flow (MDF/AAF)[1]	2.83
Peak Hour Flow/Average Annual Flow (PHF/AAF)[1]	4.00
BOD_5	
Max. Month Average/Average Annual Loading	1.18
TSS	
Max. Month Average/Average Annual Loading	1.12

1 = The MDF and PHF for 2016 through 2021 both occurred in 2020 during the COVID pandemic. 2020 had a lower than typical AAF, so the PHF/AAF and MDF/AAF peaking factors were estimated with the PHF and MDF from this year divided by the average AAF for 2016 through 2019.

Peaking factors also are developed to determine maximum month average BOD_5 and TSS loading projections. These loading peaking factors are the average historic maximum month to average annual loadings from 2016 to 2019. Data obtained during the COVID pandemic (2020 and 2021) may not represent normal flow and load conditions. For instance, the data from these years shows a wider variability in peaking factors; therefore, it is not included in this calculation. **Table 4-7** shows a summary of the peaking factors for loading at the City's WWTF for the 2016 through 2021 period.

Table 4-7

Peaking Factor Summary for Loadings

Year	BOD_5 Max. Month Average/Average Annual Peaking Factor	TSS Max. Month Average/Average Annual Peaking Factor
2016	1.09	1.10
2017	1.11	1.12
2018	1.18	1.12
2019	1.05	1.10
2020	1.13	1.25
2021	1.13	1.16
Average[1]	**1.11**	**1.11**

1 = The peaking factors used for projections are the averages of the peaking factors from 2016 to 2019. 2020 and 2021 values are not included in these averages due to the COVID pandemic.

The peaking factors presented in **Tables 4-6** and **4-7** were used to project flows and loadings in the following sections.

Projected Wastewater Flow Rates

Once existing flow rates are measured and defined, projected flow rates can be developed. Projected flows are used to analyze how well the existing system will perform in the future and determine improvements required to maintain or improve system function.

The projected flows at the WWTF were developed using the following information:

- Projected AAFs were estimated using the 2018 AAF, which is approximately 0.87 MGD, as the existing baseline. Year 2018 was used as the existing baseline for flow projections because this was the highest AAF over the last 4 years analyzed.
- The highest AAF per capita for 2016 through 2019 was 91 gpcd (**Table 4-3**), which includes I/I and commercial wastewater flows. This value was used for projecting how much additional wastewater flow the projected population growth would contribute to the City's sewer system.
- The flow peaking factors shown in **Table 4-6** were used for estimating MMFs, MDFs, and PHFs from projected AAFs.
- From 2025 to buildout, the population and projected flows include the growth as a result of expanding the sewer service area as described in **Chapter 3**.

Summaries of the projected flows for the sewer system population within the City limits, additional sewer expansion, and the total of the two populations, are presented in **Tables 4-8** through **4-10**, respectively.

Table 4-8

Projected WWTF Influent Flow for Sewer System Population Within City Limits

Year	Equivalent Sewer System Population	Projected AAF (MGD)[1]	Projected MMF (MGD)[2]	Percent of NPDES Permit Max. Month Limit[3]	Projected MDF (MGD)[4]	Projected PHF (MGD)[5]	Projected PHF with Inflow Reduction (MGD)[6]
2018 (Baseline)	**9,559**	**0.87**	**1.16**	**57%**	**1.82**	**3.06**	**--**
2019	9,669	0.78	0.87	43%	1.12	2.35	--
2020	9,757	0.80	1.15	56%	2.37	3.34	--
2021	9,829	0.84	1.02	50%	2.18	---	--
2022	9,981	0.91	1.21	59%	2.57	3.63	--
2023	10,134	0.92	1.23	60%	2.61	3.69	--
2024	10,289	0.94	1.25	61%	2.65	3.75	--
2025	10,445	0.95	1.27	62%	2.69	3.80	--
2026	10,603	0.97	1.29	63%	2.73	3.86	--
2027	10,762	0.98	1.31	64%	2.78	3.92	--
2028	10,923	0.99	1.33	65%	2.82	3.98	--
2029	11,085	1.01	1.35	66%	2.86	4.04	--
2030	11,248	1.02	1.37	67%	2.90	4.10	--
2031	11,413	1.04	1.39	68%	2.94	4.16	--
2032	11,580	1.05	1.41	69%	2.99	4.22	--
2033 (+ 10 years)	**11,748**	**1.07**	**1.43**	**70%**	**3.03**	**4.28**	**3.86**
2034	11,886	1.08	1.44	70%	3.07	4.33	3.91
2035	12,025	1.09	1.46	71%	3.10	4.38	3.96
2036	12,165	1.11	1.48	72%	3.14	4.43	4.02
2037	12,321	1.12	1.50	73%	3.18	4.49	4.07
2038	12,479	1.14	1.52	74%	3.22	4.54	4.13
2039	12,639	1.15	1.53	75%	3.26	4.60	4.19
2040	12,801	1.17	1.55	76%	3.30	4.66	4.25
2041	12,965	1.18	1.57	77%	3.34	4.72	4.31
2042	13,132	1.20	1.59	78%	3.39	4.78	4.37
2043 (+ 20 years)	**13,300**	**1.21**	**1.61**	**79%**	**3.43**	**4.84**	**4.43**
Buildout	**23,035**	**2.10**	**2.80**	**136%**	**5.94**	**8.39**	**7.97**

1 = Projected AAFs were estimated by using the 2018 AAF as the baseline and adding 91 gpcd (which was the highest historic flow per capita for 2016 through 2019) multiplied by the projected increase in sewer population from 2018.
2 = Projected MMFs were estimated by multiplying the projected AAF by the highest historic MMF/AAF peaking factor from 2016 through 2019, which was 1.33 in 2018.
3 = The City's WWTF is permitted for a maximum month average influent flow of 2.05 MGD.
4 = Projected MDFs were estimated by multiplying the projected AAF by the MDF/AAF peaking factor of 2.83.
5 = Projected PHFs were estimated by multiplying the projected AAF by the PHF/AAF peaking factor of 4.00.
6 = Projected PHFs with inflow reduction were estimated by reducing projected PHFs after 2032 by 288 gpm (0.41 MGD) to account for the removal of inflow estimated to be contributed by catch basins connected to the City's sewer system along Lawrence Street.

Table 4-9

Projected WWTF Influent Flow for Sewer System Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected AAF (MGD)[1]	Projected MMF (MGD)[2]	Projected MDF (MGD)[3]	Projected PHF (MGD)[4]
2018 (Baseline)	--	--	--	--	--
2019	--	--	--	--	--
2020	--	--	--	--	--
2021	--	--	--	--	--
2022	--	--	--	--	--
2023	--	--	--	--	--
2024	0	0.00	0.00	0.00	0.00
2025	108	0.01	0.02	0.04	0.07
2026	216	0.03	0.04	0.08	0.14
2027	324	0.04	0.05	0.12	0.21
2028	432	0.05	0.07	0.15	0.28
2029	540	0.07	0.09	0.19	0.35
2030	648	0.08	0.11	0.23	0.42
2031	755	0.10	0.13	0.27	0.49
2032	863	0.11	0.15	0.31	0.56
2033 (+ 10 years)	**971**	**0.12**	**0.16**	**0.35**	**0.63**
2034	1,041	0.13	0.17	0.37	0.68
2035	1,116	0.14	0.19	0.40	0.72
2036	1,196	0.15	0.20	0.43	0.77
2037	1,282	0.16	0.22	0.46	0.82
2038	1,374	0.17	0.23	0.49	0.88
2039	1,472	0.19	0.25	0.53	0.94
2040	1,578	0.20	0.27	0.56	1.00
2041	1,691	0.21	0.28	0.60	1.07
2042	1,812	0.23	0.30	0.65	1.14
2043 (+ 20 years)	**1,943**	**0.24**	**0.33**	**0.69**	**1.22**
Buildout	**2,771**	**0.29**	**0.39**	**0.83**	**1.43**

1 = Projected AAFs are based upon the calculated 2033, 2043, and Buildout expansion flows as the baseline. 2024 to 2033 flows were projected with a straight-line appreciation in conjunction with the City's preference on projected equivalent population growth as a result of the sewer expansion.

2 = Projected MMFs were estimated by multiplying the projected AAF by the highest historic MMF/AAF peaking factor from 2016 through 2019, which was 1.33 in 2018.

3 = Projected MDFs were estimated by multiplying the projected AAF by the MDF/AAF peaking factor of 2.83.

4 = Projected PHFs are based upon the calculated 2033, 2043, and Buildout expansion flows as the baseline. 2024 to 2033 flows were projected with a straight-line appreciation in conjunction with the City's preference on projected equivalent population growth as a result of the sewer expansion.

Table 4-10

Total Projected WWTF Flow including Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected AAF[1] (MGD)	Projected MMF[2] (MGD)	Percent of NPDES Permit Max. Month Limit[3]	Projected MDF[4] (MGD)	Projected PHF[5] (MGD)	Projected PHF with Inflow Reduction[6] (MGD)
2018 (Baseline)	**9,559**	**0.87**	**1.16**	**57%**	**1.82**	**3.06**	**--**
2019	9,669	0.78	0.87	43%	1.12	2.35	--
2020	9,757	0.80	1.15	56%	2.37	3.34	--
2021	9,829	0.84	1.02	50%	2.18	---	--
2022	9,981	0.91	1.21	59%	2.57	3.63	--
2023	10,134	0.92	1.23	60%	2.61	3.69	--
2024	10,289	0.94	1.25	61%	2.65	3.75	--
2025	10,553	0.96	1.29	63%	2.73	3.87	--
2026	10,819	0.99	1.32	65%	2.81	4.00	--
2027	11,086	1.02	1.36	66%	2.89	4.13	--
2028	11,354	1.05	1.40	68%	2.97	4.26	--
2029	11,624	1.08	1.44	70%	3.05	4.39	--
2030	11,896	1.11	1.47	72%	3.13	4.52	--
2031	12,169	1.13	1.51	74%	3.21	4.65	--
2032	12,444	1.16	1.55	76%	3.29	4.78	--
2033 (+ 10 years)	**12,720**	**1.19**	**1.59**	**78%**	**3.38**	**4.91**	**4.50**
2034	12,927	1.21	1.62	79%	3.44	5.01	4.59
2035	13,140	1.24	1.65	80%	3.50	5.10	4.69
2036	13,361	1.26	1.68	82%	3.56	5.20	4.79
2037	13,603	1.28	1.71	83%	3.64	5.31	4.90
2038	13,853	1.31	1.75	85%	3.71	5.42	5.01
2039	14,111	1.34	1.78	87%	3.79	5.54	5.13
2040	14,379	1.36	1.82	89%	3.86	5.66	5.25
2041	14,656	1.39	1.86	91%	3.95	5.79	5.38
2042	14,944	1.42	1.90	93%	4.03	5.92	5.51
2043 (+ 20 years)	**15,242**	**1.46**	**1.94**	**95%**	**4.12**	**6.06**	**5.65**
Buildout	**25,806**	**2.39**	**3.19**	**156%**	**6.77**	**9.82**	**9.40**

1 = Total projected AAF was estimated by adding City limit and sewer system expansion flows together.
2 = Total projected MMF was estimated by adding City limit and sewer system expansion flows together.
3 = The City's WWTF is permitted for a maxium month average influent flow of 2.05 MGD.
4 = Total projected MDF was estimated by adding City limit and sewer system expansion flows together.
5 = Total projected PHF was estimated by adding City limit and sewer system expansion flows together.
6 = Projected PHFs with inflow reduction were estimated by reducing projected PHFs after 2032 by 288 (0.41 MGD) to account for the removal of inflow estimated to be contributed by catch basins connected to the City's sewer system along Lawrence Street.

According to these projections, the WWTF will not exceed the NPDES permit maximum month limit capacity for flow during the 20-year planning period. However, the City should evaluate the WWTF for upgrades when the average MMF exceeds 85 percent of the NPDES permit limit. According to these projections, the City should prepare to plan and design WWTF upgrades for flow by 2038.

Historical Wastewater Flow by Basin

Table 4-11 shows the historical lift station AAF and PHF rates over the 2016 through 2020 period. These flow rates were developed using the run time records and pumping capacities for the City's lift stations.

Table 4-11

Historical AAF and PHF Rates by Lift Station

Lift Station[1]	Existing Design Firm Capacity (gpm)	2016		2017		2018		2019		2020		2016 to 2020 Average	
		AAF (gpm)	PHF (gpm)	AAF (gpm)	PHF (gpm)	AAF (gpm)	PHF (gpm)	AAF (gpm)	PHF (gpm)	AAF (gpm)	PHF (gpm)	AAF (gpm)	PHF (gpm)
Gaines Street	1,500	203	1,120	188	1,027	189	982	171	853	173	1,047	185	1,006
Monroe Street	857	144	990[3]	135	990	136	990	124	916	127	990	133	990
Port	195	23	143	21	143	21	85	19	222	20	163	21	151
Island Vista	135	4	18	4	29	5	47	5	38	3	20	4	31
Hamilton Heights	250	10	38	10	33	10	33	10	33	11	33	10	34
31st Street	100	2	15	2	12	2	13	2	13	2	17	2	14
Point Hudson[2]	150	---	---	---	---	---	---	---	---	---	---	---	---
WWTF	---	593	---	582	1,940	604	2,127	545	1,631	557	2,323	555	2,005

1 = Highlighted flows in gray exceed current firm pumping capacity.

2 = Point Hudson Lift Station is not connected to the City's SCADA system.

3 = 990 gpm, estimated from existing pump curves, is representative of all three pumps in the Monroe Street Lift Station running simultaneously.

The peak hour flow rates for the Gaines Street and Monroe Street Lift Stations are surprisingly close in magnitude considering that the Gaines Street basin is larger. The Gaines Street basin serves approximately 500 equivalent residential units (ERUs) more than the Monroe Street basin, which indicates the flow rate per ERU in the Monroe Street basin is much higher than the Gaines Street basin. As portions of the Lawrence Street sewer are still combined storm and sanitary sewer conveyance, this would correlate to higher flows in the Monroe Street basin.

Recorded data from the pump station's supervisory control and data acquisition (SCADA) systems was used to calculate the base flows for each pump station. Base flow information for the Gaines Street Lift Station is based on a magnetic flow meter that records daily totalized flows. For the Monroe Street Lift Station, timed flow tests were used to verify the station's discharge capacity. Run time records were used to multiply the measured flow rates by the run time to determine the station's peak hour. RH2 recommends the City begin recording flow totalizations at the Gaines Street Lift Station on an hourly basis to provide an improved calculation of the peak hour flow.

Projected Wastewater Flow by Basin

The City is planning for additional growth; however, it is uncertain where growth will occur within the UGA. City planning staff made an estimate of where the future growth might occur as shown in **Figure 3-3**. This population forecast was used to allocate future flows in the sewer hydraulic model for 5-, 10- and 20-year design horizons, as shown in **Table 4-12**. The additional flow associated with the projected population, allocated as shown in **Figure 3-3**, was calculated using the per capita domestic and I/I rates developed in **Chapter 3** with a peak hour factor of 4.

Table 4-12

Existing and Projected AAF and PHF Rates by Basin

Basin	Existing 2023 AAF (gpm)	Existing 2023 PHF (gpm)	Projected 2028 AAF (gpm)	Projected 2028 PHF (gpm)	Projected 2038 AAF (gpm)	Projected 2038 PHF (gpm)	Projected 2043 AAF (gpm)	Projected 2043 PHF (gpm)
Monroe Street	135	542	189	757	191	763	194	775
North Bend	10	42	12	50	14	55	16	64
Seaview/Howard Street	30	121	39	155	44	175	53	213
Southwest	-	-	-	-	-	-	-	-
West	-	-	-	-	-	-	-	-
Discovery Road	82	329	100	400	111	443	131	524
Sims Way	63	250	140	562	202	809	324	1296
San Juan Avenue	33	131	38	152	41	164	47	188
Port	21	84	21	84	21	84	21	84
Admiralty Avenue	39	158	42	168	44	175	47	186
Golf Course	19	77	24	98	28	110	34	134
Gaines Street	31	125	31	125	31	122	34	134
F Street	18	74	21	84	23	91	26	103
Hastings Avenue	74	297	92	368	103	411	123	492

The flows shown in this table are the summation of the sanitary loads assigned to the respective drainage basin in the hydraulic model and do not include cumulative gravity or pumped flows from upstream basins.

Refer to **Chapter 3** for more information regarding the development of population growth. Refer to **Chapter 6** for more information regarding the collection system evaluation.

Lift Station Hydraulic Capacity Analyses

Current lift station pumping capacities based on the calculated and measured flow rates, as well as the remaining capacity of each lift station, are provided in **Table 4-13**.

The remaining capacity is presented in terms of the remaining population each lift station is capable of supporting and is based upon a maximum per capita AAF of 91 gpcd and a PHF/AAF peaking factor of 4.00.

Table 4-13

Current AAF and PHF Rates and Remaining Capacity by Lift Station

Lift Station[1]	Existing Design Firm Capacity (gpm)	AAF (gpm)	PHF (gpm)	Remaining AAF Capacity (gpm)	Remaining PHF Capacity (gpm)	Remaining AAF Population	Remaining PHF Population
Gaines Street	1,500	189	1,194	1,311	306	20,740	1,209
Monroe Street	857	136	990	721	-133	11,398	-526
Port	195	21	85	174	111	2,757	438
Island Vista	135	5	18	130	117	2,062	464
Hamilton Heights	250	10	38	240	212	3,797	838
31st Street	100	2	7	98	93	1,554	369
Point Hudson[2]	150	1	4	149	146	2,357	578

1 = Highlighted flows in gray exceed current firm pumping capacity.
2 = Point Hudson Lift Station is not connected to the City's SCADA system, so the existing flow for this basin was estimated from the number of homes in this sewer basin.

As indicated in **Table 4-13**, all lift stations, with the exception of Monroe Street, have the capacity to support existing flows from their basins. There are many instances of all three pumps in the Monroe Street Lift Station running, which may be indicative of the lift station being unable to convey the peak flows using only two of the three pumps in the station (the desired standard). Capacity upgrades to this lift station will be necessary in the future to handle projected flows. The Monroe Street basin also experiences the greatest levels of I/I relative to other basins in the City. Operations staff states that the Monroe Street Lift Station discharge surcharges with three pumps operating simultaneously during peak flows but does not overflow.

The City is planning to perform an I/I study to identify improvements that could reduce I/I in the sewer system. These I/I improvements could reduce or mitigate the I/I component of the PHFs in the City's sewer collection system, which could reduce or mitigate projected flows. For example, it is known that Lawrence Street has storm inlets connected to the sanitary sewer. Capacity upgrades to the Monroe Street Lift Station should be performed following with the removal of upstream inflow sources.

Besides the Monroe Street Lift Station, the City's lift stations have ample capacity to convey future flows for the 20-year design horizon (**Table 4-13**). Most of the projected growth will originate in the Mill site area and be pumped by the new Mill Lift Station. All of the discharge from this station will flow by gravity to the WWTF, posing no new loads to existing lift stations. Gravity conveyance upgrades will be substantial, but lift station capacity upgrades will not. Equipment replacements for the City's lift stations will be needed as it wears out, but these costs will be covered under a maintenance line item as described in the Capital Improvement Plan in **Chapter 10**.

Projected Wastewater Loading Capacity

Once existing influent loadings are determined, projected loading capacities can be developed. Projected loadings are used to project future WWTF loading capacities and determine improvements required to increase treatment capacity.

The projected BOD_5 and TSS loadings at the WWTF were developed using the following information:

- Average annual BOD_5 loadings were projected using the 2019 average annual loadings as the baseline and adding 0.20 ppcd, which is the average annual BOD_5 loading per capita per day defined in the Orange Book, multiplied by the projected increase in sewer population from 2019. This estimation from the Orange Book represents residential contributions to loading, and it is assumed that the City's projected population growth will be mainly residential.
- Average annual TSS loadings were projected using the 2018 average annual loadings as the baseline and adding 0.20 ppcd multiplied by the projected increase in sewer population from 2018, similar to the BOD_5 loading projections.
- The loading peaking factors shown in **Table 4-7** were used for estimating maximum month average loadings from projected average annual loadings.
- From 2025 to buildout, the population includes the growth as a result of expanding the sewer service area as described in **Chapter 3**.

Summaries of the projected BOD_5 and TSS loadings for the sewer system population within City limits, additional sewer expansion, and the total of the two populations, are presented in **Tables 4-14** through **4-19**, respectively.

Table 4-14

Projected WWTF Influent BOD_5 Loading for Sewer System Population Within City Limits

Year	Equivalent Sewer System Population	Projected Average Annual BOD_5 (ppd)[1]	Projected Max. Month Average BOD_5 (ppd)[2]	Percent of NPDES Permit Max. Month Limit[3]
2018	9,559	2,509	2,968	79%
2019 (Baseline)	**9,669**	**2,591**	**2,718**	**72%**
2020	9,757	2,147	2,422	65%
2021	9,829	2,221	2,500	67%
2022	9,981	2,654	2,939	78%
2023	10,134	2,684	2,973	79%
2024	10,289	2,715	3,007	80%
2025	10,445	2,747	3,042	81%
2026	10,603	2,778	3,077	82%
2027	10,762	2,810	3,112	83%
2028	10,923	2,842	3,148	84%
2029	11,085	2,875	3,184	85%
2030	11,248	2,907	3,220	86%
2031	11,413	2,940	3,257	87%
2032	11,580	2,974	3,293	88%
2033 (+ 10 years)	**11,748**	**3,007**	**3,331**	**89%**
2034	11,886	3,035	3,361	90%
2035	12,025	3,063	3,392	90%
2036	12,165	3,091	3,423	91%
2037	12,321	3,122	3,458	92%
2038	12,479	3,153	3,493	93%
2039	12,639	3,185	3,528	94%
2040	12,801	3,218	3,564	95%
2041	12,965	3,251	3,600	96%
2042	13,132	3,284	3,637	97%
2043 (+ 20 years)	**13,300**	**3,318**	**3,674**	**98%**
Buildout	**23,035**	**5,265**	**5,831**	**155%**

1 = Projected average annual BOD_5 loadings were estimated by using the 2019 average annual BOD_5 loading as the baseline and adding 0.20 ppcd (which is the BOD_5 loading per capita per day as defined in Ecology's *Criteria for Sewage Works Design*) multiplied by the projected increase in sewer population from 2019.

2 = Projected maximum month average BOD_5 loadings were estimated by multiplying the projected average annual BOD_5 loading by the average historic maximum month to average annual BOD_5 loading peaking factor from 2016 through 2019, which was 1.11.

3 = The City's WWTF is permitted for a maximum month average influent BOD_5 loading of 3,754 ppd.

Table 4-15

Projected WWTF Influent BOD_5 Loading for Sewer System Special Study Area Expansion

Year	Equivalent Sewer System Population[1]	Projected Average Annual BOD_5 (ppd)[2]	Projected Max. Month Average BOD_5 (ppd)[3]
2024	0	0	0
2025	108	22	24
2026	216	43	48
2027	324	65	72
2028	432	86	96
2029	540	108	120
2030	648	130	143
2031	755	151	167
2032	863	173	191
2033 (+ 10 years)	**971**	**194**	**215**
2034	1,041	208	231
2035	1,116	223	247
2036	1,196	239	265
2037	1,282	256	284
2038	1,374	275	304
2039	1,472	294	326
2040	1,578	316	350
2041	1,691	338	375
2042	1,812	362	401
2043 (+ 20 years)	**1,943**	**389**	**430**
Buildout	**2,771**	**554**	**614**

1 = Projected equivalent populations were estimated as a straight line appreciation from 2024 to 2033 per the City's preference on sewer expansion.

2 = Projected average annual BOD_5 loadings were estimated by multiplying the projected equivalent populations by 0.20 ppcd (which is the BOD_5 loading per capita per day as defined in Ecology's *Criteria for Sewage Works Design*).

3 = Projected maximum month average BOD_5 loadings were estimated by multiplying the projected average annual BOD_5 loading by the average historic maximum month to average annual BOD_5 loading peaking factor from 2016 through 2019, which was 1.11.

Table 4-16

Total Projected WWTF BOD_5 Loading including Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected Average Annual BOD_5 (ppd)[1]	Projected Max. Month Average BOD_5 (ppd)[2]	Percent of NPDES Permit Max. Month Limit[3]
2018	9,559	2,509	2,968	79%
2019 (Baseline)	**9,669**	**2,591**	**2,718**	**72%**
2020	9,757	2,147	2,422	65%
2021	9,829	2,221	2,500	67%
2022	9,981	2,654	2,939	78%
2023	10,134	2,684	2,973	79%
2024	10,289	2,715	3,007	80%
2025	10,553	2,768	3,066	82%
2026	10,819	2,821	3,125	83%
2027	11,086	2,875	3,184	85%
2028	11,354	2,928	3,243	86%
2029	11,624	2,982	3,303	88%
2030	11,896	3,037	3,363	90%
2031	12,169	3,091	3,424	91%
2032	12,444	3,146	3,485	93%
2033 (+ 10 years)	**12,720**	**3,202**	**3,546**	**94%**
2034	12,927	3,243	3,592	96%
2035	13,140	3,286	3,639	97%
2036	13,361	3,330	3,688	98%
2037	13,603	3,378	3,741	100%
2038	13,853	3,428	3,797	101%
2039	14,111	3,480	3,854	103%
2040	14,379	3,533	3,913	104%
2041	14,656	3,589	3,975	106%
2042	14,944	3,646	4,039	108%
2043 (+ 20 years)	**15,242**	**3,706**	**4,105**	**109%**
Buildout	**25,806**	**5,819**	**6,445**	**172%**

1 = Projected average annual BOD_5 loadings were estimated by adding City limit and sewer system expansion loadings together.

2 = Projected maximum month average BOD_5 loadings were estimated by adding City limit and sewer system expansion loadings together.

3 = The City's WWTF is permitted for a maximum month average influent BOD_5 loading of 3,754 ppd.

According to these projections, the WWTF will exceed the NPDES permit maximum month limit capacity for BOD_5 during the 20-year planning period. However, the City should prepare the WWTF for upgrades when the maximum month average BOD_5 load exceeds 85 percent of the NPDES permit limit. According to these projections, the City will need to start planning and designing WWTF upgrades by 2027. If the special study area expansion is not implemented, then these upgrades will be delayed until 2029.

Table 4-17

Projected WWTF Influent TSS Loading for Sewer System Population Within City Limits

Year	Equivalent Sewer System Population	Projected Average Annual TSS (ppd)[1]	Projected Max. Month Average TSS (ppd)[2]	Percent of NPDES Permit Max. Month Limit[3]
2018 (Baseline)	**9,559**	**2,493**	**2,799**	**61%**
2019	9,669	2,437	2,686	59%
2020	9,757	2,188	2,725	60%
2021	9,829	2,146	2,481	54%
2022	9,981	2,577	2,862	63%
2023	10,134	2,608	2,896	63%
2024	10,289	2,639	2,930	64%
2025	10,445	2,670	2,965	65%
2026	10,603	2,702	3,000	66%
2027	10,762	2,734	3,035	66%
2028	10,923	2,766	3,071	67%
2029	11,085	2,798	3,107	68%
2030	11,248	2,831	3,143	69%
2031	11,413	2,864	3,180	70%
2032	11,580	2,897	3,217	70%
2033 (+ 10 years)	**11,748**	**2,931**	**3,254**	**71%**
2034	11,886	2,958	3,285	72%
2035	12,025	2,986	3,315	73%
2036	12,165	3,014	3,347	73%
2037	12,321	3,045	3,381	74%
2038	12,479	3,077	3,416	75%
2039	12,639	3,109	3,452	76%
2040	12,801	3,141	3,488	76%
2041	12,965	3,174	3,524	77%
2042	13,132	3,208	3,561	78%
2043 (+ 20 years)	**13,300**	**3,241**	**3,599**	**79%**
Buildout	**23,035**	**5,188**	**5,760**	**126%**

1 = Projected average annual TSS loadings were estimated by using the 2018 average annual TSS loading as the baseline and adding 0.20 ppcd (which is the TSS loading per capita per day as defined in Ecology's *Criteria for Sewage Works Design*) multiplied by the projected increase in sewer population from 2018.

2 = Projected maximum month average TSS loadings were estimated by multiplying the projected average annual TSS loading by the average historic maximum month to average annual TSS loading peaking factor from 2016 through 2019, which was 1.11.

3 = The City's WWTF is permitted for a maximum month average influent TSS loading of 4,568 ppd.

Table 4-18

Projected WWTF Influent TSS Loading for Sewer System Special Study Area Expansion

Year	Equivalent Sewer System Population[1]	Projected Average Annual TSS (ppd)[2]	Projected Max. Month Average TSS (ppd)[3]
2024	0	0	0
2025	108	22	24
2026	216	43	48
2027	324	65	72
2028	432	86	96
2029	540	108	120
2030	648	130	144
2031	755	151	168
2032	863	173	192
2033 (+ 10 years)	**971**	**194**	**216**
2034	1,041	208	231
2035	1,116	223	248
2036	1,196	239	266
2037	1,282	256	285
2038	1,374	275	305
2039	1,472	294	327
2040	1,578	316	350
2041	1,691	338	376
2042	1,812	362	402
2043 (+ 20 years)	**1,943**	**389**	**431**
Buildout	**2,771**	**554**	**615**

1 = Projected equivalent populations were estimated as a straight line appreciation from 2024 to 2033 per the City's preference on sewer expansion.

2 = Projected average annual TSS loadings were estimated by multiplying the projected equivalent populations by 0.20 ppcd (which is the TSS loading per capita as defined in Ecology's *Criteria for Sewage Works Design*).

3 = Projected maximum month average TSS loadings were estimated by multiplying the projected average annual TSS loading by the average historic maximum month to average annual TSS loading peaking factor from 2016 through 2019, which was 1.11.

Table 4-19

Total Projected WWTF TSS Loading including Special Study Area Expansion

Year	Equivalent Sewer System Population	Projected Average Annual TSS (ppd)[1]	Projected Max. Month Average TSS (ppd)[2]	Percent of NPDES Permit Max. Month Limit[3]
2018 (Baseline)	**9,559**	**2,493**	**2,799**	**61%**
2019	9,669	2,437	2,686	59%
2020	9,757	2,188	2,725	60%
2021	9,829	2,146	2,481	54%
2022	9,981	2,577	2,862	63%
2023	10,134	2,608	2,896	63%
2024	10,289	2,639	2,930	64%
2025	10,553	2,692	2,989	65%
2026	10,819	2,745	3,048	67%
2027	11,086	2,798	3,107	68%
2028	11,354	2,852	3,167	69%
2029	11,624	2,906	3,227	71%
2030	11,896	2,960	3,287	72%
2031	12,169	3,015	3,347	73%
2032	12,444	3,070	3,408	75%
2033 (+ 10 years)	**12,720**	**3,125**	**3,470**	**76%**
2034	12,927	3,167	3,516	77%
2035	13,140	3,209	3,563	78%
2036	13,361	3,253	3,612	79%
2037	13,603	3,302	3,666	80%
2038	13,853	3,352	3,721	81%
2039	14,111	3,403	3,779	83%
2040	14,379	3,457	3,838	84%
2041	14,656	3,513	3,900	85%
2042	14,944	3,570	3,964	87%
2043 (+ 20 years)	**15,242**	**3,630**	**4,030**	**88%**
Buildout	**25,806**	**5,742**	**6,376**	**140%**

1 = Projected average annual TSS loadings were estimated by adding City limit and sewer system expansion loadings together.
2 = Projected maximum month average TSS loadings were estimated by adding City limit and sewer system expansion loadings together.
3 = The City's WWTF is permitted for a maximum month average influent TSS loading of 4,568 ppd.

According to these projections, the WWTF will not exceed the NPDES permit maximum month limit capacity for TSS during the 20-year planning period. However, the City should prepare the WWTF for upgrades when the maximum month average TSS load exceeds 85 percent of the NPDES permit limit. According to these projections, the City should prepare for WWTF upgrades for TSS by 2041.

SUMMARY

Table 4-20 provides a summary of the existing, 10-year (2033), planning year (2043), and buildout flow, and BOD_5 and TSS loadings for the City's wastewater collection and treatment systems.

Table 4-20

Summary of Existing and Projected Flow and Loading at the WWTF

Flow (MGD)				
	Existing (2018)	**Projected 2033**	**Projected 2043**	**Projected Buildout**
Average Annual Flow	0.87	1.19	1.46	2.39
Max. Month Average Flow	1.16	1.59	1.94	3.19
Max. Day Flow	1.82	3.38	4.12	6.77
Peak Hour Flow	3.06	4.91	6.06	9.82
BOD_5 (ppd)				
	Existing (2019)	**Projected 2033**	**Projected 2043**	**Projected Buildout**
Average Annual BOD_5	2,591	3,202	3,706	5,819
Max. Month Average BOD_5	2,718	3,546	4,105	6,445
TSS (ppd)				
	Existing (2018)	**Projected 2033**	**Projected 2043**	**Projected Buildout**
Average Annual TSS	2,493	3,125	3,630	5,742
Max. Month Average TSS	2,799	3,470	4,030	6,376

5 | POLICIES AND COLLECTION SYSTEM DESIGN CRITERIA

INTRODUCTION

The City of Port Townsend (City) operates and plans sewer service for the City and associated sewer service area residents and businesses according to the design criteria, laws, and policies that originate from the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology).

These laws, design criteria, and policies guide the City's operation and maintenance of the sewer system on a daily basis, as well as the City's plan for growth and improvements. The overall objective is to ensure that the City provides high quality sewer service at a fair and reasonable cost to its customers. These laws, design criteria, and policies also set the standards the City must meet to ensure that the sewer system is adequate to meet existing and future flows. The collection system's ability to handle these flows is detailed in **Chapter 6**, and the analysis of the existing wastewater treatment system is detailed in **Chapter 7**. The recommended improvements for the collection system and wastewater treatment systems are identified in **Chapter 10**.

The City Council adopts regulations and policies that cannot be less stringent or in conflict with those established by the federal and state governments. The City's policies take the form of ordinances, memoranda, and operational procedures, many of which are summarized in this chapter.

The City will maintain an updated General Sewer Plan (GSP) that is coordinated with the Land Use Element of the *Comprehensive Plan* so that new development will be located where sufficient sewer system capacity exists or where the collection system can be efficiently and logically extended.

The policies associated with the following categories are presented in this chapter.

- Regulations
- Customer Service
- Collection System
- Lift Stations
- Operational
- Organizational
- Financial

REGULATIONS

National Pollutant Discharge Elimination System Permit

Wastewater discharge into surface waters of the State shall have a National Pollutant Discharge Elimination System (NPDES) permit from Ecology. Refer to **Chapter 2** for details on the City's NPDES permit. The permit contains a flow limit, influent and effluent quality standards, monitoring requirements, pretreatment requirements, and system maintenance requirements. A copy of the City's NPDES permit is included in **Appendix C**.

Other Regulations and Required Permits

Refer to **Chapter 2** for other regulations and required permits that apply to the City's Wastewater Treatment Facility (WWTF). In addition, Chapter 173-240 Washington Administrative Code (WAC) defines requirements for wastewater facilities plans and reports, and the City follows the guidelines in Ecology's 2008 *Criteria for Sewage Works Design* (Orange Book).

CUSTOMER SERVICE POLICIES

- Evaluate the prioritization of capital facilities to serve the housing and density needs of the City based on the upcoming 2025 periodic update. This likely will replace the current Policy 14.2, concerning tiers, in the Land Use Element of the *Comprehensive Plan*.

Existing Sewer Service and Connection

- Prioritize capital facilities, services, and utilities within the urban growth tiers per Policy 14.2 of the *Comprehensive Plan* and Title 13 of the Port Townsend Municipal Code (PTMC). PTMC 13.01.120 addresses City participation when funds are available as identified in the 6-year capital facilities plan. Chapter 13.23 specifies that in Tier 1, the City will participate in sewer extensions when existing structures connected to an on-site septic system benefit. Historic implementation of the tiering system has not occurred due to the lack of funding for such sewer extensions. As a result, sewer extensions have occurred at the cost of the developer who often has utilized the latecomer fee process for potential reimbursement from benefiting properties.
- Increase the capacity of the collection system and WWTF to reflect increased usage trends influenced by the City's growth and economic development per Policy 14.3 of the *Comprehensive Plan* Land Use Element.
- As the City's Urban Growth Area (UGA) is the same as the City's sewer service area, sewer service shall not extend beyond the City limits.
- Provide sewer service to properties within the City's sewer service area, provided all policies related to service can be met. Ensure that existing and new developments within the UGA have WWTF and collection line capacities to meet their needs, as well as State and federal discharge standards.

- Chapter 13.22 PTMC requires all properties that develop or redevelop within the City limits to connect to the City's sewer system when the development is located within 260 feet of a wastewater collection line with the following exception: new single-family residences that are more than 260 feet from the nearest City sewer main and are subject to review under Chapter 19.05 PTMC, Critical Areas, and the impacts of the system are adequately mitigated and conditioned through critical areas review. Any development that is a subdivision, short plat, or Planned Unit Development subject to PTMC Title 18, a land use or permit approval that requires a threshold determination under Chapter 19.04 PTMC, or structures (other than single-family residences) subject to the Critical Areas ordinance all require sewer connection regardless of location. Additionally, any on-site septic systems must be approved by the Jefferson County Public Health and be on a lot of sufficient size to meet the requirements for on-site systems.
- Sewer system extensions, required to provide sewer service to proposed developments, shall be approved by the Department of Public Works and must comply with the City's most current, adopted Engineering Design Standards, PTMC Title 13, all applicable Revised Codes of Washington (RCWs) and WACs, guidance administered by Ecology, and the WSDOT/APWA Standard Specifications. All costs of the extension shall be borne by the developer or applicant. The City's Wastewater Engineering Standards are included in **Appendix G**.
- For sewer service applications within the City limits, the City will review the availability for sewer service at the time of utility development permit review. During the utility development permitting process, the City will determine if sewer is available for the site and will address the sizing and location of the sewer extension.
- Sewer collection system, lift station, and WWTF capacity will be considered when providing sewer availability to applicants.
- Sewer availability shall expire at the time that the utility development permit expires.
- Time extensions in regard to sewer availability shall be granted in accordance with the associated permit requirements and PTMC.
- Chapters 13.21 through 13.24 PTMC provide regulations for the City's sanitary sewer system.

Proposed Sewer Service and Connection Policies

The following proposed policies are part of this GSP through its adoption by the City Council and approval by Ecology. These proposed policies will need to be memorialized as part of the 2025 periodic *Comprehensive Plan* adoption, as well as updates to the PTMC and the Engineering Design Standards.

- As the City's Urban Growth Area (UGA) is the same as the City's sewer service area, sewer service shall not extend beyond the City limits except as permitted by the Growth Management Act and governing laws according to the Special Study Area expansion described in **Chapter 2**.

- Remove and replace the ineffective tiering system with an alternative approach to achieving the goals of the City concerning sewer extensions.
- Develop policies and incentives to maximize density, including multi-family development.
- Develop policies and incentives to support affordable and attainable housing. For the purpose of this policy, attainable housing will need to be defined in terms of affordability levels or housing type.
- Develop policies to minimize the use of on-site septic systems while recognizing the requirements of WAC 246-272A-0025, which the local health officer is required to follow. This WAC allows for the development of on-site septic systems when a property is located more than 200 feet from a public sewer main. This provision does not apply to land use actions such as subdivisions.
- Develop sewer extension regulations related to pre-platted plots incentivizing development of density on pre-platted lots or preservation of pre-platted lots for future development. This goal is to discourage the combination of pre-platted lots.

Septic System Policies

- Currently, 211 properties within the City limits have been identified as using on-site sewage systems. According to the Growth Management Act, no new on-site septic sewage systems should be allowed in the UGA as new development is intended to be at urban densities that require sewers. In addition, Chapter 70.118 RCW requires counties to develop and implement management plans for on-site sewage systems.
- No new on-site septic systems are allowed inside the City limits on properties where existing City sewer main is within 260 feet of the boundary of the subject property according to PTMC.
- Existing single-family homes with septic systems are required to connect to the City's sewer system unless the nearest sewer main is greater than 260 feet. All septic systems in the City shall be monitored per Jefferson County Public Health regulations.
- All non-developing properties that annex into the City are encouraged to phase out their septic systems and connect to the City's municipal sewer system.
- Property owners with a failing septic system, as documented by Jefferson County Public Health, shall connect to the City's sewer system unless the parcel is greater than 260 feet from the nearest existing sewer main, in which case the septic system may be repaired.
- The City is aware of Engrossed Senate Bill (ESB) 5871, which became effective on July 24, 2015, and requires cities, towns, and counties to offer an administrative appeals process to consider denials of permit applications to repair or replace a septic system where connection to a sewer system is required for single-family residences. The City will review appeals to repair or replace septic systems as they are submitted in accordance with ESB 5871.

COLLECTION SYSTEM POLICIES AND DESIGN CRITERIA

Sanitary Sewer Design Criteria

- Standards for sewer system facilities are defined by WAC 173-240-050.
- All sewer lines and facilities within the City shall be designed in accordance with good engineering practice by a professional engineer with the minimum design criteria presented in the *Criteria for Sewage Works Design*, prepared by Ecology, August 2008, or as superseded by subsequent updates. Chapter C1 of this document includes standards and guidelines for design considerations (e.g., minimum pipe sizes, pipe slopes, and wastewater velocities), maintenance considerations, estimating wastewater flow rates, maintenance hole locations, leak testing, and separation from other underground utilities. These criteria have been established to ensure that the sanitary sewers convey the sewage and protect the public health and environment. The sewer lines also shall conform to the latest regulatory requirements relating to design.
- Sewers shall be designed and constructed in accordance with the City's most current Wastewater Engineering Standards.

Gravity Sewer Design Criteria

- All sewers shall be designed as a gravity sewer whenever feasible and buried at a minimum depth of 5 feet. Exceptions to depth requirements may be made on a limited basis to facilitate gravity sewer extension.
- The layout for extensions shall provide for the future continuation of the existing system as determined by the City. The smallest diameter sewer allowed is 8 inches for gravity mains. A 6-inch sewer may be approved when expansion to serve future customers is not expected.
- Side sewer connection laterals within City rights-of-way shall be 6 inches at a minimum, and side sewer laterals on private property shall be 4 inches at a minimum, in accordance with the Standard Details.
- A 6-inch-diameter lateral is required at a minimum for all commercial, industrial, and multi-family connections. A larger diameter lateral may be required based on the projected wastewater flows from the connection.
- Maintenance holes shall be a minimum of 48 inches in diameter and will be spaced at intervals ideally at every block as set forth in the City's Wastewater Engineering Standards. City blocks are typically 260 feet long. On occasion, maintenance holes may be spaced at 520 feet subject to City Engineer approval. Only new polyvinyl chloride (PVC) pipes will be considered for extending the maintenance hole interval.
- Maintenance holes also shall be located at changes in grade, direction, and pipe size, and at intersections. Maintenance holes located in areas subject to inflow may be required to include a watertight insert at the request of the Public Works Director.
- New mains connecting to an existing main shall be made via a new or existing maintenance hole.

- The minimum sewer main slope shall be 0.40 feet per 100 feet for 8-inch-diameter sewer lines. The minimum slope may be reduced if approved by the City Engineer. Sewers shall have a uniform slope between maintenance holes.
- Testing of the gravity sewer lines and maintenance holes shall be completed in the presence of the City. Testing shall be performed in accordance with WSDOT/APWA Standard Specifications Section 7-17.3(2).

Design Flow Rates

- All new gravity sewers shall be designed and constructed to have a minimum velocity of 2 feet per second when flowing full.
- Existing sewers may surcharge up to 1-foot over the crown of the pipe during the peak hour flow caused by a 20-year, 24-hour storm before requiring replacement. This criterion shall not apply if this storm produces overflows onto the finished floors of any customers. New sewers shall be designed to be no more than 75-percent full during the same storm over the 50-year design life of the main.
- No overflows will be permitted.
- This GSP did not analyze every sub-basin and instead focused on trunkline sewers. When development occurs within a sub-basin, staff and developers will need to check the capacity of the sub-basin's gravity sewer pipes. Slopes in the City generally result in gravity sewers being steeper than minimum slopes. For reference, an 8-inch gravity sewer at 0.4 percent generally will serve 300 single-family units. This is a conservative rule of thumb to check when developing an infrastructure master plan for the City's pre-platted environment and for densification of housing.

Separation Between Sanitary Sewer and Other Utilities

- A minimum horizontal separation of 10 feet and a minimum vertical separation of 3 feet is required between sewer and domestic water lines (edge to edge).
- The City's Wastewater Engineering Standards (**Appendix G**) will be followed, and the guidelines provided in Ecology's *Criteria for Sewage Works Design* should be followed for difficult spacing or other situations.

Design Period

- The design period is the length of time that a given facility will provide safe, adequate, and reliable service. The design period selected is based on the economic life of a given facility, which is determined by the structural integrity of the facility, the rate of degradation, the replacement cost, the cost of increasing the capacity of the facility, and the projected population growth rate serviced by the facility.
- The life expectancy for new sanitary sewers, using current design practices, is in excess of 50 years.

Force Main Design Criteria

- All force mains within the City shall be designed in accordance with good engineering practice by a professional engineer with the minimum design criteria presented in the *Criteria for Sewage Works Design*, prepared by Ecology, August 2008, or as superseded by subsequent updates. Chapter C2 of this document contains design considerations for force mains.

Low Pressure Sewer Design Criteria

Formalizing the use of low pressure sewer installation is necessary for effective implementation. The recommended policy and engineering standards for low pressure sewers should include the following principles:

- Low pressure sewers should only be used where gravity sewers are not reasonably feasible.
- Low pressure sewers should only be used in single-family residential zones where growth is predictable.
- Low pressure sewers should not be used in multi-family zones.
- Low pressure sewer pumps need to be owned and maintained by the property owners. The pump system should be of sufficient quality and contain alarms to minimize the chance of sewer overflow.
- Low pressure laterals are to be privately owned and maintained.
- Low pressure force mains should be designed to City standards and be City owned and maintained.
- Engineering design standards for low pressure sewer mains should specify durable materials such as high-density polyethylene (HDPE) pipe, have ample clean out and flushing ports, and be sized to accommodate entire areas where gravity sewer is not feasible.
- A master plan of locations where low pressure sewers are allowed should be developed as incorporated into the Engineering Design Standards.

Side Sewer Design Criteria

- Side sewers shall be constructed in accordance with all applicable City, local, and State regulations. Refer to the PTMC and the City's Wastewater Engineering Standards (**Appendix G**) for specific criteria.

LIFT STATION POLICIES AND DESIGN CRITERIA

- Lift stations shall be designed in accordance with the City's most current Wastewater Engineering Standards and the Ecology's *Criteria for Sewage Works Design*.
- Lift stations are expensive to operate and maintain; therefore, their installation should be limited to locations where gravity is not reasonably feasible only.

OPERATIONAL POLICIES

Facilities Maintenance

Facility maintenance is performed by the Wastewater and Compost Facility divisions of Public Works. This includes the maintenance of the WWTF, the Compost Facility, and all lift stations.

- Equipment breakdown is given the highest maintenance priority, and repairs should be made as soon as possible.
- Equipment should be replaced when it becomes obsolete.
- Worn parts should be repaired, replaced, or rebuilt before they represent a high failure probability.
- Equipment that is out of service should be returned to service as soon as possible.
- A preventive maintenance schedule shall be established for all facilities, equipment, and processes.
- Spare parts shall be stocked for all equipment items whose failure will impact the ability to meet other policy standards.
- Tools shall be obtained and maintained to repair all items whose failure will impact the ability to meet other policy standards.
- Dry, heated shop space should be available to all maintenance personnel to maintain equipment and store parts.
- Written records and reports will be maintained on each facility and item of equipment showing its operation and maintenance history.

Collection System Maintenance

The collection system is maintained by the Streets Maintenance and Collections Division of Public Works.

- At a minimum, all existing gravity mains shall be video inspected every 10 years.
- The target gravity main video inspection interval is 5 years based on the need to rehabilitate much of the gravity system.
- Gravity mains that experience periodic problems shall be video inspected every 1 to 3 years depending on the documented history of problems.
- Video inspection records will be maintained and incorporated into prioritization of either pipeline replacement or in-situ rehabilitation.
- Cleaning or jetting of sewer lines shall occur based on video inspection records.
- Root cutting of sewer lines shall be based on video inspection records and historical sewer blockage trends. Many gravity sewer lines in the City require annual root cutting. These sewer lines should be prioritized for rehabilitation.
- Many maintenance holes in the collection system are aging past their design life and experiencing corrosion. Some maintenance holes are still mortared rock or brick.

Rehabilitation and replacement of maintenance holes on a systematic basis should be implemented based on inspection records.

Temporary and Emergency Services

- Compliance with construction standards (not water quality standards) may be deferred for temporary sewer service. Provisions for reliability is necessary for temporary service to reasonably prevent system failures such as overflows.
- Compliance with all standards may be deferred for emergency sewer service.
- Compliance with all applicable NPDES waste discharge permit requirements must be met.

Reliabilities

- The City shall invest sufficient resources to ensure that the sewer system is constructed, operated, and maintained to ensure consistent and reliable service is provided to its customers.
- Reliability is achieved through investment in rehabilitation or replacement of collection system components, as well as redundant systems. For example, including back-up generators for critical lift stations improves reliability.
- The entire WWTF is built with redundant systems to ensure reliable operations. When redundant systems are compromised or need repair, restoring redundant systems should be prioritized.

ORGANIZATIONAL POLICIES

Staffing

The sewer treatment and collection systems operate based on the good work of staff. Therefore, adequate staffing with appropriate training and skills is a key to success. The City created a skills development program for the Department of Public Works staff to improve skills and address succession planning. The 2024 budget reflects the addition of a wastewater treatment apprentice position, as well as restoration of a frozen position in the Streets Maintenance and Collections Division. The following staffing policies are included in this GSP:

- The sewer utility staffing levels are established by the City Council based on the financial resources of the City and needs of the sewer utility. Staffing investments are a key portion of the periodic sewer rate modeling and projections. Staffing, capital improvements, and required operational costs are to be balanced based on rates set by City Council.
- The City has three Group II certified wastewater treatment plant operators at the WWTF and two Group I certified wastewater treatment plant operators at the Compost Facility.
- Staffing must comply with the permit-required certification levels associated with both treatment facilities. Both the WWTF and the Compost Facility are Group II operator facilities. The staffing objective is as follows:

    - WWTF – Three certified Group II operators, one of which serves as crew chief for both the WWTF and the Compost Facility.
    - Compost Facility – Two certified Group II operators.
    - WWTF and Compost Facility – A shared entry level position serves as an apprentice to support both facilities' operations.
    - Within the City – Certified electrician capable of working with 480 volt, three-phase power to serve the City's Facilities Division, Water Resources Division, Wastewater Division, and Compost Facility Division of Public Works.
- Personnel certification and training will comply with State-established standards. The City job descriptions reflect the state certification requirements. The City encourages and supports training in terms of continuing education and skill development to work in concert with State certification requirements.

FINANCIAL POLICIES

General

The sewer utility is an enterprise business unit of the City. Enterprise business units by definition are required to be fiscally sustainable in terms of self-supporting through rates and charges. Rates and charges need to be analyzed periodically to ensure revenues match expenses of operations and investment in infrastructure. A balanced approach to establishing reasonably affordable rates along with the needs of the sewer system to ensure compliance with public health and safety laws is the focus of periodic rate reviews. The following fiscal policies help establish this balance. Note, that a number of fiscal assumptions are included in **Chapter 11** with respect to rate setting. The following policies and assumptions in **Chapter 11** must align.

- The City will set rates, charges, and fees to maintain sufficient funds to operate, maintain, and upgrade its sewer system as necessary to provide safe and reliable sewer service to its customers. These rates will comply with State regulations and be evaluated in conjunction with the annual budget process to ensure that forecasted expenses and impacts of regulations are reflected in the rate structure. Typically, rates are established for a 5-year period and then re-evaluated against actual operational costs and capital infrastructure needs. The GSP will be reviewed every 5 years and no less than every 10 years. The annual budgeting process refers to the projected expenses included in the City's rate model.
- Each developed lot or parcel with active water service (excluding irrigation) is required to be connected to the City's sewer system subject to the presence of an existing on-site septic system permitted by Jefferson County Public Health. Each property shall be subjected to a monthly sewer charge whether or not such lot or parcel of real property is actually connected to the sewer system when there is an active domestic water account. The purpose of this policy is financial sustainability of the sewer system to ensure that all developed properties pay a base fee whether discharging to the sewer

system or not. This base fee provides stable funding for the fixed costs incurred by the City for operating a sewer system for the overall benefit of community public health.

- All new development shall be connected to the sewer system unless meeting the exemption requirements outlined in PTMC and state law. Note, that per PTMC, all subdivisions shall be required to provide sewer to all newly created or altered lots intended for commercial and/or residential development.
- The system development charge (SDC) and all applicable connection fees must be paid at the time a sewer connection is obtained. SDCs and fees shall be paid prior to issuance of a final permit approval or prior to occupancy, whichever comes first, accordance with the City's Municipal Code.
- The City shall collect sewer extension charges for owners of properties that individually benefit from publicly built sewer extension facilities, except for those property owners who previously paid for their fair share of such an extension through a Local Improvement District (LID) or ULID. This program has not been established and this policy is recommended to be implemented as a way to create a revolving revenue source to facilitate sewer extensions. The cost of sewer extensions paid by the City can be recovered through Local Facility Charges, frontage fees, or LIDs.
- System development charges should be used to offset rate impacts for capital improvements and not fund debt service.
- Deferral of SDCs should be considered in the setting of system development charge levels to make sure financial objectives are met. For example, if 10 of 50 new housing units per year are affordable, SDCs would need to account for a 20-percent decrease in revenue.
- City Council adopted an income-based discount program. This program should be monitored over time to evaluate participation levels and impacts on rates. The purpose of the income-based discount program is to lower the rate impact to community members burdened by the cost of housing and associated costs.
- If sewer system facilities must be installed or upgraded as a result of a developer's impacts, the new facilities or upgrades shall conform to the City's policies, criteria, and standards and shall be accomplished at the developer's expense. The City, however, shall be responsible for any portion of the costs that are attributable to general facilities, such as over-sizing or over-depth requirements, and offer latecomers fees to developers. Per RCW, the City may participate in developer extension projects and recover costs associated with the City's investment from benefited properties. This practice has not been implemented in the past and is recommended as a future way to recover costs and contribute to revolving investment in sewer infrastructure extensions.
- If written application for service is approved by the City, the application shall be considered as a contract in which the applicant agrees to abide by such rates, rules, and regulations in effect at the time of signing the application or as may be adopted thereafter by the City and to pay all charges, rates, and fees promptly.

- In addition to all other user rates and service connection fees required to be paid to the City, service call fees may apply when made at the request of the owner or occupant of the premises for assistance in locating and/or repairing a plugged sanitary sewer drain in accordance with the City's Municipal Code.
- The City shall manage its income and expenses in a self-supporting manner in compliance with applicable laws and regulations and its own financial policies.
- The City shall establish a CIP that describes the anticipated improvements or modifications to the sewer system, planned replacement of aging facilities, upgrades to existing facilities to provide additional capacity for projected growth, and construction of general facilities to aid growth. The CIP will be updated at a minimum on a 2-year basis associated with the requirement of the Growth Management Act and maintaining a current Capital Facilities Plan.
- The City shall maintain reserves for operations consistent with City reserve policies. The reserves should consider emergencies, bad debts, existing debt coverage, reserve requirements, and fluctuations in revenue.
- The City will maintain information systems that provide sufficient financial and statistical information to ensure conformance with rate-setting policies and objectives.
- Currently, the sewer utility is part of a combined utility with the water utility. It is the policy of the City to separate these utilities into separate funds to ensure accurate cost accounting and sustainability of both utilities.

Connection Charges

Connection fees are an important source of revenue for the sewer, water, and stormwater utilities. The owners of properties that have not been assessed, charged, or borne an equitable share of the cost of the sewer collection system and WWTF pay connection fees for their equitable share of connecting to the system. Connection fees help reduce the burden to existing rate payers. It is noted that some of these charges, such as SDCs for qualifying low income housing, can be deferred according to PTMC. While connection charges are an important source of resources for the sewer utility, SDC levels should be evaluated for impacts on housing and land prices. Higher SDCs combined with other permitting and connection fees typically drive down the price of land to meet market conditions. However, in some cases, land prices do not come down, thereby impacting the total cost of housing. The primary challenge with connection charges for Port Townsend is that much of the City is currently inaccessible to sewer per state and City codes, and many of the pre-platted rights-of-way do not currently have sewer pipes within them. Sewer extensions are costly, and the City sewer utility is already stressed in terms of required upgrades and repairs. Thus, there is a tradeoff between connections fees and housing affecting rates and financial sustainability. One possible approach, when legally allowed, is to expand the City deferral program to more housing options, sizes, and affordability levels or to find additional general fund sources to support objectives.

The following connection fees are available to the City to assist in sewer utility financial sustainability. Some of these strategies have been utilized in the past and others have not.

1. Latecomers Fees (also known as Developer Extension Charges): Latecomers fees are negotiated with the City, developers, and property owners for the reimbursement of a pro rata portion of the original costs of sewer system extensions and facilities and are documented in a Developer Extension Agreement, depending on the application. Latecomer fees have been the primary tool for developers to obtain partial reimbursement for their costs of installing or extending sewer mains. Many latecomers have been filed with the City in the last 20 years. Latecomer reimbursements are due for any new connections to sewer in which an agreement is in place for a period of 20 years.
2. Local Facilities Charges: If applicable, Local Facilities Charges may be due based on established fees by ordinance for specific facilities benefiting specific properties. Pursue the use of Local Facilities Charges for specific system infrastructure, such as trunkline extensions, trunkline upsizing, and lift stations. Local Facilities Charges should be used in areas where new connections are expected. Local Facilities Charges have not been used historically in the City.
3. Frontage Charges: If applicable, Frontage Charges may be due to reimburse the City for investment of sewer pipelines benefiting undeveloped properties. Frontage Charges have not been used historically in the City.
4. LID Assessments: If applicable, these assessments are often paid at the time of connection as required by lending institutions. These assessments take priority lien status right behind taxes. LIDs can be implemented by City Council Resolution or by petition of property owners. LIDs have not been used historically in the City.
5. SDCs: Connection charges shall be assessed against any property connecting to the sewer system. This charge is for the major facilities that deliver the sewage to the WWTF and for the facilities to treat and dispose of the sewage. This charge reimburses customers who have paid for the facilities described and for building capacity to accommodate growth.
6. Outstanding charges resulting from account delinquency.

This GSP recommends the City develop a connection policy reflecting its housing objectives. Examples include the following strategies as detailed previously.

- The City developed an issue paper (white paper) in 2023 suggesting expanding the deferral program for SDCs to housing that is affordable and households earning as much as 200 percent of the Area Median Income. Further study is necessary to determine the appropriate affordability level to ensure gifting of public funds prohibitions are not violated. The intent of this issue paper is to address the inability for many households to obtain housing, including workforce, fixed income, and other situations that result in incomes that cannot afford housing in the City.
- Set SDC levels tied to household size, such as those adopted by Oak Harbor. This recognizes that a small house has less impact on the sewer system than a large house.
- Port Angeles set up a program to reduce fees for middle housing.
- A deferral program or SDC tied to infill housing would recognize the benefit of new housing and rate payers connecting to the system where infrastructure already exists.

- Consider developing a front footage connection fee for all pipes installed by the City to develop a revolving fund for the installation of sewers.
- Using LIDs for new sewer extensions can be a useful tool that captures all benefited properties. This is especially beneficial where there are large unsewered areas of undeveloped properties or where existing septic systems are experiencing failures. LIDs could be implemented in a manner to incentivize development of underutilized property.

Formalization of connection fee policies occurs through City Council adoption of various connection fee levels or programs.

6 | SEWER COLLECTION SYSTEM EVALUATION

INTRODUCTION

This chapter presents the analysis of the existing City of Port Townsend (City) wastewater collection system. Individual sewer system components were analyzed to determine their ability to meet policies and design criteria under both existing and projected flow conditions. The policies and design criteria are presented in **Chapter 5**, and the wastewater system flow and loading analysis is presented in **Chapter 4**. A description of the existing wastewater system facilities and current operation is presented in **Chapter 2**. A distribution of growth map for the purpose of hydraulic modeling of trunklines is included in **Chapter 3**. The capital improvement projects resulting from the existing and projected flow condition analyses are presented in **Chapter 10**.

COLLECTION SYSTEM ANALYSIS

Hydraulic Model

Background

A computer-based hydraulic model of the existing sewer system was created using the SewerGEMS® program developed by Bentley Systems. The entire sewer collection system was modeled, including gravity mains, force mains, and sewer lift stations. The hydraulic model was created using the best information available and data provided by the City. Pipe locations, lengths, diameters, and materials were added based on the previous hydraulic sewer model, GIS data, as-built drawings, various system maps, survey information, and information acquired from the City. Maintenance hole invert and rim elevation data from the City's GIS and survey information was used, if available. The remaining elevation data was extracted from Jefferson County topographic data. Minimum slope and cover values also were used in the development of the model and are annotated in the data files. The output from this model was used to evaluate the capacity of the existing collection system and identify improvements that will be required to handle wastewater flows. The model can be updated and maintained for use as a tool to aid in future planning. Refer to **Appendix I** for basic data used to construct the model.

Model Limitations

Due to the number of data gaps and assumptions used in the model, the accuracy of the model should be confirmed prior to undertaking any replacement or rehabilitation projects, especially for projects not located along a major trunk sewer. The results of the modeling should be considered approximate, and additional investigations, such as field surveys, flow monitoring, and lift station pump down tests, should be performed in the vicinity of any proposed improvements prior to design and construction. If it is found that the input information differs significantly from actual conditions, the model should be updated accordingly and rerun to confirm the original results.

Modeling was performed using a steady-state analysis, which shows all flows reaching all downstream points simultaneously. This is conservative and not truly representative of conditions that occur, since it takes some time for wastewater to travel downstream through the sewer system, which stores and attenuates peak flows.

Flow Data

Existing and projected flow rates for the sewer drainage basins were developed in **Chapter 4**. The total existing flows are shown in **Table 4-3**, and the projected total system flows are shown in **Table 4-10** in **Chapter 4**. **Table 4-11** in **Chapter 4** details existing average annual flow and peak hour flow (PHF) for each sewer lift station. As discussed in **Chapter 4**, the City's projected wastewater flow by basin was estimated from population growth per basin as provided by City planning staff (**Figure 3-3**) and calculated from peaking factors and per capita flows as estimated in **Chapter 4**. The total existing and projected flows by basin are shown in **Table 4-12** in **Chapter 4**. It is recommended that the City obtain additional flow data from the sewer drainage basins to accurately evaluate capacity in areas with suspected deficiencies for future planning and design.

Facilities

The hydraulic model of the existing system contains all active existing system facilities. Available information for the lift stations, such as pump capacity, total dynamic head, horsepower, wet well diameter, wet well depth, and force main diameter, is included in the model. For simplicity, the existing lift stations were modeled as having variable frequency drives (VFDs) on the pumps so that they discharge at the same rate as the influent flow rate regardless of head conditions.

Hydraulic Analyses Results

Hydraulic analyses were performed based on the existing flow rates (2018), as well as projected flow rates for 2028, 2033, and 2043. In the evaluation, the criteria for listing an existing sewer pipe as deficient is that the upstream maintenance hole is surcharged more than 1 foot during the estimated PHF. The results for the 2028, 2033, and 2043 modeling are included in **Appendix I**.

Pipe Capacity Deficiencies

It is intended that this General Sewer Plan (GSP) contain an inclusive list of recommended system improvements; however, additional projects may need to be added or removed from the list as growth occurs or conditions change. The City will evaluate the capacity of the wastewater collection system as growth occurs and development applications are received.

Existing System

Currently, the existing gravity sewers do not have deficient conveyance capacity. That is, no maintenance hole surcharges over 1 foot above the crown of the pipe during existing peak flows. This was observed in the model and confirmed by the City's operations staff. Surcharging only occurs at the discharge of the Monroe Street Lift Station force main to the gravity sewer on Water Street. Design of a new and larger Water Street gravity sewer main to receive the flow is underway; therefore, it is not included in the Capital Improvement Plan (CIP) in **Chapter 10**.

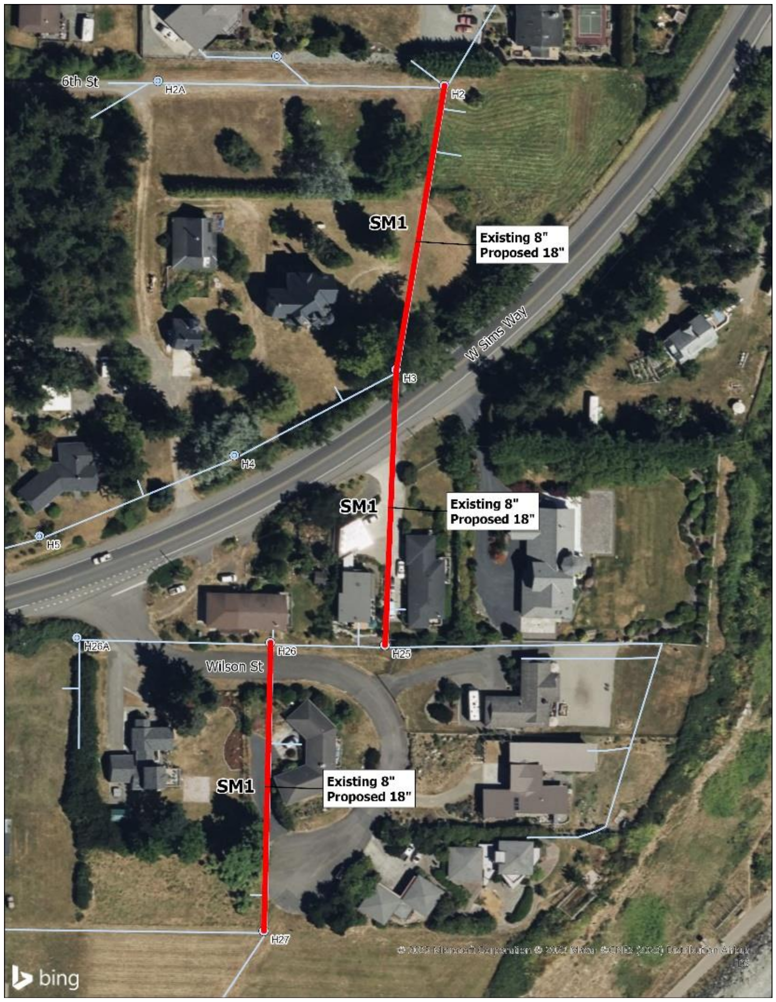
Future Analyses

The primary driver of gravity main capacity improvements for the 5-year, 6- to 10-year, and 11- to 20-year planning periods are the projected flows from the proposed development of the Mill site. Fortunately, this flow will be conveyed by gravity to the wastewater treatment facility (WWTF) following discharge from the proposed Mill Lift Station force main. Existing lift stations will not be taxed by these additional flows; however, substantial investment in the upsizing of existing pipelines will be required over the next 20 years to convey these flows to the WWTF. The following sections provide a summary of gravity conveyance deficiencies for the 5-, 10-, and 20-year design horizons. The colors of the mains to be upsized are red, green, and blue, respectively, for the 5-, 10-, and 20-year scenarios presented here and in **Chapter 10**.

5-Year Forecast Hydraulic Deficiencies

Figure 6-1 shows CIP SM1. These pipelines are estimated to be hydraulically deficient within the next 5 years after the construction of the Mill Lift Station. The pipelines, shown in red, may need their alignment shifted from existing to get more distance from existing structures.

Figure 6-1 – CIP SM1



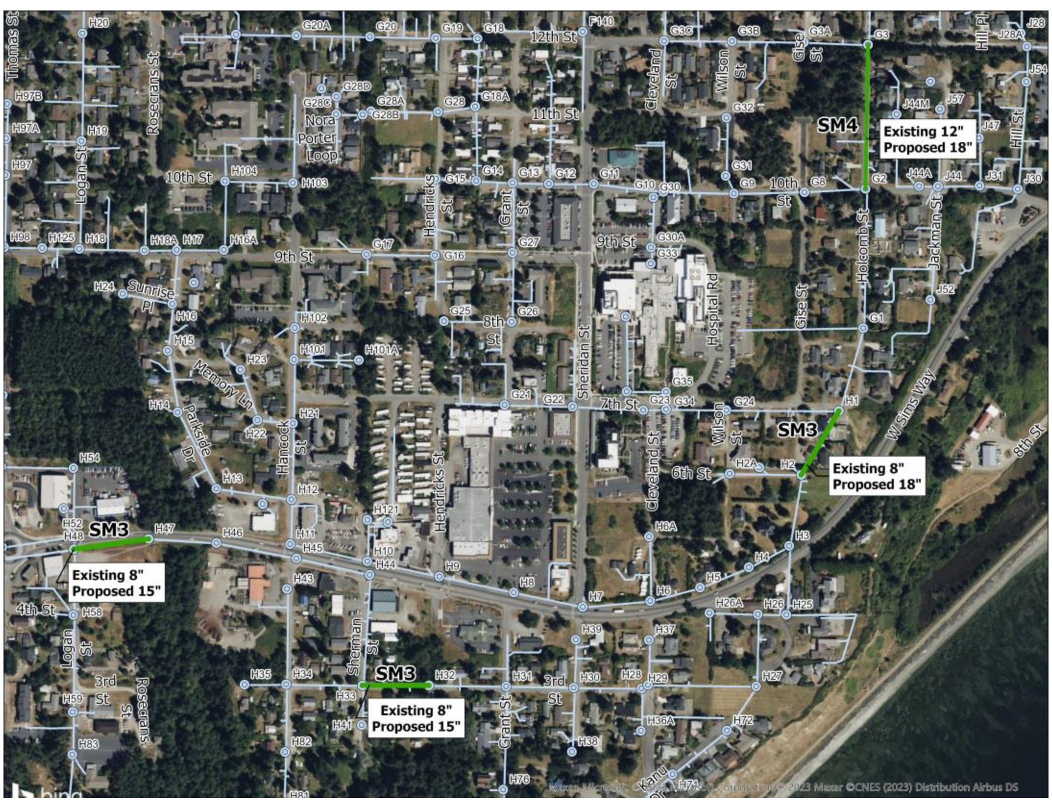
CIP SM1 must be upgraded simultaneously with the construction of the Mill Lift Station.

6- to 10-Year Forecast

The growth of the Mill site will warrant upsizing the gravity pipelines shown in green in **Figures 6-2** and **6-3** by the year 2033.

Figure 6-2 – CIP SM2

Figure 6-3 – CIPs SM3 and SM4



11- to 20-Year Forecast

Sewer mains shown in blue in **Figures 6-4** through **6-6** are anticipated to need upgrades by 2043 to be able to convey anticipated flows without causing the pipelines to flow more than 75-percent full.

Figure 6-4 – CIP SM5

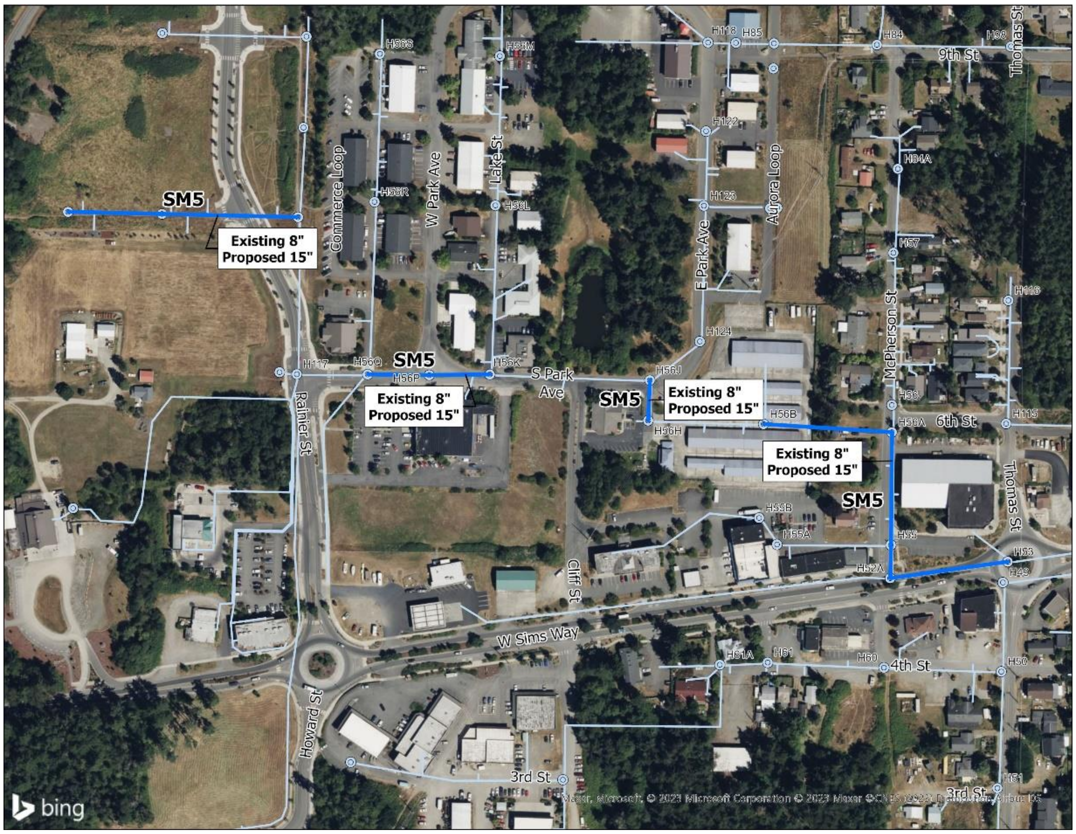
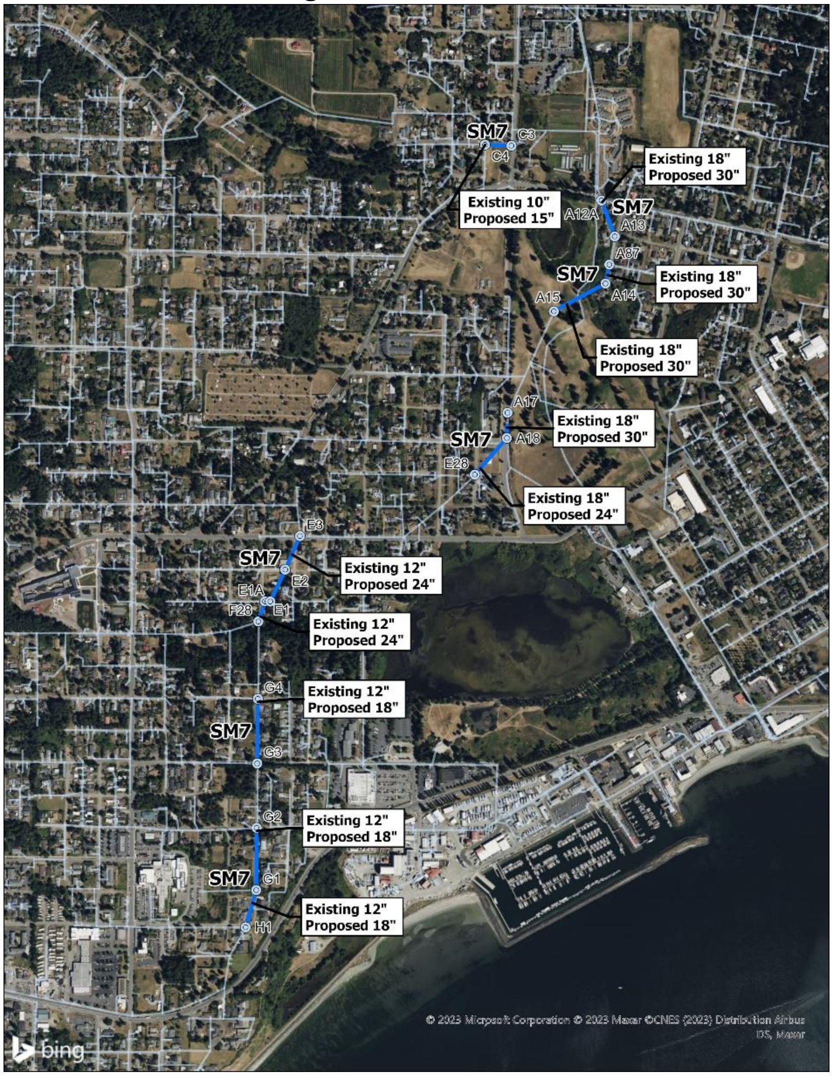


Figure 6-5 – CIP SM6

Figure 6-6 – CIP SM7



Other Existing Gravity Collection System Deficiencies

The City does not have complete knowledge about the condition of its collection system because of antiquated and broken video inspection equipment. During the attempted inspection of the Water Street gravity main in 2023, a contracted video inspection company recorded mains suspected of being structurally deficient. The results of these inspections were alarming, as some pipelines contained earthen sediments (Water Street) and others were cracked, crushed, and becoming oval in cross-section (Washington Street; **Figures 6-7** and **6-8**). Only a small sampling of the City's collection system was inspected and significant structural defects were found. It is imperative that the City begin a systematic inspection plan with a goal of viewing the interior of all pipes and maintenance holes within the next 5 to 10 years. As these inspections are performed, pipe materials should be noted and recorded in the City's GIS system to improve system records. Many pipelines are of unknown material, making pipe lifespan predictions difficult. Gaining knowledge about the existing collection system will allow the City to identify those mains that are most urgently in need of repair or replacement and will help prevent occurrences like the collapse of the Water Street gravity sewer on December 27, 2022. The City's ability to maintain and update the collection system will be greatly aided by recording pipe materials and conditions and storing this information in the GIS system it has established. Purchase of modern inspection equipment and committing employees to the inspection of pipelines will yield savings and prevent future wastewater overflows.

Figure 6-7 – CIP SM10

This section of pipe in Washington Street is in danger of imminent collapse.

Figure 6-8 – Washington Street Sewer with Cracks

Longitudinal cracks and deformation in Washington Street sewer portend collapse.

LIFT STATION ANALYSIS

Lift Station Capacity

Existing System

The hydraulic analysis of the City's existing lift stations (**Table 4-12**) shows that only the Monroe Street Lift Station does not have adequate capacity. As discussed previously, capacity analyses of each lift station are based on estimated PHF. According to discussions with the system operators, there are no known capacity deficiencies in the City's existing lift stations during current operating conditions except for the Monroe Street Lift Station. These deficiencies are discussed later in this chapter.

2028, 2033, and 2043 Lift Station Needs

Only modest population growth is forecast within the current City limits and it is dispersed throughout the City as shown in **Figure 3-3**. Of this growth, less than 20 percent is forecast to occur in the existing lift station basins. The remainder will flow by gravity to the WWTF. There will be small, incremental increases to each existing lift station over the next 20 years, leaving the total flow to be pumped by each station below each their firm capacities. None of the existing lift stations are forecast to have capacity shortfalls, except for the Monroe Street Lift Station. The station handling most of the new growth will be the proposed Mill Lift Station. Predesign studies show that a 1,062 gallons per minute (gpm) capacity is required. Refer to **Appendix J** for an estimation of the flows for this lift station. Capacity upgrades are needed for the Mill and Monroe Street Lift Stations.

Monroe Street Lift Station

The Monroe Street Lift Station is currently under capacity and regularly has all three of the station's pumps operating to convey peak flows. The station has not overflowed, but it is the City's standard to have two pumps with one redundant pump to accommodate PHFs. For this reason, the capacity must be increased, or the peak flow tributary to the station must be reduced. As part of the Water Street Sewer Replacement project, scheduled for 2024, new pump impellers will be installed for each of the station's pumps. The existing electric motors have spare capacity to accommodate larger impellers that could deliver approximately 100 gpm more from the station. However, this will not be enough to bring the lift station into compliance with desired capacity standards. RH2 Engineering, Inc., (RH2) recommends that inflow in the basin draining to the lift station be reduced to decrease the load on the lift station.

Lawrence Street, between Fillmore and Monroe Streets, has stormwater inlets connecting to the gravity sewer (**Figure 6-9**). This is a likely cause for the Monroe Street Lift Station's overload. This inflow also taxes the capacity of the WWTF unnecessarily with stormwater. Separation of the storm and sanitary sewer could possibly reduce the hydraulic loads entering the Monroe Street Lift Station. Smoke testing and video inspection of the sewer main in

Lawrence Street should be performed to locate the connections between the storm and sanitary sewer systems.

Figure 6-9 – CIP SM9

The sanitary and storm sewers in Lawrence Street must be separated to reduce hydraulic loads on wastewater facilities.

In addition to capacity shortfalls, the Monroe Street Lift Station is aging and near the shoreline, placing it at risk for flooding due to forecasted sea level rise. The *City of Port Townsend Sea Level Rise and Coastal Flooding Risk Assessment* (City of Port Townsend & Cascadia Consulting Group, 2022) (**Appendix K**) lists the Monroe Street Lift Station as a public facility at risk of flooding with the potential for "high consequence." The lift station access hatches must be elevated or the lift station must be relocated to higher ground. All pumps, pipes, valves, electrical panels, and controls must be replaced with new units to increase the reliability of this vital lift station. Flow measurement also should be added to the station to assist the City in quantifying the inflow tributary to the lift station.

Hydraulically, the lift station's force main is performing well and appears to be in good condition. It is approaching 60 years in age, and record drawings show that it is cast iron pipe. When the existing 10-inch cast iron force main is exposed for any reason, the exterior should be inspected for pitting and corrosion. Cast iron pipe from the 1960s came with cement mortar lining, and the main could still be in good condition. Out of caution, the City should monitor the discharge pressure characteristics of the lift station closely. Sudden decreases in pressure could indicate a breach in the pipe. Increases show occlusion of the pipeline due to corrosion or sediment deposition. The City should take all opportunities to observe the main's exterior for deterioration since exterior corrosion of the iron main is a risk in the marine environment.

Work to separate the Lawrence Street storm and sanitary sewers should be completed prior to designing improvements for the Monroe Street Lift Station. This will allow the pumps to be sized appropriately if inflow is substantially reduced. RH2 suspects that PHF could drop dramatically with the storm inlets removed from the sanitary sewer. This may be adequate to provide a temporary solution to the Monroe Street Lift Station's capacity problem. This temporary solution may allow the full lift station rehabilitation or relocation to be delayed by 5 to 10 years.

Other Lift Station Improvements

A budget will be set aside in the CIP for minor repairs and replacements of pump motors, pump impellers, telemetry unit replacement, valve overhauls, panel replacements, generator replacements, force main repairs, and other minor improvements to keep the existing lift stations operating reliably. The City has two existing major lift stations: Monroe Street and Gaines Street. Gaines Street was upgraded in 2021, and Monroe Street will be scheduled for upgrades as discussed previously. The Mill site will add another major lift station within the next 2 to 3 years. All major lift stations will be relatively new and/or rehabilitated in the 2020s, and no additional capacity or significant upgrades will be needed during the 20-year planning horizon. The remaining lift stations are small with minor replacement needs. The CIP will include a general allowance to cover these needs.

7 | EXISTING TREATMENT FACILITIES ASSESSMENT

BACKGROUND

History and Introduction

The City of Port Townsend's (City) original wastewater treatment facility (WWTF) was constructed in 1967 to receive wastewater from approximately 90 percent of the City's sewer services and to provide primary treatment and disinfection with chlorine gas. The WWTF was expanded in 1993 to provide full secondary treatment. This expansion included a new Headworks facility, oxidation ditches, secondary clarifiers, chlorine contact basins, conversion of the original plant primary treatment tanks to aerobic sludge holding tanks, a Control building, and electrical and supervisory control and data acquisition (SCADA) system improvements.

The City's Compost Facility is located at the Jefferson County Landfill and receives dewatered biosolids from the WWTF, as well as dewatered septage from Jefferson County (County), yard waste from the City and County, and other wood wastes. Liquids generated from these processes, including septage filtrate, contaminated stormwater runoff, and compost aeration condensate, are treated in a separate wastewater treatment facility consisting of a sequencing batch reactor (SBR) with disinfection and effluent disposal to constructed wetlands followed by discharge to infiltration basins for ultimate disposal.

This chapter presents the evaluations of the existing WWTF and Compost Facility conditions, including the existing liquid stream and solids handling processes. It also presents an evaluation of the electrical and SCADA systems. Deficiencies identified from the evaluations are described, and recommendations for capital improvements are summarized. The analyses of needed improvements to the treatment facilities for water quality and capacity are provided in **Chapter 8**. All WWTF capital improvements are identified in **Chapter 10**.

System Overview

Wastewater from the City's collection system is conveyed to the WWTF and flows via gravity to the Influent Pump Station located on the WWTF site. Wastewater from the Influent Pump Station, which also includes facility-generated wastewater and process drains, is pumped to the inlet of the Headworks. From the Headworks, wastewater enters the oxidation ditches, secondary clarifiers, and chlorine contact basins before heading to the Strait of Juan de Fuca through an outfall structure. Waste sludge is captured in the aerobic sludge holding tanks and pumped to the belt press, and dewatered solids are hauled off to the City's Compost Facility. An important consideration in a wastewater treatment system is that virtually all of the system components must have redundant or back-up components. For example, the plant must be able to run with one clarifier out of service. Thus, upgrades to a system also require upgrades to the redundant components. This adds to the cost of upgrades significantly but is a requirement to ensure that the plant operates reliably.

The approximate locations of major WWTF process units are outlined in **Figure 7-1** and shown schematically in **Figure 7-2**.

Figure 7-1 – Existing WWTF Overall Site Plan

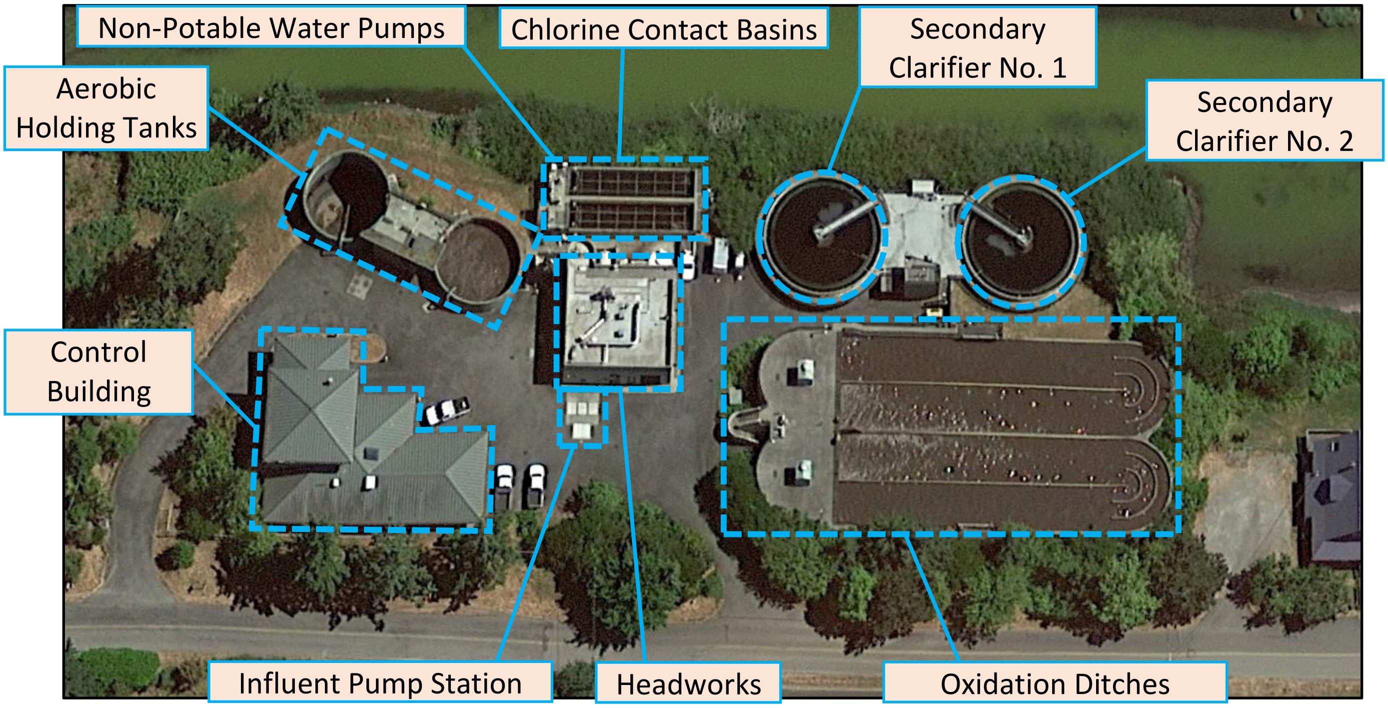
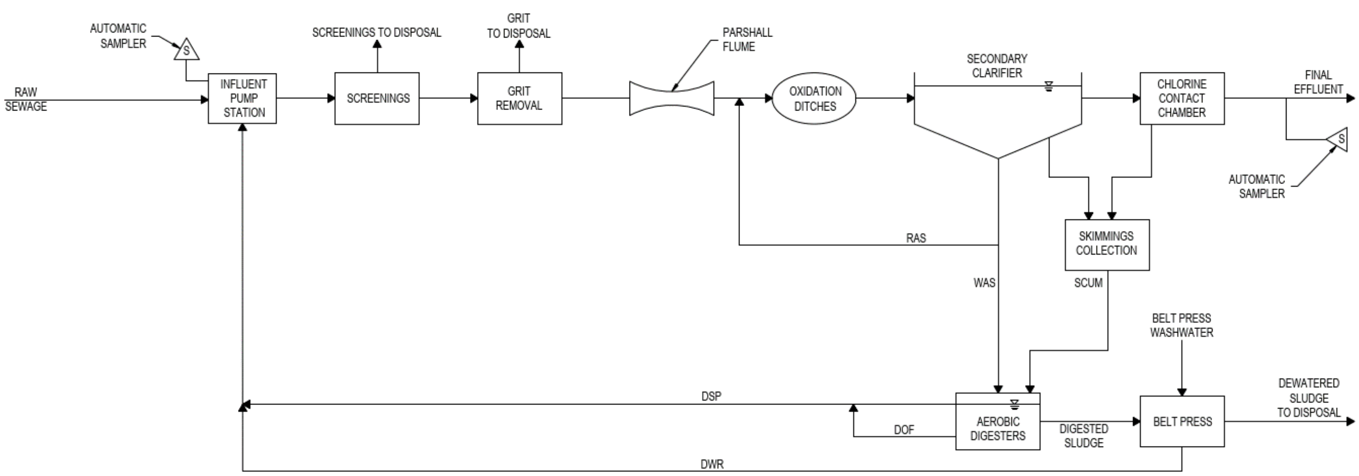


Figure 7-2 – Existing WWTF Process Schematic



Historical WWTF Performance

The historical performance of the WWTF from 2019 through 2022 is compared to the City's National Pollutant Discharge Elimination System (NPDES) Permit limits as shown in **Table 7-1**.

Table 7-1

WWTF Performance Based on NPDES Permit Effluent Limits (2019-2022)

Parameter	Interval	NPDES Limit	Highest Recorded Value by Year 2019	2020	2021	2022
BOD (mg/L)	Avg. Month	30	5.8	6.0	5.9	5.1
	Avg. Week	45	7.7	7.2	6.9	5.6
TSS (mg/L)	Avg. Month	30	3.6	4.0	4.5	3.4
	Avg. Week	45	5.0	4.8	5.9	3.8
Total Residual Chlorine (mg/L)	Avg. Month	0.50	0.02	0.03	0.03	0.03
	Avg. Week	0.75	0.03	0.10	0.06	0.04
pH	Daily Min.	6.0	7.3	7.2	7.2	7.2
	Daily Max.	9.0	7.4	7.3	7.6	7.4
Fecal Coliform Bacteria (colonies/100 mL)	Monthly[1]	200	14	6	6	7
	Weekly[1,2]	400	29	20	37	<400

1 = Geometric mean.

2 = December 2022 weekly geometric mean data unavailable but no exceedances were noted.

As shown in the table, the City has maintained compliance with its NPDES Permit limits and no exceedances of the permit were reported for the last 4 years. As required by the NPDES Permit, the City also monitors priority nutrients, priority pollutants, and other parameters and undergoes whole effluent toxicity testing in the winter and summer of the final year of each permit cycle. None of these items have prompted additional activities or permit actions in recent years. The WWTF is well maintained and earned the Washington State Department of Ecology's Outstanding Performance Award for the 25th consecutive year in 2022.

As noted in **Chapter 2**, the City also is subject to the Puget Sound Nutrient General Permit (PSNGP). Starting in February 2022, the City was required to monitor and report nitrogen compounds on its Discharge Monitoring Reports. **Table 7-2** is a summary of the monthly sampling results for 2022.

Table 7-2

Monthly Nitrogen Sampling Results

Sample Date	Calculated TIN (mg/L)	Sample Date	Calculated TIN (mg/L)
2/2/2022	8.44	2/9/2022	6.92
3/2/2022	4.89	3/9/2022	5.51
4/5/2022	6.93	4/12/2022	4.71
5/3/2022	2.58	5/10/2022	2.13
6/7/2022	3.94	6/14/2022	5.91
7/5/2022	0.91	7/12/2022	0.65
8/2/2022	0.80	8/9/2022	1.06
9/6/2022	35.20	9/13/2022	1.66
10/4/2022	3.61	10/11/2022	4.49
11/1/2022	8.83	11/8/2022	7.56
12/6/2022	10.50	12/13/2022	8.25

The average annual Total Inorganic Nitrogen (TIN) is well below 10 milligrams per liter (mg/L). Only two samples exceeded 10 mg/L in the sampling period.

WWTF EXISTING PROCESS UNITS EVALUATION

Introduction

The WWTF secondary treatment expansion in 1993 was the last major improvement or expansion to the facility. This section provides a review of the general conditions of each major process or area within the WWTF. The analyses and findings provided herein were based on observation of visible areas around the WWTF, discussions with City operations and maintenance staff, and a 2019 *Condition Assessment Summary Report* performed by Jacobs (**Appendix L**).

Although most equipment and processes continue to function satisfactorily and meet existing demands, several of these systems are nearing the end of their design life and need to be replaced or upgraded. In general, these include major improvements to the Influent Pump Station, Headworks, secondary clarifiers, oxidation ditches, and electrical and SCADA systems. Other minor improvements that were previously noted are also described in this chapter.

Overall, the visible elements of the WWTF generally appear to be in good physical condition except where noted otherwise. The age of the equipment and processes is one of the main drivers for the WWTF improvements, and details are provided in the subsequent sections.

Influent Pump Station

Overview

The City's collection system includes two influent gravity sewer mains that enter the Influent Pump Station (IPS), which is located near the center of the WWTF site. The IPS also receives various WWTF process drains.

The IPS consists of a below-grade, cast-in-place concrete structure that houses 3 submersible influent pumps, each with a nominal capacity of 2,250 gallons per minute. Each of the three pumps have below-grade check valve systems outside of the wet well. Downstream of the check valve systems, the discharge piping from the pumps combines to a common force main that directs flow up to the elevated Headworks channels.

Under normal operating conditions, one pump operates as the lead pump, a second lag pump turns on during extreme flow events, and the third pump serves as a redundant pump. The pumps are cycled weekly to avoid overuse of any single pump and to prolong the service life of all three pumps.

Condition Assessment

IPS Structure

The existing IPS structure was constructed as part of the 1993 secondary treatment expansion project. The interior liner is detaching from the concrete and portions of the cast-in-place concrete walls and ceiling are corroding. There is notable exposed aggregate and the surfaces need to be rehabilitated in the near term to prolong the useful life of this structure.

IPS Mechanical

The original submersible pumps from the 1993 WWTF secondary treatment expansion project experienced corrosion and were replaced after the expansion with Flygt N-style impeller pumps. Since then, minimal corrosion has been noted and no major repairs have been necessary for the Flygt pumps. The stainless steel pump guide rails are generally in satisfactory condition with only minor corrosion. Due to the IPS needing to remain in operation, the pump discharge piping and fittings were not able to be observed. However, due to the age and condition of the IPS infrastructure, it is recommended to further evaluate this system during other improvement work in the IPS and prioritize replacing mechanical components if determined necessary.

Major Electrical and Control Equipment

Major improvements to the IPS electrical and control equipment are expected during the planning period due to significant corrosion and aging infrastructure. The junction boxes, conduits, and level instrumentation directly inside the IPS, as well as the power raceways and variable frequency drives (VFDs) from the electrical room need to be replaced in the near term. Additionally, one of the electrical conduits has corroded to the point where one of the pumps is now out of service. In an emergency, this pump can be brought back into service by a quick pump wiring change; however, this is an example of the urgency needed to rebuild the IPS. The power and control cables of the pumps are connected to plugs located near the top of the IPS. These plugs are accessible and should be maintained to allow WWTF staff to efficiently disconnect and remove pumps from the IPS if needed.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the IPS is as follows:

1. Rehabilitate the concrete infrastructure inside the IPS wet well. Coat the interior walls and ceiling for future corrosion protection.
2. Evaluate the condition of the mechanical equipment in the IPS and replace it if necessary.
3. Replace the electrical equipment associated with the IPS, including raceways, VFDs, and instrumentation.

Headworks

Overview

The Headworks building was constructed as part of the 1993 WWTF secondary treatment expansion project to include a mechanical bar screen in the covered concrete influent channel. In approximately 2009, the original screen was replaced with a new automatic Parkson Aqua Guard mechanical bar screen that has a 66-inch nominal width. The IPS discharges raw water into the influent channel through the bar screen. Screenings are dewatered in a compactor system that discharges to the screenings and grit hopper in the Headworks building before being disposed offsite. A bypass channel is adjacent to the main influent channel and houses a manual bar screen that can be isolated with stop gates.

Screened influent enters the original Smith and Loveless Pistagrit vortex-style grit removal chamber located on the northern side of the Headworks building. The grit chamber is 10 feet in diameter and is nominally rated at 7 million gallons per day. Screened influent also can be diverted to bypass the grit chamber if necessary. De-gritted influent from the grit chamber flows through a 1-foot-wide Parshall flume in a separate concrete channel and combines with return activated sludge (RAS) at the end of the Headworks before entering the oxidation ditches. The settled grit slurry in the grit removal chamber is directed to the grit classifier, which dewaters and washes the grit, before being discharged to the screenings and grit hopper and disposed offsite. The grit classifier was replaced around 2009 and is located on the main level of the Headworks building.

The Headworks screen and grit removal system is an important part of the plant operation. However, failures in the system do not disrupt plant operation. The result of a Headworks equipment failure is that grit is transferred to the oxidation ditches, which creates the need for additional cleaning. Careful maintenance and inspection of the equipment, maximizing the life of the equipment, can extend when equipment replacement would be needed. There is budget provided in the Capital Improvement Plan (CIP) for replacement if needed. However, given the Headworks ultimately will be replaced, if staff can extend the life of this equipment to the time of the Headworks building replacement, savings in the overall CIP will be realized.

Condition Assessment

Headworks Influent Channels Structure

The influent channels are cast-in-place concrete. These structures appear to be in satisfactory condition, requiring only some rehabilitation work relating to the interior liner system. The embedded liner was not adequately installed on a concrete support column in the RAS return basin and is peeling away at the corners of the column. Liner failure also was observed previously near the temporary gates. Significant liner failures exist over the RAS and influent splitter weirs and under the cover of the influent wet well, which will need to be improved. Concrete corrosion has been noted previously at the bottom of the Parshall flume; however, the Parshall flume and associated instrumentation appear to provide accurate influent flow readings.

Mechanical Screens

The mechanical screen appears to be functioning well with minimal corrosion observed. Other components, including channel covers and gates, appear to be in good condition. Near the screen, a short section of ductile iron non-potable water pipe was previously observed to be uncoated and moderately corroded where there was no thermal insulation.

Grit Removal Chamber and Grit Room

The original vortex grit unit appears to be functioning well with minor wearing that are not uncommon or of concern. However, the grit unit was not dewatered and out of service during the site visit, so submerged components could not be reviewed. No significant grit accumulation downstream of the grit unit has been reported. The air lift tube and cyclone have been rebuilt previously due to the original units wearing out and appear to be in good condition. The screenings compactor and compactor tube have been noted to be in good condition; overall, no corrosion issues have been observed in the grit room.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the Headworks is as follows:

1. Repair the embedded plastic liner on the concrete columns and walls in the Headworks influent channels. These improvements should be included with the IPS concrete liner system improvements as previously discussed. These improvements should occur in the near term and more details are included in **Chapter 10** (**CIP F1**).
2. Due to the age of infrastructure, it is recommended to plan for the replacement of the screen and grit removal equipment within the next 5 to 10 years. More details are included in **Chapter 10**.

Summary of Minor Findings

Based on the conditions assessment, a summary of the recommendations for minor improvements to the Headworks is as follows:

1. Repair and coat the ductile iron non-potable water pipe near the mechanical screen.
2. Perform minor repairs to Headworks equipment to extend its life until the Headworks building is replaced.

Activated Sludge System

Overview

Prior to the addition of secondary treatment to the WWTF, the facility provided treatment utilizing two primary treatment tanks and chlorine disinfection. During the secondary treatment improvements in 1993, the activated sludge system was added to the WWTF and included two oxidation ditches and two secondary clarifiers. The existing primary treatment tanks were converted into aerobic sludge holding tanks. The current activated sludge system is a suspended growth system that utilizes microorganisms in the liquid of the oxidation ditches to provide biological treatment of the wastewater. The oxidation ditches and secondary clarifiers were configured within the hydraulic profile such that influent could flow by gravity from the Headworks to the oxidation ditches, the secondary clarifiers, and then the chlorine contact basin before reaching the outfall. Each of the activated sludge components is discussed in greater detail as follows.

Oxidation Ditches

The oxidation ditches are where biological treatment occurs. This system utilizes a combination of mixing wastewater and oxygen to break down organics. The ditches also are operated such that a small anaerobic zone provides some nitrogen removal. Wastewater from the Headworks and RAS processes combine and flow to the two oxidation ditches using isolation gates. The oxidation ditches are original Eimco Carrousel Systems, each with a nominal volume of 0.57 million gallons. Each ditch contains a deck-mounted vertical paddle mixer/aerator that supplies dissolved oxygen into the ditch. These mixer/aerators operate on a two-speed mode, high and low, and each utilizes a 75-horsepower motor. The gearbox assemblies for the mixer shafts are housed in noise enclosure structures on top of the ditches. The mixed liquor enters the oxidation ditches, flows around the Carrousel system, and exits over adjustable weirs to downstream processes.

Secondary Clarifiers and Processes

Clarifiers serve the purpose of separating solids from water after the biological treatment has occurred in the oxidation ditches. After exiting the oxidation ditches, the mixed liquor is split between two 50-foot-diameter Eimco secondary clarifiers. The two secondary clarifiers are circular concrete tanks that are identical in size and construction. The secondary clarifier mechanisms are original, each operating on a 0.75-horsepower drive motor. Each clarifier mechanism directs settled mixed liquor to three RAS pumps that return to the splitter box downstream of the Headworks Parshall flume. Each mechanism also collects floatable items (referred to herein as scum) and directs the collected material to a scum box in each clarifier. An existing scum pump conveys scum to the aerobic holding tanks. Settled sludge from the clarifiers also is pumped to the aerobic holding tanks using two waste activated sludge (WAS) pumps. Clarified effluent exits over the clarifier weirs and discharges to the chlorine contact basins.

Chlorine Contact Basins

Prior to discharge to the Strait of Juan de Fuca, treated water must be disinfected. The current system utilizes a chlorination system approach to disinfection. The clarified effluent from the secondary clarifiers enters the chlorine contact basins and is disinfected with chlorine, dechlorinated with sodium bisulfite, and finally discharged through the outfall of the WWTF. The two chlorine contact chamber structures are original, and two feed pumps are used to dose liquid sodium hypochlorite into the clarified effluent. The original fiberglass reinforced plastic (FRP) tank holding the hypochlorite was previously replaced with a 6,200-gallon high density polyethylene (HDPE) tank. Once dosed with hypochlorite, the effluent flows through a serpentine path throughout the chlorine contact basins to meet contact time requirements. The effluent is then dechlorinated with liquid sodium bisulfite before being discharged through the outfall. The sodium bisulfite is held in a 1,100-gallon tank manufactured by Chemical Proof Corporation. Two Peabody Floway non-potable water pumps at the end of the chlorine contact basins supply part of the effluent back throughout the plant for various processes. Scum also is collected near the end of these basins and pumped to the aerobic holding tanks.

Condition Assessment

Oxidation Ditches

The visible concrete of the oxidation ditches generally appeared to be in good condition; however, submerged concrete was not observed due to both ditches remaining in operation. The mixer/aerators appear to be in good condition with minimal vibration and both gearbox enclosures appear to be sufficiently ventilated. The paddle of one mixer/aerator was replaced previously and there is a spare motor available. Further assessment of the ditches is provided in **Chapter 8**.

Secondary Clarifiers and Processes

The original clarifier mechanisms appear to be in satisfactory condition and the original drives and motors are still in service. These items have been in service for over 30 years now, and have reached their expected design life. However, with careful monitoring and maintenance, the design life can be extended. Minor corrosion has been noted on the mechanism in areas with coating defects that have become noticeable over time; however, no major mechanical or capacity issues have previously been noted. The original carbon steel fasteners on the mechanisms were replaced previously with stainless steel hardware due to past failures, and other carbon steel support brackets have been previously observed to be corroding. Minimal corrosion issues have been noted on the concrete floor inside the secondary clarifiers, with only minor leaching and exposed aggregate observed in the clarifier launders. The steel walkway, FRP weirs, and baffles of the clarifiers all appear to be in sufficient condition.

There have been no major concerns with the WAS/RAS station between the two secondary clarifiers as the piping and appurtenances are in a good overall condition. Only minor replacement and maintenance work has been required in the past. No major capacity, functionality, or conditions-based issues have been observed for the RAS, WAS, and scum systems.

Chlorine Contact Basins

Overall, the chlorine contact basins are in satisfactory condition with only a few issues noted. The gate operator stems have been observed to be corroding at the water surface and a few wood planks above the water are rotting. The conditions of the planks below water have not been observed. No major capacity, functionality, or conditions-based issues were observed with these basins. No corrosion issues have been noted for the sodium hypochlorite or sodium bisulfite systems, and no issues have been noted on the HDPE hypochlorite storage tank. The City has observed previously that the existing non-potable water pumps have corrosion issues.

Discharge Outfall

The existing discharge outfall into the Strait of Juan de Fuca was not evaluated as part of this General Sewer Plan (GSP). The City is separately actively working with the Washington State Department of Ecology (Ecology) and Jacobs on the outfall replacement/upgrade, and that work was in progress at the time of this GSP. Further discussion is contained within **Chapter 8**.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the activated sludge system is as follows.

Oxidation Ditches

Chapter 8 discusses operational modifications to maintain nutrient reduction within the existing system capacity and improve actual treatment capacity. Ultimately, the oxidation ditches will have to be replaced with larger ditches to address increasing demands on the system and nutrient removal. Interim improvements will be needed for nutrient removal. The evaluation in **Chapter 8** provides the recommended next steps for improvements on the oxidation ditches; more details are provided in **Chapters 8** and **10**.

Secondary Clarifiers and Processes

Clarifier upgrades are included in the CIP. The clarifiers need to be maintained as they are not planned to be replaced in the next 20 years. Extending the life of the clarifiers provides significant savings over the long term.

1. Re-coat the concrete launders of both secondary clarifiers.
2. The existing mechanisms of both secondary clarifiers are at or nearing the end of their design life. Continue to monitor mechanisms annually and at manufacturer recommended frequency on drive units and consider oil testing as recommended by the manufacturer. Plan to replace the mechanisms and replace or rehabilitate the drive units.

Chlorine Contact Basins

Continued maintenance of the chlorine contact basins is recommended as these facilities are not planned to be replaced in the next 20 years.

1. Replace the non-potable water pumps in-kind and associated electrical equipment in the near term.

Summary of Minor Findings

Based on the conditions assessment, a summary of the recommendations for minor improvements to the activated sludge system is as follows.

Secondary Clarifiers and Processes

1. Replace the carbon steel weir support brackets with stainless steel brackets in the near term.
2. Re-coat areas of the mechanisms that have notable spot corrosion.

Chlorine Contact Basins

1. Repair or replace gate operator stems with notable corrosion.
2. Evaluate the condition of all wood planks associated with the chlorine contact basins and repair or replace components as necessary.

Sludge Holding, Dewatering, and Disposal

Overview

The WAS pumped from the secondary clarifiers enters the aerobic holding tanks that provide sludge storage prior to dewatering. The sludge in these holding tanks is aerated to stay mixed and aerobic. Rotary lobe blowers located in the lower level of the Control building supply the air into the holding tanks. Decanting is required to thicken the sludge before it is pumped to the belt filter press for dewatering. This process is facilitated by the addition of polymer solution into the feed sludge for enhanced dewatering. The dewatered sludge produced from the WWTF is loaded onto a sludge hauling truck via a shaftless screw conveyor and delivered offsite to the City's Compost Facility.

Condition Assessment

No major capacity or conditions-based issues have been observed in either the aerobic holding tanks or the blower room. The rotary lobe blowers have been noted to be in good overall condition with adequate capacity. Some coarse bubble diffusers also have been previously noted to be missing. The aerobic holding tanks were converted from the original primary treatment tanks and a thorough evaluation is recommended to evaluate the structural integrity of the infrastructure.

The belt press is original and appears to be in good condition with no significant corrosion. The belt press room is well ventilated with only minor corrosion previously noted at the entrance steel door base frame and on light fixture metal housings. The aluminum platforms and grating are in good condition, but the grout under the aluminum column bases has deteriorated. No issues have been noted with the shaftless screw conveyor for sludge disposal.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the sludge holding system is as follows:

1. Due to aging infrastructure, it is recommended to plan for upgrades to the solids handling equipment, including the existing rotary lobe blowers, WAS pumps, and belt press unit within the next 5 to 10 years. More details are provided in **Chapter 8**.
2. Evaluate the structural integrity of the aerobic holding tanks and plan for repairs within the next 5 to 10 years. More details are provided in **Chapter 8**.

Summary of Minor Findings

Based on the conditions assessment, a summary of the recommendations for minor improvements to the sludge holding system is as follows:

1. Identify coarse bubble diffusers that are potentially missing and replace as needed.
2. Repair the grout under the aluminum column bases in the belt filter press room.
3. Repair minor corrosion within the belt filter press room as needed.

Odor Control System

Overview

The odor control system focuses on removing foul air from the most odoriferous locations in the treatment process, including the IPS, Headworks, and grit and screenings holding room. The original odor control system directs air from the Headworks influent channel, influent wet well, and grit room to a carbon scrubber vessel located outside and adjacent to the Headworks building. The odor control fan for pulling this air is located adjacent to the carbon scrubber vessel.

Condition Assessment

As described previously, severe corrosion and degradation of the concrete liner within the Headworks has been noted, indicating the potential build-up of sulfuric gases. Historically, there have been infrequent off-site odor complaints, indicating there may be sufficient air exchange to contain odors but not enough to reduce sulfuric gas formation on contact surfaces. Spot penetrations have been noted along the ducting from the Headworks to the carbon vessel, which could be a result of internal corrosion. The carbon scrubber vessel that holds activated carbon appears to be in good physical condition.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the odor control system is as follows:

1. Upgrade the odor control fan and activated carbon system to increase treatment capacity.
2. Replace the odor control ducting from the top of the Headworks to the carbon scrubber vessel.

Electrical and SCADA Existing Systems Evaluation

Electrical Components

Overview

Wastewater treatment plants are highly dependent on electricity. Electrical systems, including back-up power, deserve critical attention to avoid system failures. The existing electrical service and distribution equipment dates back to the 1993 WWTF expansion and upgrades. Electrical utility service is supplied to the facility by Jefferson County Public Utility District (PUD) from a PUD-owned 1,000 kilovolt-amperes pad-mounted transformer. The secondary electrical service to the facility is a 1,600 Amperes (A) service with the main service disconnect located within Motor Control Center (MCC) No. 1. MCC No. 1 resides in the ground level of the Headworks building. Located within MCC No. 1 are feeder circuit breakers that feed power to other MCCs located throughout the WWTF. MCC No. 1 feeds power to MCC No. 1X, which also is located on the ground level of the Headworks building, MCC No. 2 is located in the RAS/WAS pump station, MCC No. 3 is located in the Control building, and MCC No. 4 is located at the digesters. The MCCs are used to distribute power to all motors and equipment throughout the facility. Critical electrical loads and equipment that require backup power are supplied from MCC No. 1X. MCC No. 1X includes a 600 A automatic transfer switch (ATS) for automatically switching to backup power in the event of a power failure. A 475 kilowatt standby diesel generator, manufactured by Caterpillar, is located in the ground level of the Headworks building. This generator is connected to the ATS in MCC No. 1X and supplies backup power to all the electrical loads and equipment powered out of MCC No. 1X. The existing

MCC equipment throughout the facility is manufactured by Cutler-Hammer/Eaton and are Unitrol model MCCs.

Some of the motors throughout the facility utilize variable frequency drives (VFDs) for modulating motor speed. These motors include the influent pumps, RAS pumps, and the belt press feed pump. The VFDs are manufactured by Reliance Electric.

Condition Assessment

- The existing MCC equipment looks to be well maintained and in good condition considering the age of the equipment. This equipment is approximately 30 years old and is nearing the end of its expected lifespan. The typical lifespan for similar electrical equipment is approximately 25 to 40 years. One of the issues with maintaining older equipment is locating replacement parts when equipment fails. Fortunately for the City, Eaton has robust aftermarket support and is still able to support replacement of components for the Unitrol model MCC. However, that may not be the case for long. It is estimated that this equipment has approximately 5 to 10 years of life remaining.
- The City's existing VFDs, manufactured by Reliance Electric, are no longer supported and are obsolete. Reliance Electric was purchased by Rockwell Automation in 1996, and Rockwell Automation no longer supports these drives. Replacement of all seven VFDs at the WWTF is recommended.
- An Arc Flash Analysis has not been performed for the existing electrical distribution system, which is required by the National Electrical Code (NEC) for services of this size. It is recommended that a plantwide electrical short circuit, protective device coordination, and arc flash analysis be completed soon. These studies need to be completed to be in compliance with the NEC and need to be updated every 5 years.
- The standby generator, while also nearing the end of its expected 25- to 40-year lifespan, looks to have been maintained well and is in good working condition. Similar to the MCC equipment, it is estimated that this equipment has approximately 5 to 10 years of life remaining.
- Significant corrosion was observed on the conduits and conduit supports inside the IPS. Replacement of the conduits, supports, conductors, and cables inside the IPS is recommended.
- Some corrosion and rust were observed throughout the WWTF on various enclosures, flexible conduits, and fittings. It is recommended to remove this rust where able to do so and add rust protectant coating to extend the life of these components. Full replacement may be needed in some areas if corrosion is severe enough.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the electrical system is as follows:

1. Plan for MCC and standby generator replacement within the next 5 to 10 years.
2. Budget for near-term replacement of all seven VFDs.

3. Perform a short circuit, protective device coordination, and arc flash analysis on the electrical distribution system.
4. Replace conduits, supports, conductors, and cables inside the IPS.
5. Address electrical enclosure and conduit corrosion as needed throughout the WWTF.

Central SCADA System

Overview

The SCADA system is the computer and electronic control element of the plant. SCADA allows for automation of system processes and monitoring and is the system that enables plant operators to control physical processes within the plant. The central components of the SCADA system and instruments are from the 1993 WWTF upgrades. The existing SCADA system consists of three control panels located throughout the facility that are interconnected via a DH+ serial communication protocol. A SCADA human machine interface (HMI) computer located at the WWTF allows the City to monitor and control the system. The HMI computer was last upgraded around 2017. The three control panels include the Main Control Panel, CP-3, which is located in the Control building. The other two control panels are considered Remote Input/Output (I/O) panels as they do not contain a central processing unit (CPU) and instead allow for an I/O extension to the Main Control Panel. The first Remote I/O panel, CP-1, is located on the ground level of the Headworks building. The second Remote I/O panel, CP-2, is located in the RAS/WAS pump station.

Condition Assessment

- All three control panels are equipped with obsolete Allen-Bradley PLC-5 programmable logic controller (PLC) equipment. These were considered obsolete by Allen-Bradley in 2011, so parts are difficult and expensive to obtain. Replacement of these components with Allen-Bradley ControlLogix PLC equipment is recommended.
- The SCADA HMI computer does not require major additional upgrades at this time. The computer hardware should be replaced within the next 5 years. The typical lifespan of SCADA computer hardware is 5 to 10 years. The Factory Talk View SE software currently installed can be reinstalled on the new hardware.
- Uninterruptible power supply (UPS) equipment located within each of the control panels is well maintained but has exceeded its useful expected life. Replacement of the UPS equipment is recommended.
- PLC and UPS replacements should occur as soon as possible.
- The communication network infrastructure is using an outdated serial network platform. The new PLC CPUs require Ethernet-based communications instead of serial communication. Replacement of the existing serial communication network with an Ethernet-based network is required when the PLCs are updated. This network can be either a copper-based Ethernet network or a fiber optic based Ethernet network. A fiber optic network is recommended as it is not subject to electrical interference or lightning, it can be installed at longer distances, and it will provide the City with a higher speed network.

- The Parshall flume flow meter transmitter (FIT-460) has issues with the LCD display. The original manufacturer, Magnetrol, no longer supports replacements, so this meter should be replaced as soon as possible.
- The instruments inside the IPS are corroded and need to be replaced. The gas transmitter inside the wet well is extremely corroded and there is no reading on the panel meter, which indicates failure.
- Many instruments have been abandoned in place, including:
    - Network radio antenna;
    - Milltronics MultiRanger Plus transmitter (previously used for hypochlorite tank level measurement); and
    - De-energized Dechlor controller (Strantrol 190-300).

Summary of Major Findings

Based on the conditions assessment, a SCADA system overhaul is recommended in the near term. A summary of the recommendations for major improvements to the central SCADA system is as follows:

- Replace existing LE and LIT-210 wet well level instruments with a single-sealed unit, equal to VegaPLUS WL61.
- Replace existing LSH and LSL-210 wet well low-level and high-level float switches with new switches, Intrinsic Safety Barriers, and 316L SST mounting pole.
- Replace existing AE and AIT-240 wet well explosive gas sensor instruments with a new remote sensor that draws and returns samples to the wet well.
- Replace all conduit inside the wet well and under buried conditions with handhole access and sealed transitions to protect all cables.
- Replace obsolete Allen-Bradley PLC-5 system with ControlLogix PLC equipment.
- Replace Serial Remote I/O network with Ethernet Device Level Ring network. Fiber optic cable is recommended.
- Replace existing UPSs at the three control panels.
- Replace the Parshall flume flow meter with a new FIT-460.
- Plan for replacement of the SCADA HMI computer hardware.

COMPOST FACILITY EXISTING SYSTEMS EVALUATION

Overview

The City's Compost Facility is located at the Jefferson County Transfer Station Site and handles yard waste and septage accepted from both the County and the City. The dewatered sludge generated from the WWTF also is delivered to this facility. The compost mixtures incorporate dewatered biosolids and yard waste to produce compost piles that are aerated. The compost is transferred with a front-end loader to be cured before it is screened and prepared for distribution in conformance with Ecology requirements.

The septage received at the Compost Facility is screened in a septage screening vault and held in two steel, aerated 10,000-gallon tanks. The septage is then dewatered and the filtrate from this process, as well as all other liquid waste streams around the facility, drain to a sequencing batch reactor (SBR) for treatment. Dewatered sludge feeds into the facility's compost mixing process as previously discussed. The SBR is approximately 42,000 gallons and consists of a submerged turbine aerator, methanol feed pump, WAS pump, and supernatant pump station. The WAS from the SBR is pumped back to the septage screening vault, while the supernatant is disinfected with sodium hypochlorite and discharged to constructed wetlands for further treatment. The constructed wetlands are made up of two cells, each with an area of approximately 6,500 square feet, that have a combined approximate maximum detention time of 17 total days. The treated effluent from these wetlands enters a flow control structure and discharges to the infiltration basins for final disposal.

Odors resulting from the septage holding tanks and compost aeration system are treated with biofilter media. This media consists of finished compost, soil and/or wood chips, and ground yard waste, and it is monitored for temperature, moisture content, and pH for process control and operation. A fan provides air pressure to discharge odorous air through the biofilter media evenly.

Figure 7-3 shows the approximate locations of the major Compost Facility processes, and **Figure 7-4** shows the general process schematic of the Compost Facility.

Figure 7-3 – Existing Compost Facility Overall Site Plan

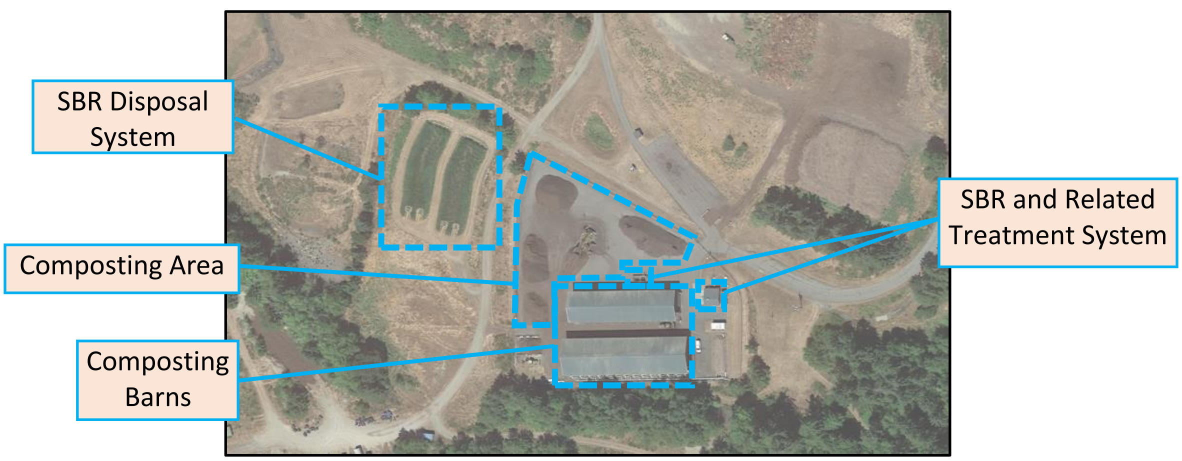
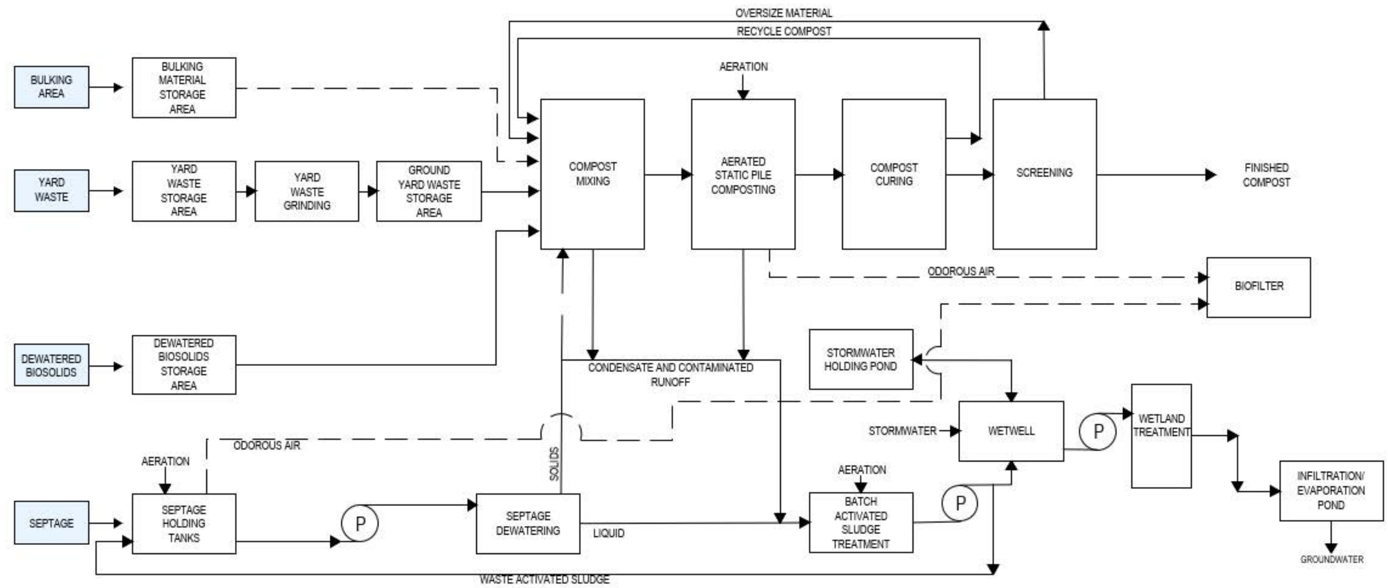


Figure 7-4 – Existing Compost Facility Process Schematic



Condition Assessment

Solids Handling Influent System

Septage haulers manually rake the bar screen and wash down the septage receiving area and screening vault. From the initial screening, septage is sent to one of two holding tanks. A significant amount of grit has been noted in one of the two 10,000-gallon septage holding tanks such that only the other tank is usable and is limiting the overall holding capacity. Grit is difficult to remove from these tanks. A new holding tank with a larger capacity should be installed, along with associated blowers to provide aeration into the holding tank. The influent system should be automated by installing a new packaged septage screening and grit removal system with an influent meter to monitor flow.

Septage Treatment System

The existing SBR appeared to be in good physical condition and continues to provide sufficient treatment. However, the blowers, pumps, and other associated equipment are aging and should be considered for replacement in the future.

Compost Facility Infrastructure

Due to the age of infrastructure and equipment, the composting screen, front-end loader, and aeration blowers associated with the composting process are nearing the end of their useful life and should be replaced. The concrete supports of the compost pole building have notable deterioration and need to be refurbished. Around the facility, the asphalt has degraded and should be repaired. In the existing pole building, the lighting is insufficient. Adequate accommodations and sufficient on-site fire flow capacity should be available to operational staff who will be present regularly.

Summary of Major Findings

Based on the conditions assessment, a summary of the recommendations for major improvements to the Compost Facility is as follows. Refer to the Proposed CIP Implementation Schedule in **Chapter 10** for the timeframes of the recommendations.

Solids Handling Influent System

1. Install an automated, packaged septage screening and grit removal system.
2. Install an influent meter to monitor flow.

Septage Treatment System

1. Remove the two existing septage holding tanks and install a new larger septage holding tank.
2. Install new aeration blowers for the new septage holding tank.
3. Replace aging SBR equipment.
4. Replace the WAS, chlorination, and wetland disposal pumps.

Compost Facility Infrastructure

1. Replace the composting screen.
2. Replace the composting front-end loader.
3. Replace the composting aeration blowers.
4. Refurbish the compost holding bay concrete supports.
5. Repair and seal asphalt around the facility.
6. Install new lighting inside the existing pole building.
7. Install a new hydrant connected to the water main feeding the facility.
8. Construct a new office for staffing accommodations.

TREATMENT FACILITIES ASSESSMENT CONCLUSION

This chapter described the recommended major and minor improvements for the City's WWTF and Compost Facility based on an evaluation of existing conditions. Given the major capital improvements and impacts on City operations, the next three chapters provide a basis for a capital improvement plan. Alternatives analyses for major capital improvements are presented in **Chapter 8**, and the recommended capital improvement projects are identified and further detailed in **Chapter 10**. The City's operations and maintenance program is presented in **Chapter 9**.

8 | TREATMENT FACILITIES ANALYSIS

INTRODUCTION

The future regulatory requirements for the wastewater treatment facility (WWTF) are outlined in **Chapter 2** of this General Sewer Plan (GSP). **Chapter 4** projects growth of the influent flow and loading. **Chapter 7** evaluates the condition of the existing facilities. In addition to these items, this chapter evaluates the ability of the City of Port Townsend's (City) WWTF to reliably meet the requirements of its National Pollutant Discharge Elimination System (NPDES) Permit through the planning period given the major considerations presented in previous chapters. This chapter analyzes alternatives to meet the needs of the WWTF through the planning period and provides recommendations for improvements.

MAJOR CONSIDERATIONS FOR WWTF IMPROVEMENTS

Based on the analyses of the previous chapters, the major factors influencing the WWTF planning are:

- Growth;
- Future regulations, specifically nitrogen removal requirements;
- Footprint constraints of the WWTF;
- Age and condition of the existing facility components.

Each factor is briefly introduced in the following sections.

Growth in Flow and Loading

The existing and projected flow and loading is defined in **Chapter 4**. The projected values are summarized in **Table 8-1**, along with the current rated capacity of the WWTF per the NPDES Permit.

Table 8-1

Projected Influent Flow and Loading

Parameter	Existing	2033	2043	Buildout	NPDES Permit Rating	85% of Permit Rating
Hydraulic Loading (MGD)						
Annual Average Daily Flow	0.87	1.19	1.46	2.39	1.44	1.22
Maximum Month Daily Flow	1.16	1.59	1.94	3.19	2.05	1.74
Maximum Day Flow	1.82	3.38	4.12	6.77	-	-
Peak Hour Flow	3.06	4.91	6.06	9.82	-	-
BOD Loading (ppd)						
Annual Average Daily BOD	2,591	3,202	3,706	5,819	3,754	3,191
Maximum Month Daily BOD	2,718	3,546	4,105	6,445	-	-
TSS Loading (ppd)						
Annual Average Daily TSS	2,493	3,125	3,630	5,742	4,568	3,883
Maximum Month Daily TSS	2,799	3,470	4,030	6,376	-	-

Green shaded cells exceed 85% of the rated capacity and orange shaded cells exceed 100% of rated capacity.

TSS = total suspended solids

As shown in the table, the projected 2043 flow and biochemical oxygen demand (BOD) loading is very near to the permitted capacity of the WWTF. Further, the projected 2033 BOD loading exceeds 85 percent of the rated capacity. The City's NPDES Permit requires the City to begin planning for an expansion of facility capacity when flow and loading exceeds 85 percent of the permitted maximum month value for 3 consecutive months. It takes considerable time (up to 10 years) to properly plan for and permit major treatment plant expansion, and as such, it is recommended that the City begin planning for such an expansion in the first 5 years of the planning period.

Regulatory Changes – Nitrogen Reduction

As discussed in **Chapter 2**, the future regulations that will most significantly influence WWTF planning are the nitrogen limits proposed by the Puget Sound Nutrient General Permit (PSNGP), which became effective in 2022. The City is considered to be in the category of "WWTFs with small [Total Inorganic Nitrogen] TIN loads" by the PSNGP. As detailed in **Chapter 2**, the PSNGP requires dischargers in this category to:

- Develop and implement a Nitrogen Optimization Plan (NOP). The general intent of the NOP is to assess and recommend optimization strategies to maximize TIN removal at the existing WWTF primarily through operational changes, minor on-site improvements, and off-site source control. The dischargers were required to select an initial optimization strategy by December 31, 2022. The NOP should analyze and document the performance of the selected optimization strategy. The NOP must be submitted by March 31, 2026; and
- Complete an all known available and reasonable methods of prevention, control, and treatment (AKART) analysis that evaluates reasonable treatment alternatives that will maintain the WWTF annual average effluent TIN below 10 milligrams per liter (mg/L). This analysis must include wastewater characterization, analysis of treatment technologies,

economic evaluation, environmental justice review, recommendation of the most reasonable treatment alternative, and an implementation schedule. The AKART analysis must be submitted by December 31, 2025. Notably, the PSNGP states that "permittees that maintain an annual TIN average of < 10 mg/L and do not document an increase in load through their [Discharge Monitoring Reports] DMRs do not have to submit this analysis."

- Meet additional monitoring and record retention requirements as discussed in **Chapter 2**.

For the purposes of this GSP, an annual average effluent TIN below 10 mg/L is considered the benchmark for analyzing alternatives for improvements to the WWTF. The existing WWTF was not designed with a dedicated denitrification process, which would be necessary to reliably provide TIN reduction at the permitted flow and loading conditions. Upgrading the WWTF to provide TIN reduction at the permitted flow and loading would necessitate a major reconfiguration of the facility.

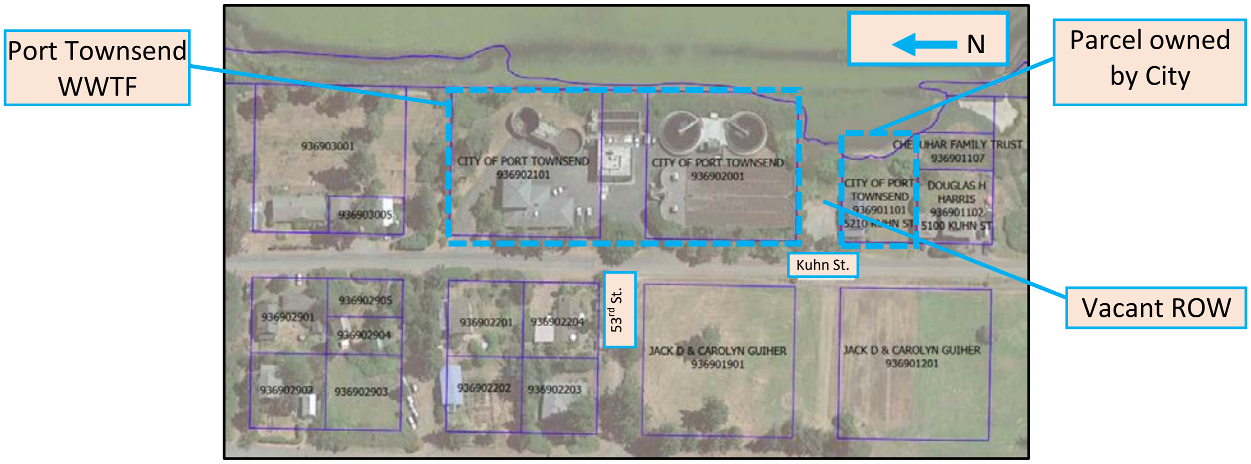
It is understood that continued modeling by the Washington State Department of Ecology (Ecology) or other factors may change the structure of the final TIN limit. It should be noted that the final TIN limit may be different from an annual average of 10 mg/L for the City, and as such, it is likely in the City's best interest to extend the useful life of the existing WWTF infrastructure and defer the need to make major improvements until the future effluent nitrogen limits have been finalized. As discussed in the **Activated Sludge System** section, the City is currently utilizing an optimization strategy to meet a TIN limit of 10 mg/L. This chapter discusses improvements of limited mechanical and structural scope that could be made to allow the TIN limit to continue to be reliably met for at least a portion of the planning period.

It should be noted that if regulatory conditions result in more stringent limits, the timeline for planning improvements may be accelerated and capital costs increased, which would require either significant grant resources and/or larger rate increases.

WWTF Site Footprint

One of the major factors influencing WWTF planning is the constrained nature of the existing WWTF site. The site is bounded to the east by the body of water referred to as the Chinese Gardens. To the west, the site is bounded by Kuhn Street. **Figure 8-1** shows the existing site aerial with parcel lines and ownership, as well as the surrounding areas.

Figure 8-1 – WWTF and Surrounding Parcels

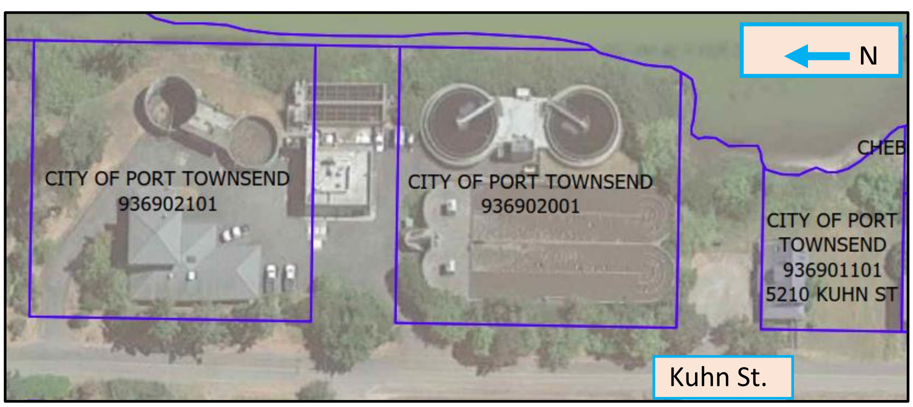


The WWTF occupies two parcels transected by platted right-of-way (ROW) extending from 53rd Street. The City owns an additional parcel to the south of the WWTF that contains a single structure (house converted to an office). This parcel is separated from the WWTF parcels by platted, vacant ROW. Similarly, a platted strip of vacant ROW lies immediately north of the northmost WWTF parcel. To the north and south beyond are private parcels.

The platted and vacant ROW section north and south of the WWTF parcel must be maintained for public access to the waterfront per Revised Code of Washington (RCW) 35.79.035. This area potentially could be used for below-grade utilities, but it is not prudent to plan any above-grade tankage and infrastructure in these areas.

Figure 8-2 shows the current WWTF and parcels.

Figure 8-2 – WWTF Site Aerial



On **Figure 8-2**, there are three general spaces within the existing WWTF footprint that are not occupied with permanent, above-grade WWTF infrastructure:

- The northeast corner of the site, north of the existing sludge holding tanks, is vacant and could be utilized. However, this area is relatively small and is isolated from the main process piping and interconnections. This space may be used for ancillary improvements. However, this space does not readily facilitate any significant expansion of the WWTF;

- The southmost parcel, which contains one existing building, could potentially be repurposed for expansion of the WWTF. However, as previously stated, the southern section of unused ROW cannot be used for permanent, above-grade infrastructure. As such, this parcel will remain somewhat isolated from the main WWTF infrastructure. Relative to the size of the existing WWTF, the parcel is also relatively small and could support only limited new infrastructure. Similar to the northeast corner of the WWTF, this parcel does not readily facilitate any significant expansion of the WWTF; and
- The paved area north of the oxidation ditches is relatively small and encumbered by significant below-grade utilities. The area also is used for parking and vehicle access. This area does not readily facilitate any significant expansion of the WWTF.

In general, the existing WWTF infrastructure occupies most of the area included in the City parcels and there is not sufficient available space on these parcels to plan for a major expansion of the WWTF.

Age and Condition

Chapter 7 summarized the existing conditions of the major unit processes and areas of the WWTF. The facility has been exceptionally well maintained. However, the last major improvements to the facility were made over 30 years ago and numerous improvements will be needed during the planning period due to the age of the infrastructure. It is known that major changes to the facility will be needed during the planning period to meet new regulations and growth. The recommendations in this chapter seek to avoid unnecessarily investing in the rehabilitation of aging items that are likely to be substantially reconfigured or replaced later in the planning period. The intent is to make improvements that maintain the operability and reliability of the WWTF and extend its useful life while avoiding major sunk costs for such improvements.

Due to its size, the concrete oxidation ditch tankage is the largest and most valuable asset at the WWTF. Understanding the remaining useful life of this tankage is critical in analyzing the activated sludge system improvements. As noted in **Chapter 7**, the existing oxidation ditch concrete appears to be in good physical condition. However, these tanks were designed over 30 years ago and will be over 50 years of age at the end of the planning period. Further, the tankage was not designed to current codes and may not meet current requirements for seismic conditions, as an example. As discussed in the **Activated Sludge System** section, major improvements will be needed later in the planning period to expand facility capacity while meeting nitrogen reduction requirements. Some options for these improvements include reuse of the existing oxidation ditch tankage. It should be noted that any significant reconfiguration of the oxidation ditches will require substantial structural modifications to meet current codes. This likely will be very costly and may not be prudent given the advanced age of the structure at the time of the improvements. This factor warrants significant consideration when analyzing activated sludge system improvements in the subsequent sections of this chapter.

APPROACH TO WWTF ANALYSES

Improvements to the activated sludge system (oxidation ditches and clarifiers) are needed for nitrogen reduction and to expand WWTF capacity. These improvements are expected to have the largest impact on WWTF planning; therefore, the major WWTF processes are reviewed in the following order:

1. Activated sludge system.
2. Preliminary treatment system.
3. Effluent disinfection system.
4. Solids handling system.

ACTIVATED SLUDGE SYSTEM

Existing Activated Sludge System

Original Design Criteria

The existing activated sludge system consists of two oxidation ditches and two secondary clarifiers. Each ditch contains a single two-speed mechanical surface aerator (referred to herein as mixer/aerators). The design criteria for the oxidation ditches is included in **Table 8-2** from the original construction drawings.

Table 8-2

Original Oxidation Ditch Design Criteria

Oxidation Ditches	Quantity
Aeration Basin	2
Volume, Each (MG)	0.57
MLSS (mg/L)	2,800
MLVSS (mg/L)	2,100
Hydraulic Retention Time (hrs)	
Average Annual Design	22
Maximum Month Design	15
Maximum Day Design	9
Solids Retention Time (Days)	
Average Day	15
F/M	
Average	0.10
Maximum Month	0.14
Oxygen Required (lb/hr)	
Average	100
Maximum Day	340
Surface Aerators, 2 Speed	2
Size, Each (hp)	75

MG = million gallons
MLVSS = mixed liquor volatile suspended solids
lb/hr = pounds per hour
hp = horsepower

The original design criteria shown in **Table 8-2** assumes two basins are online. At the average annual condition, with a solids retention time (SRT) of 15 days, the predicted mixed liquor suspended solids (MLSS) concentration is 2,800 mg/L with two basins online. The original design loading for the WWTF is included in **Table 8-3**.

Table 8-3

Original Facility Design Flow and Load

WWTF Influent - Design Loadings and Flow Rates		
	YR 1993	**YR 2013**
Design Flow Rates (MGD)		
Average Annual (AAF)	0.96	1.27
Maximum Month (MMF)	1.33	1.81
Maximum Day (MDF)	2.34	2.92
Peak Hour (PHF)	4.35	5.27
Design BOD Loadings (ppd)		
Average Day	1,444	2,054
Maximum Month	2,055	2,804
Maximum Day	3,846	5,346
Design TSS Loadings (ppd)		
Average Day	1,444	2,054
Maximum Month	2,158	3,018
Maximum Day	5,121	7,102

It should be noted that the 20-year design values (2013 values) shown in the table are slightly below the currently permitted values shown in **Table 8-1**. For the purposes of this chapter, the permitted values generally are used for the subsequent analyses.

Capacity Analysis

The ability to settle the biological floc of an activated sludge system in the secondary clarifiers typically constrains the capacity of the system. The solids loading rate (SLR) to the clarifiers represents the allowable solids load per unit of clarifier operating surface area. The typical secondary clarifier SLR design criteria is an average of 25 pounds per square foot per day (lb/sf/d) and a peak SLR of 40 lb/sf/d for conventional activated sludge. As the microbial population increases in the oxidation ditches (represented by the MLSS concentration), clarifier SLR generally increases proportionally. As SRT increases, so does the MLSS concentration due to the extended time available for microbial growth. As such, the SRT and MLSS are both indirectly limited by the settleability of the activated sludge. The existing WWTF includes two 50-foot diameter secondary clarifiers. **Table 8-4** shows the calculated SLR for operating scenarios with one or two clarifiers online. This table assumes both oxidation ditches are online and the MLSS is constant at 2,800 mg/L for all conditions.

Table 8-4

Predicted Clarifier SLR for Existing Activated Sludge System at MLSS 2,800 mg/L

		One Clarifier	Two Clarifiers
Condition	**MM Influent Flow (MGD)**	**SLR (lb/sf/d)**	**SLR (lb/sf/d)**
Design Average Annual	1.27	23	11
Design Maximum Month	1.81	32	16
Permitted Maximum Month	2.05	37	18

RAS rate at 50% of the influent flow rate per design criteria.

As shown in the table, at the original maximum month design condition of 1.81 million gallons per day (MGD), as well as at the permitted maximum month condition of 2.05 MGD, the clarifier SLR is below the recommended range with two oxidation ditches and two clarifiers in service. However, if one clarifier is out of service, as must be considered for normal maintenance or a failure, the SLR will exceed the recommended range. Although not shown in the table, a similar result would be expected if one oxidation ditch is out of service with two clarifiers online.

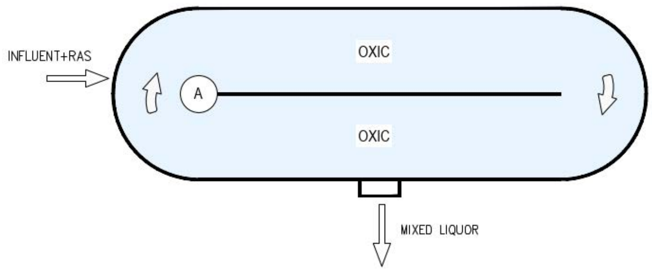
Due to the existing constraints presented in the **WWTF Site Footprint** section, there appears to be no simple method to add a third clarifier to the site, which would otherwise alleviate the potential single clarifier condition. The third clarifier would most practically be located immediately adjacent to the existing clarifiers to facilitate the large and complex pipe connections. This is not feasible with the current oxidation ditches and parcel boundaries.

As shown in this analysis, the clarifier SLR effectively limits the WWTF capacity approximately at the current WWTP rating. Further, there is no readily available location to add a third clarifier on the site to alleviate this capacity restraint.

Current Strategy for Nitrogen Reduction

The original activated sludge system was designed and expected to produce fully nitrified effluent (ammonia converted to nitrate). At the design loading with the existing aerators at full speed, there should be sufficient oxygen transfer and SRT to allow for full nitrification. However, in this configuration, minimal denitrification is likely to occur, which is necessary to convert nitrate to nitrogen gas to reduce overall nitrogen in the effluent. At the time the WWTF was designed, denitrification was not a consideration. For denitrification to occur, an anoxic environment must be provided in the system. No dedicated anoxic environment was provided in the oxidation ditches as originally configured. The oxidation ditches each consist of an entirely aerated, closed loop reactor as shown in **Figure 8-3**.

Figure 8-3 – Existing Oxidation Ditch Configuration

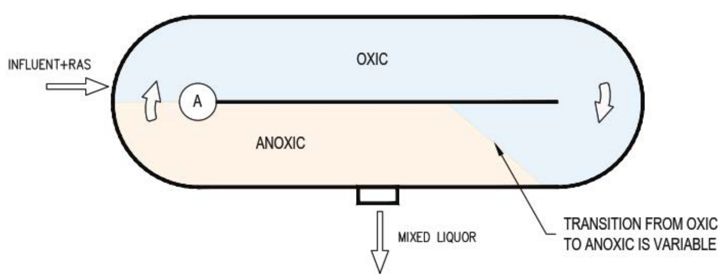


Note: Single ditch shown.

The result of this configuration is minimal TIN reduction in the effluent. Further, nitrification consumes alkalinity and without denitrification it can be difficult to maintain effluent pH within NPDES Permit limits without supplementing alkalinity to the process.

As previously noted, the WWTF is required to implement and monitor an optimization strategy to reduce effluent TIN as required by the PSNGP. When operated as designed, the aerators provide sufficient oxygen to maintain adequate dissolved oxygen (DO) concentration throughout the entirety of the reactor. As an optimization strategy, the operators are currently operating the aerator for each ditch in low speed. By doing this, the oxygen transfer is limited, which allows for the creation of an anoxic area that is low or devoid of oxygen on the downstream end of the reactor loop. This configuration is similar to that described in Table 8-24, row (o) of *Wastewater Engineering: Treatment and Resource Recovery,* 5th edition (2013, Metcalf & Eddy). **Figure 8-4** illustrates this configuration.

Figure 8-4 – Current Operation of Existing Oxidation Ditch with Aerator at Low Speed



Note: Single ditch shown.

This approach has generally allowed the operators to reliably maintain effluent TIN below 10 mg/L at the current flow and loading conditions. However, this approach has several drawbacks, which are discussed as follows:

- **Reduction in capacity:** By limiting the aerators to low speed, the capacity of the oxidation ditches is effectively reduced. The oxidation ditch design criteria (**Table 8-2**) assumed that the aerators are operating at a high speed to provide peak oxygen transfer. Maintaining the aerators at a low speed, to create the anoxic zone, reduces the capacity of the system to oxidize influent constituents and significantly reduces the design capacity for BOD removal. Currently, the influent is below the design BOD load, but with growth, it is expected that the aerators will need to run at high speed more consistently to meet BOD demand. Without a dedicated anoxic zone, the entire ditch volume is expected to be aerobic with the aerators in high speed and TIN reduction will not substantially occur.

- **Anoxic zone variability:** Currently, there is no automation that would control the mixer/aerator speed between low and high speed based on loading conditions and the resulting DO demand. As such, the aerators are operated manually and predominately in low speed. With the normal diurnal variability in loading and subsequent DO utilization, the size of the anoxic zone may vary significantly and is generally uncontrolled. This issue will be exacerbated as flow and loading increases and will make reliably meeting the permit limits more challenging.
- **Anoxic zone location:** In the current optimization strategy, the anoxic zone is inherently at the downstream end of the reactor. Typically, activated sludge systems designed for nitrogen removal include anoxic zones upstream of oxic zones such that some influent carbon can be used by organisms to perform denitrification. This configuration allows for efficient use of carbon and a higher rate of denitrification. The current optimization strategy does not allow for this approach.
- **Filamentous Organism Growth:** Filamentous organisms can reduce the settleability of activated sludge significantly, which, as previously discussed, restrains the capacity of activated sludge systems. These organisms can thrive in low DO environments and should be a significant concern with the current optimization strategy, which inherently creates areas of low DO. The WWTF's current sludge volume index values, which measure the settleability of the activated sludge, tend to be in the range of 150 to 250. These values generally are considered to be indicative of relatively poor settling sludge. This issue will be of further concern with growth in flow and loading.

The current optimization strategy is reducing effluent TIN substantially and has been implemented without incurring capital expenditures. The City's operators are effectively managing the system to reliably produce TIN below 10 mg/L. While this approach has been valuable to the City in meeting the initial PSNGP requirements, for the reasons previously stated, it is not recommended that this strategy be relied upon for more than approximately the next 5 years (2028).

It is in the best City's interest to maintain TIN reduction going forward. The current optimization strategy should continue to be utilized, but more permanent improvements should be prioritized in the next 5 years. Given this, the remaining analyses of this chapter review improvements of limited scope that can be made soon to continue to provide TIN reduction, extend the useful life of the activated sludge system, and allow for deferral of significant improvements to the WWTF.

Screening of Nitrogen Treatment Options

Nitrogen is reduced via biological treatment of wastewater through aerobic activated sludge treatment as discussed previously. Aerobic activated sludge systems have been utilized for this purpose in a variety of configurations. To support nitrogen reduction, each process seeks to provide nitrification though an aerobic system and denitrification through an environment low in, or devoid of, dissolved oxygen. There are two general categories of activated sludge systems: suspended growth and attached growth. Within these categories and subcategories, many variations exist.

Suspended Growth Processes

Suspended growth processes are detailed in Chapter 8 of Metcalf & Eddy (2013) and generally include the basic subcategories for each system as listed.

- Complete-mix systems – Large, single stage tanks with substantial mixing/recirculation equipment to dilute influent into the tank and avoid short circuiting.
  - The existing oxidation ditch system is an extended aeration system that constitutes a special type of complete-mix system. An oxidation ditch is completely mixed due to the high rate of recycle but also contains of single point of aeration that creates an oxygen gradient along the flow path of the reactor.
- Plug flow, staged systems – Typically consist of long, narrow basins with multiple zones.
- Sequencing batch reactors (SBRs) – Consist of two or more tanks to which batches of influent are cycled for treatment.

Of the three general subcategories of suspended growth processes, complete-mix and plug flow, staged systems are applicable for analysis at this site as discussed further in this chapter. Improving the existing oxidation ditch system is reviewed first in the **Improvements to Existing Oxidation Ditch System** section. Implementing a plug flow, staged system would constitute complete replacement of the existing activated sludge system and is evaluated in the **Replacement of the Existing Oxidation System** section.

SBRs are not considered practical to implement at the existing WWTF site as they represent an entirely new process configuration with new tankage. As previously established in the **WWTF Site Footprint** section, there is not sufficient available space on the site to maintain the operation of the existing system while adding the new tankage that would be necessary for an SBR system.

Attached Growth Processes

Attached growth processes are detailed in Chapter 9 of Metcalf & Eddy (2013) and generally include the basic subcategories for each system as listed.

- Standard biofilm processes – Various configurations in which flow passes through either stationary or moving carriers to which biofilm is attached.
- Integrated biofilm and activated sludge processes – Various configurations in which either stationary or moving biofilm carriers are utilized with suspended growth activated sludge to provide treatment.

Similar to SBRs, most standard biofilm processes are not practical for consideration at the existing site. However, one standard biofilm process and three integrated processes are screened for applicability in this section. These systems typically are promoted as supplemental equipment options intended to represent minimally invasive improvements to existing activated sludge systems and include the following.

- Integrated biofilm and activated sludge processes
  - Integrated fixed film activated sludge (IFAS)
  - Membrane aerated biofilm reactors (MABR)
  - Mobile organic biofilm (MOB)

- Standard biofilm processes
    - Denitrification filters for tertiary treatment

Attached Growth – IFAS

IFAS is a biological treatment that integrates suspended growth activated sludge with fixed film growth. IFAS adds inert carriers, typically plastic, to the activated sludge system to facilitate fixed film growth. A screen retains the carriers in the reactors while suspended growth is carried through the normal flow path to the secondary clarifiers and returned by the return activated sludge (RAS) or wasted. Multiple manufacturers provide IFAS systems, with many proven installations. The typically stated benefits of this system include:

- Biomass density can be increased through the addition of fixed film organisms without proportionally increasing the secondary clarifier SLR;
- Simultaneous nitrification and denitrification can potentially occur within the biofilm; however, there is not enough information to verify that this can reliably be achieved at all operating conditions;
- Nitrification and denitrification can be achieved at SRTs lower than conventional flocculant sludge;
- The likelihood of microbial washout at high flows is decreased due to the retention of the fixed film organisms; and
- Reduced yield of waste sludge.

However, IFAS is not considered compatible with a closed loop oxidation ditch system and surface aerators. Floor-mounted diffused aeration is necessary to ensure that the media remains adequately suspended throughout the reactor. Further, multiple partitioned zones would be necessary to ensure that the media remains evenly distributed along the length of the reactor. These requirements would incur a high capital cost and would be difficult to implement. Further, the system likely would only incrementally increase the overall capacity of the activated sludge system. This option is not considered further.

Attached Growth – MABR

MABR is biological treatment that integrates suspended growth activated sludge with fixed film growth. In this system, cassettes of membranes are installed into one or more zones of an activated sludge system. The membrane cassettes are similar to those used in membrane bioreactor systems; however, with MABR, the membranes are used as both a fixed biofilm carrier and an aeration device. The membranes are stationary in the tank and biofilm attaches to the surface of the membranes. The membranes are used to transfer oxygen directly to the biofilm. Suspended growth activated sludge develops in the bulk liquid, is passed to subsequent zones, and is returned from the secondary clarifiers. The MABR process has been characterized in Ecology's *Criteria for Sewage Works Design* as a new and developmental technology as defined in Section G1-5.4.1.

The typically stated benefits of MABR include:

- Biomass density can be increased through the addition of fixed film organisms without proportionally increasing the clarifier SLR;
- The total system oxygen transfer efficiency is increased as a portion of the total oxygen is delivered through the membranes directly to the biomass in lieu of passing through the bulk liquid;
- Simultaneous nitrification and denitrification potentially can occur within the biofilm, but there is not enough information to verify that this can be achieved reliably at all operating conditions;
- Nitrification and denitrification can be achieved at SRTs lower than conventional flocculant sludge;
- The likelihood of microbial washout at high flows is decreased due to the retention of the fixed film organisms; and
- Reduced yield of waste sludge.

The primary difficulty with implementing MABR into the existing WWTF is that MABR cassettes typically are installed within the initial partitioned zone of a plug flow system. It is unlikely that MABR could be integrated into a closed loop oxidation ditch system. Implementing this system would require many of the same elements as IFAS; therefore, this option is not considered further.

Attached Growth – MOB

MOB is a biological treatment process intended to enhance suspended growth activated sludge systems. Nuvoda is currently the only company known to sell such systems. The MOB process consists of adding small organic carriers to an activated sludge system to facilitate biofilm development. The porous organic carriers are manufactured from Kenaf plant stalks. The carriers vary in size but are generally near 1 millimeter in diameter. These organic carriers have a very high surface area relative to the particle size and facilitate faster settling compared to conventional flocculant sludge. As such, the process intends to intensify activated sludge systems by adding a biofilm component to increase biomass concentration while increasing settleability. The carriers are removed from the RAS stream via a rotary drum screen and returned to the basins.

The MOB process has been implemented at a few municipal facilities over approximately the last 5 years. Notably, demonstration of the Nuvoda process was undertaken at the Edmonds WWTF in Washington and the Forest Grove WWTF in Oregon in recent years. However, neither of these facilities include oxidation ditches, so the findings are not directly applicable to the City.

By adding MOB directly to the existing oxidation ditch, the carriers should add a biofilm component to the activated sludge, which may allow for some denitrification within the anoxic environment internal to the biofilm. However, the relative effect that this will have on effluent TIN is difficult to predict based on the limited data from similar operating facilities. Further, the system requires screening to be added to the RAS system, which will require additional process building space that will be costly and challenging to implement on the already constrained site. For these reasons, the City's WWTF is not recommended to be an early adopter of this technology.

Attached Growth – Denitrification Filters for Tertiary Treatment

Various tertiary treatment systems exist for the purposes of removing nutrients from the secondary effluent. The existing oxidation ditches are shown to full nitrify the effluent at design conditions; therefore, a tertiary treatment system that provides denitrification may be considered for this facility. Denitrification filters are the logical technology to review. These filters are a subset of biofilm processes that can be used as a tertiary treatment process to aid in effluent TIN reduction. In this process, nitrified effluent (in which most ammonia has been converted to nitrate) is passed through a filter bed containing heterotrophic organisms that metabolized nitrate into nitrogen gas in the anoxic conditions of the filter bed. This typically requires a carbon feed ahead of the filter as most of the influent carbon has been reduced through the preceding secondary process.

For this technology to be applied at the City, an effluent pump station would be required to lift secondary effluent from downstream end of the clarifiers to the denitrification filters. This is not recommended as the construction of an effluent pump station and filters on the existing site would be extremely difficult to configure and implement, would be costly, and would further reduce the available footprint at the WWTF. Further, implementation of a tertiary treatment system of any sort will not inherently increase the WWTF capacity as it will not improve the activated sludge system. As such, tertiary treatment systems, such as denitrification filters, are not considered further for this facility.

Improvements to the Existing Oxidation Ditch System

Based on the analyses of the previous section, improving the existing oxidation ditch system is likely to be the only feasible approach that does not constitute a complete replacement of the existing system. The intent of this section is to review options for improving the existing system that include limited mechanical and structural improvements, are relatively low cost, would extend the useful life of the existing infrastructure, and would delay the need for major improvements. The applicable options include:

1. The addition of anoxic tankage external to the oxidation ditches;
2. The creation of a dedicated anoxic zone internal to the oxidation ditches; and
3. Cyclic aeration of the oxidation ditches.

The anoxic zone tankage would need to equate to approximately 20 to 30 percent of the volume of the existing ditches. There is no feasible method to add external anoxic tankage of this size to the site based on the constraints identified in the **WWTF Site Footprint**. As such, the first option is not considered applicable.

The two remaining options are analyzed in the following sections.

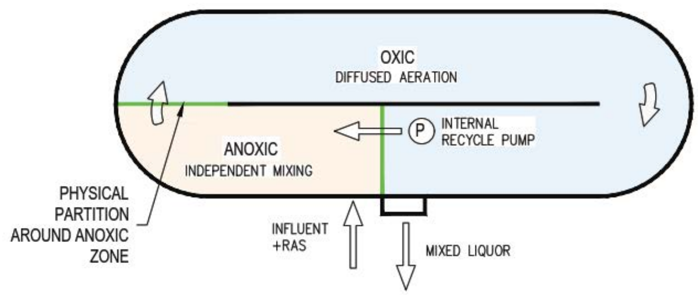
Creation of Dedicated Anoxic Zone Internal to Oxidation Ditches

The existing optimization strategy represents one method of creating an anoxic zone within the oxidation ditches by reducing aeration to create a zone relatively devoid of oxygen. As previously discussed, this configuration has significant limitations that preclude relying on this option through the planning period.

Another option consists of physically partitioning an anoxic zone and adding new equipment to the system. The Modified Ludzack-Ettinger (MLE) process that fits this approach is one of the most common activated sludge processes used for biological nitrogen removal. This process is shown in Table 8-24, row (b) of Metcalf & Eddy (2013). The MLE configuration creates a dedicated anoxic zone upstream of the aerobic zone. An internal recycle pump returns mixed liquor from the downstream end of the aerobic zone to the anoxic zone at a high rate (typically 3 to 5 times the influent flow rate) to return the nitrate for denitrification in the anoxic zone. Placement of the anoxic zone upstream of the aerobic zone allows for influent carbon to be utilized for denitrification.

To implement this configuration within the existing tankage at the WWTF, an anoxic zone would be created with a physical partition within the ditch as shown in **Figure 8-5**.

Figure 8-5 – Conceptual Conversion of Existing Oxidation Ditches to MLE Configuration



Note: Single ditch shown.

As shown in the figure, this fundamental change to the ditch configuration essentially converts the ditch from a closed-loop reactor to a staged, continuous flow reactor. The mixer/aerator, which is necessary to provide a high degree of mixing and recirculation in a closed-loop reactor, would be removed. The MLE configuration would utilize an internal recycle pump, new mixing equipment in the anoxic zone, and diffused aeration with external blowers for the oxic zone. Additionally, it would be prudent to place the partition adjacent to the mixed liquor outfall and relocate the influent/RAS discharge location as shown in the figure to make the best usage of the tankage volume.

These changes would consist primarily of mechanical equipment additions. There would be significant new motor loads for the aeration blowers, mixing equipment, and internal recycle pumps that likely would prompt major electrical system changes. Any approach that continues to utilize the existing aerators and minimize equipment additions would be less costly than conversion to the MLE configuration shown.

Further, these improvements would not be expected to significantly expand the system’s capacity beyond the projected 2043 loading values. The system will remain inherently limited by the SLR capacity of the two clarifiers. The MLE system could allow for modest improvements in aeration system oxygen transfer and mixed liquor settleability, but these would only be expected to incrementally increase the capacity of the activated sludge system with the existing two clarifiers.

The cost and complexity of this configuration, coupled with the minimal capacity expansion that it affords, preclude this option from further consideration.

Cyclical Operation of the Oxidation Ditches

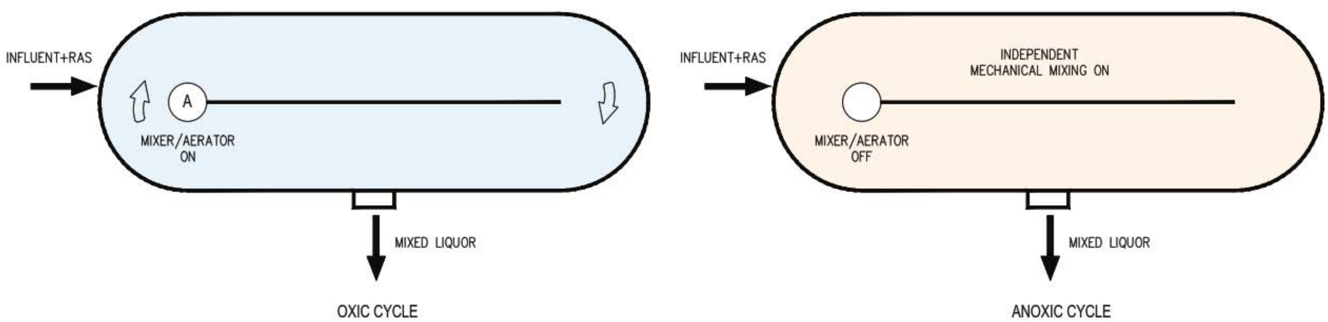
As previously discussed, the City's current TIN reduction optimization strategy creates an anoxic environment in the oxidation ditches by operating the aerators in low speed. This approach creates an anoxic zone internal to the ditch without necessitating physical partitions and other improvements discussed in the **Creation of Dedicated Anoxic Zone Internal to Oxidation Ditches** section.

Another approach to creating an anoxic environment in the ditches without physical partitions is to create anoxic cycles by cyclically turning off the aerator periodically each day. This approach has been utilized in multiple similar facilities to reduce TIN below 10 mg/L or less and is described in Table 8-24, row (p) of Metcalf & Eddy (2013). This approach is readily applicable for retrofitting facilities with two oxidation ditches. At a minimum, it would be necessary to add the following items to the existing ditches:

- Mechanical mixing equipment for each ditch to maintain the activated sludge in suspension during the anoxic cycles when the mixer/aerators are offline. This equipment likely would consist of one or two low speed, large blade, submersible mixers.
- Oxidation-reduction potential control equipment to determine when the nitrate is depleted to suspend the anoxic cycle.

Figure 8-6 illustrates the cyclical operation of the two oxidation ditches.

Figure 8-6– Conceptual Conversion of Existing Oxidation Ditches to Cyclic Operation



Note: Single ditch shown in either oxic or anoxic cycle.

There are some significant benefits to this approach. First, it represents limited structural and mechanical improvements consisting primarily of small equipment additions and control system programming. Further, it allows for continued use of the mixer/aerators, which decreases the cost of this option relative to conversion to an MLE process. Lastly, this option could be implemented with a relatively short outage of the existing tankage and by taking each ditch offline in series.

Conversion to cyclic operation generally should regain most of the permitted capacity of the WWTF while providing for TIN reduction to below 10 mg/L. It is recommended that the capacity of this system be based on an average annual clarifier SLR of 25 lb/d/sf. Based on **Table 8-4**, this would equate to 1.40 MGD with one clarifier online, which is approximately the same as the current rated capacity of the WWTF (1.44 MGD average annual). An average annual flow of 1.4 MGD is projected to occur in approximately 2040 per **Table 8-1**. As previously noted, the City must begin planning for an expansion of WWTF capacity when the facility exceeds 85 percent of its rated capacity.

Assuming a capacity of 1.4 MGD with cyclical ditch operation, 85 percent would equal an approximate average annual flow of 1.20 MGD, which is projected to occur by 2033.

Implementing cyclic operation is recommended soon as it will assist the WWTF in maintaining TIN below 10 mg/L as growth in flow and loading occurs. These improvements are of limited mechanical and structural scope and represent a relatively low-cost approach to regaining WWTF capacity and maintaining TIN reduction with the existing system. Further, the ultimate TIN requirements of the PSNGP are not yet finalized; therefore, delaying major improvements by extending the useful life of the existing infrastructure is in the best interest of the ratepayers. This approach is predicated on major improvements to the activated sludge system likely occurring between 2033 and 2040, as 85 percent of the WWTF capacity is expected to be exceeded by 2033.

Replacement of the Existing Oxidation Ditch System

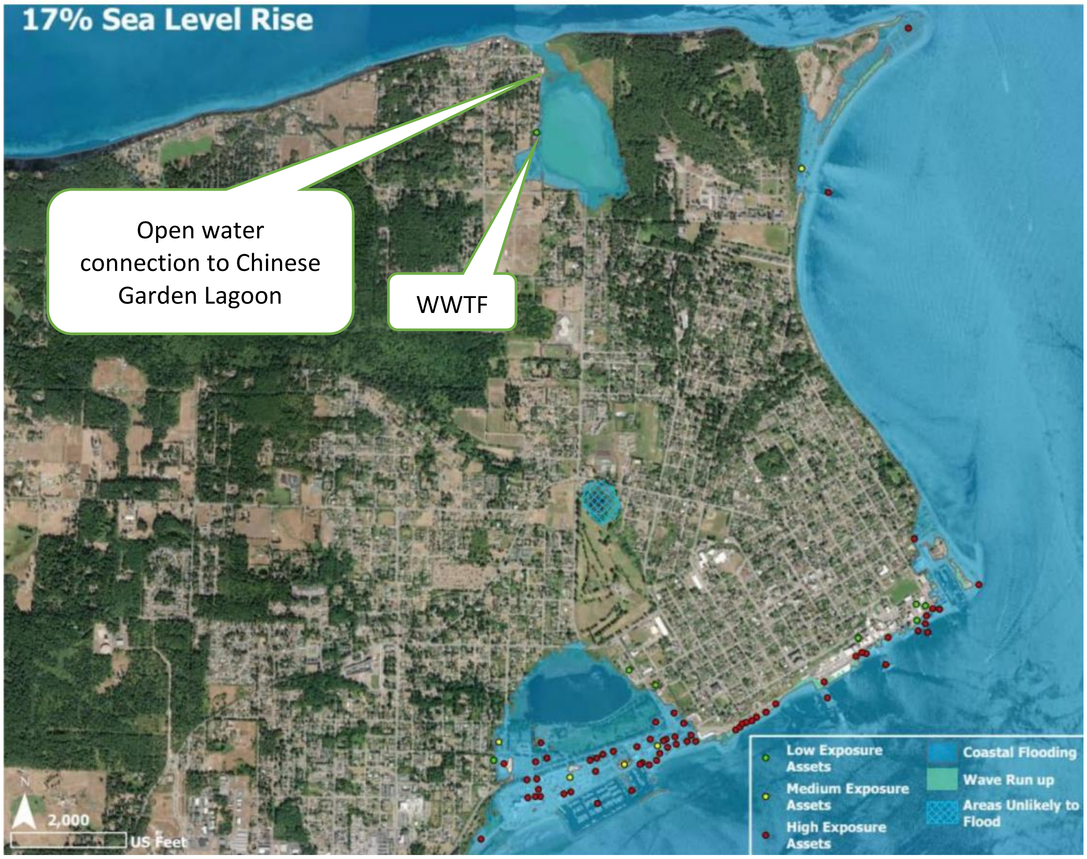
The analyses of the previous sections resulted in recommending cyclical operation of the oxidation ditches as a near-term improvement that is minimally invasive to the WWTF. As discussed, this approach may provide reliable TIN reduction as the City grows, although major improvements should be planned and implemented to ensure continued, reliable treatment. Major improvements also are anticipated given the age of the infrastructure. The useful life and capacity of this infrastructure could be extended to approximately 2040 by making improvements to implement cyclical oxidation ditch operation in the next 5 years. The City is fortunate to be able to get extended life out of the oxidation ditches and replacement will be timely in addressing its age and growth concurrently.

None of the options previously analyzed were shown to meet the TIN objectives at the flow and loading levels expected at the end of the planning period due to the SLR limitation of the two secondary clarifiers. Based on the initial review of alternatives in the **Screening of Nitrogen Treatment Options** section, conversion to a plug flow, staged system is the only other practical alternative that should be considered for the longer term improvements and capacity expansion of the WWTF.

Plug flow, staged systems have been configured to provide a much higher rate of treatment relative to oxidation ditches. A prudently designed plug flow system can allow for treatment capacity that is double that of an oxidation ditch system with a similar footprint. The activated sludge in a plug flow system should have substantially improved settleability compared to that of an oxidation ditch system, which allows for a much higher clarifier SLR to be achieved. This enables significantly increased MLSS concentrations to be achieved, which allows for a higher rate of biological treatment per reactor area.

In 2022, the City commissioned a study on sea level rise impacts on Port Townsend, including wastewater infrastructure. The *City of Port Townsend Sea Level Rise and Coastal Flooding Risk Assessment* (Cascadia Consulting Group, 2022) is contained in **Appendix K**. As noted in the study, in the long term, there will be impacts that could affect wastewater infrastructure. Any future planning for improvements intended to last beyond the next 20 years should factor this study and latest available information on sea level rise into the siting and hydraulics of the proposed improvements. **Figure 8-7** illustrates an open water connection between the Strait and Chinese Garden Lagoon. This plan for future improvements (lasting beyond 20 years) takes into account this probability of sea level rise as illustrated in **Figure 8-10**. Refer to the **Outfall** section in this chapter for further discussion on sea level rise.

Figure 8-7 – Sea Level Rise Projects for 17% Probability of Exceedance including Storm Surge



Given the effects of sea level rise, site constraints, and the need to apply the best known and available technology to replace aging infrastructure and to improve the capacity of the WWTF, options for replacing the oxidation ditches with a plug flow system are reviewed in this section.

On-Site Implementation of Plug Flow Reactors – Replace Existing Oxidation Ditches

It is likely that the only location plug flow reactors could be constructed onsite are within the existing footprint of the oxidation ditches. Various methods of constructing such basins were considered. The two primary approaches consist of the following:

- Option 1 – Conversion of each ditch, in series, into a plug flow aeration basin with multiple partitioned zones, floor-mounted diffused aeration, internal recycle, and other improvements.
- Option 2 – Complete demolition of the existing oxidation ditches and reconstruction of plug flow aeration basins in this location.

The result of these analyses is that neither option is recommended for similar reasons noted in the analyses of converting the existing oxidation ditches to an MLE or similar process. Substantial structural improvements would be necessary for each ditch to ensure reliability and longevity. There also would be significant new equipment, access platforms, electrical, and control items to install. These items necessitate months of construction, resulting in an extended outage period for each ditch. This outage would reduce the reliability and redundancy of the existing activated sludge system and expose the City to substantial risk of permit violation for an extended period.

Further, this approach would not facilitate the future construction of a third clarifier as it would be unlikely to create additional unused space on the WWTF site.

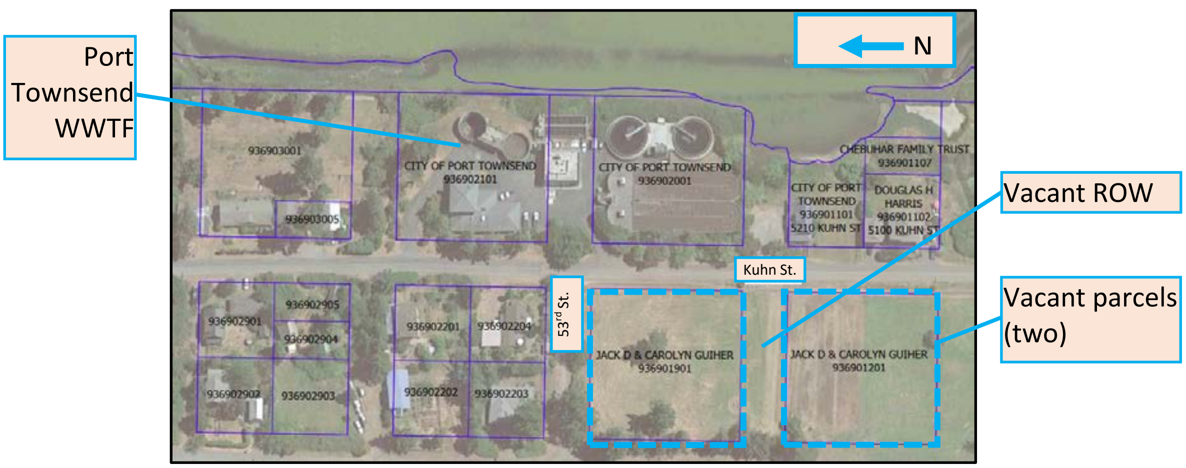
This approach is not considered further.

Off-Site Implementation of Plug Flow Reactors

The previous analyses have not identified a practical approach to provide sufficient treatment capacity with TIN reduction at the existing WWTF beyond approximately 2040. As flow and loading growth continues, constructing major improvements on the existing site becomes even more challenging as the existing tankage must be maintained in operation through construction to provide reliable treatment. As previously noted, limited improvements for cyclical ditch operation should allow for continued use of the existing WWTF infrastructure to approximately 2040, which will allow the City to begin planning for a major expansion of the WWTF. It is recommended that this expansion be planned to be offsite and near the existing WWTF.

Figure 8-8 shows the existing site aerial with parcel lines and ownership, as well as the surrounding areas.

Figure 8-8 – WWTF and Surrounding Parcels

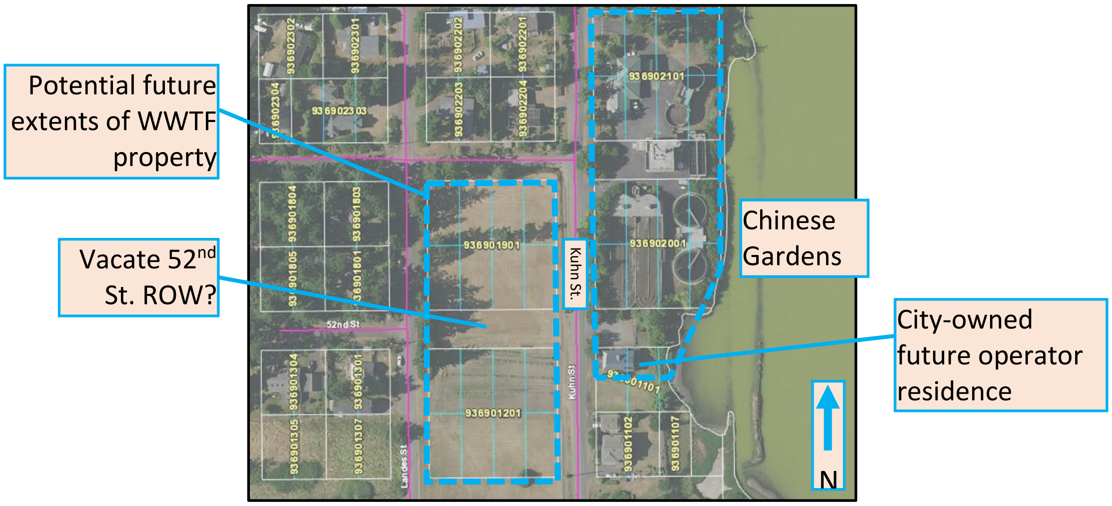


Two parcels immediately west of Kuhn Street with the same owner could provide sufficient space for an expansion of the WWTF. The utilization of these parcels most likely would include construction of activated sludge system tankage, specifically plug flow aeration basins, at this location.

In addition to procuring these parcels, vacating the 52nd Street ROW separating both parcels for the purposes of providing a single contiguous parcel would help provide ample space for new oxidation ditches and future facilities that may be needed well beyond the planning period.

Figure 8-9 shows these major considerations.

Figure 8-9 – Adjacent Parcel Acquisition Considerations



Activated Sludge System Recommendations

The previous analyses resulted in the following major findings:

- The facility is projected to exceed 85 percent of the permitted BOD loading by 2033.
- The facility flow and loading is projected to reach its rated capacity at approximately 2043.
- The current optimization strategy effectively reduces TIN below 10 mg/L but results in a significant reduction in the realistic capacity of the activated sludge system.
- Implementation of cyclical oxidation ditch operation, as an alternative to the current optimization strategy, would be a relatively low cost approach to maintaining TIN reduction until the expansion can occur.
- Providing TIN reduction at the flow and loading projected late in the planning period would necessitate a major expansion of the WWTF that will be most effectively completed through the acquisition of off-site adjacent parcels.

The recommended basic approach and phasing of the WWTF improvements follows.

Years 0 to 5 (2024 to 2028)

In the next 5 years, the City will need to coordinate with Ecology and the requirements of the Puget Sound Nutrient General Permit, which may require the need to implement cyclical oxidation ditch operation to ensure continued TIN reduction and maintain the existing activated sludge system capacity. The City also should begin the early work preparing for the future major expansion of the WWTF. This work generally should include the following:

- Complete a preliminary design for the cyclical oxidation ditch improvements (**Capital Improvement Project (CIP) F8** in **Chapter 10**). Determine if an Engineering Report meeting the requirements of Washington Administrative Code (WAC) 240-173-060 will be required by Ecology.
- Complete improvements to implement cyclical oxidation ditch operation (**CIP F8** in **Chapter 10**).

- Complete a Nitrogen Optimization Plan per the PSNGP and submit to Ecology by March 31, 2026.
- Complete other WWTF rehabilitation work to extend the life of the existing infrastructure in the most economical manner feasible to avoid significant capital costs for items that will be removed or reconfigured with the major expansion of the WWTF (**Chapter 10**).
- Acquire parcels of land to support the major expansion of the WWTF (**CIP F11** in **Chapter 10**).

Years 6 to 10 (2028 to 2033)

- Complete an Engineering Report per WAC 173-240-060 for the major expansion of the WWTF. Submit the report for review and approval by Ecology (**CIP F12** in **Chapter 10**).
- Commence permitting, preliminary design, and funding acquisition related to the major expansion of the WWTF (**CIP F12** in **Chapter 10**).

Years 11 to 20 (2034 to 2043)

During this period, the design and construction of the major expansion of the WWTF (**CIP F12** in **Chapter 10**) should be completed. A basic description of the proposed major improvements is discussed in this section.

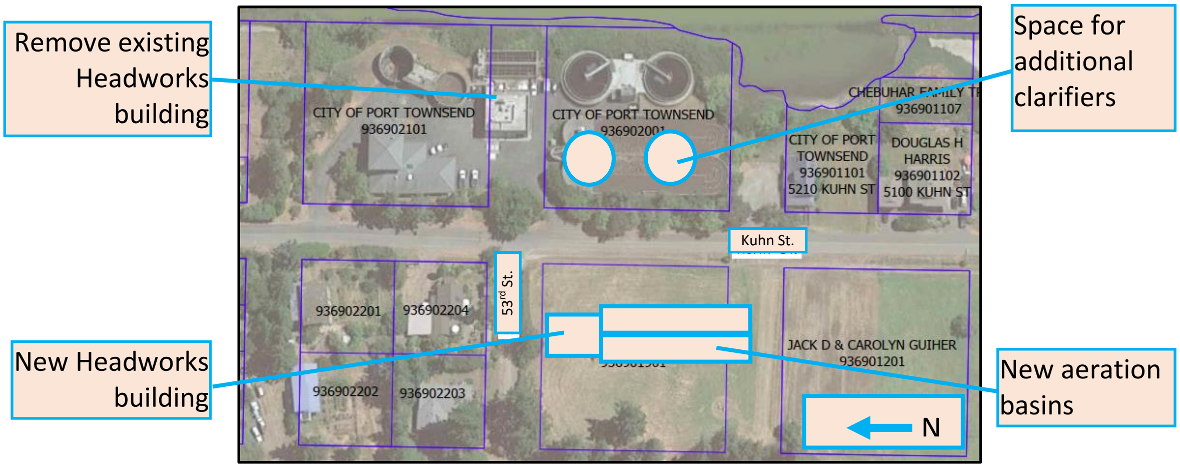
Pending the land acquisition and configuration of the new parcels, at a minimum, a new activated sludge system would be constructed on the new parcels. The existing secondary clarifiers likely could remain at the current location. With the implementation of biological treatment on the new parcels, the existing oxidation ditches could be removed. This would allow for future secondary clarifiers to be constructed within the footprint of the demolished oxidation ditches.

To provide TIN reduction, a conservative approach to planning the new activated sludge system consists of two plug flow, staged aeration basins on the new parcels. The exact size, configuration, and equipment options would be analyzed thoroughly and determined in a future Engineering Report.

All influent flow by gravity to the existing WWTF is collected at the Influent Pump Station (IPS) and pumped to the existing Headworks, with subsequent gravity flow to the oxidation ditches. The proposed future configuration of the WWTF, with biological treatment on the higher ground of the new parcels, will prompt significant changes to the hydraulic profile of the WWTF. Influent will need to be lifted to the new aeration basins. In order to avoid an additional pump station between the existing Headworks and the new basins, it would be most practical to construct a new Headworks on the new parcels and refurbish or replace the existing IPS at or near its existing location. This is further discussed in the following **Preliminary Treatment** section.

Figure 8-10 schematically displays a conceptual reconfiguration of the WWTF utilizing the currently undeveloped parcels west of Kuhn Street.

Figure 8-10 – Basic Configuration of Expanded WWTF



PRELIMINARY TREATMENT

Chapter 7 identified improvements to rectify conditions-based needs for the IPS and Headworks. The most significant of these improvements include:

1. Wet well rehabilitation, piping and pump replacement, and electrical raceway replacement at the IPS; and
2. In-kind replacement of the existing screen and grit equipment, and concrete channel rehabilitation at the Headworks.

Summary of Analysis

Table 8-5 shows the design criteria for the existing IPS and Headworks from the original construction drawings.

Table 8-5

Preliminary Treatment Design Criteria from 1990 Project

Influent Pumps	
Type	Submersible, VS
Number	3.00
Capacity, Each (gpm)	2,250
Horsepower, Each (hp)	35
Headworks	
Parshall Flume	1
Throat Width (in)	12
Bar Screen	1
Width (ft)	1.50
Screenings Press	1
Grit Removal	1
Diameter (ft)	10.00
Peak Capacity (MGD)	7
Grit Classifier	1

As shown, two pumps in service should provide a nominal flow of 4,500 gallons per minute (gpm) (6.48 MGD). This is in excess of the projected 2043 peak hour flow of 6.06 MGD with one pump out of service. The IPS should provide sufficient capacity and redundancy through the planning period.

In general, the Headworks equipment and channels were designed for a peak flow of approximately 7 MGD, which is above the projected 2043 peak hour flow of 6.06 MGD. The Headworks includes a single mechanical bar screen and a back-up channel with a manually raked bar screen. However, the mechanical screen should provide sufficient capacity and the back-up screen provides sufficient redundancy. As previously noted, a budgetary allocation is established for the in-kind replacement of the screen if needed during the planning period.

Similarly, the grit removal system is expected to provide sufficient capacity through the planning period, and any improvements needed will be for the in-kind replacement of aging equipment as previously noted.

Recommendations

Based on this review, the existing IPS and Headworks should not require replacements during the planning period to increase capacity or redundancy. As noted in Chapter 7, age and condition may require replacement or repair in the next 5 to 10 years. However, as discussed in the **Activated Sludge System** section, future replacement of the activated sludge system likely would provide the opportune time to replace the existing preliminary treatment system. The overall approach to the activated sludge system improvements involves constructing new aeration basins offsite, on the currently vacant parcels west of Kuhn Street. As noted, this likely would necessitate constructing a new Headworks facility on the new parcels, adjacent to the new aeration basins. With this configuration, it is most likely that the IPS would be significantly changed or replaced and potentially relocated. The IPS would lift all influent and return flows up to the new Headworks location. The configuration of this infrastructure would be analyzed thoroughly in the future Engineering Report as discussed in the **Activated Sludge System** section. Given that the preliminary treatment system is expected to be replaced in conjunction with the activated sludge system improvements planned for the second half of the planning period, it is prudent to extend the life of this infrastructure through limited rehabilitation while avoiding significant sunk costs in improving this system.

Further, the new Headworks will allow for improvements over the existing configuration. For instance, the new Headworks should include mechanical fine screening, which will provide 2-dimensional screening with much improved screenings capture compared to the existing 1-dimensional bar screen. The fine screens would provide a minimum of ⅜-inch screening, and ¼-inch screening could be considered. Additionally, two mechanical screens could be included in the new Headworks for redundancy and to reduce operational labor in the event of an outage of a single mechanical screen. Similarly, a new grit removal system would present opportunities for improvements relative to the existing grit system. Such improvements are not feasible to make to the existing Headworks; therefore, it is prudent to extend the life of the existing infrastructure as feasible while planning for a future new, off-site Headworks.

EFFLUENT DISINFECTION

Chapter 7 identified relatively minor repair and replacement needs for the existing chlorination system. Replacement of the non-potable water pumps also was recommended and represents the only capital improvement project identified based on the conditions assessment of the disinfection system.

Summary of Analysis

The design criteria for the existing chlorine contact chambers is compared to the 2043 average and peak hour flow values in **Table 8-6**.

Table 8-6

Disinfection System Design Criteria from 1990 Project

Design Criteria	Quantity
Chlorine Contact Chamber	2
Volume, Each	
cubic feet	6,480
gallons	48,500
2043 Average Annual Flow (MGD)	1.46
2043 Peak Hour Flow (MGD)	6.06
Contact Time (Both Tanks Online) (min)	
at Average Annual Flow	96
at Peak Hour Flow	23
Maximum Chlorine Dose at Peak Flow (mg/L)	6
Hypochlorite Feed Pumps	2
Hypochlorite Storage Tank (gal)	5,200

The typical design range for disinfection contact time based on average design flow is 30 to 120 minutes per Metcalf & Eddy (2013). With two contact tanks online at the 2043 average annual flow of 1.46 MGD, there is 96 minutes of contact time, which is well within the accepted range. With one tank offline, the contact time would be approximately 48 minutes, which is still within the recommended range.

Typical design ranges for disinfection contact time based on peak design flow is 15 to 90 minutes per Metcalf & Eddy (2013). The contact time of 23 minutes with two tanks online at the projected 2043 peak hour flow is within the recommended range. With one tank out of service, the contact time would be reduced to approximately 12 minutes. While this is below the recommended range and could cause an increase in coliform discharge, it is likely that weekly and monthly average coliform values would remain below permit limits as the average contact times are sufficient.

Based on this analysis, expanding capacity, or improving redundancy of the chlorination system, should not be required during the planning period.

Recommendations

No major improvements appear to be needed for the effluent disinfection system during the planning period. Minor repairs and rehabilitation should be completed as necessary to maintain reliable operation of the system. However, future sea level rise and other considerations may in the long term require improvements to, or replacement of, the existing disinfection system.

OUTFALL

The City has received funding and is actively working with Ecology and Jacobs Engineering Group on an evaluation and modifications to the existing outfall. The project is currently under further alternatives evaluation. Initial evaluations of the outfall dating back to the 2000 *Wastewater Facilities Plan* suggest that sliplining and pumping would be the least cost option. Since that time, significant work has been completed, including the approval of a Facilities Plan Amendment in 2019 by Ecology. This amendment recommends digging in a parallel pipe to the existing pipe and replacing the diffusers. This option has been recommended as the least cost option. Prior to entering the permitting phase of the project, resource agencies and the public spoke out against the project due to potential impacts to eel grass and kelp beds. **Figure 8-11** illustrates the approximate outfall configuration. Note, the difference between the Chinese Garden Lagoon and the WWTF outfall. The Chinese Garden Lagoon outfall often is exposed on the beach and is confused by the public as being the WWTF outfall.

The City's WWTF outfall is always submerged; however, storms periodically expose and damage the existing concrete pipe on the beach. Staff immediately repairs the concrete when damaged. One need for the outfall project, no matter the solution, is to replace the beach section of pipe and protect it against heavy North Beach surf.

Figure 8-11 – Approximate Outfall Configuration

Staff is re-evaluating possible solutions, including sliplining the pipe. Staff also is considering the impact of sea level rise on the Chinese Garden Lagoon. Currently, the outfall does not use the Chinese Garden Lagoon; however, at a Marine Resources Committee meeting, a suggestion was made to look for environmental improvements of combining the sewer outfall with the Chinese Garden Lagoon.

Given this work is already underway, further evaluation in this GSP is not included and will be handled in separate documents that will be submitted to Ecology for review and approval.

TERTIARY TREATMENT – WATER REUSE/RECLAMATION

The City currently discharges all of its effluent to the existing outfall. The City frequently hears from the community about its desire to implement water reuse practices in the name of water conservation and environmental stewardship. A detailed description of water reuse as it relates to regulations and standards is included in Chapter 4 of the adopted 2019 *Water System Plan* (WSP) (available on the City website). Given water reuse begins at the WWTF, the following information is provided concerning the application of water reuse opportunities in the City, as well as financial limitations.

How would reclaimed water from the WWTF be used in Port Townsend? Chapter 4 of the WSP, specifically Table 4-7, lists all of the allowable uses and the associated class of reclaimed water allowable for such use. In general, higher levels of treatment are required for reclaimed water where there is a potential for human exposure, such as irrigation water. What is the greatest environmental and societal benefit? How is water reuse helpful in the light of climate change and sea level rise? These are all very good questions. The WSP outlines that the cost would be prohibitive, thus no specific actions or investments are included in the WSP. This GSP outlines the most common comments heard by the City and likely the most probable applications of water reuse, recognizing that there is benefit to seeking opportunities. Practically, this GSP does not include specific investments in the CIP given the rate impacts. However, staff recommends keeping water reuse on the horizon and looking for grant opportunities to negate the capital cost of operating a water reuse system. The following brief discussion of potential water reuse applications provides very high level considerations.

- Water reuse for industrial process water is one option available. This option requires the least amount of treatment because industrial water is non-contact use. Given that the City has a huge industrial water user, the Port Townsend Paper Mill, this thought was brought up in the recent Water Supply Agreement discussions. The City could reliably provide approximately 900,000 gallons of the mill's average daily use of 11 million gallons. A reclaimed water pipeline would have to be constructed across the City from the WWTF to the Paper Mill. This water supply pipeline would cost in the tens of millions to construct. Depending on whether or not workers were exposed to the water determines the level of treatment required. Likely, Class A treatment would be required. If tertiary or enhanced treatment is required, funding for an order of magnitude cost estimate of $20 million would be needed.
- Irrigation is the most common beneficial use of reclaimed wastewater. Due to human exposure in parks and to food in gardens, Class A reclamation standards must be met. To make reclaimed water available throughout the City, a second water system would need to be created. These systems are constructed of purple pipe to reduce the chance of accidental cross connection. Cities with reclaimed water available for irrigation also require extensive investment at each property for cross-connection prevention as required by the Washington State Department of Health. A more likely beneficial use of reclaimed irrigation water is to focus on the large expanses of irrigated areas such as the Fort, golf course, parks, and school play fields. This would help reduce peak water use by the City during the summer months when irrigation demands increase water consumption from 1 MGD to nearly 2 MGD. Note, water reclamation is limited to the irrigation season between May and October for this application. Dedicated water pipelines, reservoirs, and pumps stations are required to accomplish any type of irrigation use. The cost of this infrastructure is in addition to the cost of enhanced or tertiary treatment. Given tertiary or enhanced treatment is required, funding for an order of magnitude cost estimate of $20 to $50 million would be required to build an irrigation system. Irrigation of the Fort, Jefferson County fairgrounds, and nearby schools would require the least amount of infrastructure development.
- Water reclamation for environmental benefit might be the most practical implementation strategy. For example, the City is currently exploring options for enhancing the water quality of the Chinese Garden Lagoon given its propensity for algae blooms. With sea level rise, the lagoon will ultimately connect with the Strait of Juan de Fuca and provide an

inland estuary that will result in great habitat enhancements. The question for this application would be whether accelerating this connection would make sense or not with wastewater discharge to the lagoon.

- Water reclamation for groundwater augmentation could be another practical use. Groundwater injection occurs through either direct injection or percolation. The aquifer under the City is not a drinking water supply and is approximately at sea level. A number of irrigation wells exist within the City, including one owned by the City. Pumping of this aquifer invites salt water intrusion on all three sides of the City. Infiltration of reclaimed water can offset the impact of pumping. The exact configuration of the aquifer is not readily known; therefore, a great amount of research would be required to validate this approach for reclaimed water reuse. Depending on the level of treatment, investment levels likely approach $10 million for this option.

All of the applications discussed require extensive permitting to ensure unintended consequences are not a result. Given the extensive needs of investment in the foundational systems of the WWTF and collection system, the rate payers may not be willing to pay for a reclaimed water system at this time. Adding reclaimed water to the capital plan would require nearly doubling the investment levels, which would more than triple current sewer rates. Therefore, this GSP recommends expending resources on water reuse only if an environmental improvement grant makes it financially feasible.

The improvements noted in the previous sections and in the **Chapter 10** CIP will still need to be implemented, even if the City decides to pursue tertiary treatment for water reclamation. Given the space limitations and capital cost concerns, pursuing this further at this time is not feasible.

SOLIDS HANDLING

The conditions assessment in **Chapter 7** identified primarily minor improvements to maintain reliable operation of the solids handling system during the planning period. This chapter reviews the potential improvements needed to ensure sufficient system capacity and redundancy is available with this system. The analyses are divided between the on- and off-site solids handling system components.

On-Site WWTF Solids Handling System

The existing on-site solids handling system includes two aerobic holding tanks followed by sludge dewatering via a single belt press. The aerobic holding tanks where retrofitted during the 1990 project to provide waste activated sludge (WAS) storage. These concrete tanks originally were constructed in approximately 1970. The dewatering system was installed in the 1990 project. Dewatered sludge is composted as discussed in the **Off-Site Compost Facility** section.

Summary of Analysis

The on-site solids handling system is not intended to provide substantial stabilization of the WAS as the solids are stabilized via off-site composting. As currently configured, the on-site system is generally intended to equalize and store WAS to enable periodic operation of the dewatering belt press during normal staff hours. As such, the aerobic holding tanks are not required to provide significant volatile solids destruction, and the dewatered sludge is not intended to meet Class B requirements. The design criteria from the 1990 project for the existing aerobic holding tanks is shown in **Table 8-7**.

Table 8-7

Aerobic Holding Tank Design Criteria from 1990 Project

Aerobic Digesters	**Quantity**
Number of Digesters	2
Total Volume (ft^3)	6,480
Total Volume (gal)	360,000
Digester Blowers	3
Capacity Each (cfm)	720
Horsepower, Each (hp)	75

At the 2043 maximum month loading condition, the WWTF is expected to produce WAS at approximately 4,000 pounds per day (ppd) total solids. At an average concentration of 8,000 mg/L, this equates to 60,000 gallons per day (gpd). As shown in **Table 8-7**, the two aerobic holding tanks provide a total volume of approximately 360,000 gallons. With one tank offline, the system should provide approximately 3 days of storage volume without thickening. The operators currently decant the tanks to increase the solids concentration and reduce the volume fed to the belt press. With or without decanting, 3 days should be sufficient equalization for the dewatering system should one tank be offline. The aeration system also appears sufficiently sized to maintain an aerobic environment in the tanks without allowing significant volatile solids destruction. By utilizing the composting system to provide sludge stabilization, the aerobic holding tank system is expected to provide sufficient capacity and redundancy in WAS storage through the planning period.

The design criteria from the 1990 project for the dewatering system is shown in **Table 8-8**.

Table 8-8

Dewatering System Design Criteria from 1990 Project

Dewatering System	**Quantity**
Size (meters)	1.5
Feed Rate (gpm/meter)	50
Polymer Usage (lb/dry ton)	30

The belt press is currently operated up to 3 days per week for approximately 8-hour shifts. Based on staff input, it is preferred that the belt press be operated no more than 4 days per week for 8 hours per day. Given this, the belt press is operating at about 75 percent or less of the allowable operating time per week. Based on the projected increase in flow and loading in **Table 8-1**, sludge production would be expected to increase approximately 20 percent by 2033 and 40 percent by 2043 compared to existing levels. As such, it is likely that the belt provides sufficient capacity to approximately 2033 by operating up to 4 days per week. Beyond 2033, the belt press may need to be operated up to 5 days per week to provide sufficient capacity or be replaced with a larger unit.

It should be noted that the City has a single belt press, so there is no inherent dewatering system redundancy. If needed, the City could rent a mobile dewatering unit to process sludge. Appropriately sized units for the City's WWTF should be readily available for rental in an emergency.

Recommendations

As noted in **Chapter 7**, the existing on-site solids handling system is generally in good condition. As discussed in this section, the system provides sufficient capacity and redundancy for the City's needs. However, the aerobic holding system tankage is expected to be over 70 years of age at the end of the planning period, while the belt press and ancillary equipment will generally be over 50 years of age by 2043. It is prudent to plan for replacement of the major mechanical equipment for the solids handling equipment, such as the belt press, sludge pumps, blowers, etc., as well as other refurbishments, such as the aerobic holding tankage, late in the planning period. It is difficult to predict the scope of this work. Further, the WWTF is expected to be significantly reconfigured by the end of the planning period as discussed in the **Activated Sludge System** section. Based on these factors, it is recommended that the City establish a budgetary allocation for on-site solids handling system improvements late in the planning period. As an initial allocation, $3 million is recommended. The scope of the improvements and associated costs should be reviewed thoroughly in the future, likely as part of the Engineering Report that will be required for the major WWTF expansion project.

Off-Site Compost Facility

The City operates a Compost Facility at the Jefferson County (County) Transfer Station site. The City transports dewatered sludge from the WWTF to the facility for composting. An aerial image of the facility is included in the **Chapter 7**.

Summary of Analysis

The composting system utilizes the aerated static pile method. The facility includes two covered areas, referred to as "barns." The south barn occupies approximately 11,000 square feet (sf) and is used for the aerated static piles. The north barn is 8,000 sf and is primarily used as a finishing/storage barn. The City received carbon in the form of yard waste collected by the City's solid waste hauler and provided by self-haulers at the Jefferson County transfer station. The City chips yard waste annually for use as a bulking agent in the composting process. The City owns screening equipment, a front-end loader, and other heavy equipment necessary to operate the composting system.

Based on the projected increase in loading shown in **Table 8-1**, sludge hauled to the compost facility would be expected to increase approximately 20 percent by 2033 and 40 percent by 2043 compared to existing levels.

The City is also contracting to take waste activated sludge from the new Port Hadlock WWTF. Port Hadlock will purchase and operate a gravity dewatering system and haul the dewatered sludge to the Compost Facility. The City will mix with the Port Hadlock sludge with the City's WWTF solids to compost on site. It is estimated that Port Hadlock will supply a 5 yard load approximately 8 times per year.

The Compost Facility site has ample space for the existing operation and has sufficient available space to expand in the future if desired. As growth occurs, the City likely will convert the north barn first to house additional aerated static piles. At a minimum, this would consist of adding aeration equipment to this barn. An additional barn likely would be the next major addition with growth.

Septage Receiving System

As discussed in **Chapter 7**, the City also receives septage to the Compost Facility from the County, which necessitates a small SBR treatment plant at the facility. The SBR system discharges to an engineered wetland treatment system west of the Compost Facility. As noted in **Chapter 7**, some improvements to the SBR are required to replace and rehabilitate aging items. Septage solids are mixed with City sludge and composted. For the purposes of this GSP, it is assumed that if septage receiving were expanded, the overall impact on the solids portion of the composting operation would not be significantly impacted. On the other hand, if septage receiving was expanded, significant improvements to the liquid treatment potion of the compost facility would be required.

The current CIP in **Chapter 10** includes operations and maintenance and repair/replacement projects to keep the existing septage facility running for the next 20 years. This would keep the system functioning at the same treatment capacity as current. However, the City was approached by the County to evaluate options to take all of the County's septage.

The City's septage receiving facility currently handles approximately 40 percent of the County's total annual septage generation. The remainder is trucked to facilities outside of the County for treatment. When including 20 years of growth, the facility would need to treat a maximum month average daily flow of 6,500 gpd, and a peak day of 10,000 gallons. This is significantly higher than the rated capacity of the existing facility.

Alternatives were analyzed, including upgrading the on-site facilities, trucking to the City's main WWTF, and building a pump station and pumping from the septage facility to the main WWTF. The recommended alternative was to expand capacity at the site, as the other alternatives were much more costly or unfeasible. The upgrade alternative would cost approximately $4M (2023 dollars). This information was presented to County staff and County Commissioners for review.

The County is considering their options and the availability of funding. The next step for this upgrade would be a dedicated Engineering Report to analyze and recommend the SBR improvements and detail the associated costs.

As noted previously, this GSP only includes repair/replacement projects at this time. If expansion is decided upon, and funding is found by the County, then a separate amendment would be submitted.

ELECTRICAL AND CONTROLS

Chapter 7 identified necessary improvements for the electrical and control systems. **Chapter 10** includes the CIP projects for these items to maintain the reliability and operability of these systems. However, one of the main considerations for electrical improvements is the timing of the recommended motor control center (MCC) and generator replacements due to these items nearing the end of their useful life. As discussed in this chapter, a major reconfiguration of the WWTF is planned to support the necessary treatment objectives. As noted in the **Activated Sludge System Recommendations**, the major improvements to the WWTF are likely to consist of abandonment of the existing Headworks and oxidation ditches and replacement with a new Headworks and plug flow aeration basins on adjacent property. Additionally, the IPS will be reconfigured or replaced to pump to the new Headworks at a higher elevation than the existing Headworks. The project also may include, or at least allow provisions for, an additional secondary clarifier on the existing site.

The improvements associated with the major reconfiguration of the WWTF will significantly impact the electrical system at the WWTP by decommissioning major motor loads through removal of existing processes, as well as adding new motor loads associated with the new systems. It would be most economical for the City to maintain the existing MCCs and generator until they are completely replaced through the major reconfiguration project. However, **Chapter 7** conservatively recommended replacement of this equipment in 5 to 10 years. This timing may be slightly in advance of the major improvements that are expected to occur between 10 and 20 years. For conservative planning purposes, it is recommended that the City budget for replacement of this equipment in 5 to 10 years. However, pending the progress on the major improvements project, as well as continued spare parts availability for the existing electrical equipment, it may be possible to forego some of the recommended in-kind electrical equipment replacements prior to the major reconfiguration project.

REFERENCES

Metcalf & Eddy Inc., Tchobanoglous, G., Burton, F. L., Tsuchihashi, R., & Stensel, H.D. (2013). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill Professional.

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9 | OPERATIONS AND MAINTENANCE

INTRODUCTION

The City of Port Townsend's (City) wastewater operations and maintenance (O&M) program consists of the following elements:

1. Normal operation of the wastewater collection system, wastewater treatment facility (WWTF), and Compost Facility.
2. Emergency operation of the wastewater collection system, WWTF, and Compost Facility, when one or more of the components is not available for normal use due to natural or human-made events.
3. A preventive maintenance program to ensure that the wastewater system is receiving maintenance in accordance with generally accepted standards.

NORMAL OPERATIONS

City Personnel

The City's wastewater division functions under the provisions of the City's National Pollutant Discharge Elimination System (NPDES) Permit and the direction of the Public Works Director. Wastewater treatment facilities have special employment requirements for staff as outlined in Chapter 70A.212 Revised Code of Washington (RCW).

In accordance with the RCW, it shall be unlawful for any person, firm, corporation, municipal corporation, or other governmental subdivision or agency to operate or maintain a wastewater treatment facility unless the individual persons performing the duties of an operator as defined in NPDES Permit S.5.3.B, or in any lawful rule, order, or regulation, without being duly certified under the provisions of the chapter.

The municipality is required to designate a person on site at its WWTF as the operator in responsible command of the operation and maintenance of the system. This person is required to be certified at a level equal to or higher than the classification rating of the facility, or Group II for the City.

The WWTF also is required, while staffed on more than one daily shift, to have a shift supervisor designated in charge of each shift at a level no lower than one level lower than the classification rating of II for the City. Based on the RCW, all staff shall be subordinate to the operator in responsible charge.

The current wastewater division organization structure is as shown in **Figure 9-1**. Staff must:

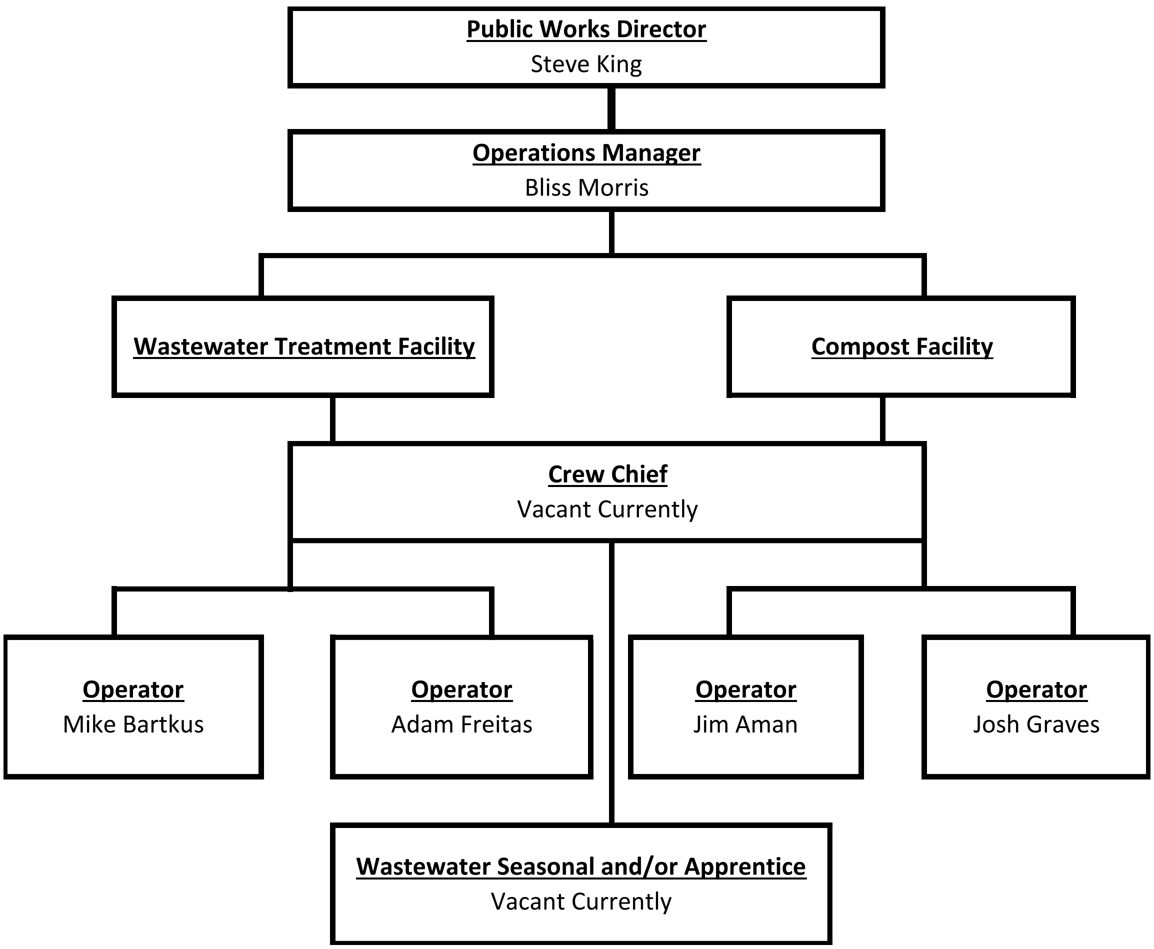
1. Institute adequate O&M programs for the entire sewage system;
2. Keep maintenance records on all major electrical, supervisory control and data acquisition (SCADA), and mechanical components of the WWTF, as well as the collections system and pumping stations. Such records must clearly specify the

frequency and type of maintenance recommended by the manufacturer and must show the frequency and type of maintenance performed;

3. Ensure all operations and maintenance tasks done on the WWTF process equipment or systems are operated or supervised by an operator certified by the State of Washington. The Permittee may allow qualified mechanics, programmers, network engineers, electricians, or other trained tradespersons appropriate for specific tasks to perform work on equipment as long as a certified operator is on site to supervise, authorize, and verify that the work performed does not adversely impact facility operations, effluent quality, or process monitoring and alarm reliability; and
4. Make maintenance records available for inspection at all times.

Figure 9-1

Wastewater Division Organization Chart



Personnel Responsibilities

The key responsibilities of the wastewater O&M staff are summarized as follows.

Public Works Director – Under the direction of the City Manager, the Public Works Director leads or facilitates planning, implements capital improvement projects, and directs the long-term programs of the department, including Engineering and Construction, Streets Maintenance and Collections, Stormwater, Transportation, Water Resources, Wastewater, Compost Facility, Parks, Facilities, and contractual management of Trash Collection/Recycling.

Operations Manager – Under the direction of the Public Works Director, the Operations Manager provides oversight and management of the City's wastewater division. This position coordinates planning objectives, capital improvement projects, and O&M plans to implement City-defined objectives for the wastewater division. The Operations Manager coordinates closely with other divisions and City departments to develop operational strategies, budgets, and long-range planning efforts. The Operations Manager also serves as Operator in Charge when there are vacant positions.

WWTF Operator Crew Chief – The Operator Crew Chief serves to assist the Operations Manager in the leadership and management of the WWTF. This position provides backup and support when the Operations Manager is unavailable or on leave.

WWTF Operators – The Operator is a fully skilled journey level position capable of operating and maintaining all functional areas of the WWTF with minimal guidance or direction.

Compost Facility Operator – The Operator is a fully skilled journey level position capable of operating and maintaining all functional areas of the Compost Facility with minimal guidance or direction.

Wastewater Seasonal and/or Apprentice – The Apprentice will serve both the Compost Facility and the WWTF to help with additional work and receive training to become a certified Operator. This position will be especially important during construction of the WWTF upgrades, when staff is stressed with additional work caused by construction disruptions.

Certification of Personnel

Table 9-1 shows the current certifications of the City's WWTF and Compost Facility O&M staff.

Table 9-1
Personnel Certification

Last Name	First Name	Certificate Number	Group
Morris	Bliss	7234	II
Bartkus	Mike	6354	II
Freitas	Adam	8277	II
Aman	Jim	8839	I
Graves	Josh	8721	I

It is City policy to maintain a well-qualified, technically trained staff. The City annually allocates funds for personnel training, certification, and membership in professional organizations. The City believes that the time and money invested in training, certification, and professional organizations are necessary to provide safety and meet permit compliance.

Available Equipment

The wastewater division has several types of equipment available for daily routine O&M of the wastewater system. If additional equipment is required for specific projects, the City will rent or contract with a local contractor for the services needed. A stock of supplies in sufficient quantities for normal system O&M and anticipated emergencies are stored at each facility. A list of major equipment and chemicals used in the normal operation of the wastewater division can be found in **Table 9-2**.

Table 9-2

Wastewater Division Equipment List

WWTF	Compost Facility	Collection System
	Equipment	
MultiQuip Power 45 Tow Behind Generator	Case Loader	Vactor Truck with Rodder and Cutter
Katolight Tow Behind Generator	John Deere Loader	Push Camera
Chambers Boss LTG Light Tower	John Deere Backhoe	CCTV Camera Truck
12-inch Cargo Sport Box Trailer	Rotomix Mixer	(2) International Dump Truck (25%)
--	Kubota/Brush Hog (33%)	GMC Dump Truck (33%)
--	International Dump Truck	John Deere Loader (25%)
--	--	Excavator (25%)
--	--	John Deere Backhoe (33%)
--	--	Skid Steer with Attachments (33%)
--	--	Kenworth Dump Truck (25%)
--	--	HMA Trailer (15%)
--	--	Asphalt Roller (15%)
--	--	Equipment Trailer (25%)
	Chemical Inventory	
--	Polymer	RootX
--	Methanol	--
--	Chlorine Gas	--

The following representatives typically provide supplies and chemicals to the City.

- Supplies: MASCO Petroleum, 727 Marine Drive, Port Angeles, WA 98363, (360) 640-4444
- Equipment: NAPA Auto Parts, 2321 W Sims Way, Port Townsend, WA 98368, (360) 385-3131
- Equipment: McGuire Bearing Company, 915 S Center Street, Tacoma, WA 98409, (253) 572-2700

Wastewater division employees are equipped with cell phones. The phones provide the capability for personnel to communicate with other cities and Jefferson County as needed.

Routine Operations

Routine operations involve the analysis, formulation, and implementation of procedures to ensure that the facilities are functioning efficiently and treating sewer to meet discharge standards.

Continuity of Service

As the local sewer authority and publicly owned treatment works, the City shall maintain a structure of authority and responsibility to ensure that wastewater service is continuous. For example, changes in City Council or staff shall not have a pronounced effect on the City's level of treatment in terms of meeting the requirements of the NPDES Permit and water quality standards.

Routine Wastewater Quality Sampling

The Washington State Department of Ecology (Ecology) has adopted federal regulations that specify minimum monitoring requirements for the wastewater system. There are two types of reporting at the treatment facility: process and compliance reporting. Process reporting involves collecting data by analyzing samples collected in the facility and reporting the data to the operations team. The data is used by the operations team to evaluate the facility's performance, monitor trends, and make appropriate daily adjustments. These minor daily adjustments ensure the facility is continuously operated meeting the discharge limits identified in the NPDES Permit. Compliance testing includes analytical and record data reported to Ecology that demonstrates the City is compliant with the discharge limits. Reporting requirements are contained in the NPDES Permit, a copy of which is included in **Appendix C**.

EMERGENCY OPERATIONS

Capabilities

The City is well equipped to accommodate short-term system failures and abnormalities. Its capabilities are as follows.

Emergency Equipment

The City is equipped with the necessary tools to deal with common emergencies. If a more serious emergency should develop, the City will hire a local contractor who has a stock of spare parts necessary to make repairs to alleviate the emergency condition. The primary emergency response tool for the collection system are two Vactor trucks and a portable back-up generator. The WWTF and lift stations are monitored by staff through the Mission telemetry system.

Emergency Telephone

The wastewater division has an emergency phone number for public or City staff to directly contact sewer department personnel after normal business hours. The number is (360) 344-9779.

Standby Personnel

The designated standby person can generally respond to a call within 30 minutes. A list of emergency telephone numbers is provided to each on-call employee. New employees will be added to the end of the list at the beginning of the next calendar year's standby schedule.

Contacts

The City maintains a list of utility and agency contacts for routine and emergency use as shown in **Table 9-3**.

Table 9-3

Utility and Agency Contacts

Agency	Phone
Utility Contacts	
Jefferson County Public Utility District	(360) 385-5800 (24 Hours)
Astound	(800) 427-8686
CenturyLink	(833) 591-0933
JeffCom Non-Emergency Line	(360) 344-9779
Other Emergencies	911
Agency Contacts *For collection system overflows, plant bypasses, upsets, or loss of disinfection, contact the following immediately.*	
Ecology SW Regional Office	(360) 407-6300 (24 Hours)
Department of Health Shellfish	(360) 236-3330 (Daytime) (360) 789-8962 (After Hours)
Jefferson County Health Department	(360) 385-9444

Material Readiness

Some critical repair parts, tools, and equipment are on-hand and kept in fully operational condition. As repair parts are used, they are re-ordered. Inventories are kept current and adequate for most common emergencies that reasonably can be anticipated. The City has ready access to an inventory of repair parts, including parts required for repair of each type and size of pipe within the service area. Additionally, the City has been provided with after-hours emergency contact phone numbers for key material suppliers, which gives the City 24-hour access to parts not kept in inventory. The City's 24-hour contact at Ferguson is Daryl Clark at (360) 340-8088.

PREVENTIVE MAINTENANCE

Maintenance schedules that meet or exceed manufacturer's recommendations have been established for all critical components in the City's wastewater system.

Each year the Public Works Department cleans approximately one-quarter of the City's sewer lines. This process begins in March and is completed by the end of October.

The sewer lines are cleaned with a cleaning nozzle that is propelled from one maintenance hole to the next using water under high pressure (1,500 to 2,000 pounds per square inch). The nozzle is then pulled back to the starting maintenance hole. As the nozzle is pulled back, water scours the inside of the sewer pipe. Any debris in the pipe is pulled back with the water. The debris is removed from the maintenance hole with a vacuum unit. If roots are found, they are cut with a root cutter. The City cleans and root cuts any problem areas once or twice per year. City sewer lines requiring a higher level of maintenance are cleaned annually or semi-annually.

Per the recommendations in **Chapter 6**, the City will begin a video inspection program with the goal of viewing the interior of all pipes and maintenance holes within the next 5 to 10 years. This program will help identify mains most urgently in need of repairs or replacement and will help prevent overflows.

The lift stations are checked three times weekly and include wireless monitoring and alarm equipment for flows, backups, and power outages.

The following schedule is used as a minimum for preventive maintenance; the manufacturer's recommendations should be followed where conflict exists.

Wastewater Division

Wastewater Treatment Facility	
Frequency	***Task or Activity***
Daily	Sample influent and effluent water quality per state and federal requirements.
As Needed	Adjust the treatment process in the field as influent wastewater quality or quantity changes to maintain high quality effluent.
As Needed	Dewater the biosolids produced at the WWTF and haul the dewatered biosolids to the Compost Facility.
As Needed	Repair, maintain, and replace WWTF equipment.
As Needed	Clean, paint, and perform small repairs at the WWTF buildings.
As Needed	Clean and perform small repairs for the WWTF vehicles.
As Needed	Water, mow, and trim the landscaping.

Compost Facility	
Frequency	***Task or Activity***
Monthly	Grease blowers, mixer, screen, and rotary screen thickener (RST). Check mixer gear box and fill, if needed.
Monthly	Run bio-filter fans and grease, if needed.
Monthly	Exercise valves, spin blower shafts, and lift station heaters.
Monthly	Fill shower drain and flush with hot water. Inspect fire extinguishers.
Monthly	Change dissolved oxygen membrane and loader bucket pin.
Every 2 Months	Spray down sequencing batch reactor (SBR).
Every 2 Months	Sample compost for finished product quality.
Quarterly	Sample water quality at the facility per state and federal requirements.
Quarterly	Inspect the first aid kit.
Quarterly	Clean the bar screen. Drain and clean the RST flock mixer tank.
Every 4 Months	Clean catch basins and septage holding tanks.
Every 6 Months	Grease motor control center room vent fan.
Every 6 Months	Change oil for septage blower nos. 1 and 2 and the SBR blower.
Annually	Sample water quality at the facility per state and federal requirements.
Annually	Perform an annual safety inspection of the facility. Change batteries in the smoke detectors.
Annually	Grease screens and bio-filter fans. Change oil for the septage pump, air filters, and tractor. Change fluids for the SBR mixer.
Annually	Deep clean the RST and inspect lube latches.
Every 2 Years	Change fuel at the filter diesel tank.
Every 2 Years	Change oil for the pond pump, waste pump, filtrate pump, air compressor, and pressure washer.
As Needed	Water, mow, and trim the landscaping.

Sewage Lift Stations	
Frequency	***Task or Activity***
3 Times per Week	Inspect and maintain the Gaines Street, Monroe Street, and Port Lift Stations.

Weekly	Inspect and maintain the remaining smaller lift stations.
As Needed	Perform routine maintenance on the pumps, valves, and controls.
As Needed	Perform routine maintenance of lift station structures and surrounding site.

Collection System	
Frequency	***Task or Activity***
Semi-Annually	Clean identified problem sewer lines of clogs and debris. Cut roots if found.
Annually	Clean approximately 2.4 miles of sewers not identified as problem lines.
As Needed	Inspect, clean, and evaluate maintenance holes and sewer pipeline condition when hours are available for the program.
As Needed	Perform unscheduled cleaning of periodic clogs and backups in the sewer system.
As Needed	Perform minor construction to maintain the existing system, including maintenance hole cover replacements, maintenance hole replacements, and spot pipe repairs.

STAFFING

The preventive maintenance procedures, as well as the normal and emergency operations of the utility, are described in the previous sections. The hours of labor and supervisory activity required to effectively provide this ongoing maintenance and operations schedule forms the basis for determining adequate staffing levels.

Current Staff

The City's wastewater division staff currently includes approximately eight personnel assigned to the operation and maintenance of the sewer system. The staff is made up of management personnel and operators as shown in **Figure 9-1**.

Currently, the City's wastewater collections, which is part of the Streets Maintenance and Collections crew, consists of 2.23 full-time equivalents (FTEs). In addition, the WWTF has a total of 3.5 FTEs, and the Compost Facility has a total of 2.5 FTEs.

Proposed Staffing

The City currently is preparing a rate study for the wastewater division. The following FTEs will be planned for as part of this study.

The 2024 budget includes a position to increase the wastewater collections FTE count to 2.56. In addition, the City is hoping to retain two seasonal positions, which would equate to 0.33 FTE annually, for seasonal assistance with the collections system. Therefore, a total of 2.6 FTEs is recommended for the wastewater collections.

The City has budgeted in 2024 to add 1.0 FTE for the WWTF and Compost Facility. This new position would be a shared maintenance worker with the ability to become an operator. This position also is intended to help with the additional workload caused by projects being performed at the WWTF. As a result, 0.5 FTE would be added to the WWTF, for a total of 5.0 FTEs. The other 0.5 FTE would assist with the Compost Facility, for a total of 3.0 FTEs. Finally, the City has budgeted for a full-time electrician to be shared between the Facilities (0.5), Water (0.2), and Wastewater (0.3) divisions.

After positions have been filled according to the 2024 budget, the following FTE counts apply (including the Operation Manager’s pro-rated portion):

- Wastewater Collections – 2.6
- WWTF – 5.0
- Compost Facility – 3.0
- Total is 10.6 FTEs

10 | CAPITAL IMPROVEMENT PLAN

INTRODUCTION

This chapter presents proposed improvements to the City of Port Townsend's (City) sewer system that are necessary to resolve existing system deficiencies and plan for the projected sewer system growth. The sewer system improvements were identified from the results of the collection system evaluation presented in **Chapter 6**, the Wastewater Treatment Facility (WWTF) and Compost Facility evaluation presented in **Chapter 7**, and WWTF improvements alternatives analyses presented in **Chapter 8**. The sewer system improvements were sized to meet the system's projected 2040 flow and loading conditions.

A Capital Improvement Plan number, herein referred to as a CIP number, has been assigned to each improvement. The improvements are organized and presented in this chapter according to the following primary categories. *Note: The number symbol will be replaced with a corresponding improvement number in the descriptions.*

- 5-Year System Improvements
  - Wastewater Treatment Facility Improvements (CIP F#)
  - Compost Facility and Solids Handling Improvements (CIP C#)
  - Lift Station and Miscellaneous Collection System Improvements (CIP WW#)
  - Sewer Main Improvements (CIP SM#)
- 6- to 10-Year System Improvements
  - Wastewater Treatment Facility Improvements (CIP F#)
  - Sewer Main Improvements (CIP SM#)
- 11- to 20-Year System Improvements (long-term planning capital improvements)
  - Wastewater Treatment Facility Improvements (CIP F#)
  - Compost Facility and Solids Handling Improvements (CIP C#)
  - Sewer Main Improvements (CIP SM#)
- Planning Improvements
  - Miscellaneous and Planning Improvements (CIP M#)

The remainder of this chapter presents a brief description of each group of improvements, the criteria for prioritization, the basis for the cost estimates, and the schedule for implementation.

For planning purposes, the improvement projects described herein are based on one alternative route or conventional concept for providing the necessary improvement. Other methods of achieving the same result, such as obtaining flow capacity increases by adding one large gravity main versus using multiple gravity pipes, force main/gravity main combinations, or multiple force mains, should be considered during design to ensure the best and lowest cost alternative design is selected. Further evaluation should be performed when more information is available regarding when and where future developments will occur.

DESCRIPTION OF IMPROVEMENTS

This section provides a general description of each group of improvements and an overview of the system deficiencies they will resolve. Some of the improvements are necessary to resolve existing system deficiencies. These improvements are discussed in **Chapters 6**, **7**, and **8**.

Collection system improvements to accommodate new growth are not shown in detail in this CIP. It is assumed that most of the new growth will occur at or near the Mill site. This CIP includes a lift station to allow development of the Mill site and conveyance for the new lift station's discharge throughout the existing collection system.

It is intended that this General Sewer Plan (GSP) contain an inclusive list of recommended system improvements; however, additional projects may need to be added or removed from the list as growth occurs or conditions change. The City will evaluate the capacity of the wastewater collection system, WWTF, and Compost Facility as growth occurs and as development permits are received.

5-Year System Improvements

The following improvements were identified by City staff, from the results of the WWTF and system analyses, and from previously prepared CIPs, as discussed in **Chapters 6**, **7**, and **8**. These improvements are primarily necessary to serve the existing sewer service area. The improvements include the major pipeline and facility construction that is required to properly serve the existing sewer service area now and within the next 5 years. The improvement costs shall be borne by the existing customers unless over-sizing of the improvements provides a benefit to developers, in which case the City may pass those costs on depending on goals and policies for development, especially as it relates to housing.

The improvements are based on existing peak hour flow rates; however, the proposed pipe diameters for recommended replacement pipelines are based on peak hour flow projections. The proposed system improvements are illustrated in **Figure 10-1**. RH2 Engineering, Inc.'s (RH2) analysis shows the best apparent replacement alignment for the collection system improvements based on information currently available. A variety of alternatives are possible for the collection system CIP projects listed, and alternatives should and will be considered during the design of each project.

Wastewater Treatment Facility Improvements (F#)

CIP F1 – Influent Pump Station and Odor Control Improvements

Deficiency: Portions of the Influent Pump Station (IPS) are heavily corroded, and the interior liner is detaching from the concrete. The electrical conduits and equipment inside the pump station also have corroded severely. In addition, a 2019 conditions assessment by Jacobs Engineering Group (Jacobs) recommended odor control system improvements to increase treatment capacity.

Improvement: Repair the concrete liner system within the IPS and Headworks channels. Repair the ductwork of the odor control system, upsize the fan, and add a new carbon tank. A full conditions assessment of the mechanical components inside the IPS is recommended to determine if the pipes and fittings need to be replaced. Replace the electrical and supervisory control and data acquisition (SCADA) equipment and instrumentation inside the IPS. All flows entering the IPS will need to be temporarily bypassed while improvements within the IPS are being performed.

Cost: $2,120,000

CIP F5 – Non-Potable Water Pump Replacements (City to Install)

Deficiency: The existing non-potable water (NPW) pumps located at the end of the chlorine contact basins are heavily corroded and in need of replacement.

Improvement: Replace the NPW pumps in-kind. Provide equipment and instrumentation necessary to allow a fully functional and integrated system. This work is anticipated to be completed by City staff.

Cost: $120,000

CIP F6 – SCADA Upgrades

Deficiency: The existing SCADA system at the WWTF is aging and in need of replacement as spare parts become harder to acquire. The existing software is outdated and needs updating.

Improvement: Replace the programmable logic controller (PLC) and uninterruptible power supply (UPS) equipment in all three control panels and replace the existing SCADA human machine interface (HMI) computer hardware. Upgrade the network to an Ethernet Device Level Ring network and convert the existing Allen-Bradley PLC-5 system to ControlLogix PLC equipment.

Cost: $1,140,000

CIP F7 – Electrical Upgrades

Deficiency: Most of the existing electrical equipment and instrumentation is original to the WWTF and is recommended to be upgraded or replaced as failures occur.

Improvement: Replace aging electrical equipment as failures occur and/or stock up on spare parts. Replace all variable frequency drives (VFDs), aging field instrumentation, and miscellaneous panel components.

Cost: $630,000

CIP F8 – Near-Term Oxidation Ditch Improvements

Deficiency: Near-term improvements are recommended to upgrade the equipment at the oxidation ditch. The system is losing treatment capacity due to the nitrogen removal operations at the WWTF.

Improvement: Upgrade the oxidation ditches to replace one of the mixer aerators in-kind, and install independent mechanical mixers and instrumentation and access platforms at both ditches. Install the necessary equipment and instrumentation to automate flow isolation into the ditches. These improvements will enable cyclical operation of the ditches by alternating between oxic and anoxic cycles as discussed in **Chapter 8**. A preliminary design for the ditches is recommended before implementing the improvements. While the improvements are being performed within the ditches, rehabilitate the structures and remove sludge and grit as necessary.

Note that the engineering will begin in the 5-year plan, but the City has currently budgeted construction in the 6- to 10-year CIP for purposes of rate mitigation. However, if funding can be procured, this project should be constructed sooner to minimize potential risk.

Cost: $2,940,000

CIP F9 – Outfall Upgrades

Deficiency: The existing outfall needs to be replaced due to the age of the infrastructure.

Improvement: Plan and design a replacement outfall project.

Cost: $4,000,000

CIP F11 – Land Acquisition for WWTF Expansion

Deficiency: The WWTF will require additional footprint to construct additional infrastructure necessary for providing sufficient long-term treatment capacity.

Improvement: In anticipation of the future WWTF expansion, acquire additional parcels of land as described in **Chapter 8**.

Cost: $2,000,000

Compost Facility and Solids Handling Improvements (C#)

CIP C1 – Solids Handling Influent Screening and Grit Removal

Deficiency: The bar screens currently are manually raked and washed down by haulers. This process should be automated and grit should be removed in the process.

Improvement: Install a packaged septage screening and grit removal system with a new influent meter to monitor flow.

Cost: $890,000

CIP C2 – Solids Handling Tank Replacement and Mechanical Upgrades

Deficiency: One of the two existing septage holding tanks has accumulated a significant amount of grit, making only one tank operable. The equipment associated with the septage treatment system also needs to be replaced due to its age.

Improvement: Replace the existing solids handling tanks with a larger 50,000-gallon holding tank with new blowers. Replace the pumps for the waste activated sludge (WAS), chlorination, and wetland disposal processes, and replace the sequencing batch reactor (SBR) blower.

Cost: $700,000

CIP C3 – Compost Screen Replacement

Deficiency: The existing composting screen is nearing the end of its useful life and is due for replacement.

Improvement: Install a new compost screen to replace the existing screen.

Cost: $460,000

CIP C4 – Compost Case Loader Replacement

Deficiency: The existing front-end loader in the Compost Facility is nearing the end of its useful life and is due for replacement.

Improvement: Replace the existing front-end loader with a new loader.

Cost: $390,000

CIP C5 – Compost Blowers Replacements

Deficiency: The existing composting aeration blowers are nearing the end of their useful life and are due for replacement.

Improvement: Replace the existing compost blowers with new compost blowers.

Cost: $80,000

CIP C7 – 6-Inch Hydrant Line

Deficiency: The Compost Facility needs additional water supply to meet process demands.

Improvement: Install approximately 1,100 linear feet (lf) of 6-inch water main from the facility's primary water main and connect to a hydrant located on the Compost Facility site.

Cost: $670,000

CIP C8 – Office with Dedicated Lunchroom

Deficiency: Expanding the Compost Facility and its associated processes will require more space for City staff.

Improvement: Add an office space with a dedicated lunchroom for City operators and staff use.

Cost: $300,000

Lift Station and Miscellaneous Collection System Improvements (WW#)

CIP WW1 – Existing Monroe Street Lift Station Improvements

Deficiency: The existing Monroe Street Lift Station does not have adequate pumping capacity to meet existing hydraulic loads. The sewers on Lawrence Street, tributary to the Monroe Street Lift Station, are still combined and the station is overwhelmed by stormwater inflow during peak rainfall events. These extreme events cause all three pumps at the station to run. The pump capacity deficiency could be mitigated by the separation of storm sewers from sanitary sewers on Lawrence Street. For this reason, the upgrade of the lift station should be performed after the Lawrence Street sewer separation project (CIP SM9) and after flows into the Monroe Street Lift Station have been observed for at least 2 years.

The station must be relocated or elevated to prevent the access hatches from being inundated as sea level continues to rise.

Improvement: Relocate the station to a new site that minimizes the risk of flooding over a 75-year design life. Rebuild the Monroe Street Lift Station with pumps, valves, and electrical gear capable of handling the higher flow rates being received. Begin predesign for this project after the Lawrence Street storm and sanitary sewer separation project has been completed and influent flows have been analyzed. It is possible that influent flows to the Monroe Street Lift Station could be significantly reduced with the Lawrence Street improvement project.

Cost: $5,000,000

CIP WW2 – Sewer Camera Van, Video Camera and Tractor, Recording Software and Hardware, and Staff Training

Deficiency: The City's existing video inspection equipment is outdated and no longer functioning. New pipeline video equipment is needed to allow the City to inspect every pipe in its system at least once every 10 years, and preferably every 5 years. Lack of functioning video inspection equipment leaves the City unaware of the condition of its aging collection system. The Water Street collapse may have been avoided if the City were able to see its deteriorating condition. Knowledge of pipeline condition is an essential component of an asset management system to schedule and budget repairs and replacements of aging mains and maintenance holes.

Improvement: Procure new video camera, camera tractor, and software to record, store, and annotate digital videos. Procure a van to house the equipment with power supply, cable reels, and workstation with multiple monitor screens. This CIP item also includes training for the new equipment.

Cost: $300,000

CIP WW3 – General Lift Station Improvements

Deficiency: Replace components at various lift stations as needed due to aging parts and equipment failures.

Improvement: Replace pumps, generators, valves, electrical power supply equipment, and other essential lift station components as needed.

Cost: $1,000,000

CIP WW4 – Mill Lift Station

Deficiency: Currently, there is no sewer service at the Mill site. This lift station and force main will allow for development of the Mill site to its potential.

Improvement: Procure property and construct a submersible lift station with an ultimate firm capacity of 1,062 gallons per minute. The station is to include backup power generation and a 4,500-foot-long, 10-inch-diameter force main as shown in **Figure 10-1**. Costs also include gravity piping in the area to supply the lift station.

Cost: $6,300,000

Sewer Main Improvements (SM#)

CIP SM1 – Sims Way Crossing and Wilson Street Realignment

Deficiency: The concrete gravity sewer main in W Sims Way and Wilson Street lacks the hydraulic capacity to convey the projected 5-year flows from the proposed Mill Lift Station. Furthermore, portions of this pipeline pass beneath an existing residence.

Improvement: Replace approximately 786 lf of existing 8-inch gravity pipe with new 18-inch gravity sewer in a different alignment on an easement to be procured. This project must be completed concurrently with the construction of the Mill Lift Station (CIP WW4).

Cost: $1,212,000

CIP SM8 – Sewer System Defect Investigation and Repair

Deficiency: There are a number of known structural deficiencies throughout the sewer system, particularly in the older parts of the sewer collection system. The degree of structural degradation at sites the City was able to video inspect indicate there may be additional structural defects in other areas of the system.

Improvement: Systematically investigate and repair high priority, compromised sewer mains with an emphasis on the areas of known structural degradation. Investigations will include video inspections with some smoke testing of gravity sewer mains in areas where defects are suspected by the City's collections operations staff. Replacements will be made to the extent allowed by the yearly collection system repair budget.

Cost: $3,300,000

CIP SM9 – Lawrence Street Combined Sewer Separation

Deficiency: The Lawrence Street sewer combines sanitary sewer and stormwater in the same pipe. Stormwater peak flows impose significant hydraulic loads on the sanitary sewer collection system and the Monroe Street Lift Station and consumes treatment capacity at the WWTF.

Improvement: Reconstruct the storm and sanitary sewer collection pipelines in Lawrence Street from Fillmore Street to Monroe Street to fully separate the storm drains. Perform smoke testing and video inspection of the Lawrence Street sewer first to determine the level of connectivity between the storm and sanitary sewers. The amount of asphalt disturbance will require full street repaving and modification of street geometric design to provide Americans with Disabilities Act compliant ramps at intersections. This project is split evenly with the City's stormwater division because of the magnitude of the cost and the equal benefit received by the wastewater and stormwater divisions. The cost shown is the half share to be funded by the City's wastewater division.

Cost: $2,826,000

CIP SM10 – Suitcase Pipe Replacement on Washington Street

Deficiency: During a video inspection in 2023, it was observed that the vitrified clay pipe in Washington Street between Taylor and Adams Streets was becoming crushed and in imminent danger of collapse. The video inspector classified the failure as a "suitcase" because of cracks observed at the 12, 3, 6 and 9 o'clock positions on the pipe. These cracks were acting like hinges, allowing the pipe to slowly close like a suitcase. Replacement of this main is urgent to prevent it from completely losing its ability to convey wastewater.

Improvement: Replace the existing pipeline with new 8-inch polyvinyl chloride (PVC) pipe by open-cut methods.

Cost: $399,000

CIP SM12 – Water Street Sewer Replacement

Deficiency: The existing 14-inch-diameter, asbestos cement pipe in Water Street collapsed during a king tide on December 27, 2022. After an emergency repair of the collapse, video inspection of the 14-inch gravity sewer detected corrosion, broken pipe, and sediment accumulation in the main, indicating a breach in the pipeline. The sediment prevented a full pipeline inspection and hydraulic cleaning methods were abandoned because of the risk to the fragile main. In early 2023, the City deemed the main to be in immediate need of replacement and applied for funding. The City received funding from the State of Washington's Public Works Board in August 2023, and design has been underway since that time with the intent of constructing the project in 2024.

Improvement: Replace approximately 1,600 lf of existing 14-inch gravity pipe by extending the Monroe Street Lift Station force main by approximately 1,600 feet. This extension will be made by horizontal directional drilling (HDD). Approximately 350 feet of the gravity main will be converted to force main by pipe bursting or sliplining the existing gravity main. Four service laterals, currently connected to the gravity main being converted to a force main, will be transferred to an 8-inch main sliplined into the failing 14-inch gravity sewer.

Cost: $2,100,000

6- to 10-Year System Improvements

The 6- to 10-year improvements were identified from the results of the WWTF and system analyses discussed in **Chapters 6** and **7** and the WWTF improvements alternatives analyses presented in **Chapter 8**.

The 6- to 10-year system improvements are illustrated in **Figure 10-1**. Alternatives for the collection system improvements are possible, and further evaluation should be performed when more information is available regarding when and where future developments will occur.

Wastewater Treatment Facility Improvements (CIP F#)

CIP F2: Headworks Rehabilitation

Deficiency: The existing Headworks screen and grit mechanism are aging and in need of replacement.

Improvement: Install a new replacement screen and remove the existing grit mechanism to install a new mechanism and appurtenances. Increase the power feeder size and provide instrumentation for a fully integrated system.

Cost: $1,200,000

CIP F3 – Clarifier No. 1 Improvements

Deficiency: The original secondary clarifier mechanisms are reaching the end of their useful life and are in need of replacement. Improvements are planned to be phased so that one clarifier can remain online.

Improvement: Replace the existing Clarifier No. 1 mechanism with a stainless steel mechanism, replace the drive unit, and recoat the launder. Remove the existing power feeder conductors and re-land the conductors after the mechanism replacement is complete. Perform a conditions assessment to determine if other improvements are needed.

Cost: $1,250,000

CIP F4 – Clarifier No. 2 Improvements

Deficiency: The original secondary clarifier mechanisms are reaching the end of their useful life and are in need of replacement. Improvements are planned to be phased so that one clarifier can remain online.

Improvement: Replace the existing Clarifier No. 2 mechanism with a stainless steel mechanism, replace the drive unit, and recoat the launder. Remove the existing power feeder conductors and re-land the conductors after the mechanism replacement is complete. Perform a conditions assessment to determine if other improvements are needed.

Cost: $1,250,000

Sewer Main Improvements (CIP SM#)

CIP SM2 – Howard Street and S Park Avenue

Deficiency: The gravity sewer main in Howard Street and S Park Avenue has hydraulic capacity deficiencies, and a portion of these sewer mains need to be upsized.

Improvement: Replace approximately 1,079 lf of existing 8-inch gravity pipe with new 15-inch gravity sewer pipe by open-cut methods as shown in **Figure 10-1**.

Cost: $1,578,000

CIP SM3 – Sims Way, 3rd Street, and Gise Street

Deficiency: The gravity sewer mains in Sims Way, 3rd Street, and Gise Street have hydraulic capacity deficiencies, and a portion of these sewer mains need to be upsized.

Improvement: Replace approximately 273 lf of existing 8-inch gravity pipe with new 18-inch gravity sewer pipe, and replace approximately 523 lf of existing 8-inch gravity pipe with new 15-inch gravity sewer pipe by open-cut methods as shown in **Figure 10-1**.

Cost: $1,186,000

CIP SM4 – Holcomb Street

Deficiency: The gravity sewer main in Holcomb Street has hydraulic capacity deficiencies and a portion of the sewer main needs to be upsized.

Improvement: Replace approximately 531 lf of existing 12-inch gravity pipe with new 18-inch gravity sewer pipe by open-cut methods as shown in **Figure 10-1**.

Cost: $819,000

11- to 20-Year System Improvements (Long-Term Planning Capital Improvements)

The long-term improvements were identified from the results of the WWTF and system analyses discussed in **Chapters 6** and **7** and the WWTF improvements alternatives analyses presented in **Chapter 8**. These improvements are necessary to serve projected population growth in the City and expansion areas. The improvements include the major facility and conveyance construction that will be required to serve those areas.

The additional system improvements required for long-term improvements are illustrated in **Figure 10-1**.

Wastewater Treatment Facility Improvements (CIP F#)

CIP F12 – Long-Term WWTF Expansion (Budgetary Estimate)

Deficiency: Long-term, major expansion of the WWTF is required to provide biological treatment for the projected flow and loads and to provide nitrogen removal.

Improvement: Construct a new activated sludge system consisting of aeration basins and secondary clarifiers. This involves constructing new aeration basins on the newly acquired parcels and removing the existing oxidation ditches to construct future secondary clarifiers within the existing footprint. Modify the hydraulics of the WWTF such that influent flow is lifted to the new aeration basins. This may involve constructing a new Headworks and refurbishing or replacing the existing IPS.

Cost: $30,000,000

Compost Facility and Solids Handling Improvements (C#)

CIP C6 – Compost Facility Infrastructure Upgrades

Deficiency: The Compost Facility needs infrastructure upgrades to bring the facility up to current codes and to ensure safety for the operators.

Improvement: Perform infrastructure upgrades at the Compost Facility, including repairing and sealing the asphalt around the facility, adding lights to the barns, and reinforcing the existing concrete support poles of the barns.

Cost: $410,000

Sewer Main Improvements (SM#)

CIP SM5 – Howard Street, S Park Avenue, and McPherson Street

Deficiency: The gravity sewer mains in Howard Street, S Park Avenue, and McPherson Street have hydraulic capacity deficiencies, and a portion of these sewer mains need to be upsized.

Improvement: Replace approximately 1,685 lf of existing 8-inch sewer with new 15-inch gravity sewer pipe by open-cut methods as shown in **Figure 10-1**.

Cost: $2,463,000

CIP SM6 – West Sims Way and 3rd Street

Deficiency: The existing 8-inch concrete gravity sewer mains in West Sims Way and 3rd Street have hydraulic capacity deficiencies, and a portion of these sewer mains need to be upsized.

Improvement: Replace approximately 1,150 lf of existing 8-inch concrete sewer main with new 15-inch gravity sewer pipe by open-cut methods as shown in **Figure 10-1**.

Cost: $1,679,000

CIP SM7 – Future Interceptor Sizing

Deficiency: Existing 8-, 10-, 12-, and 18-inch sewer interceptor in the City's collection system is failing and has hydraulic capacity deficiencies. Portions of the sewer interceptor need to be upsized.

Improvement: Replace approximately 3,785 lf of existing 10-, 12-, and 18-inch sewer interceptor. Install approximately 220 lf of new 15-inch sewer interceptor, approximately 1,365 lf of new 18-inch sewer interceptor, approximately 1,165 lf of new 24-inch sewer interceptor, and approximately 1,035 lf of new 30-inch sewer interceptor by open-cut methods as shown in **Figure 10-1**.

Cost: $6,722,000

CIP SM11 – Long-Term Sewer System Investigation and Refurbishment

Deficiency: It is suspected that there are many structurally deficient sewer mains in the City's collection system. There are several known structural deficiencies, particularly in the older parts of the collection system that have been video inspected. The degree of structural degradation observed (such as Water and Washington Streets) indicates there are other structurally deficient mains in the older parts of the sewer collection system. The condition of the collection system is not well known because of a lack of adequate inspection equipment. The pipe material and age of many of the mains is also unknown because of incomplete record drawings. RH2 believes that many structurally deficient mains will be discovered once the City begins a regular video inspection program and many of these mains will need to be replaced or repaired.

Improvement: Systematically investigate all un-inspected sewer mains with an emphasis on the areas of known structural degradation that pose a threat of imminent pipe collapse. Replace or line the existing mains and maintenance holes that are structurally deficient. The cost presented represents the "least optimistic" scenario. That is, all pipes that are of concrete, vitrified clay, asbestos cement, or unknown material are assumed to be deficient and will need lining using cured-in-place pipe (CIPP) starting in 10 years. The estimated cost could be reduced if vitrified clay pipes are still in good condition or if unknown pipes are made of PVC. If pipes are in such dire condition that they cannot be lined (like the Water Street sewer in 2023), a more expensive open-cut replacement method will be required. To be conservative, RH2 has estimated that all pipes of substandard or unknown material will be lined with CIPP.

Cost: $56,000,000

Planning Improvements

Miscellaneous and Planning Improvements (CIP M#)

CIP M1 – Arc Flash Analysis

Improvement: Perform an electrical short circuit, protective device coordination, and arc flash analysis for the electrical distribution equipment at the City's wastewater facilities. Prepare a report summarizing the calculations and recommendations for protective device settings and Personal Protective Equipment requirements.

CIP M2 – Public Works Shop (Sewer Collection Share)

Deficiency: The City Shops is home to the water, streets, stormwater, and wastewater collections maintenance crews and equipment. The shops are in disrepair and a new maintenance facility is needed. The first step is to do a schematic design and needs assessment.

Improvement: The cost shown is the share to be funded by the City's Sewer Utility. The estimated cost for the sewer utility portion of this assessment is $100,000.

CIP M3 – General Sewer Plan Update

Deficiency: The City's GSP should be updated every 10 years in coordination with its Water System Plan update.

Improvement: The City plans to update its GSP every 10 years. In addition, the City may review the GSP at the 5-year mark and adjust the projections and improvements as necessary. This may be completed between 2032 and 2033, and 2042 and 2043.

CIP M4 – Downtown Restrooms

Improvement: The cost shown is the share to be funded by the City's Sewer Utility. The estimated sewer fund cost is $250,000. Costs may vary depending on the location and size of the facility. This estimate is planning-level only and anticipates use of other funding sources to assist in the project development.

ESTIMATING COSTS OF IMPROVEMENTS

Project costs for the proposed improvements were estimated based on costs of similar recently constructed sewer projects around the Puget Sound area and are presented in 2023 dollars. The unit costs for each pipe size are based on estimates of all construction-related improvements, such as materials and labor for installation, services, maintenance holes, connections to the existing system, trench restoration, asphalt surface restoration, and other work for a complete installation. Project cost estimates for sewer pipe projects were determined from the unit costs (i.e., cost per foot-length) shown in **Tables 10-1** and **10-2** and the proposed diameter and approximate length of each improvement. The costs shown in

Tables 10-1 and **10-2** include indirect costs estimated at 50 percent of the construction cost for engineering preliminary design, final design, construction contract administration, project administration, permitting, and legal and administrative services.

Table 10-1
Gravity Sewer Pipe Unit Costs for Open-Cut Construction

Sewer Main Diameter (in.)	Project Cost per Linear Foot (2023 $ per lf)
8	$1,314
12	$1,394
15	$1,461
18	$1,542
21	$1,668
24	$1,802
30	$2,119
36	$2,501

Table 10-2
Gravity Sewer Pipe Unit Costs for Cured-in-Place Pipe

Sewer Main Diameter (in.)	Project Cost per Linear Foot (2023 $ per lf)
6	$350
8	$322
10	$331
12	$341
14	$399
15	$399
16	$475
18	$475
22	$686
24	$974
30	$1,357

The cost estimates shown in **Table 10-3** include the estimated construction cost of the improvement and indirect costs estimated at 50 percent of the construction cost for engineering preliminary design, final design, construction contract administration, project administration, permitting, and legal and administrative services. The construction cost estimates include a sales tax of 8.6 percent.

Cost estimates prepared by RH2 for projects in the CIP are Class 5 estimates, based on standards established by the American Association of Cost Engineers (AACE). Class 5 estimates are described as generally being prepared with limited information and subsequently have wide accuracy ranges. The typical accuracy range for this cost estimate class is from -20 percent to -50 percent on the low side and from +30 percent to +100 percent on the high side.

The final cost of the projects will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule, and other variable factors. As a result, the final project costs likely will vary from those presented. Because of these factors, funding needs must be reviewed carefully prior to making specific financial decisions or establishing final budgets.

PRIORITIZING IMPROVEMENTS

The existing system improvements were prioritized by the City based on the perceived need for the improvement to be completed prior to projects with fewer deficiencies or less risk of damage due to failure of the system. Priority and schedule for any future developer-funded projects is dependent on the timing and design of specific developments areas.

Future projects that are not identified as part of the City's CIP may become necessary. Such projects may be required to remedy an emergency situation or address unforeseen problems. Due to budgetary constraints, the completion of such projects may require modifications to the recommended CIP. The City retains the flexibility to reschedule, expand, or reduce the projects included in the CIP and to add new projects to the CIP, as best determined by rate payers and the City Council, when new information becomes available for review and analysis.

SCHEDULE OF IMPROVEMENTS

The results of prioritizing the improvements were used to assist in establishing an implementation schedule that can be used by the City for preparing its CIP. The implementation schedule for the proposed improvements is shown in **Table 10-3**. It should be noted that the implementation schedule shown is, to some extent, flexible. The implementation schedule should be modified based on City preferences, budget, or as development fluctuates. The City should review **Table 10-3** at least annually and reprioritize as necessary to match budget, growth, flows, and other City conditions/priorities. This provides the City with the flexibility to coordinate these projects with road or other projects within the same area.

Future Project Cost Adjustments

All cost estimates shown in the tables are presented in 2023 dollars. Therefore, it is recommended that future costs be adjusted to account for the effects of inflation and changing construction market conditions at the actual time of project implementation. Future costs can be estimated using the Engineering News Record Construction Cost Index for the Seattle area or by applying an estimated rate of inflation that reflects the current and anticipated future market conditions.

The CIP presented in **Table 10-3** is based on the information currently available. As the City implements the recommendations, the cost and timing of projects may be revised.

Table 10-3
Proposed CIP Implementation Schedule

CIP No.	Project Description	Length (LF)	Estimated Cost (2023 $)	2024	2025	2026	2027	2028	6-10 years	11-20 years
	Sewer Main Improvements									
SM1	Sims Way Crossing and Wilson Street Realignment	786	$1,212,000	$100K	$606K	$506K				
SM2	Howard Street and S Park Avenue	1,079	$1,578,000						$1,578K	
SM3	Sims Way, 3rd Street, and Gise Street	796	$1,186,000						$1,186K	
SM4	Holcomb Street	531	$819,000						$819K	
SM5	Howard Street, S Park Avenue, and McPherson Street	1,685	$2,463,000							$2,463K
SM6	West Sims Way and 3rd Street	1,149	$1,679,000							$1,679K
SM7	Future Interceptor Upsizing	3,785	$6,722,000							$6,722K
SM8	Sewer System Defect Investigation and Repair	--	$3,300,000	$150K	$350K	$350K	$350K	$350K	$1,750K	
SM9	Lawrence Street Combined Sewer Separation*	1,800	$2,826,000		$500K	$1,163K	$1,163K			
SM10	Suitcase Pipe Replacement on Washington Street	303	$399,000		$399K					
SM11	Long-Term Sewer System Investigation and Refurbishment**	--	$56,000,000							$56,000K**
SM12	Water Street Sewer Replacement	1,600	$2,100,000	$2,100K						
	Total - Sewer Main Improvements		**$80,284,000**	**$2,350K**	**$1,855K**	**$2,019K**	**$1,513K**	**$350K**	**$5,333K**	**$66,864K**
	Lift Station Improvements									
WW1	Existing Monroe Street Lift Station Improvements		$5,000,000					$500K	$4,500K	
WW2	Sewer Camera Van, Video Camera and Tractor, Recording Software and Hardware, and Staff Training		$300,000	$300K						
WW3	General Lift Station Improvements		$1,000,000	$50K	$50K	$50K	$50K	$50K	$250K	$500K
WW4	Mill Lift Station		$6,300,000	$1,100K	$3,200K	$2,000K				
	Total - Lift Station Improvements		**$12,600,000**	**$1,450K**	**$3,250K**	**$2,050K**	**$50K**	**$550K**	**$4,750K**	**$500K**
	Wastewater Treatment Facility Improvements									
F1	Influent Pump Station and Odor Control Improvements		$2,120,000	$300K	$1,820K					
F2	Headworks Rehabilitation		$1,200,000						$1,200K	
F3	Clarifier No. 1 Improvements		$1,250,000						$1,250K	
F4	Clarifier No. 2 Improvements		$1,250,000						$1,250K	
F5	Non-Potable Water Pump Replacements (City to Install)		$120,000	$60K		$60K				
F6	SCADA Upgrades		$1,140,000		$150K	$990K				
F7	Electrical Upgrades		$630,000			$630K				
F8	Near-Term Oxidation Ditch Improvements		$2,940,000		$100K			$400K	$2,440K	
F9	Outfall Upgrades		$4,000,000	$500K	$600K	$2,900K				
F10	On-Site Solids Handling Improvements		$3,000,000						$3,000K	
F11	Land Acquisition for WWTF Expansion		$2,000,000		$2,000K					
F12	Long-Term WWTF Expansion (Budgetary Estimate)		$30,000,000							$30,000K
	Total - Facility Improvements		**$49,650,000**	**$860K**	**$4,670K**	**$4,580K**	**$0K**	**$400K**	**$9,140K**	**$30,000K**
	Compost Facility and Solids Handling Improvements									
C1	Solids Handling Influent Screening and Grit Removal		$890,000			$160K	$365K	$365K		
C2	Solids Handling Tank Replacement and Mechanical Upgrades		$700,000		$150K	$130K	$130K	$130K	$160K	
C3	Compost Screen Replacement		$460,000	$460K						
C4	Compost Case Loader Replacement		$390,000		$390K					
C5	Compost Blowers Replacements		$80,000	$19K	$19K	$19K	$23K			
C6	Compost Facility Infrastructure Upgrades		$410,000		$15K					$395K
C7	6-inch Hydrant Line		$670,000		$100K	$285K	$285K			
C8	Office with Dedicated Lunchroom		$300,000		$300K					
	Total - Facility Improvements		**$3,900,000**	**$479K**	**$974K**	**$594K**	**$803K**	**$495K**	**$160K**	**$395K**
	Miscellaneous and Planning Improvements									
M1	Arc Flash Analysis		$90,000		$90K					
M2	Public Works Shop - Sewer Collection Share		$2,850,000		$100K				$2,750K	
M3	General Sewer Plan Update		$250,000							$250K
M4	Downtown Restrooms		$250,000		$250K					
	Total - Miscellaneous Improvements		**$3,440,000**	**$0K**	**$440K**	**$0K**	**$0K**	**$0K**	**$2,750K**	**$250K**
Total Estimated Project Costs of City-funded Improvements			**$149,874,000**	**$5,139K**	**$11,189K**	**$9,243K**	**$2,366K**	**$1,795K**	**$22,133K**	**$98,009K**

*50% cost shown in the CIP table. It is assumed an additional 50% will be paid by the Road and Storm Drainage departments.

**Costs are budgetary for pipe replacement of unknown materials. As the City video inspects the system and updates condition, this is subject to change. Rate analysis only includes anticipated grants to reduce City expenditure to $21 million.

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Vicinity Map

Esri, HERE, Garmin, USGS, EPA

Figure 10-1
Capital Improvement Plan Map
Collection System

City of Port Townsend
General Sewer Plan

COORDINATE SYSTEM: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET PLOT DATE: SEP 27, 2023 BY: MEMOTO J:\DATA\TWNSD\21-0226\GIS\MODEL\MODEL PIPES - COPY.APRX

City of Port Townsend

1 inch : 2,000 Feet

0 500 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

RH2

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11 | FINANCIAL ANALYSIS

INTRODUCTION

The financial analysis assesses the ability of the City of Port Townsend's (City) sewer utility to remain financially viable during the planning period, considering its recent historical performance as well as anticipated future needs. It also evaluates the affordability of the City's sewer rates, both at existing levels and with any rate increases needed to support the planned capital program.

FINANCIAL HISTORY

The City tracks the financial activities of its water and sewer utilities in a set of joint funds.

- Water/Sewer Operating Fund (411)
- Water/Sewer Capital Fund (415)
- Olympic Gravity Water System Fund (417)
- Water/Sewer Debt Reserve Fund (430)
- System Development Charge Fund (495)

The City has historically recovered the cost of ongoing operations and maintenance through a combination of base fees and volume fees, imposing a separate capital surcharge to recover costs associated with debt service and capital investment. Though the City originally introduced the capital surcharge in 2013 to communicate the rate impacts of major capital projects to ratepayers, it has decided to consolidate it into the "main" rate structure to recognize that capital investment is an ongoing obligation of the City's sewer utility. As a result, this analysis includes capital surcharge revenue in the definition of "rate revenue."

Table 11-1 summarizes the financial performance of the City's sewer utility from 2018 through 2023, given its allocated share of revenues, expenses, and reserve balances from each of the funds listed above. Key findings include:

- Though the City historically transferred utility taxes directly to its General Fund, it began to account for utility tax revenue in Fund 411 in 2019. Excluding the impacts of this change in accounting practices, the City's sewer rate revenue increased by about 10 percent from 2018 to 2023. Most of this increase is attributable to the City's decisions to increase its sewer base fees and volume fees by a total of approximately 9 percent during this period. The remainder can be explained by recent growth in the City's sewer customer base;
- Excluding the impacts of the City's change in utility tax accounting practices, the sewer utility's operating expenses increased by about 38 percent from 2018 to 2023. Inflation likely contributed significantly toward this increase, as the Consumer Price Index for the Seattle-Tacoma-Bellevue area increased by 26 percent during this period. In addition, labor costs, including salaries and benefits, have increased at a rate exceeding inflation;

Table 11-1

Summary of Historical Financial Performance ($000s)

Fund Resources and Uses Arising from Cash Transactions – Sewer Utility Share	2018 Actual	2019 Actual	2020 Actual	2021 Actual	2022 Actual	2023 Budget
Beginning Cash & Investments ($000s)	$2,160	$1,803	$2,288	$3,142	$4,057	$4,767
Operating Revenues						
Intergovernmental	$ -	$ -	$ 0	$ 0	$ -	$ -
Rate Revenue	2,626	3,168	3,080	3,251	3,414	3,450
Other Charges for Services	258	285	190	200	198	222
Miscellaneous	3	10	8	10	13	2
Total ($000s)	$2,886	$3,463	$3,279	$3,461	$3,625	$3,675
Operating Expenses						
General Government	$ 221	$ 217	$ 228	$ 0	$ -	$ -
Utility Operations	1,885	2,527	2,477	2,911	3,067	3,456
Total ($000s)	$2,106	$2,743	$2,704	$2,911	$3,067	$3,456
Net Operating Income (Loss)	**$780**	**$720**	**$575**	**$550**	**$558**	**$219**
Operating Ratio	***1.37***	***1.26***	***1.21***	***1.19***	***1.18***	***1.06***
Other Increases (Decreases) in Fund Resources						
Capital Revenues	19	544	396	495	617	259
Custodial Activities (Net)	(1)	-	-	-	-	-
Debt Proceeds	-	-	189	-	2	-
Net Transfers In (Out)	(236)	(90)	32	115	743	(8)
Debt Service	(168)	(167)	(113)	(119)	(64)	(52)
Capital Expenditures	(751)	(484)	(224)	(126)	(1,175)	(339)
Net Other Resources (Uses)	0	(38)	-	-	28	-
Net Change in Fund Position ($000s)	(357)	485	855	915	710	80
Ending Cash & Investments ($000s)	$1,803	$2,288	$3,142	$4,057	$4,767	$4,847
Days of Cash on Hand	***313***	***304***	***424***	***509***	***567***	***512***

- The operating ratio provides a means of evaluating the self-sufficiency of the City's sewer utility as an enterprise, measuring the ability of annual operating revenues to cover annual operating costs. A ratio of 1.0 indicates that the City's sewer utility is collecting exactly enough revenue to pay for its operating costs. **Table 11-1** indicates that while the sewer utility was generally able to cover its operating expenses from 2018 to 2023, there was a net cash flow deficiency in 2018 for the sewer funds overall after capital expenditures and interfund transfers had been covered; and
- Days of cash on hand is a measure of financial security, quantifying how long the City's sewer utility would be able to fund daily operating and maintenance costs if it received no additional revenue. It is calculated by dividing unrestricted cash by the average daily cost of operations. While there is no formal minimum standard for this metric, bond rating

agencies have recently expressed a preference for a minimum of 180 days of cash on hand for utilities seeking the highest bond ratings. Considering its operating and capital reserves, the sewer utility maintained over 300 days of cash on hand between 2018 and 2023.

CAPITAL FUNDING RESOURCES

Other than cash financing, the City may fund the sewer Capital Improvement Plan (CIP) from a variety of sources, described in further detail below.

Grant and Low-Cost Loan Programs

Historically, federal and state grant programs were available to local utilities for capital funding assistance. However, these assistance programs have been mostly eliminated, substantially reduced in scope and amount, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funded and heavily subscribed. Nonetheless, the benefit of low-interest loans makes the effort of applying worthwhile. **Appendix N** includes a document published by the Washington State Department of Commerce that outlines state programs, eligibility requirements, and contact information.

System Development Charges (SDCs)

SDCs are a form of connection charge authorized in Revised Code of Washington (RCW) 35.92.025. The City imposes SDCs on development seeking to connect (or upsize an existing connection) to its sewer system as a condition of service, and are in addition to any other costs of connection. Typically based on a blend of historical and planned future capital investment in system infrastructure, the underlying premise is that growth (future customers) will pay for growth-related costs that the utility has incurred (or will incur) to provide capacity to serve new customers. The key components of the SDC calculation are described below.

- **Existing Cost Basis:** The SDC recovers a proportionate share of the cost of existing assets from growth. City records indicate a cumulative investment of $26.7 million in existing assets.
- **Interest:** RCW 35.92.025 allows up to 10 years of interest accrued on existing assets to be included in the cost basis. Based on the original cost and acquisition date of the sewer utility's assets, the SDC cost basis includes $14.9 million in interest.
- **Future System Costs:** The SDC recovers a proportionate share of costs associated with future capital projects from growth to recognize that growth either directly drives or otherwise benefits from these projects. **Table 10-3** indicates a total projected capital cost of $115.7 million in 2023 dollars – the SDC cost basis is adjusted to exclude $6.8 million in costs that the City expects to fund with grants and other sources external to the sewer utility on the premise that the SDC should only recover a share of the investment made in the sewer system by the utility and its ratepayers. In addition, the SDC calculation deducts a provision for future asset retirements to recognize that certain projects in the CIP will replace existing assets. This adjustment intends to avoid double charging development for an asset and its replacement concurrently, recognizing that the assets added through the

CIP will generally cost more than the historical acquisition costs of the existing assets. Based on the projected cost of replacement projects and the expected life of the facilities being replaced, the estimated provision for asset retirements is $3.6 million.

- **System Capacity:** The City imposes sewer SDCs based on water meter size as a representation of how much wastewater a connection could generate, using meter-and-service equivalent (MSE) ratios published by the American Water Works Association (AWWA) to assign equivalent residential units (ERUs) to each meter size. (AWWA also publishes equivalency ratios based on maximum continuous flow capacity, which the City uses to assign ERUs to water service connections – because water meters are often sized to meet demands that do not enter the sewer system, such as irrigation and fire flow, the City's SDC methodology uses MSEs to assign sewer ERUs.)

  The SDC analysis estimates the ERU capacity of the sewer system by:

  1. Estimating the number of existing ERUs using utility billing records. Based on a current inventory of sewer customers by meter size, the City serves an estimated 4,781 ERUs;
  2. Estimating the average flow/loading contributions per ERU using influent data from the City's wastewater treatment plant. An average of 2016 to 2021 data suggests that an ERU contributes 174 gallons per day (gpd) of flow on an annual average basis, 216 gpd of flow on a maximum month basis, 0.54 pounds per day of maximum month 5-day Biochemical Oxygen Demand, and 0.55 pounds per day of maximum month total suspended solids; and
  3. Equating the design capacity of the wastewater treatment plant to an equivalent number of ERUs, given the constraining measure of capacity. Based on the unit flows/loadings summarized above, the wastewater treatment plant can accommodate an estimated 6,673 ERUs based on annual average daily flow capacity of 1.44 million gallons per day.

Table 11-2 summarizes the sewer SDC calculation.

Table 11-2

Sewer SDC Calculation

Sewer SDC Cost Basis ($000s)	
Existing Assets as of 12/31/22	$ 26,685
Plus: Estimated 2023 Expenditures (Net of 50% Grant Funding)	300
Less: Estimated Cost of Assets Being Retired Through CIP Projects	(3,567)
Plus: Interest on Existing Assets	14,905
Future Capital Projects (2023 Dollars)	115,128
Less: Projects Funded by Grants or External Contributions	(6,796)
Net SDC Cost Basis	$146,655
System Capacity in ERUs	6,673
Maximum Sewer SDC per ERU	**$21,978**

Table 11-2 indicates that the City could justify increasing its sewer SDC to $21,978 per ERU. Recognizing that such a high SDC could adversely impact growth in the City's service area and

contradict the City's objective to encourage the development of affordable housing, the City adopted the following changes effective April 1, 2024 (Ordinance 3330):

- Increasing the sewer SDC from $3,758 to $5,258 per ERU based on inflation in the Engineering News-Record Construction Cost Index (20-City Average) from 2013 (when the SDC had last been updated) to 2023. The financial plan assumes that beginning in 2025, the City will adjust the sewer SDC annually for inflation.
- Establishing an alternate methodology for assigning ERUs to single-family connections based on house size (excluding garages). Parcel data from the Jefferson County Assessor informed the proposed structure, which includes five tiers based on square footage:

Residential – Single-Unit and Mobile Home		
House Size in Square Feet (SF)	Number of ERUs	SDC
Up to 750 SF	0.36	$1,871
751 – 1,500 SF	0.70	$3,676
1,501 – 1,900 SF	1.00	$5,258
1,901 – 2,600 SF	1.30	$6,819
Larger Than 2,600 SF	1.90	$10,011

Bonds

While general obligation bonds pledge the full faith and credit of the issuing entity, revenue bonds are typically secured by utility revenues. With this limited commitment, revenue bonds normally bear higher interest rates than other types of debt and also require additional security conditions intended to protect bondholders from default risk. These conditions may include the maintenance of dedicated reserves and minimum standards of financial performance (e.g., debt service coverage).

Revenue bonds can be issued in Washington State without a public vote. While there is no explicit statutory bonding limit, the conditions that come with revenue bonds often impose practical limits on a utility's level of indebtedness. An excessive debt burden may reduce a utility's flexibility to phase in rate increases, also resulting in a higher overall cost of capital investment given the related interest payments. It is worth noting that bond rating agencies also consider a utility's debt service coverage when assigning a rating – higher levels of indebtedness make it more difficult for a utility to meet the coverage ratios that the rating agencies require for the highest ratings (and the lowest interest rates). In recent years, these coverage ratios have often exceeded the minimum legal standards outlined in the applicable bond covenants.

CURRENT REVENUE

The primary goal of the financial analysis is to develop a viable financial plan to support execution of the planned capital projects while funding ongoing operations and maintaining affordable rates. This study defines the amount of revenue needed to meet the system's financial obligations including:

- Operation and maintenance costs;
- Administrative and overhead costs;

- Policy-based needs (e.g., reserve funding);
- Capital costs; and
- Existing/new debt service obligations.

The City operates its sewer utility as an enterprise, relying on revenue from its sewer rates (as opposed to taxes or other external resources) to cover the expenses outlined above. The rate-setting process includes both operating and capital elements.

Financial Policies

The ensuing discussion summarizes the key financial policies used in this analysis.

Utility Reserves

Reserves are a key component of any utility financial strategy, as they provide the flexibility to manage variations in costs and revenues that could otherwise have an adverse impact on ratepayers. The financial analysis separates resources into the following funds:

- Operating Reserve: Providing an unrestricted cash balance to accommodate the short-term cycles of revenues and expenses, these reserves are intended to address variations in revenues and expenses (including anticipated variations in billing/receipt cycles, as well as unanticipated variations due to weather or economic conditions). The financial analysis assumes a minimum balance target of 60 days of operating expenses for this reserve, which based on projected 2024 operating expenses equates to about $725,000.
- Capital Reserve: Providing a source of cash for emergency asset replacements or capital project overruns, this reserve enforces an appropriate segregation of resources restricted or designated for capital purposes. This analysis does not include a minimum balance for this reserve, assuming that the City would be able to delay or seek external funding for capital projects as needed.
- Bond Reserve: Bond covenants establish reserve requirements as a means of protecting bondholders against the risk of nonpayment. While the City's sewer utility does not currently have outstanding debt that requires such a reserve, the forecast assumes a minimum balance equal to one year's debt service payment for future revenue bonds.

Recognizing that revenue bonds will likely be needed to fund at least part of the projected capital costs, this analysis also targets a combined unrestricted cash balance (including both operating and capital reserves, but not restricted bond reserves) of 180 days of operating expenses. Though not a formal requirement, this policy is based on recommendations from the bond rating agencies for borrowers seeking to optimize their bond ratings. Given the near-term expense forecast, the combined target balance would be roughly $2,178,000 in 2024.

Financial Performance Standards

The financial plan (revenue requirement analysis) uses a pair of sufficiency tests to establish the amount of revenue needed to meet the annual financial obligations of the City's sewer utility.

- Cash Flow Test: To satisfy this test, operating revenues must be adequate to fund all known cash requirements, including operations and maintenance (O&M) expenses, debt service, rate-funded capital outlays, and reserve funding.
- Coverage Test: Though the sewer utility currently has no debt requiring coverage, the financial analysis assumes that the utility's net revenue would need to be greater than or equal to 1.25 times annual parity debt service (based on the requirements typically outlined in bond covenants) in the event of future debt issuance.

The annual revenue requirement is broadly defined as the amount of revenue needed to satisfy both of these tests. Short-term cash flow deficits may occur as part of a strategy to phase rate increases in, as long as the utility has sufficient reserves on hand to absorb them; however, any applicable debt service coverage requirements must always be met.

Capital Funding Plan

As shown in **Table 11-3**, the sewer utility's 20-year CIP includes $115.1 million in project costs (in 2023 dollars) with $51.9 million expected to occur in the next 10 years (2024 to 2033). Based on input from City staff, the financial plan assumes construction cost inflation of 5 percent for 2024 and 4 percent per year thereafter. Adjusting for inflation, **Table 11-3** shows a total 20-year capital expenditure of $180.1 million, of which $63.8 million is projected to occur within the next 10 years. Note that **Table 11-3** only includes $21.3 million of the $56.0 million estimated for the long-term sewer system refurbishment program – due to financing constraints, the remainder will either need to be funded by grants or delayed beyond the 20-year period.

Shown in further detail in **Table 11-4**, the capital funding plan for the 10-year CIP (2024 to 2033) consists of the following components:

- $6.3 million in grant funding, including $4.1 million for the Mill Road Lift Station, $1.2 million for the Lawrence Street Combined Sewer Separation, and $1.1 million for the Water Street Sewer Replacement (in addition to $300,000 in grant funding attributable to 2023 expenditures on the Water Street project).
- $483,000 in funding from the City's Equipment Rental & Replacement (ERR) Fund for the purchase of a new screen for the City's Compost Facility (the ERR Fund is an internal service fund of the City that is external to the sewer utility).
- $1.1 million in Public Works Trust Fund loans for the Water Street Sewer Replacement. At an interest rate of 0.86 percent, the annual payment on this loan (including an additional $300,000 attributable to 2023 expenditures on this project) would be about $80,000.
- A $4.5 million State Revolving Fund (SRF) loan for the outfall upgrades. At an interest rate of 1.2 percent, the annual payment on this 20-year loan would be about $253,000.
- $30.9 million in revenue bond proceeds to fund various capital projects over the 10-year planning period. With interest rates of 3.5 to 4.0 percent, the annual payment on these 20-year bonds would increase to $2.3 million by the end of the planning period.

- $2.0 million in Local Facilities Charges imposed on properties in the area benefitting from the Mill Road Lift Station at the time of connection.
- $18.6 million in sewer utility cash resources, including $3.1 million in SDCs and $15.5 million of cash contributions generated through rates.

Table 11-3

Capital Cost Forecast

Capital Project Expenditures ($000s)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	Future	Total
Sewer Main Improvements												
Sims Way Crossing & Wilson Street Realignment	$ 100	$ 606	$ 506	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,212
Howard Street & South Park Avenue	-	-	-	-	-	-	-	-	400	1,178	-	1,578
Sims Way, Third Street, & Gise Street	-	-	-	-	-	-	-	-	300	886	-	1,186
Holcomb Street	-	-	-	-	-	-	-	-	150	669	-	819
Howard St., South Park Ave, & McPherson St.	-	-	-	-	-	-	-	-	-	-	2,463	2,463
West Sims Way & 3rd Street	-	-	-	-	-	-	-	-	-	-	1,679	1,679
Future Interceptor Upsizing	-	-	-	-	-	-	-	-	-	-	6,722	6,722
Sewer System Defect Investigation & Repair	150	350	350	350	350	350	350	350	350	350	-	3,300
Lawrence Street Combined Sewer Separation	-	500	1,163	1,163	-	-	-	-	-	-	-	2,826
Suitcase Pipe Replacement on Washington St.	-	399	-	-	-	-	-	-	-	-	-	399
Long-Term Sewer System Refurbishment	-	-	-	-	-	-	-	-	-	-	21,250	21,250
Water Street Sewer Replacement	2,100	-	-	-	-	-	-	-	-	-	-	2,100
Lift Station Improvements												
Existing Monroe St. Pump Station Improvements	-	-	-	-	500	1,000	3,500	-	-	-	-	5,000
Sewer Camera Van, Video Camera, & Tractor	300	-	-	-	-	-	-	-	-	-	-	300
General Lift Station Improvements	50	50	50	50	50	50	50	50	50	50	500	1,000
Mill Road Lift Station	1,100	3,200	2,000	-	-	-	-	-	-	-	-	6,300
Wastewater Facility Improvements												
Influent Pump Station & Odor Control Improvements	300	1,820	-	-	-	-	-	-	-	-	-	2,120
Headworks Rehabilitation	-	-	-	-	-	100	500	600	-	-	-	1,200
Clarifier No. 1 Improvements	-	-	-	-	-	150	475	625	-	-	-	1,250
Clarifier No. 2 Improvements	-	-	-	-	-	150	475	625	-	-	-	1,250
NPW Pump Replacements	60	-	60	-	-	-	-	-	-	-	-	120
SCADA Upgrades	-	150	990	-	-	-	-	-	-	-	-	1,140
Electrical Upgrades	-	-	630	-	-	-	-	-	-	-	-	630
Near-Term Oxidation Ditch Improvements	-	100	-	-	400	150	1,072	1,222	-	-	-	2,944

Table 11-3

Capital Cost Forecast (Continued)

Capital Project Expenditures ($000s)	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**Future**	**Total**
Outfall Upgrades	500	600	2,900	-	-	-	-	-	-	-	-	4,000
Onsite Solids Handling	-	-	-	-	-	200	1,300	1,500	-	-	-	3,000
Land Acquisition for WWTP Expansion	-	2,000	-	-	-	-	-	-	-	-	-	2,000
Long-Term WWTP Expansion	-	-	-	-	-	-	-	-	-	-	30,000	30,000
Compost Facility & Solids Handling Improvements												
Solids Handling Influent Screening & Grit Removal	-	-	160	365	365	-	-	-	-	-	-	890
Solids Handling Tank Repl. & Mechanical Upgrades	-	150	130	130	130	32	32	32	32	32	-	700
Compost Screen Replacement	460	-	-	-	-	-	-	-	-	-	-	460
Compost Case Loader Replacement	-	390	-	-	-	-	-	-	-	-	-	390
Compost Blower Replacements	19	19	19	23	-	-	-	-	-	-	-	80
Compost Facility Infrastructure Upgrades	-	15	-	-	-	-	-	-	-	-	395	410
6-Inch Hydrant Line	-	100	285	285	-	-	-	-	-	-	-	670
Office with Dedicated Lunchroom	-	300	-	-	-	-	-	-	-	-	-	300
Miscellaneous & Planning Improvements												
Arc Flash Analysis	-	90	-	-	-	-	-	-	-	-	-	90
Public Works Shop (Sewer Collection Share)	-	100	-	-	-	-	-	-	-	2,750	-	2,850
General Sewer Plan Update	-	-	-	-	-	-	-	-	-	-	250	250
Downtown Restrooms	-	250	-	-	-	-	-	-	-	-	-	250
Total (2023 Dollars)	$5,139	$11,189	$ 9,243	$2,366	$1,795	$2,182	$ 7,754	$5,004	$1,282	$5,915	$ 63,259	$115,128
Total Projected Expenditures (with Inflation)	**$5,396**	**$12,218**	**$10,497**	**$2,795**	**$2,205**	**$2,787**	**$10,302**	**$6,914**	**$1,842**	**$8,840**	**$116,270**	**$180,067**

Table 11-4

Capital Funding Strategy

Capital Reserve Projections ($000s)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2024-2033 Total
Beginning Balance	$ 259	$ 5,019	$11,309	$2,783	$ 1,502	$10,948	$9,786	$1,648	$4,273	$5,924	$ 259
Plus: Interest Earnings	4	75	170	42	23	164	147	25	64	89	802
Plus: Grants – Mill Lift Station Project	1,000	3,100	-	-	-	-	-	-	-	-	4,100
Plus: Grants – Lawrence Street Sewer Separation Project	-	-	581	582	-	-	-	-	-	-	1,163
Plus: Grants – Water Street Sewer Replacement	1,050	-	-	-	-	-	-	-	-	-	1,050
Plus: PWTF Loan – Water Street Sewer Replacement	1,050	-	-	-	-	-	-	-	-	-	1,050
Plus: SRF Loan – Outfall Upgrades	4,474	-	-	-	-	-	-	-	-	-	4,474
Plus: Revenue Bonds	-	14,200	-	-	10,100	-	-	6,600	-	-	30,900
Plus: ERR Reserves – Compost Screen Replacement	483	-	-	-	-	-	-	-	-	-	483
Plus: Transfer from Operating Fund	1,552	570	637	288	903	813	1,644	2,534	3,040	4,233	16,216
Plus: Transfer from SDC Fund	344	363	382	403	425	448	173	180	188	197	3,103
Plus: Local SDC for Mill Road Lift Station Project	200	200	200	200	200	200	200	200	200	200	2,000
Less: Capital Expenditures	(5,396)	(12,218)	(10,497)	(2,795)	(2,204)	(2,787)	(10,302)	(6,914)	(1,842)	(8,840)	(63,796)
Ending Balance	$5,019	$11,309	$ 2,783	$1,502	$10,948	$9,786	$ 1,648	$4,273	$5,924	$1,803	$1,803

Revenue Requirement

The revenue requirement analysis evaluates the sewer utility's ability to cover its projected costs under its currently adopted rates. In the event of any projected deficiencies, this analysis will serve as the basis for a strategy of recommended rate revenue adjustments.

Projected Financial Performance

The revenue requirement analysis is developed from the City's adopted 2023 Budget with other assumptions:

- The forecast of sewer rate revenue is based on 2023 budgeted revenue provided by the City, adjusted for customer growth. Based on the forecast of the City's sewered population presented in **Table 3-3**, the analysis assumes growth of about 1.4 percent per year (the long-term annual average growth rate) through 2029 and 0.5 percent annual growth thereafter. These projections are somewhat lower than the population projections presented in **Table 3-3**, recognizing the difference between conservatism for financial planning and conservatism in system planning. As previously noted, the projection of "rate revenue" reflects the consolidation of the capital surcharge into the "main" sewer rate structure;
- Interest earnings are calculated on the sewer utility's projected fund balances assuming an annual interest earnings rate of 1.5 percent;
- The operating forecast generally holds most of the sewer utility's other operating revenues at 2023 levels moving forward;
- The forecast of operating expenses generally adjusts the 2023 budgeted expenditures for inflation assuming 5.0-percent inflation for 2024 and 4.0-percent inflation thereafter. Though lower than recent inflation observed in the Consumer Price Index, these inflation assumptions intend to recognize longer-term inflationary trends while maintaining a reasonable degree of conservatism; and
- Taxes are calculated based on the projected revenues and prevailing rates:
    - City Utility Tax: 16.0 percent;
    - State Excise Tax (Sewer): 3.852 percent; and
    - Business & Occupation (B&O) Tax: 1.75 percent.

Table 11-5 summarizes the sewer utility's projected financial performance and rate revenue needs.

Table 11-5

Projected Financial Performance and Revenue Requirements ($000s)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Revenue										
Rate Revenue at 2023 Rates	$3,072	$3,114	$3,156	$3,199	$3,243	$3,287	$3,304	$3,321	$3,337	$3,354
Other Operating Revenues	237	237	237	237	237	237	237	237	237	237
Use of Fund 430 for Debt Service	18	83	873	-	-	-	-	-	-	-
Total Revenues	$3,327	$3,433	$4,266	$3,436	$3,480	$3,524	$3,541	$3,558	$3,574	$3,591
Expenses										
Operating Expenses	$4,417	$4,061	$4,210	$4,364	$4,525	$4,692	$4,812	$4,985	$5,165	$ 5,351
Debt Service	69	335	1,421	1,421	1,420	2,230	2,230	2,229	2,758	2,758
Direct Funding for Capital Projects	-	-	-	-	-	-	169	-	-	2,627
Additions to Operating Reserve	-	-	24	25	26	27	20	29	29	31
Total Expenses	$4,487	$4,397	$5,655	$5,810	$5,971	$6,949	$7,231	$7,243	$7,952	$10,767
Net Cash Flow	($1,160)	($964)	($1,389)	($2,374)	($2,491)	($3,425)	($3,690)	($3,685)	($4,378)	($7,176)
Annual Rate Increase	**39.7%[1]**	**13.0%**	**13.0%**	**13.0%**	**13.0%**	**13.0%**	**13.0%**	**13.0%**	**13.0%**	**13.0%**
Rate Revenue After Rate Increases	$3,986	$4,915	$5,630	$6,449	$7,387	$8,462	$9,609	$10,913	$12,393	$14,074
Net Cash Flow After Rate Increases	($411)	$512	$662	$313	$930	$841	$1,495	$2,563	$3,070	$1,637
Debt Coverage After Rate Increases	(N/A)	(N/A)	1.62	1.98	2.54	1.92	2.19	2.59	2.46	2.96
Projected Ending Balances (Sewer Share)										
Operating Fund	$ 726	$ 668	$ 692	$ 717	$ 744	$ 771	$ 791	$ 819	$ 849	$ 880
Capital Fund	5,019	11,309	2,783	1,502	10,948	9,786	1,648	4,273	5,924	1,803
Total	$5,745	$11,977	$3,475	$2,220	$11,692	$10,558	$2,439	$5,093	$6,773	$2,683
Combined Balance as Days of O&M	*475 Days*	*1,076 Days*	*301 Days*	*186 Days*	*943 Days*	*821 Days*	*185 Days*	*373 Days*	*479 Days*	*183 Days*

1. The 2024 rate increase reflects the consolidation of the capital surcharge into the “main” sewer rate, targeting a 13.0% increase over the total existing sewer bill.

Table 11-5 indicates that at 2023 rates, the City’s sewer revenues are insufficient to cover the sewer utility’s expenses – with inflation, projected increases in debt service, and capital funding needs, the cash-flow deficiency generally grows larger over time (except in 2025, when total operating expenses are expected to decrease after accounting for several one-time expenses built into the 2024 projections). **Table 11-5** shows a strategy of 13.0-percent annual rate increases from 2024 to 2033, which are projected to enable the sewer utility to cover the projected needs while maintaining a combined fund balance of at least 180 days of operating expenses. The City Council passed Ordinance 3332 at its February 20, 2024, meeting, adopting the rate increases for 2024 (effective April 1, 2024) through 2028 – the City intends to revisit the sewer financial plan in 2028 and assess whether the rate increases shown for 2029 and future years are still needed given any capital funding assistance (e.g., grants, low-cost loans, forgivable principal loans) that the City is able to obtain.

CURRENT AND PROJECTED SEWER RATES

The City imposes a two-tiered base rate on residential users, with residences using more than 3,000 gallons paying a higher base rate than those using 3,000 gallons or less. Multi-family, commercial, and governmental users pay a base rate based on their water meter size and a volume rate per thousand gallons of water usage. Effective April 1, 2024, the City eliminated the capital surcharge and increased the rest of the sewer rate structure proportionately to maintain revenue neutrality. **Table 11-6** shows the sewer rate schedule adopted by the City Council on February 20, 2024.

Table 11-6

Sewer Rate Forecast

Sewer Rate Structure (Including Utility Tax)	Jan-Mar 2024	Apr-Dec 2024	2025	2026	2027	2028
Monthly Base Rate						
Residential (Including Duplexes)						
Usage ≤ 3,000 Gallons	$46.46	$63.36	$71.60	$80.91	$91.42	$103.31
Usage > 3,000 Gallons	$57.44	$78.33	$88.51	$100.02	$113.02	$127.71
Multi-Family/Commercial/Government:						
5/8” – 3/4” Meter	$41.18	$56.16	$63.46	$71.71	$81.03	$91.57
1” Meter	$61.77	$84.23	$95.18	$107.56	$121.54	$137.34
1-1/2” Meter	$102.94	$140.37	$158.62	$179.24	$202.55	$228.88
2” Meter	$157.84	$215.24	$243.23	$274.84	$310.57	$350.95
3” Meter	$576.48	$786.12	$888.32	$1,003.80	$1,134.29	$1,281.75
4” Meter	$645.11	$879.72	$994.08	$1,123.31	$1,269.34	$1,434.35
6” Meter	$960.80	$1,310.22	$1,480.55	$1,673.02	$1,890.51	$2,136.28
8” Meter	$1,317.67	$1,796.87	$2,030.46	$2,294.42	$2,592.69	$2,929.74
Volume Rate per 1,000 Gallons						
Multi-Family (3+ Units)	$4.73	$6.45	$7.29	$8.24	$9.31	$10.52
Commercial A (2” or Smaller Meter)	$6.38	$8.70	$9.83	$11.11	$12.55	$14.18
Commercia B (3” or Larger Meter)	$4.18	$5.70	$6.45	$7.28	$8.23	$9.30
Government	$6.24	$8.51	$9.62	$10.87	$12.29	$13.88
Capital Surcharge per Month						
Standard	$9.00	-	-	-	-	-
Low-Income	$4.50	-	-	-	-	-

Utility Rate Affordability Analysis

A key objective of this financial chapter is to evaluate the City’s ability to execute the planned capital improvement projects while maintaining reasonable sewer rates. Recognizing that a holistic assessment of rate affordability must consider the total utility bill, **Table 11-7** shows a forecast of combined utility bills under the adopted rates for a residential customer using 3,000 gallons of water per month.

The City has historically offered citizens with income levels at or below 150 percent of the poverty level (PL) for Jefferson County a 50-percent discount on their water base charge (excluding volume charges), their sewer charge, and their stormwater charge. Effective April 1, 2024, the City replaced its low-income discount program with an income-based discount program consisting of the following tiers:

Income Level	Discount to Water Base Charge, Sewer Charge, and Stormwater Charge
> 350% of PL	0% (Customer Pays 100% of Charges)
300% – 350% of PL	25% (Customer Pays 75% of Charges)
200% – 300% of PL	50% (Customer Pays 50% of Charges)
≤ 200% of PL	75% (Customer Pays 25% of Charges)

Table 11-7 shows the bills for residential customers using 3,000 gallons of water per month under each of these income thresholds.

Table 11-7

Combined Utility Bill Forecast

Average Monthly Residential Bill @ 3,000 Gallons	Jan-Mar 2024	Apr-Dec 2024	2025	2026	2027	2028
Income > 350% of PL						
Water[1]	$ 70.84	$ 74.31	$ 76.86	$ 77.79	$ 80.90	$ 84.14
Sewer	55.46	63.36	71.60	80.91	91.42	103.31
Stormwater	16.89	20.05	22.01	24.41	27.02	29.62
Total	$143.19	$157.72	$170.47	$183.11	$199.34	$217.07
Change from Prior Year		+$14.53	+$12.75	+$12.64	+$16.23	+$17.73
Percent Change from Prior Year		+10.1%	+8.1%	+7.4%	+8.9%	+8.9%
Income Between 300% – 350% of PL						
Water[1] (25% Discount to Base Charge)	$ 70.84	$ 59.14	$ 61.14	$ 61.91	$ 64.39	$ 66.96
Sewer (25% Discount)	55.46	47.52	53.70	60.68	68.57	77.48
Stormwater (25% Discount)	16.89	15.04	16.51	18.31	20.27	22.22
Total	$143.19	$121.70	$131.35	$140.90	$153.23	$166.66
Change from Prior Year		($21.49)	+$9.65	+$9.55	+$12.33	+$13.43
Percent Change from Prior Year		-15.0%	+7.9%	+7.3%	+8.8%	+8.8%
Income Between 200% – 300% of PL						
Water[1] (50% Discount to Base Charge)	$ 70.84	$43.97	$45.43	$46.04	$ 47.88	$ 49.80
Sewer (50% Discount)	55.46	31.68	35.80	40.46	45.71	51.66
Stormwater (50% Discount)	16.89	10.03	11.01	12.21	13.51	14.81
Total	$143.19	$85.68	$92.24	$98.71	$107.10	$116.27
Change from Prior Year		($57.51)	+$6.56	+$6.47	+$8.39	+$9.17
Percent Change from Prior Year		-40.2%	+7.7%	+7.0%	+8.5%	+8.6%
Income ≤ 150% of PL						
Water[1] (75% Discount to Base Charge)	$42.40	$28.79	$29.72	$30.16	$31.37	$32.62
Sewer (75% Discount)	27.73	15.84	17.90	20.23	22.86	25.83
Stormwater (75% Discount)	8.27	5.01	5.50	6.10	6.76	7.41
Total	$78.40	$49.64	$53.12	$56.49	$60.99	$65.86
Change from Prior Year		($28.76)	+$3.48	+$3.37	+$4.50	+$4.87
Percent Change from Prior Year		-36.7%	+7.0%	+6.3%	+8.0%	+8.0%

1. Assumes 4% inflationary increases for 2027 and 2028; the City has only adopted water rates through 2026.

While the term "reasonable" is relatively subjective in its definition, agencies that offer low-cost loans to utilities often use an "affordability index" based on median household income (MHI) to define a threshold beyond which utility rates impose financial hardship on ratepayers. The benchmark most often used in this evaluation is 4.5 percent of the median household income in the relevant demographic area for the combined water/sewer bill. The 2022 American Community Survey indicates a median income of $59,193 (in 2022 dollars) for households in the City of Port Townsend – adjusting for increases in the state minimum wage from 2022 to 2024 (12.3 percent), the equivalent 2024 median income level would be $66,505. **Table 11-8** summarizes the affordability evaluation of the City's rates based on median household income.

Table 11-8

Monthly Utility Bill as a Percentage of Median Household Income

	Jan-Mar 2024	Apr-Dec 2024	2025	2026	2027	2028
Water Bill @ 3,000 Gallons	$ 70.84	$ 74.31	$ 76.86	$ 77.79	$ 80.90	$ 84.14
Sewer Bill @ 3,000 Gallons	55.46	63.36	71.60	80.91	91.42	103.31
Combined Monthly Water/Sewer Bill	$126.30	$137.67	$148.46	$158.70	$172.32	$187.45
Annual MHI[1]	$66,505	$66,505	$69,166	$71,932	$74,809	$77,802
Combined Bill as Percent of MHI	2.3%	2.5%	2.6%	2.6%	2.8%	2.9%

1. Assumes that MHI increases annually with inflation at 4% per year.

Table 11-8 shows that the combined water/sewer bill at 3,000 gallons is expected to remain within the range of 2.5 to 3.0 percent of MHI through 2028 – even without the assumed inflationary adjustments to MHI, the combined bill would only reach about 3.4 percent of MHI by 2028. Though the City's rates could be considered "affordable" by this standard, there has been a growing consensus in the industry that median household income is of limited value in assessing the impacts of utility rates on customers with income levels far below the area median. As discussions about rate affordability continue to evolve, two alternative metrics have been gaining traction as providing a more meaningful basis for evaluating affordability:

Hours at Minimum Wage (HM)

HM quantifies the amount of time that someone earning minimum wage (currently $16.28 per hour in Washington State) would need to work in order to pay their combined water/sewer bill, assuming that they use a "lifeline" volume of 50 gallons per capita per day (gpcd). Based on the City's average household size of 1.85 people, this assumption equates to just over 2,800 gallons per month per household (for simplicity, this assessment rounds the usage level up to 3,000 gallons per month). The literature discussing HM recommends 8.0 hours as a threshold for defining "affordable" rates.

Affordability Ratio at the 20th Income Percentile (AR_{20})

AR_{20} expresses the combined water/sewer bill (at 50 gpcd) as a percentage of the net disposable income (NDI) of a household in the 20th income percentile after accounting for the cost of food, housing, power, healthcare, and taxes.

- Based on data from the American Community Survey, the estimated gross income of a household at the 20th income percentile is about $25,113 (roughly $2,100 per month).

- Based on data from the Bureau of Labor Statistics' Consumer Expenditure Survey, the estimated annual expenditures for the essential needs listed above add up to $20,605 for a household of two and $15,852 for a household of three. Though it is somewhat counterintuitive that a household of two would spend *more* than a household of three on these essential needs, the Consumer Expenditure Survey data suggests that on average, a household of three gets a greater tax refund than a household of two (possibly due to dependent tax credits) and spends less on healthcare despite spending more in most other areas.

The parameters above suggest that the NDI for a household in the 20th income percentile falls into the range of $376 to $772 per month, depending on whether the expense estimates for the two-person or three-person household (which is more common for households in Washington State) are used. The literature discussing AR_{20} recommends 10.0 percent of NDI as a threshold for "affordable" rates.

Both HM and AR_{20} focus specifically on the combined water/sewer bill and do not explicitly account for stormwater charges. While this is possibly because residential stormwater charges have historically been low compared to water and sewer charges, stormwater rate increases driven by infrastructure investments and water quality improvements are at a point where they arguably should be considered in an affordability assessment. It is reasonable to expect that the methodology for determining these metrics (as well as the suggested affordability thresholds) may evolve over time as a result of stormwater rate increases. With this caveat, **Table 11-9** summarizes the affordability analysis for low-income residents based on the current definitions of HM and AR_{20}.

Table 11-9

Rate Affordability Assessment Based on HM and AR_{20}

	Jan-Mar 2024	Apr-Dec 2024	2025	2026	2027	2028
Residential (Income > 350% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$126.30	$137.67	$148.46	$158.70	$172.32	$187.45
Bill as HM (Target: ≤ 8.0 Hours)	7.8 Hours	8.5 Hours	8.8 Hours	9.0 Hours	9.4 Hours	9.8 Hours
Bill as % of NDI (AR_{20}, Target: ≤ 10.0%)	16.4 – 33.6%	17.8 – 36.6%	19.2 – 39.5%	20.6 – 42.2%	22.3 – 45.8%	24.3 – 49.9%
Residential (Income Between 300 – 350% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$126.30	$106.66	$114.84	$122.59	$132.96	$144.44
Bill as HM (Target: ≤ 8.0 Hours)	7.8 Hours	6.6 Hours	6.8 Hours	7.0 Hours	7.3 Hours	7.6 Hours
Bill as % of NDI (AR_{20}, Target: ≤ 10.0%)	16.4 – 33.6%	13.8 – 28.4%	14.9 – 30.5%	15.9 – 32.6%	17.2 – 35.4%	18.7 – 38.4%
Residential (Income Between 200 – 300% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$126.30	$75.65	$81.23	$86.50	$93.59	$101.46
Bill as HM (Target: ≤ 8.0 Hours)	7.8 Hours	4.6 Hours	4.8 Hours	4.9 Hours	5.1 Hours	5.3 Hours
Bill as % of NDI (AR_{20}, Target: ≤ 10.0%)	16.4 – 33.6%	9.8 – 20.1%	10.5 – 21.6%	11.2 – 23.0%	12.1 – 24.9%	13.1 – 27.0%
Residential (Income ≤ 150% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$70.13	$44.63	$47.62	$50.39	$54.23	$58.45
Bill as HM (Target: ≤ 8.0 Hours)	4.3 Hours	2.7 Hours	2.8 Hours	2.9 Hours	3.0 Hours	3.1 Hours
Bill as % of NDI (AR_{20}, Target: ≤ 10.0%)	9.1 – 18.7%	5.8 – 11.9%	6.2 – 12.7%	6.5 – 13.4%	7.0 – 14.4%	7.6 – 15.5%
Projected Minimum Hourly Wage[1]	$16.28	$16.28	$16.93	$17.61	$18.31	$19.05
Monthly NDI of Household @ 20th Percentile[2]	$376 – $772	$376 – $772	$376 – $772	$376 – $772	$376 – $772	$376 – $772

[1]Assumes that minimum wage increases annually with inflation (assumed to be 4% per year) per RCW 49.46.020.
[2]Range based on two-person and three-person homes; remains the same since both income and expenses are assumed to increase with inflation.

Table 11-9 shows that under the City's "standard" residential rate schedule (applicable to customers with annual income above 350 percent of PL), the bill for a residential customer using 3,000 gallons per month generally exceeds the suggested affordability thresholds based on HM and AR_{20}. The City's introduction of a new income-based discount program in April 2024 appears to materially improve the affordability of rates for customers below 350 percent of PL. It is worth noting that the estimated annual income for a household in the City at the 20th income percentile ($25,113) represents approximately 123 percent of the 2024 Federal Poverty Guideline of $20,440 for a household of two – in **Table 11-9**, this household would fall into the lowest income category (150 percent of PL).

Rate Burden (EPA Methodology)

The U.S. Environmental Protection Agency (EPA) has developed a method for evaluating the household burden of utility rates associated with water utilities. The framework for measuring household affordability and financial capability include:

1. The Household Burden Indicator (HBI), defined as basic water service costs (includes water, wastewater, and stormwater combined) as a percent of the 20th percentile household income (i.e., the Lowest Quintile of Income (LQI) for the Service Area); and
2. The Poverty Prevalence Indicator (PPI), defined as the percentage of community households at or below 200 percent of the Federal Poverty Level (FPL).

Table 11-10 summarizes the guidelines for evaluating the relative rate burden using the EPA's methodology.

Table 11-10

Summary of Rate Burden Evaluation Based on EPA Methodology

HBI – Water Costs as a Percent of Income at LQI	PPI – Percent of Households Below 200% of FPL		
	≥ 35%	20 – 35%	< 20%
≥ 10%	Very High Burden	High Burden	Moderate-High Burden
7 – 10%	High Burden	Moderate-High Burden	Moderate-Low Burden
< 7%	Moderate-High Burden	Moderate-Low Burden	Low Burden

Rates are generally considered to be "high burden" if total basic water costs are a relatively high percentage of household income for the LQI household, and a relatively large proportion of the community households are economically challenged. However, if less than 20 percent of households are below 200 percent of FPL, the community as a whole may be affluent enough to pay for water at a relatively cost without it becoming a high burden (although some households might still struggle). This approach also suggests that utility service may be highly burdensome and unaffordable if a large proportion of the community's households are below 200 percent of FPL, even if water bills are a relatively low percent of LQI (the lower-left portion of **Table 11-10**).

City staff estimated that approximately 29.5 percent of households in the City have income levels below 200 percent of FPL. **Table 11-11** summarizes the evaluation of rate burden under the EPA methodology.

Table 11-11

Rate Burden Assessment Based on EPA Methodology

	Jan-Mar 2024	Apr-Dec 2024	2025	2026	2027	2028
Annual Income at 20th Income Percentile[1]	$25,113	$25,113	$26,118	$27,162	$28,249	$29,379
Monthly Income at 20th Income Percentile[1]	$2,093	$2,093	$2,176	$2,264	$2,354	$2,448
Residential (Income > 350% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$126.30	$137.67	$148.46	$158.70	$172.32	$187.45
Bill as % of Monthly Income @ 20th Percentile	6.8%	7.5%	7.8%	8.1%	8.5%	8.9%
Rate Burden	Mod. Low	Mod. High	Mod. High	Mod. High	Mod. High	Mod. High
Residential (Income Between 300 – 350% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$126.30	$106.66	$114.84	$122.59	$132.96	$144.44
Bill as % of Monthly Income @ 20th Percentile	6.8%	5.8%	6.0%	6.2%	6.5%	6.8%
Rate Burden	Mod. Low	Mod. Low	Mod. Low	Mod. Low	Mod. Low	Mod. Low
Residential (Income Between 200 – 300% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$126.30	$75.65	$81.23	$86.50	$93.59	$101.46
Bill as % of Monthly Income @ 20th Percentile	6.8%	4.1%	4.2%	4.4%	4.5%	4.7%
Rate Burden	Mod. Low	Mod. Low	Mod. Low	Mod. Low	Mod. Low	Mod. Low
Residential (Income ≤ 150% of PL)						
Monthly Water/Sewer Bill @ 3,000 Gallons	$70.13	$44.63	$47.62	$50.39	$54.23	$58.45
Bill as % of Monthly Income @ 20th Percentile	3.7%	2.4%	2.4%	2.5%	2.6%	2.7%
Rate Burden	Mod. Low	Mod. Low	Mod. Low	Mod. Low	Mod. Low	Mod. Low

[1]Assumes that minimum wage increases annually with inflation (assumed to be 4% per year) per RCW 49.46.020.

Table 11-11 shows that under the “standard” residential rate schedule (applicable to customers with annual income above 350 percent of PL), the bill for a residential customer using 3,000 gallons per month would be considered a “moderate-high” rate burden. The City’s introduction of the income-based discount program in April 2024 appears to help alleviate the burden to an extent, reducing it to the “moderate-low” level through at least 2028. Given the expected rate increases shown in **Table 11-5** for 2029 and future years, it is reasonable to expect that the rate burden may shift to higher levels over time unless the City can secure additional grant funding for the capital plan.

Table 11-11 (as well as **Table 11-9**) show affordability assessments under each of the levels in the City’s income-based discount program to recognize that: (a) not all qualifying customers will enroll in the program; and (b) customers with below-average income levels that exceed the 20th percentile might also be burdened by rates.

CONCLUSION

Table 11-5 indicates that the City will need to increase its sewer rates significantly in order to cover projected debt service payments on debt issued to fund several of the City’s upcoming capital projects. In addition to debt service, this rate strategy also considers the need to keep up with rising operating costs. The recommended strategy envisions rate increases of 13 percent per year and inflationary increases to the City’s sewer SDC to provide additional funds to offset system capital costs.

The affordability assessment suggests that the City's utility rates may impose a significant burden on lower-income citizens. By expanding its rate discount program, the City has taken a significant step to alleviate the rate burden for customers that qualify for and enroll in the program.

Though the City Council has adopted sewer rates through 2028, the City may be able to reduce future rate increases if it is successful in obtaining additional funding assistance for its capital program. It would be prudent for the City to regularly monitor the financial position of its sewer utility, revisiting the key underlying assumptions to ensure that the utility's revenues remain sufficient to meet its financial obligations.

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Appendix A

2019 Stormwater Management Plan

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Stormwater Management Plan

Prepared for

City of Port Townsend

January 2019

Prepared by

Parametrix

Stormwater Management Plan

Prepared for

City of Port Townsend

Prepared by

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January 2019 | 553-2836-004

CITATION

Parametrix. 2019. Stormwater
Management Plan. Prepared by
Parametrix, Seattle, WA. January 2019.

TABLE OF CONTENTS

1. INTRODUCTION AND PURPOSE 1-1
1.1 Public Input Process 1-1
1.2 Introduction 1-1
1.3 Comprehensive Program Mission 1-2
1.4 Plan Outline 1-2
1.5 Plan Resources 1-3
2. THE WATERSHEDS AND BASINS 2-1
2.1 Project Area Description 2-1
2.2 Physical Conditions of the Area 2-1
2.2.1 Topography and Drainage 2-1
2.2.2 Local Geology 2-2
2.2.3 Soils 2-9
2.3 Area Climate and Hydrology 2-9
2.3.1 Hydrology 2-9
2.4 Water Quality 2-10
2.5 Climate Change 2-10
3. THE BUILT ENVIRONMENT 3-1
3.1 Land Use 3-1
3.1.1 Existing Land Cover 3-2
3.1.2 Future Land Use and Land Cover 3-9
3.1.3 Estimating Runoff Potential 3-15
3.1.4 Catchments with Largest Increase Potential 3-25
3.2 Stormwater System Operation and Maintenance 3-27
3.2.1 Asset Identification 3-28
3.2.2 Level of Service 3-28
3.2.3 Reporting 3-28
4. BASIN PLANNING 4-1
4.1 Planning Objectives 4-1
4.2 Drainage Connectivity 4-1
4.2.1 Drainage System Hierarchy 4-2
4.2.2 Drainage System Connectivity 4-6
4.2.3 Drainage System Protection 4-6
4.2.4 Evaluating Potential Capacity Needs and Impacts 4-8
4.2.5 Drainageway Potential Impact Assessment 4-21
4.2.6 Potential Impacts to Closed System Wetlands 4-25
4.3 Drainage System Stormwater Improvements 4-25
4.4 Roadway Inventory for Upgrade Opportunities 4-26

TABLE OF CONTENTS (CONTINUED)

5. CAPITAL PROJECTS PLAN 5-1
5.1 Proposed Capital Projects 5-1
5.2 Proposed Recurring Capital Projects 5-5
6. IMPLEMENTATION 6-1
6.1 Capital Plan Priorities and Schedule 6-1
6.1.1 Capital Projects for Existing Flood Control 6-1
6.1.2 Non-Capital Recurring Projects 6-2
6.2 Stormwater Control Standards and Policies 6-3
6.2.1 Stormwater Control from New Development 6-3
6.2.2 Drainage System Protection 6-4
6.2.3 Drainage System Review and Upgrades 6-7
6.2.4 Other Drainage System Protection Measures 6-8
6.3 Funding and Resources 6-10
6.3.1 Capital Projects 6-10
6.4 Summary Implementation Plan 6-12
7. REFERENCES 7-1

LIST OF FIGURES

1 Stormwater Drainage Basins 2-3
2 Drainage Basins Discharge Locations 2-4
3 Topography 2-5
4 Flood Hazard Zones 2-6
5 Area Geology 2-7
6 Annual Water Budget 2-8
7 Hydrologic Soil Groups 2-11
8 Drainage Catchment Areas 3-7
9 Land Use 3-11
10 Vacant Lands and Development Potential 3-12
11 Catchment Nodes 3-17
12 Stormwater Facilities 4-3
13 Stormwater System Levels 4-4
14a Pipe Capacity “Look Up Table” 4-9
14b Ditch Capacity “Look up Table” 4-10
15 Long Paths, CDCs & KDs 4-11
16 Roadway Drainage for Long Path Conveyance Sizing 4-19
17 CDCs & KDs High Velocity Reaches 4-23
18 Future Impact Estimate Wetland Footprints 4-27
19 Capital Projects 5-3

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

2-1 Rainfall Depths for 24-Hour Events 2-9
3-1 Existing Land Cover 3-2
3-2 Existing Land Use Model Inputs 3-4
3-3 Future Land Use Model Inputs 3-13
3-4 Buildable Area – Impervious Comparison 3-19
3-5a Peak Runoff at Nodes or for Total Catchment – Existing 3-23
3-5b Peak Runoff at Nodes or for Total Catchment – Future 3-24
3-6 Potential Change in Peak Flows by Catchment Area 3-25
3-7 Existing Inventory of Public Facilities 3-29
3-8 Maintenance Frequency and Personnel 3-30
4-1 Basins and Disposition or Discharge Point 4-2
4-2a Pipe Capacity for Reaches of Different Slopes 4-9
4-2b Ditch Capacity for Reaches of Different Slopes 4-9
4-3 Catchment Area Peak flows and Maximum Required Drainage Conveyance 4-13
4-4 Drainage Facility Size Estimates for Drainage Paths Exceeding Minimum Conveyance Sizing 4-15
4-5 Peak Flows in Reaches for Structure Sizing 4-17
4-6 Peak flows in Reaches for Long-Path Conveyance Sizing 4-18
4-7 Peak Flow Increase at Key Nodes due to future Development 4-21
4-8 CDC and KD Velocity Thresholds 4-22
4-9 Potentially Impacted Wetlands 4-25
5-1 Capital Projects 5-2
5-2 Other Built Capital Projects 5-5
6-1 Capital Projects Rankings and Priority 6-1
6-2 Summary of the Roadway Drainage Improvement Plan 6-2
6-3 Summary of Stormwater Control and Drainage Protection 6-6
6-4 Summary of Drainage System Review and Upgrades 6-7
6-5 Summary of Other Drainage System Protection Measures 6-9
6-7 Summary Cost Plan – Capital (2019-2024) 6-10
6-8 Summary Cost Plan - Resources 6-11
6-9 Summary Implementation Schedule 6-12
6-10 Updated CIP with $6 Surcharge and Development Fee 6-15

TABLE OF CONTENTS (CONTINUED)

APPENDICES

A Kickoff Meetings
B Public Input Process
C FEMA Flood Mapping
D Modeling Analysis
E Roadway Inventory
F Small-Site Stormwater Management Guide
G Capital Projects Worksheets
H Stormwater Manual Comparison
I Updated Capital Improvements Plan

ACRONYMS AND ABBREVIATIONS

BMP	best management practice
CAO	Critical Area Ordinance
CDC	Critical Drainage Corridors
Ecology	Washington State Department of Ecology
EDS	Engineering Design Standards
FTE	full time equivalent
HSG	hydrologic soil groups
KD	Key Drainageway
LID	low impact development
MEP	maximum extent practicable
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
PTMC	Port Townsend Municipal Code
RSL	relative sea level
SMP	Stormwater Management Plan
SWMMWW	Stormwater Management Manual for Western Washington
USDA	U.S. Department of Agriculture

1. INTRODUCTION AND PURPOSE

1.1 Public Input Process

The planning process included public participation via public open house, public comment periods and a technical advisory task force committee. The first SMP Technical Advisory Task Force meeting was held on August 30, 2017. The purpose of the Task Force was to provide a wide variety of perspectives on the City's existing stormwater utility and input on the creation and adoption of the SMP. A second task force meeting was held on November 2, 2017. Materials provided in the two meetings are included in Appendix A.

A public open house was held between the two Task Force meetings to present the plan purpose and findings (to date) and solicit input from the general public, such as known flooding problems for capital project.

During the SMP adoption process there were two public comment periods. The first comment period was early in the process and the goal was to gain feedback on what topics the public would like to see covered in the SMP and what was important regarding stormwater. The second comment period was to provide comments on the draft version of the SMP

The input provided throughout the public participation process was reviewed by the Plan team and included where appropriate in this final draft. The materials and minutes from city council sub-committee meetings, planning commission meetings and workshops, and the city council meetings and workshop are included in Appendix B.

1.2 Introduction

The City of Port Townsend is unique in many ways, notably when it comes to climate, landscape, and history of its development. Annual rainfall of about 17 inches is 70 percent of the amount that falls in Port Angeles, just 30 miles to the west, and 25 percent of Quilcene's, 23 miles to the south. There are no "streams" in our common understanding of the term and the City is surrounded on three sides by water: the Strait of Juan de Fuca, Admiralty Inlet, and Port Townsend Bay (all parts of the Salish Sea). Much of the land was platted in the 1890s, with no regard to topography, drainage patterns, or infrastructure. These conditions result in challenges for the City and property owners to follow natural drainage patterns, control changes from new development, and apply western Washington stormwater manual standards that were developed for wetter climates with streams and more traditional land development approaches.

In 1986, the City prepared the "Comprehensive Storm Water Drainage Plan for Port Townsend" (CH2MHill et al. 1987) which was used as the basis for establishing the City's municipal stormwater utility. Deficiencies in this plan were noted when preparing the Growth Management Plan in the early 1990s, which resulted in initiating a new comprehensive plan (Port Townsend 1996) and an updated Stormwater Management Plan (SMP) (Port Townsend 1999). Notable in the draft 1999 SMP was the idea of a "natural drainage systems" approach, which included the mapping of "Critical Drainage Corridors". The draft 1999 plan was never adopted; however, the natural drainage systems approach was adopted through the 1996 Comprehensive Plan through policies and goals in both the Land Use and Utility Elements of the 1996 Comprehensive Plan. The Critical Drainage Corridors were protected through regulatory language in the city's Critical Area Ordinance (CAO).

This SMP update addresses ongoing management of the existing system and plots a course for the future of the system. While there are many pieces already in place—system mapping, adopted standards, and a recognized need to consider development and protect resources—the SMP includes analyses, approaches, priorities, specific projects, mechanisms, updated performance standards, and an implementation plan. In addition, since stormwater practice and regulations continue to evolve and the approach and responsibility of municipalities to control stormwater discharges and manage infrastructure increases, this Plan recommends policy and regulatory updates. The SMP is an important tool for the City to use for day-to-day development review, operations, and long-term planning.

The objectives of the SMP include:

- Updating and defining drainage connectivity and mapping;
- Preparing updated policies for protecting the natural and built drainage system;
- Describing approaches to protect and improve the existing roadway drainage system;
- Preparing standard designs for future road drainage infrastructure;
- Assessing the existing impacts and potential changes due to new development;
- Preparing concept designs for capital projects to address existing stormwater problem areas; and
- Preparing site development information and review materials, including low impact development (LID) measures, redevelopment, new site development, and water quality retrofitting.

The SMP presents the background objectives existing conditions summary, basin analysis, consideration of future land use, recommended stormwater controls, and capital projects to address existing stormwater problems.

1.3 Comprehensive Program Mission

The project kick-off with both the City and Parametrix teams was held on June 20, 2017. The purpose of the kickoff was to develop the Plan vision and team mission to complete the plan, brainstorm the Plan needs and goals, discuss risks and threats to project success, and finalize the schedule and work plan for the adoption of an updated SMP. The team agreed on the following Vision and Mission statement:

> **A fully functional, achievable, and sustainable stormwater system that is integrated into the landscape, supports envisioned growth, protects residents, and nurtures the environment.**

Additional information to help guide plan preparation was collected by the team. The kick-off meeting day included a field tour of key areas and problem areas in the city. Notes from the meeting brainstorming are provided in Appendix A.

1.4 Plan Outline

The Plan structure follows this general outline: Section 2 describes the study area, with a discussion of the physical setting and natural drainage system; Section 3 describes the current built environment in the context of how it affects water resources, such as land cover and stormwater facilities; Section 4 describes the basis for stormwater planning, establishes stormwater control targets, and presents the proposed SMP approaches; Section 5 describes the proposed capital projects; and Section 6 includes the implementation plan.

1.5 Plan Resources

The City prepared the Draft Storm Water Management Plan in 1999 (Port Townsend 1999). This plan was very thorough and provides a strong platform on which this SMP plan update was built. Key material used for a starting point includes the original drainage basin mapping and critical drainage corridors (CDC) map.

The existing available GIS mapping from the city was used extensively, including topography, the mapped drainage basins, CDCs, road network, drainage patterns and conveyance, wetlands, floodplains and soils mapping. The City staff also prepared new information for this plan, such as a roadway inventory, new and revised catchment inventory, and updated CDC and key drainageway (KD) mapping.

Other information, such as water quality sampling and some rainfall data, was provided by the City. Other geology and climate data were collected from reliable Internet sources.

2. THE WATERSHEDS AND BASINS

2.1 Project Area Description

The City is located on the Quimper Peninsula, surrounded on three sides by the Strait of Juan de Fuca, Admiralty Inlet, and Port Townsend Bay, all parts of the Salish Sea. Figure 1 shows the city limits, streets, named receiving waters, wetlands and potential wetlands, CDCs, KDs, and drainage basins. There are no well-defined perennial or named streams. There is a long linear depression that generally drains toward "Chinese Gardens" which contains a connected series of wetlands and a designated floodplain. CDCs are regulated by the City's Critical Areas ordinance. KDs are defined in this Plan and regulated by stormwater codes and design standards.

The general disposition of surface waters is shown on Figure 2. Drainage basins in the City drain either to closed depressions or directly to the ocean. The basins that discharge to the ocean are via a storm sewer system, flow through surface ravines or through outlets from the two large named wetlands, Chinese Gardens and Kah Tai Lagoon. The closed basins discharge into groundwater at small wetlands. Additional detailed discussion of the drainage basins is provided in the 1987 Comprehensive Stormwater Drainage Plan (CH2M Hill et al. 1987).

2.2 Physical Conditions of the Area

2.2.1 Topography and Drainage

The landscape and general topography of the City indicates irregular and undulating slopes. Figure 3 is a topographic map of the City which shows the location of the low-lying areas, closed depressions and geologic drainage features. Generally, there are relatively flat "plateaus" along the east and west sides of the City with a valley (low lands) going through the middle. High bluffs dominate the ocean edge. Strong erosional drainage patterns are not well-seen and are generally limited to drainage from the plateau, notably in the southwest corner of the city. The formation of the large-scale landforms found are an outcome of many processes, including deposition by advancing and receding glaciers, changing sea levels, isostatic rebound after the glaciers have gone, and other apparent significant land forming events. However, there is little evidence of landscape-level changes due to streams and flowing water over the last several thousand years since the glaciers retreated, other than very local drainage patterns.

The topography of the City indicates low-lying areas and subtle drainage paths to form the natural drainage disposition shown on Figures 2 and 3. Topographic maps and the built environment (i.e., both built drainage network and existing roads) were used to define the drainage basins and their discharge location. Figure 3 indicates by shading the location of low-lying drainage patterns within the major drainage basins that lead to receiving water. The drainage patterns described in this section and shown on Figures 1 through 3 form the drainage network on which the stormwater planning is based.

As shown on Figure 2, stormwater runoff drains directly to: the ocean either via storm sewers (pipes) or from the two large named wetlands (Chinese Gardens and Kah Tai Lagoon) via an overflow pipe or to closed basins that discharge into the groundwater, often at small wetlands and surface ravines. The flow path and disposition of stormwater is an important factor in the stormwater impact analysis, future control decisions and policies and potential basin retrofitting.

Designated floodplains and coastal flood hazard zones as mapped by FEMA exist in the low coastline areas along the entire City shoreline (Figure 4). The only non-coastal floodplain in the City has also been mapped in Drainage Basin 4, for which detailed information can be found in Appendix C (Polaris 1996). Wetlands have also been mapped throughout the city annotated as "wetlands" or "potential wetlands" (Figure 4). A wetland has been delineated by a wetland specialist and documented by a wetland report; a potential wetland is identified through aerial mapping by a topographic depression or wet area in the landscape and does not have a delineation wetland report and has not been field verified.

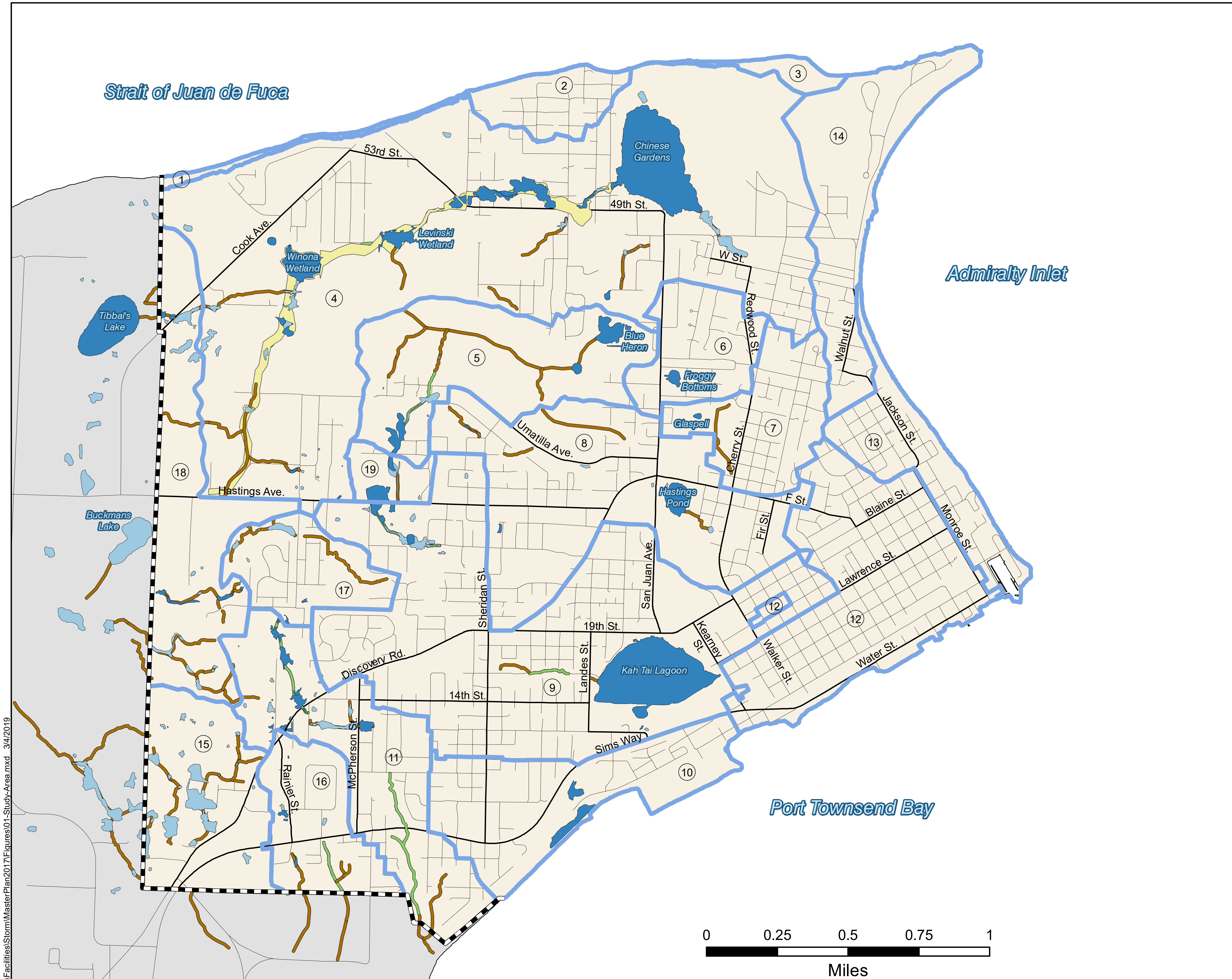
2.2.2 Local Geology

The geology and climate of the area contribute substantially to defining stormwater planning approaches for the City. The relatively poorly defined natural drainage paths are a direct result of the recent geologic past and the lack of rainfall to form drainage patterns and provide perennial streams.

The dominant geologic formation that resulted in local landforms is known as the Vashon recessional drift, made up of sediments deposited during and after the last retreat of the Puget Lobe glacier. The landforms are made up of a combination of materials deposited during previous advances as till, outwash coming from the glacier as it retreated, and materials left behind as the ice stagnated and melted. Because the Vashon recessional drift is the last deposit left by the melting glacier, it is relatively undisturbed (Washington State Department of Ecology [Ecology] 1981). No interpretations of the existing smaller-scale landforms in the City were found, and virtually all of the City is mapped as "Vashon Till (Qvt)" on the Surficial Geologic Map of the Port Townsend Quadrangle (Pessl et al. 1989) (Figure 5). Small areas of "Marsh, Swamp, or Bog" (Qm), "Recessional-Continental" deposits (Qvrc) and "Advance Outwash" (Qva) are also found. This mixture of material sources, depositional environments, and geologic processes demonstrates that highly variable landforms.

As described earlier, annual rainfall in the City is very low when compared to nearby areas due to the Olympic Mountains rain shadow. In addition, the historical forest cover before the arrival of European settlement resulted in low basin response and runoff from the rain that does fall. Consequently, there was limited water available to carve drainage channels. Low areas that appear to have been created by water are present (see Figure3) and may have resulted from the last processes of the melting glaciers or in the slow response to several thousand years of rainfall since the glaciers melted.

Ecology conducted a study of ground water resources in eastern Jefferson County (Ecology 1981) and developed a compelling analysis of the annual water budgets for the Port Townsend area that demonstrates the amount of water typically available for surface water runoff. Figure 6, replicated here from Ecology 1981, shows the relative percentages of average annual rainfall needed to replenish soil moisture and the resultant remaining water surplus available for runoff. The results show that the average annual excess water available (water surplus) for runoff is *just 0.6 inches* (precipitation minus evapotranspiration), although under seasonally variable infiltration and evapotranspiration or in different locations, it could be more or less. This is a very small amount of water available for runoff. By comparison, the excess available runoff (water surplus) in Quilcene, just 30 miles south of the City, is 29.7 inches (Ecology 1981). This excess runoff in Quilcene is also reflected in local drainage patterns and development of channels in the same glacial materials. As the amount of average annual precipitation increases moving south from Port Townsend, the number of streams also increases to the south (Ecology 1981).



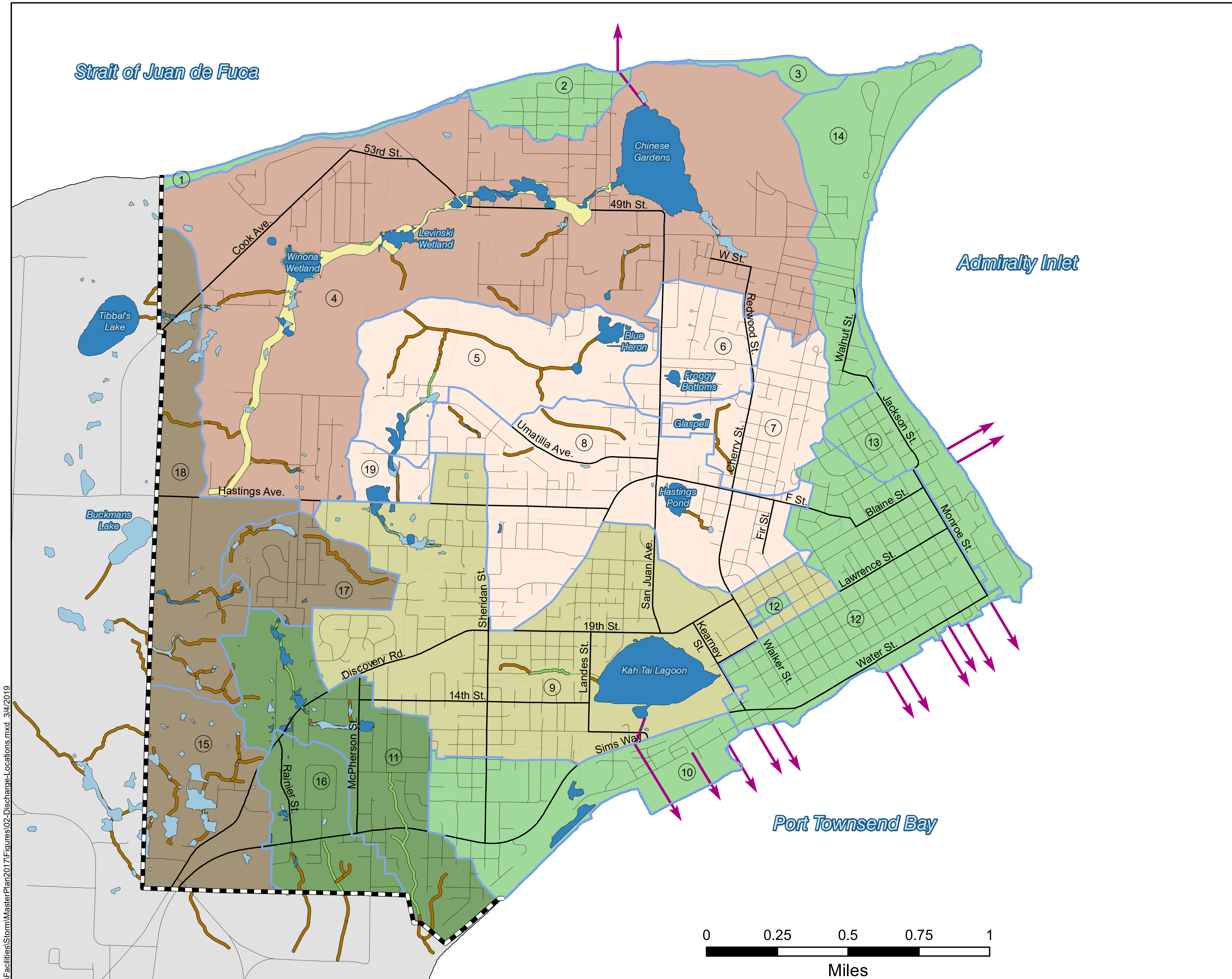
Stormwater Drainage Basins

Figure 1

- Drainage Basins
- Wetlands
- Potential Wetlands
- 100 Year Flood
- Critical Drainage Corridors
- Key Drainageways
- City Limits

Drainage Basin Discharge Locations

Figure 2



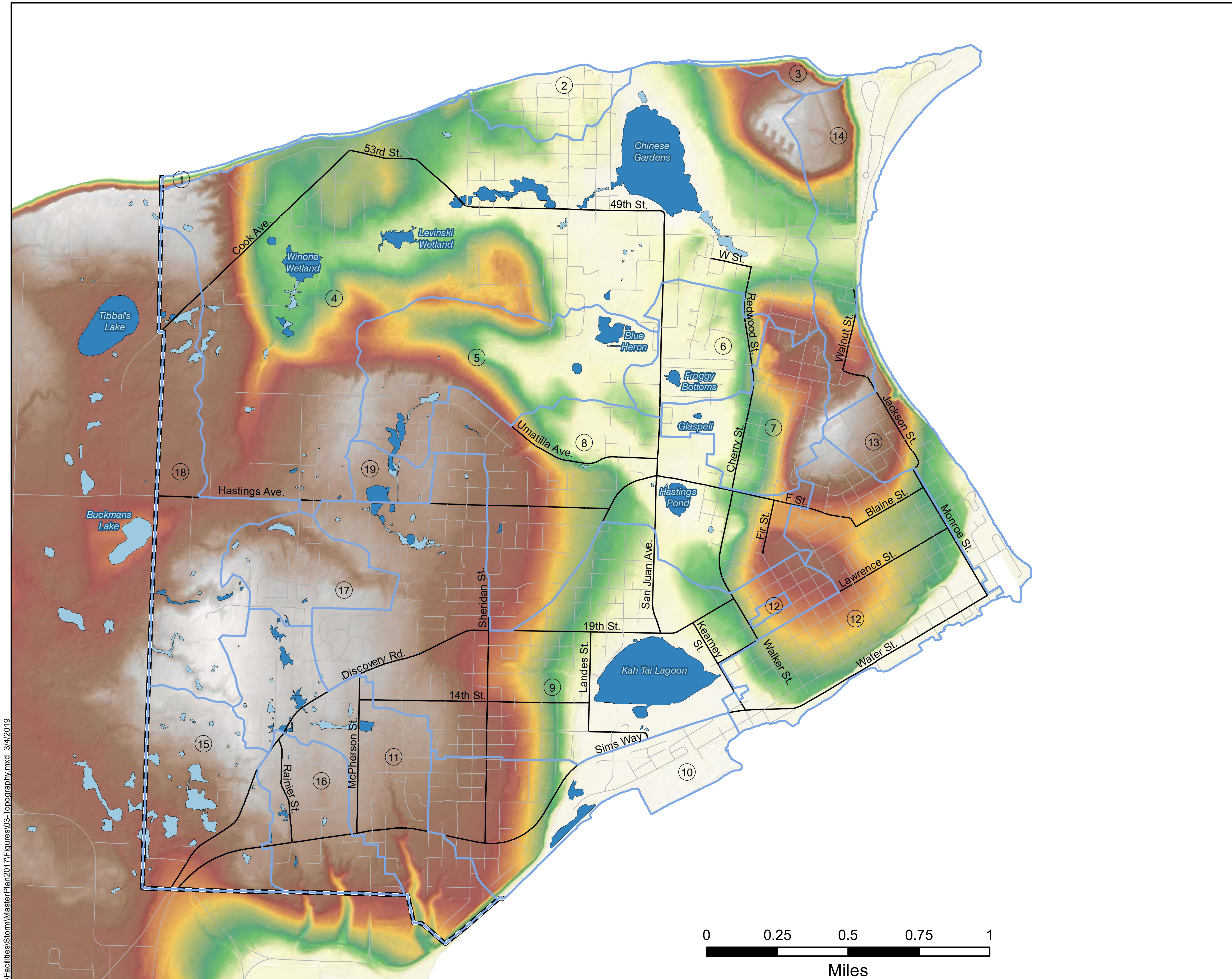
Discharge Locations

- Drains to Salish Sea
- Kah Tai Lagoon (Overflows to Salish Sea)
- Chinese Gardens (Overflows to Salish Sea)
- Closed Basin (No Outlet)
- Drains to Ravines
- Drains to County
- Outfalls

Features

- Drainage Basins
- Wetlands
- Potential Wetlands
- 100 Year Flood
- Critical Drainage Corridors
- Key Drainageways
- City Limits

Topography
Figure 3



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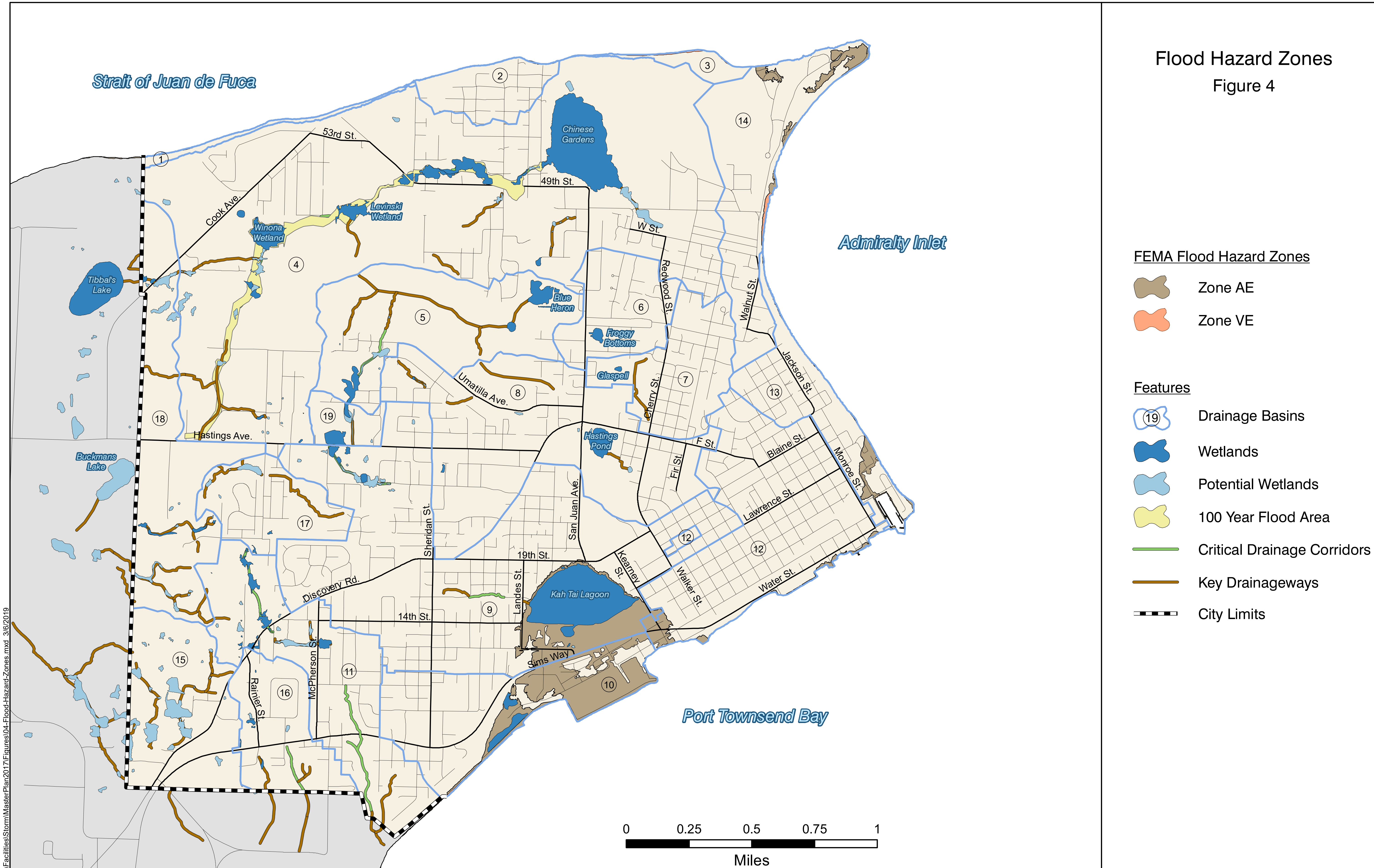
Flood Hazard Zones

Figure 4



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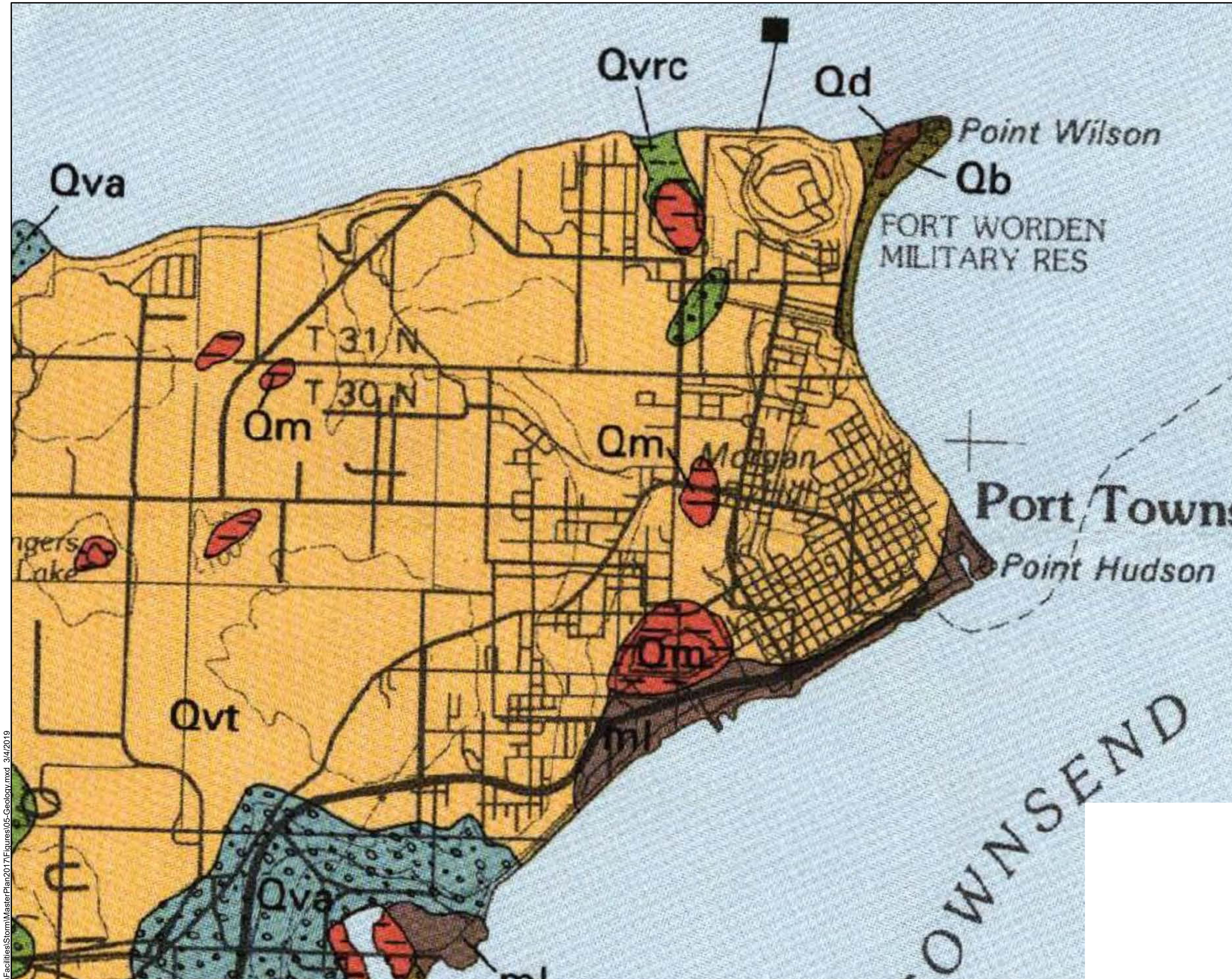

Area Geology

Figure 5

Surficial Geologic Map of the Port Townsend 30- by 60-Minute Quadrangle, Puget Sound Region, Washington by Fred Pessl, Jr., D.P. Dethier, D.B. Booth, and J.P. Minard 1989

Qb: Beach Deposits
Qd: Dune Deposits
Qm: Marsh, Bog, or Swamp
Qvrc: Recessional-Continental
Qvt: Vashon Till

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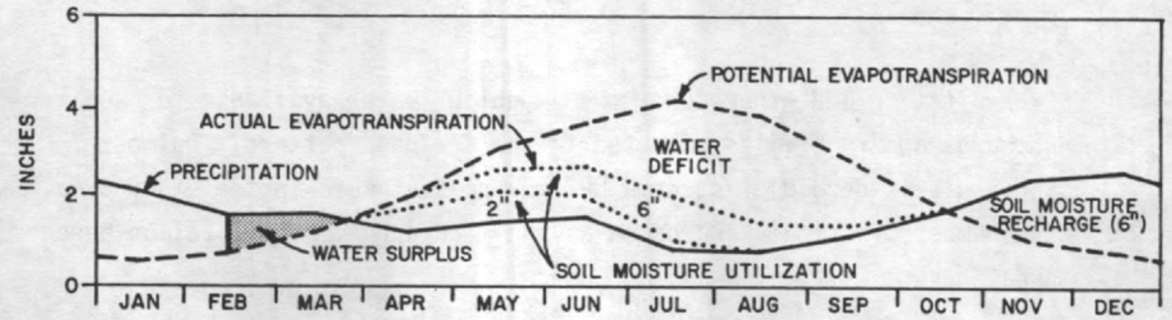
PORT TOWNSEND

WATER HOLDING CAPACITY OF SOIL	2"	6"
PRECIPITATION	18.3	
POTENTIAL EVAPO-TRANSPIRATION	25.2	
ACTUAL EVAPO-TRANSPIRATION	14.4	17.7
WATER SURPLUS	3.9	0.6



QUILCENE 2 SW

WATER HOLDING CAPACITY OF SOIL	2"	6"
PRECIPITATION	50.0	
POTENTIAL EVAPO-TRANSPIRATION	25.1	
ACTUAL EVAPO-TRANSPIRATION	17.4	20.3
WATER SURPLUS	32.6	29.7

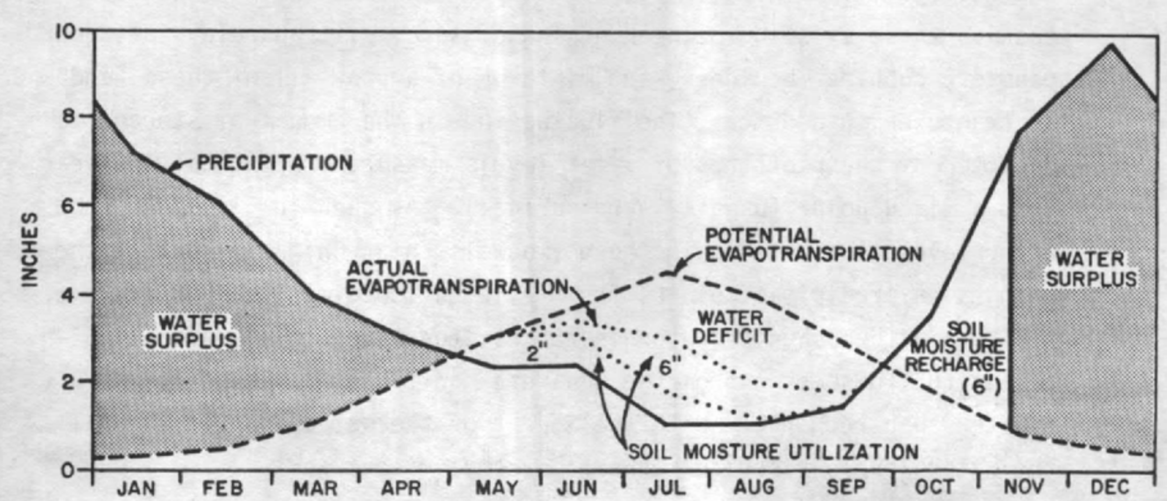


Figure 19. MEAN ANNUAL WATER BUDGETS.

31

Annual Water Budget
(Ecology 1981)

Figure 6

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2.2.3 Soils

Soils in the area were mapped by the Natural Resources Conservation Service (NRCS), as shown on Figure 7. The NRCS divides soils into four hydrologic soil groups (HSG) defined by the expected rainfall infiltration and runoff response. These soils categories provide information for hydrologic modeling and planning-level information regarding localized infiltration potential (or lack thereof). These data will be used for testing potential impacts described in Section 4 below. Figure 7 has highlighted HSG "A" and HSG "D" which represents the soils most likely to have high infiltration and low infiltration respectively. The hydrologic soil groups will be used to support on-site infiltration feasibility7.

2.3 Area Climate and Hydrology

2.3.1 Hydrology

Port Townsend is located in the rain shadow of the Olympic Mountains. The precipitation in the area usually falls as rain, with about 65 percent of the yearly precipitation occurring between October and March. Current hydrological parameters in the City are:

- Average annual rainfall: 17.64 inches
- Mean storm events: 50
- Mean storm depth[1]: 0.266 inches

[1] Data from the Port Townsend Station located at latitude 48.07, longitude 122.45 (Perrich 1992).

Rainfall depths for selected 24-hour storm events are shown in Table 2-1.

Table 2-1. Rainfall Depths for 24-Hour Events [2]

Return Frequency	Precipitation Depth (inches)
2-year	1.17
10-year	1.72
25-year	2.03
100-year	2.50

[2] Data taken from National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (reference needed)

Hydrologic modeling is used to predict runoff from under different land use scenarios. Modeling for this Plan was done using MGSFlood. The predicted runoff rates are used for sizing conveyance structures such as culverts and ditches. Stormwater models use the long-term regional rainfall records which are tailored to the specific location being analyzed (i.e., Port Townsend). The maximum adjustment in the rainfall record allowed by Ecology is a factor of 0.78, which does not fully reflect the reduction needed when comparing Port Townsend rainfall records to nearby stations used in the long-term model record. Consequently, the modeled rainfall amounts used, and the resultant peak flow rates (described in sections below), may be higher than observed amounts. Because of this, conveyance structures may be larger than needed for the design storms used. However, the structure sizing is not that sensitive to modest changes in rainfall extremes, therefore the overall effect on results is expected to be minor. Also, the impact analysis is comparative, using the same rainfall record, which means the existing and future conditions are similarly different (high or low) but the comparative difference is reasonably accurate.

The rational method is another appropriate approach for calculating peak flows in for conveyance design. However, the rainfall intensity numbers used in the rational method also rely on location-specific rainfall data. These data have not been calculated for Port Townsend and the available nearby rainfall stations do not have the type of data or length of records needed to be appropriate data sources. Similar adjustments can be made to nearby available rainfall data if this method is used but is also expected to over-predict runoff rates.

2.4 Water Quality

No stormwater quality data has been collected by the City at city outfalls. The Jefferson County Health Department collected dry and wet weather samples to evaluate e coli from storm sewer outfalls in 2013 and 2014. The samples can inform some elements of stormwater planning which would be focused on education (usually pet waste), source controls, and illicit discharges. There is insufficient available data to inform a basin or outfall-specific stormwater quality retrofit prioritization plan, which is the norm, not the exception, in most of Puget Sound communities. However, stormwater is a presumptive practice; therefore, a surrogate such as the percentage of roadways and intensity of development in a basin can be used to prioritize locations for stormwater treatment retrofits to improve water quality.

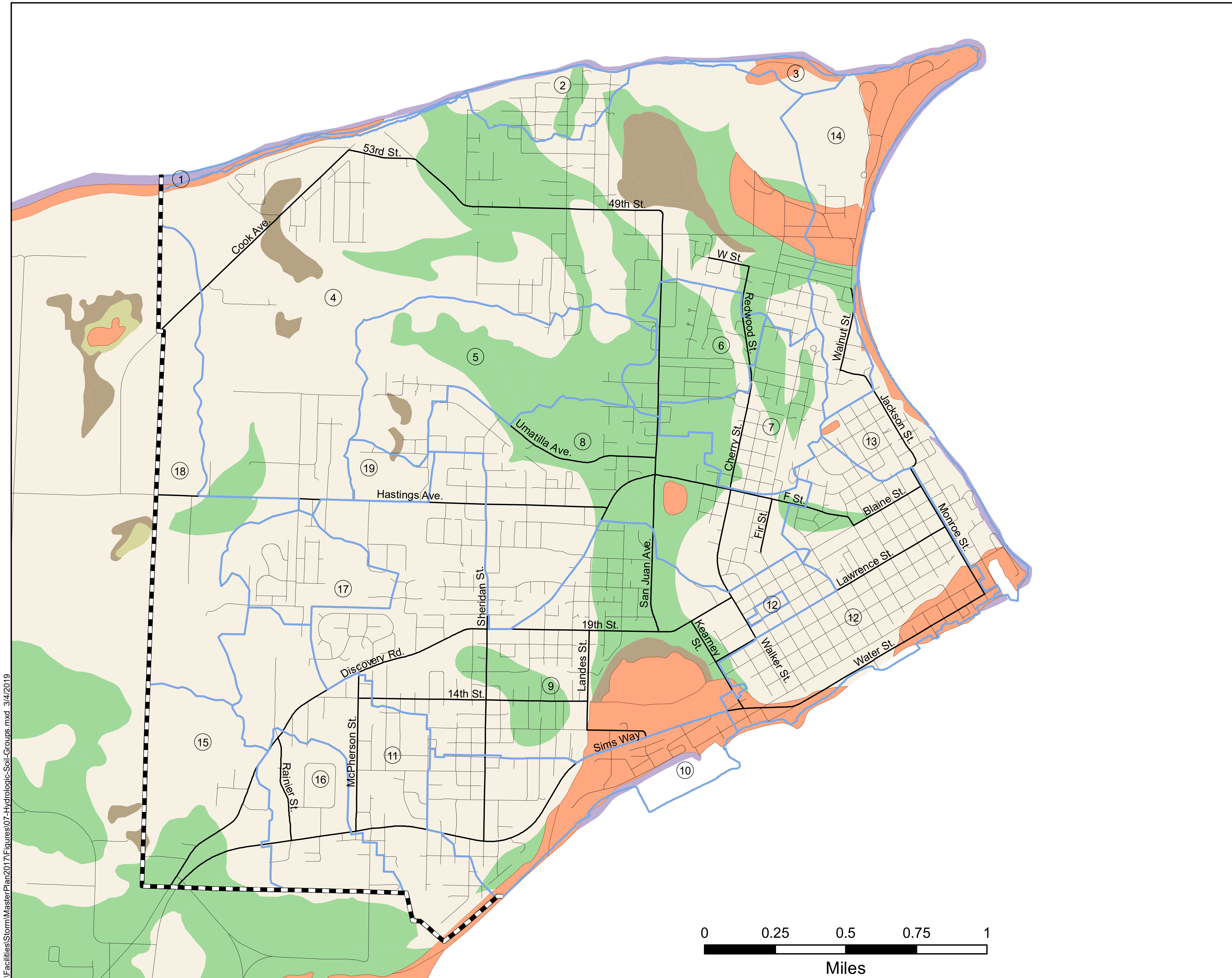
2.5 Climate Change

Change in climate is expected to result in more extreme weather such as larger storms of greater intensity, changes in seasonal rainfall patterns, more extreme difference between wet and dry years, or changes in snow and snow melt patterns. In addition, warming weather is resulting in higher sea levels which can impact coastal communities, such as Port Townsend.

Change in the global climate is expected to increase temperatures in western Washington 4.2^{o} F to 5.4^{o} F by 2050 in the Puget Sound Region and more extreme weather may be expected. For example, according to a study done by University of Washington (Mauger et al. 2015), the wettest days (99th percentile of 24-hour precipitation totals) in the Pacific Northwest are projected to increase in precipitation by 22 percent by the 2080s and the frequency of those events are predicted to increase from 2 days per year historically (1970-1999) to 7 days per year in the future (2070-2099). According to some models, around the Puget Sound watershed and Port Townsend, the maximum 24-hour precipitation event is projected to have an increase precipitation of 6 percent to 10 percent by 2040, and 10 percent to 11.5 percent by 2080.

Precipitation in general is projected to increase in fall, winter and spring and decrease in summer. Around the Puget Sound watershed and Port Townsend, it is projected that winter precipitation will increase on average of 7 percent to 8.5 percent by 2040, while summer precipitation will decrease on average by 10 percent to 11.5 percent. Additionally, the average snowpack is predicted to decline in the Puget Sound region, causing the spring peak in streamflow to occur earlier in the year and decreasing summer minimum flows.

In addition, warming weather is resulting in higher sea levels which can impact coastal communities such as Port Townsend. Based on a University of Washington study on projected sea level rise (Miller et al. 2018), around Port Townsend there is a 99 percent probability that relative sea level (RSL) will increase by 0.1 feet by 2030 and a 50 percent probability that RSL will increase by 0.4 feet. By 2070, that increases to a 99 percent probability that the RSL will rise by 0.4 feet and 50 percent probability of over 1.3 feet. These projections all assume high greenhouse gas scenario. In a low greenhouse gas scenario, the projections remain the same for 2030, and decrease slightly to a 99 percent probability of RSL rises by 0.3 feet and 50 percent probability of over 1.1 feet in 2070. Looking farther ahead, in 2150 there is a 99 percent probability that RSL will increase by 0.3 feet and 50 percent probability that RSL will increase by 2.8 feet. Furthermore, in the event of a subduction zone earthquake, some parts of Washington coast may be subject to land level changes, based on multiple seismic deformation models, of 0 to 0.3 feet subduction.



Hydrologic Soil Groups
Figure 7

Runoff Potential (1)

- A - Low
- C - Moderate
- C/D - Moderate to High
- D - High
- Variable
- Cut and Fill, Rough Broken, Water, Reservoir

(1) Hydrologic Soil Groups per 2005 Stormwater Management Manual for Western Washington

- 19 Drainage Basins
- City Limits

3. THE BUILT ENVIRONMENT

Stormwater plans are prepared to address both current and proposed conditions: the effects of land conversion on stream hydrology and the impacts of pollution-generating activities on water quality. Land drainage has been included in design for centuries; stormwater management has been the norm for the past several decades in Washington and continues to evolve as the practice learns from the past and new issues come to the forefront. Existing land use and land cover have created drainage conditions observed today, including some localized flooding and erosion impacts. Development of vacant undeveloped lands, redevelopment, and infill will bring future potential impacts, if not properly controlled. The measures and standards for control to be used in Port Townsend will follow the general approach for stormwater management used elsewhere in western Washington, with adjustments due to local conditions found in Port Townsend.

As described before, the City will be unique in its approach to addressing stormwater management because of the following unique local conditions: there are no natural streams but there are obvious pathways, drainage basins, and receiving waters; new development will be predominantly infill into pre-platted areas with or without existing opened rights-of-way; rainfall is relatively low; and the road system is the dominant drainage conveyance network.

In this section, existing land use (as defined by imperviousness) is estimated to evaluate existing drainage needs, primarily in the road system, and identify areas with potentially high stormwater quality impacts. There are no reliable mapped data for determining existing imperviousness, therefore estimates were made using approaches described below. Future land use is estimated by both the development potential and estimated allowable development. This generally tends to over predict future impacts, which means the planning outcomes tend to be reliably protective.

Runoff modeling requires soils and land cover data. Figure 7 provides the source for soils data. Land cover refers to the general type and condition of vegetated surfaces, such as forests, pastures, and open landscapes, each of which has a different runoff response to precipitation. The City used visual estimates for land cover data. In low precipitation areas with moderate soil runoff response such as Port Townsend, runoff rates are relatively insensitive to land cover.

In addition, for purposes of hydrologic modeling, each drainage basin in the City was further divided into subbasins, referred to as “catchment” areas as shown on Figure 8. The catchment boundaries are defined by both topography and the built environment—existing roads and stormwater infrastructure.

3.1 Land Use

An inventory of impervious area and land cover, described in terms of aerial coverage within a catchment, is needed to prepare modeling or characterization analyses that relate runoff potential or quality characteristics to a point in the conveyance system. Impervious land cover can include amounts and types of impervious surface, for example roads, sidewalks, rooftops, or parking lots, or a stormwater management description like pollution generating or “effective” impervious surface. Available data to make these characterizations varies widely between different jurisdictions. Fortunately, there are a number of approaches to either translate available data into categories that are useful for stormwater management or basin planning evaluations. Data are needed to characterize existing conditions and to project the changes that could occur due to new development.

3.1.1 Existing Land Cover

Existing land use and imperviousness is estimated to evaluate existing conditions to determine drainage needs, primarily in the road system, identify areas with potentially high stormwater quality impacts, and provide a baseline for modeling existing runoff conditions. For the modeling analysis, imperviousness is calculated for each catchment within a drainage basin. The approach for estimating existing imperviousness is described below.

For rights-of-way, two categories were identified: opened rights-of-way (which means an existing public road is present) and unopened rights-of-way (an undeveloped, platted right-of-way with no public road). For opened rights-of-way, the length of roadways in the catchments were measured and multiplied by 22-feet to estimate the area of impervious surface. The right-of-way per catchment is shown in Table 3-1. The opened rights-of-way are an estimated 40 percent imperviousness based on a typical roadway width of 22-feet of pavement in a 60-foot wide platted right-of-way, plus some consideration of sidewalks and driveways in the right-of-way. For unopened rights-of-way, imperviousness is assumed to be zero.

The remaining land (i.e., not platted rights-of-way) was classified into developed land, critical areas (undevelopable land including steep slopes, wetlands, and CDCs), or vacant land. For developed land, the estimated imperviousness is 37 percent of the developed land area. Vacant land was further divided into conservation or public lands (which are assumed will remain undeveloped) underdeveloped land (which are large tracts with little development or a single house) and undeveloped (developable land either platted land or not). For vacant land, the estimated imperviousness was assumed to be zero for current baseline conditions.

Runoff modeling requires land cover data and soils types. Land cover refers to the general type and condition of vegetated surfaces, such as forests, pastures, and open landscapes, each of which has a different runoff response to precipitation. Visual estimates were used to provide data for land cover. In low precipitation areas with moderate soil runoff response such as Port Townsend, runoff rates are relatively insensitive to land cover. Figure 7 provides the source for soils data. Tables 3-1 and 3-2 provides a breakdown of total catchment area breakdown (see Figure 8), rights-of-way impervious area, rights-of-way unopened area, developed area, critical areas, vacant conservation/public land and vacant underdeveloped/developable land.

Table 3-1. Existing Land Cover

				Remaining Land			
	Total	Right-of-Way				Vacant	
Catchment	Area (ac.)	Open (ac.)	Unopened (ac.)	Developed (ac.)	Critical Areas (ac.)	Conservation/public	Underdeveloped/ Developable
1	12.8	0.0	0.0	0.0	12.8	0.0	0.0
2	62.7	13.7	4.8	15.1	2.0	24.1	3.4
3	19.1	0.0	0.0	0.0	10.9	0.0	8.1
4a	46.5	0.0	0.0	0.0	46.5	0.0	0.0
4b	80.3	0.1	0.2	0.9	7.1	0.8	71.2
4c	122.4	15.0	4.2	7.4	8.9	21.9	65.0
4d	47.4	0.1	0.0	0.0	8.6	0.1	38.6
4e	26.7	4.6	1.0	5.2	1.5	7.9	6.7
4f	83.7	8.5	2.3	13.3	6.3	52.5	1.0
4g	107.6	17.5	15.2	27.6	19.8	25.4	2.2

Table 3-1. Existing Land Cover (continued)

Catchment	Total Area (ac.)	Right-of-Way		Remaining Land			
						Vacant	
		Open (ac.)	Unopened (ac.)	Developed (ac.)	Critical Areas (ac.)	Conservation/public	Underdeveloped/ Developable
4h	46.4	2.8	4.2	8.2	3.0	1.2	27.0
4i	114.2	7.2	26.8	43.3	11.3	9.9	15.7
4j	38.0	2.3	0.2	33.5	2.0	0.0	0.0
4k	129.9	13.9	24.1	66.3	11.2	13.6	0.8
4l	314.8	22.9	45.7	160.2	37.3	25.6	23.2
4m	38.4	3.7	8.6	16.3	1.7	8.1	0.0
5a	85.7	1.5	14.0	65.5	1.2	1.7	1.9
5b	54.8	2.6	1.9	17.8	9.5	23.0	0.0
5c	36.9	3.1	4.3	8.0	9.5	4.7	7.3
5d	61.4	1.8	17.9	34.4	2.4	1.8	3.1
6a	80.4	18.4	6.7	25.0	2.9	26.9	0.5
6b	14.6	3.6	1.3	5.7	0.0	4.0	0.0
6c	5.8	0.9	1.0	0.3	1.2	2.3	0.0
7a	19.6	3.4	2.0	4.6	3.1	6.4	0.0
7b	7.4	0.0	0.0	0.2	0.0	7.2	0.0
7c	48.5	16.5	3.1	5.8	0.7	22.4	0.0
7d	26.0	7.1	1.0	3.9	1.6	11.0	1.3
7e	18.8	1.4	0.5	13.0	0.1	3.9	0.0
7f	6.6	0.1	0.0	4.9	0.9	0.6	0.0
8a	70.8	13.7	4.2	11.7	0.9	40.1	0.2
8b	107.3	14.2	3.6	14.3	9.6	37.8	27.9
8c	61.9	12.3	6.3	18.4	3.3	21.2	0.5
8d	8.0	3.4	0.3	1.9	0.2	2.2	0.0
8e	2.7	0.6	0.0	1.1	0.0	0.9	0.0
8f	31.9	9.6	4.5	4.0	0.0	13.8	0.0
8g	13.9	3.1	0.9	3.3	0.2	5.6	0.8
8h	5.7	0.3	0.1	4.4	0.0	0.9	0.0
8i	50.6	4.7	8.3	30.1	0.4	6.6	0.4
8j	18.4	4.3	2.0	7.4	0.5	4.2	0.0
8k	32.6	2.8	4.3	13.8	8.4	3.0	0.2
9a	46.4	0.0	0.0	0.0	46.4	0.0	0.0
9b	137.7	34.6	16.2	33.5	1.3	52.0	0.0
9c	30.5	8.6	3.3	5.0	1.0	12.4	0.1
9d	39.0	13.6	1.0	2.0	0.1	22.2	0.0
9e	13.8	5.8	1.1	0.8	1.7	3.4	1.7
9f	108.8	24.2	16.3	11.5	7.7	35.2	21.4
9g	26.2	0.4	0.0	0.0	0.0	0.0	25.7
9h	39.9	7.4	0.5	6.6	0.0	25.4	0.0
9i	25.1	7.2	2.3	2.9	0.0	12.4	0.2
9j	99.6	16.3	6.3	35.0	13.2	28.7	0.0
9k	15.9	3.3	1.2	1.4	0.0	10.0	0.0
9l	49.3	16.4	4.1	10.4	0.2	18.2	0.0

Table 3-1. Existing Land Cover (continued)

Catchment	Total Area (ac.)	Right-of-Way		Remaining Land			
		Open (ac.)	Unopened (ac.)	Developed (ac.)	Critical Areas (ac.)	Vacant	
						Conservation/public	Underdeveloped/ Developable
9m	17.1	7.0	0.1	0.8	0.2	9.1	0.0
10a	103.9	24.7	6.3	15.1	12.0	45.7	0.1
10b	23.5	3.9	0.7	5.3	3.8	9.8	0.0
10c	51.0	2.2	1.3	0.0	1.0	46.5	0.0
10d	21.4	5.2	0.8	0.0	0.3	15.1	0.0
11a	72.1	2.0	9.8	41.2	14.9	3.5	0.7
11b	76.7	17.8	6.5	10.4	5.4	33.6	3.0
11c	28.8	5.5	1.5	7.4	6.8	7.7	0.0
11d	3.7	0.0	0.0	0.0	3.7	0.0	0.0
11e	26.7	4.4	1.5	4.7	9.3	6.2	0.6
11f	33.6	6.3	2.7	10.3	1.4	12.9	0.0
12a	86.6	32.9	3.8	4.4	2.0	43.5	0.1
12b	20.1	4.3	1.2	0.5	3.1	10.5	0.4
12c	26.9	10.9	0.5	0.4	1.6	13.4	0.1
12d	30.8	13.0	0.4	2.1	1.2	13.4	0.7
12e	13.5	3.6	0.4	0.6	1.3	6.7	0.9
12f	112.2	38.6	0.7	9.5	1.6	57.2	4.6
12g	14.3	2.0	0.1	1.3	0.5	10.5	0.0
13a	44.8	5.4	0.8	3.4	2.1	30.0	3.1
13b	51.9	15.9	1.1	4.1	1.6	24.5	4.6
13c	18.8	0.6	0.8	1.8	10.7	4.4	0.5
14	193.6	10.3	4.9	11.6	21.9	13.0	131.8
15a	131.7	5.1	7.8	77.8	30.1	10.9	0.0
15b	24.6	4.0	1.3	13.8	0.6	4.4	0.6
15c	24.0	1.3	0.3	12.0	2.3	4.2	3.8
16a	42.9	6.7	5.8	14.5	6.1	9.3	0.5
16b	62.7	8.3	5.4	22.5	6.6	19.9	0.0
16c	7.5	1.6	1.1	0.9	0.1	3.7	0.0
17a	53.7	7.0	5.5	34.1	0.7	6.4	0.0
17b	46.4	5.8	1.2	15.7	6.4	16.4	0.9
18a	141.6	5.0	4.4	105.0	15.1	12.1	0.0
18b	84.6	2.9	7.7	61.8	9.4	0.3	2.7

Table 3-2. Existing Land Use Model Inputs

Catchment	Total Area (ac.)	Impervious (ac.)	Percent Impervious	Pervious (ac.)		
				Hydrologic Soil Type A - Forest	Hydrologic Soil Type C - Forest	Hydrologic Soil Type D - Forest
1	12.8	0.00	0.0%	11.5	1.3	0.0
2	62.7	11.1	17.7%	35.1	16.5	0.0
3	19.1	0.01	0.1%	19.0	0.00	0.0
4a	46.5	0.00	0.0%	2.1	2.1	42.3

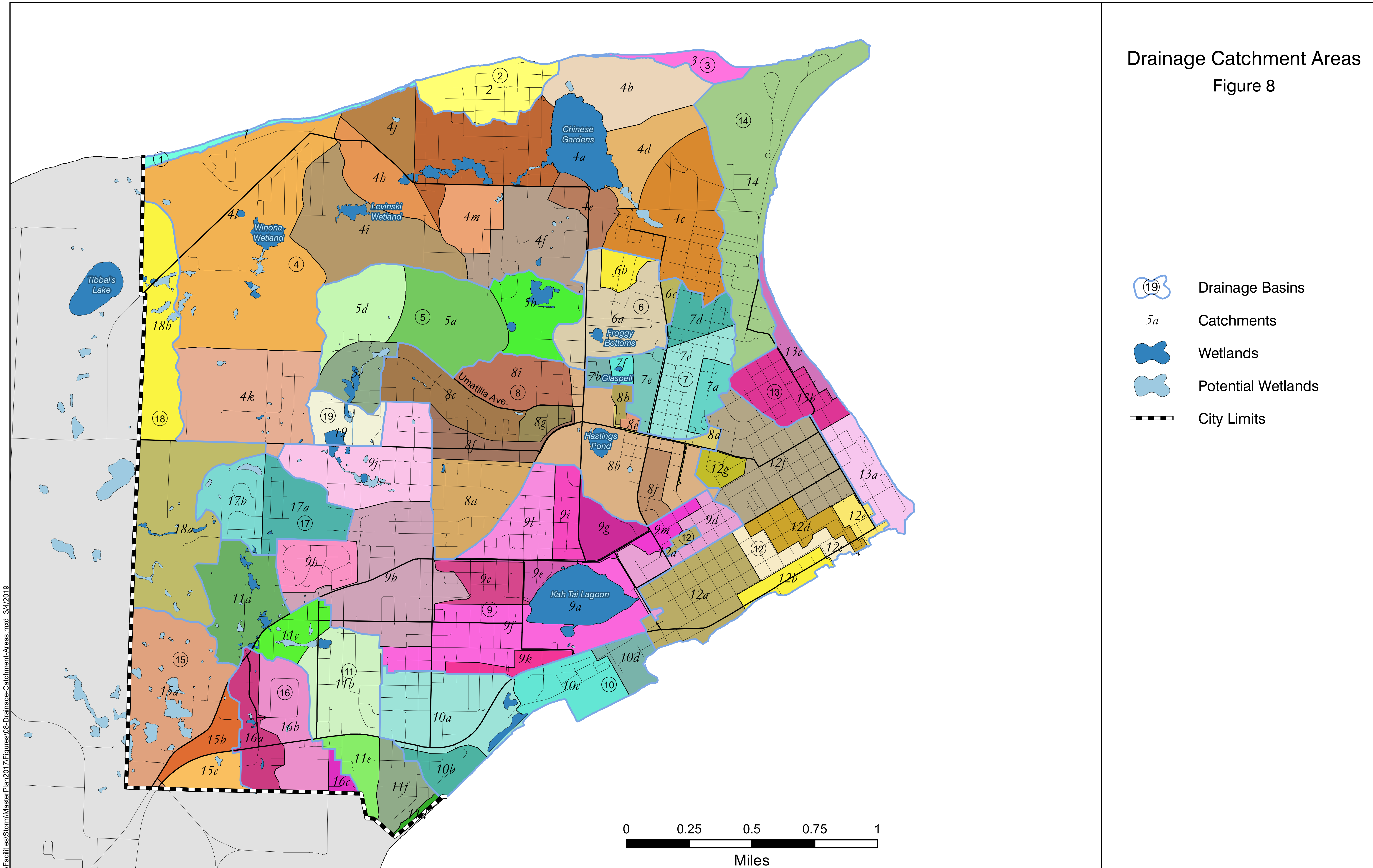
Table 3-2. Existing Land Use Model Inputs (continued)

Catchment	Total Area (ac.)	Impervious (ac.)	Percent Impervious	Pervious (ac.)		
				Hydrologic Soil Type A - Forest	Hydrologic Soil Type C - Forest	Hydrologic Soil Type D - Forest
4b	80.3	0.3	0.3%	66.8	11.80	1.4
4c	122.4	18.2	14.8%	47.9	53.35	2.9
4d	47.4	0.2	0.4%	16.3	22.0	8.9
4e	26.7	3.7	13.7%	17.7	3.6	1.8
4f	83.7	10.4	12.4%	40.1	32.5	0.8
4g	107.6	13.8	12.8%	27.1	66.7	0.0
4h	46.4	1.2	2.5%	32.8	12.4	0.0
4i	114.2	5.4	4.7%	87.3	21.6	0.0
4j	38.0	1.9	4.9%	10.7	25.5	0.0
4k	129.9	7.5	5.8%	107.1	15.3	0.0
4l	314.8	15.1	4.8%	274.0	0.0	25.8
4m	38.4	2.8	7.3%	14.7	20.9	0.0
5a	85.7	1.0	1.2%	30.5	54.3	0.0
5b	54.8	4.3	7.9%	12.5	38.0	0.0
5c	36.9	2.7	7.4%	20.6	10.1	3.5
5d	61.4	1.3	2.1%	23.8	36.4	0.0
6a	80.4	13.8	17.2%	33.9	32.7	0.0
6b	14.6	2.3	16.0%	5.6	6.7	0.0
6c	5.8	0.9	14.7%	0.0	5.0	0.0
7a	19.6	2.5	12.9%	13.7	3.3	0.0
7b	7.4	1.5	20.2%	0.0	5.9	0.0
7c	48.5	11.5	23.7%	26.4	10.6	0.0
7d	26.0	5.6	21.5%	8.7	12.1	0.0
7e	18.8	1.5	8.1%	4.6	12.7	0.0
7f	6.6	0.2	3.1%	0.0	6.4	0.0
8a	70.8	10.5	14.9%	60.1	0.2	0.0
8b	107.3	11.0	10.3%	42.2	54.1	0.0
8c	61.9	10.2	16.4%	42.4	9.4	0.0
8d	8.0	2.1	26.6%	3.7	2.1	0.0
8e	2.7	0.6	21.4%	0.0	2.1	0.0
8f	31.9	6.0	18.7%	22.3	3.6	0.0
8g	13.9	2.1	15.0%	0.4	11.5	0.0
8h	5.7	1.2	21.4%	0.0	4.5	0.0
8i	50.6	3.6	7.1%	0.0	47.1	0.0
8j	18.4	3.6	19.7%	14.8	0.0	0.0
8k	32.6	2.1	6.5%	30.2	0.0	0.3
9a	46.4	0.0	0.0%	0.0	5.5	40.9
9b	137.7	23.5	17.1%	102.6	11.6	0.0
9c	30.5	5.6	18.3%	22.7	2.2	0.0
9d	39.0	9.4	24.2%	25.6	4.0	0.0
9e	13.8	3.2	23.1%	3.5	7.1	0.0
9f	108.8	16.1	14.8%	46.4	44.8	1.5
9g	26.2	7.2	27.6%	8.0	11.0	0.0

Table 3-2. Existing Land Use Model Inputs (continued)

				Pervious (ac.)		
Catchment	Total Area (ac.)	Impervious (ac.)	Percent Impervious	Hydrologic Soil Type A - Forest	Hydrologic Soil Type C - Forest	Hydrologic Soil Type D - Forest
9h	39.9	6.6	16.6%	33.3	0.0	0.0
9i	25.1	8.3	32.9%	0.0	16.9	0.0
9j	99.6	9.5	9.5%	90.2	0.0	0.0
9k	15.9	6.3	39.2%	9.5	0.2	0.0
9l	49.3	9.0	18.2%	19.8	20.5	0.0
9m	17.1	13.3	77.9%	3.5	0.3	0.0
10a	103.9	11.5	11.0%	91.5	1.0	0.0
10b	23.5	4.6	19.7%	9.2	9.7	0.0
10c	51.0	6.1	12.0%	44.9	0.0	0.0
10d	21.4	2.3	10.7%	19.1	0.0	0.0
11a	72.1	9.6	13.3%	62.4	0.0	0.0
11b	76.7	8.6	11.2%	68.1	0.0	0.0
11c	28.8	2.9	10.0%	25.9	0.0	0.0
11d	3.7	1.1	30.6%	2.6	0.0	0.0
11e	26.7	6.0	22.3%	20.6	0.2	0.0
11f	33.6	13.7	40.9%	19.6	0.3	0.0
12a	86.6	15.5	17.9%	68.4	2.7	0.0
12b	20.1	6.1	30.3%	14.0	0.0	0.0
12c	26.9	8.1	30.0%	18.8	0.0	0.0
12d	30.8	6.0	19.5%	24.8	0.0	0.0
12e	13.5	15.2[1]	112.7%[1]	-1.72	0.0	0.0
12f	112.2	17.5	15.6%	90.7	4.1	0.0
12g	14.3	5.5	38.6%	3.7	5.2	0.0
13a	44.8	9.3	20.7%	35.5	0.0	0.0
13b	51.9	8.1	15.5%	43.9	0.0	0.0
13c	18.8	6.0	32.0%	12.5	0.3	0.0
14.00	193.6	12.2	6.3%	161.7	19.7	0.0
15a	131.7	3.2	2.4%	102.4	25.3	0.8
15b	24.6	2.8	11.2%	15.3	6.6	0.0
15c	24.0	2.6	10.7%	12.5	9.0	0.0
16a	42.9	8.6	20.0%	34.3	0.0	0.0
16b	62.7	4.0	6.4%	58.7	0.0	0.0
16c	7.5	2.4	32.1%	5.1	0.0	0.0
17a	53.7	6.8	12.7%	46.9	0.0	0.0
17b	46.4	5.6	12.0%	40.8	0.0	0.0
18a	141.6	2.6	1.8%	119.8	19.2	0.0
18b	84.6	1.6	1.9%	83.0	0.0	0.0

[1] The approach used to calculate existing impervious area resulted in an area larger than the basin. These numbers were adjusted to show the maximum area possible.



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3.1.2 Future Land Use and Land Cover

Existing land use, as described above, is used in runoff models to evaluate existing drainage conditions and needs and identify areas with potential stormwater impacts. Future land use, mainly in the form of new impervious surfaces and converted land cover, is used to predict future potential runoff impacts. Future potential impact areas are the focus of the SMP.

The unopened rights-of-way and the "developable land" categories are where the potential runoff changes will occur. For planning purposes, potential land conversion estimates are made for full build-out to predict where impacts could occur which then point to the need for measures to minimize or manage those impacts.

For unopened rights-of-way, the total potential conversion of land area is estimated to be 40 percent impervious, following the assumption used for existing opened rights-of-way in Section 3.1.1. Some of the unopened rights-of-way are located adjacent to public and conservation lands and may never be opened, resulting in an over-estimation of future imperviousness, thus the modeling results can be considered conservative.

For vacant land, public and conservation lands are expected to remain pervious and undeveloped. Underdeveloped and remaining developable lands are assumed to be developed to their full, allowable potential. The estimated future fully developed impervious percentage is 37 percent, which was provided by City staff to use in runoff modeling. This is a typical approach in stormwater planning, although it has been found to overpredict actual development that occurs.

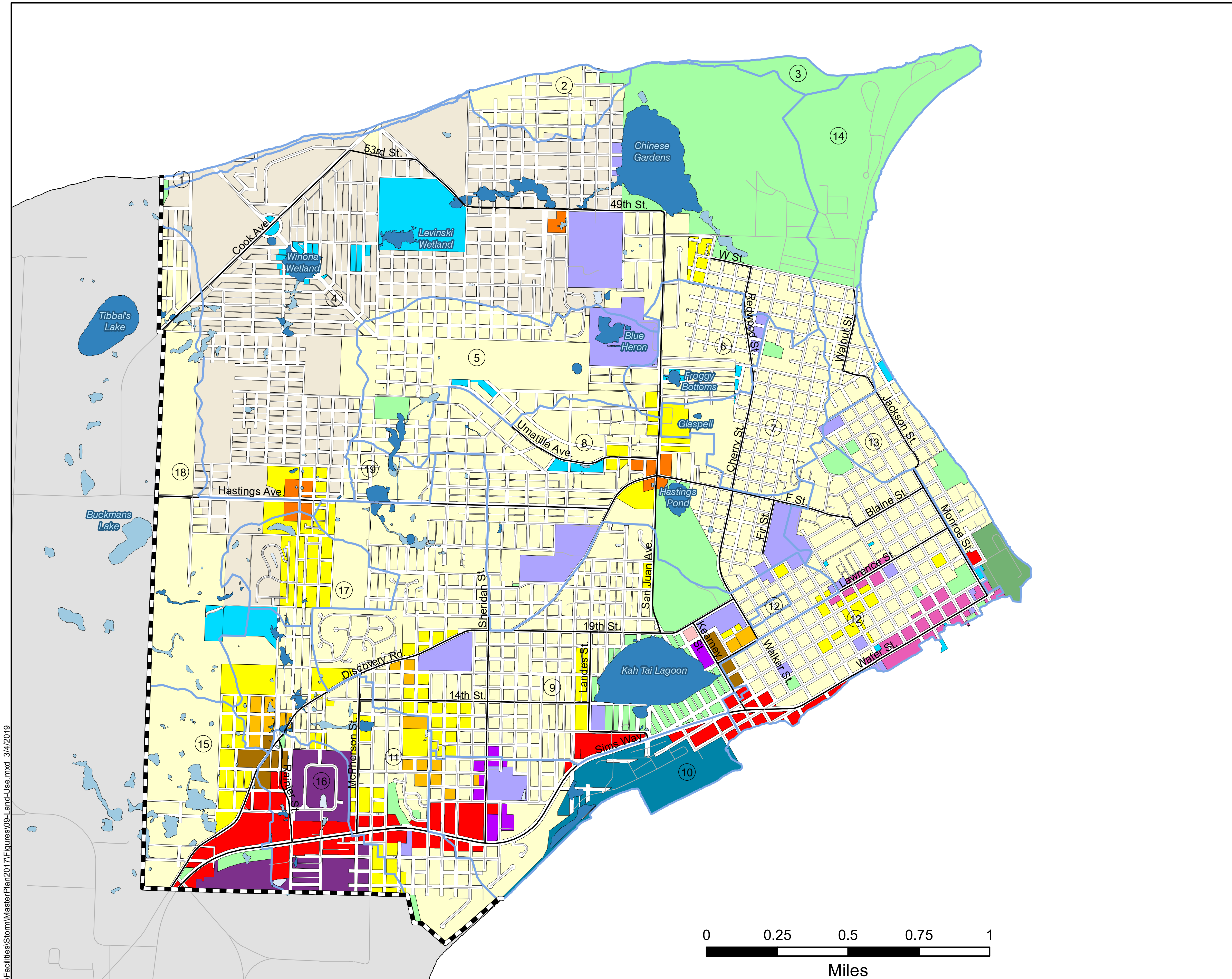
Larger tracts that will construct new roads within new rights-of-way use an estimate of 37 percent future impervious (which is the same percent used for future developable land), while existing unopened rights-of-way will use 40 percent imperviousness. The 3 percent difference is small and is not expected to result in significantly different modeling outcomes.

Land cover conversion will assume that the remaining uncovered pervious lands will be "pasture" (which includes lawns and non-forested open spaces; this is a modeling convention term) and or remain in part forest. The land cover is visually estimated from recent aerial photos. For the model it will be assumed that 50 percent of the forest in developable land will convert to pasture, and that pasture will remain pasture.

The potential development and conversion to impervious surfaces described here are used to model and predict the highest potential for future impacts to the natural drainage ways, drainage systems, and existing wetlands. However, the reality is that runoff would be controlled to some extent at each site, with full control following the stormwater manual at larger sites and to the maximum extent practicable at small sites or individual platted lots. The amount of control or runoff reduction is catchment-specific, considering soils conditions and developable tract types. In the modeling results, if the potential for future impacts is found or exceeds thresholds, a closer catchment-specific analysis and adjustment may be made if the conservative assumptions (developable and underdeveloped lands developed to their full, allowable potential with no stormwater controls) result in an impact. Catchments that still could have impacts after these adjustments are applied may become candidates for regional control facilities.

Existing Land Use is shown on Figure 9. Vacant lands and development potential are shown in Figure 10. Soils mapping and potential for good infiltration conditions are shown in Figure 7. Using this information, the estimates for future conditions for full buildout for the MGSFlood model are shown in Table 3-3.

Land-Use
Figure 9



Residential Districts
- R-I Min. 10,000 sq. ft. lot
- R-II Min. 5,000 sq. ft. lot
- R-III 10 to 16 d.u per 40,000 s.f.
- R-IV 15 to 24 d.u per 40,000 s.f.

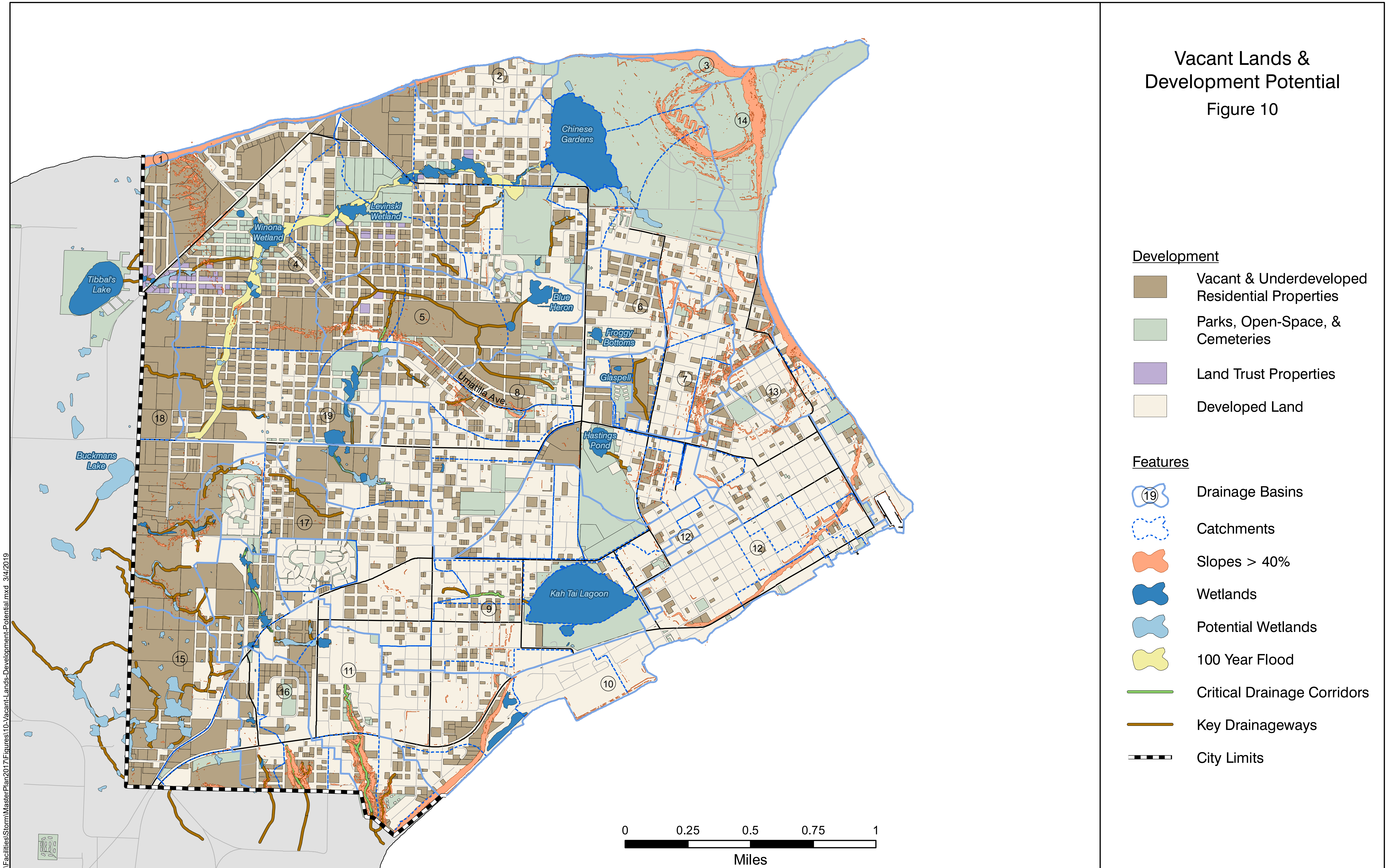
Mixed Use Districts
- C-I/MU Neighborhood Mixed Use
- C-II/MU Community Mixed Use

Commercial Districts
- C-I Neighborhood Commercial
- C-II General Commercial
- C-II(H) Hospital Commercial
- C-III Historic Commercial

Marine-Related and Manufacturing Districts
- M-C Commercial / Light Manufacturing
- M-II(A) Marine Related Uses
- M-II(B) Marine Related Uses

Public, Park and Open Space Districts
- P/OS Existing Park or Open Space
- P/OS(B) Public / Mixed Use
- P-I Public / Infrastructure

Wetlands and Stormwater Basins
- Wetlands
- Potential Wetlands
- Drainage Basins



Vacant Lands &
Development Potential
Figure 10
Development
Vacant & Underdeveloped Residential Properties
Parks, Open-Space, & Cemeteries
Land Trust Properties
Developed Land
Features
Drainage Basins
Catchments
Slopes > 40%
Wetlands
Potential Wetlands
100 Year Flood
Critical Drainage Corridors
Key Drainageways
City Limits
Chinese Gardens
Levinski Wetland
Winona Wetland
Tibbal's Lake
Blue Heron
Froggy Bottoms
Glaspell
Umatilla Ave
Hastings Pond
Buckmans Lake
Kah Tai Lagoon
0 0.25 0.5 0.75 1
Miles
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Table 3-3. Future Land Use Model Inputs

Catchment	Total Area (ac.)	Impervious (ac.)	Percent Impervious	Pervious (ac.)		
				Hydrologic Soil Type A - Forest	Hydrologic Soil Type C - Forest	Hydrologic Soil Type D - Forest
1	12.8	0.1	7.6%	10.6	1.2	0.0
2	62.7	27.7	44.2%	23.8	11.2	0.0
3	19.1	0.00	0.1%	19.0	0.0	0.0
4a	46.5	0.1	0.3%	2.1	2.1	42.2
4b	80.3	0.1	1.2%	66.2	11.7	1.4
4c	122.4	30.7	25.1%	42.2	46.9	2.6
4d	47.4	0.2	0.5%	16.3	21.1	8.9
4e	26.7	8.9	33.3%	13.7	2.8	1.4
4f	83.7	35.8	42.8%	26.2	21.2	0.5
4g	107.6	41.6	38.7%	19.1	46.9	0.0
4h	46.4	6.3	13.7%	29.1	10.1	0.0
4i	114.2	36.5	31.9%	62.4	15.4	0.0
4j	38.0	14.4	37.7%	7.0	16.7	0.0
4k	129.9	48.1	37.0%	71.6	10.2	0.00
4l	314.8	106.8	33.9%	190.2	0.0	17.9
4m	38.4	15.3	39.8%	9.5	13.6	0.0
5a	85.7	31.5	36.8%	19.5	34.7	0.0
5b	54.8	20.2	36.8%	8.6	26.0	0.0
5c	36.9	9.9	26.8%	16.3	7.1	2.8
5d	61.4	21.1	35.8%	15.6	23.9	0.0
6a	80.4	35.1	44.7%	22.6	21.9	0.0
6b	14.6	6.4	44.1%	3.8	4.4	0.0
6c	5.8	2.4	40.5%	0.0	3.5	0.0
7a	19.6	7.6	38.9%	9.6	2.3	0.0
7b	7.4	4.2	57.1%	0.0	3.2	0.0
7c	48.5	23.2	47.9%	18.0	7.3	0.0
7d	26.0	11.5	44.4%	5.8	8.6	0.0
7e	18.8	7.7	42.3%	2.9	8.0	0.0
7f	6.6	2.3	34.3%	0.0	4.3	0.0
8a	70.8	31.4	44.3%	39.3	0.2	0.0
8b	107.3	32.1	29.9%	32.1	42.3	0.0
8c	61.9	27.5	44.4%	28.2	6.3	0.0
8d	8.0	3.8	47.4%	2.7	1.5	0.0
8e	2.7	1.3	49.7%	0.0	1.4	0.0
8f	31.9	14.4	45.0%	15.1	2.5	0.0

Table 3-3. Future Land Use Model Inputs (continued)

				Pervious (ac.)		
Catchment	**Total Area (ac.)**	**Impervious (ac.)**	**Percent Impervious**	**Hydrologic Soil Type A - Forest**	**Hydrologic Soil Type C - Forest**	**Hydrologic Soil Type D - Forest**
8g	13.9	5.8	41.5%	0.3	7.9	0.0
8h	5.7	3.2	56.2%	0.0	2.5	0.0
8i	50.6	20.5	40.5%	0.0	30.1	0.0
8j	18.4	8.8	47.7%	9.6	0.0	0.0
8k	32.6	10.5	32.1%	21.9	0.0	0.2
9a	46.4	1.9	4.1%	0.0	5.3	39.2
9b	137.7	61.6	44.8%	68.3	7.7	0.0
9c	30.5	13.6	44.5%	15.5	1.5	0.0
9d	39.0	18.8	48.3%	17.5	2.7	0.0
9e	13.8	5.3	38.6%	2.8	5.7	0.0
9f	108.8	41.2	37.9%	33.9	32.7	1.1
9g	26.2	7.2	27.7%	7.1	10.1	0.0
9h	39.9	18.7	46.8%	21.2	0.0	0.0
9i	25.1	14.9	59.2%	0.0	10.2	0.0
9j	99.6	36.1	36.2%	63.6	0.0	0.0
9k	15.9	10.9	68.7%	4.9	0.1	0.0
9l	49.3	21.2	43.0%	13.8	14.3	0.0
9m	17.1	17.0	99.5%	0.1	0.0	0.0
10a	103.9	37.3	35.9%	65.9	0.7	0.0
10b	23.5	10.5	44.6%	6.3	6.7	0.0
10c	51.0	23.9	46.8%	27.2	0.0	0.0
10d	21.4	8.2	38.4%	13.2	0.0	0.0
11a	72.1	31.4	43.6%	40.6	0.0	0.0
11b	76.7	27.8	36.2%	48.9	0.0	0.0
11c	28.8	9.4	32.7%	19.4	0.0	0.0
11d	3.7	1.2	30.7%	2.6	0.0	0.0
11e	26.7	11.5	42.9%	15.2	0.2	0.0
11f	33.6	23.4	69.7%	10.1	0.2	0.0
12a	86.6	34.9	40.3%	49.7	1.1	0.0
12b	20.1	10.9	54.1%	9.2	0.0	0.0
12c	26.9	13.5	50.3%	13.3	0.0	0.0
12d	30.8	11.1	38.8%	18.8	0.0	0.0
12e	13.5	13.5	100.0%	0.0	0.0	0.0
12f	112.2	42.5	37.9%	66.7	3.0	0.0
12g	14.3	9.9	69.1%	1.8	2.6	0.0
13a	44.8	22.2	49.5%	22.7	0.0	0.0
13b	51.9	19.1	36.8%	32.8	0.0	0.0

Table 3-3. Future Land Use Model Inputs (continued)

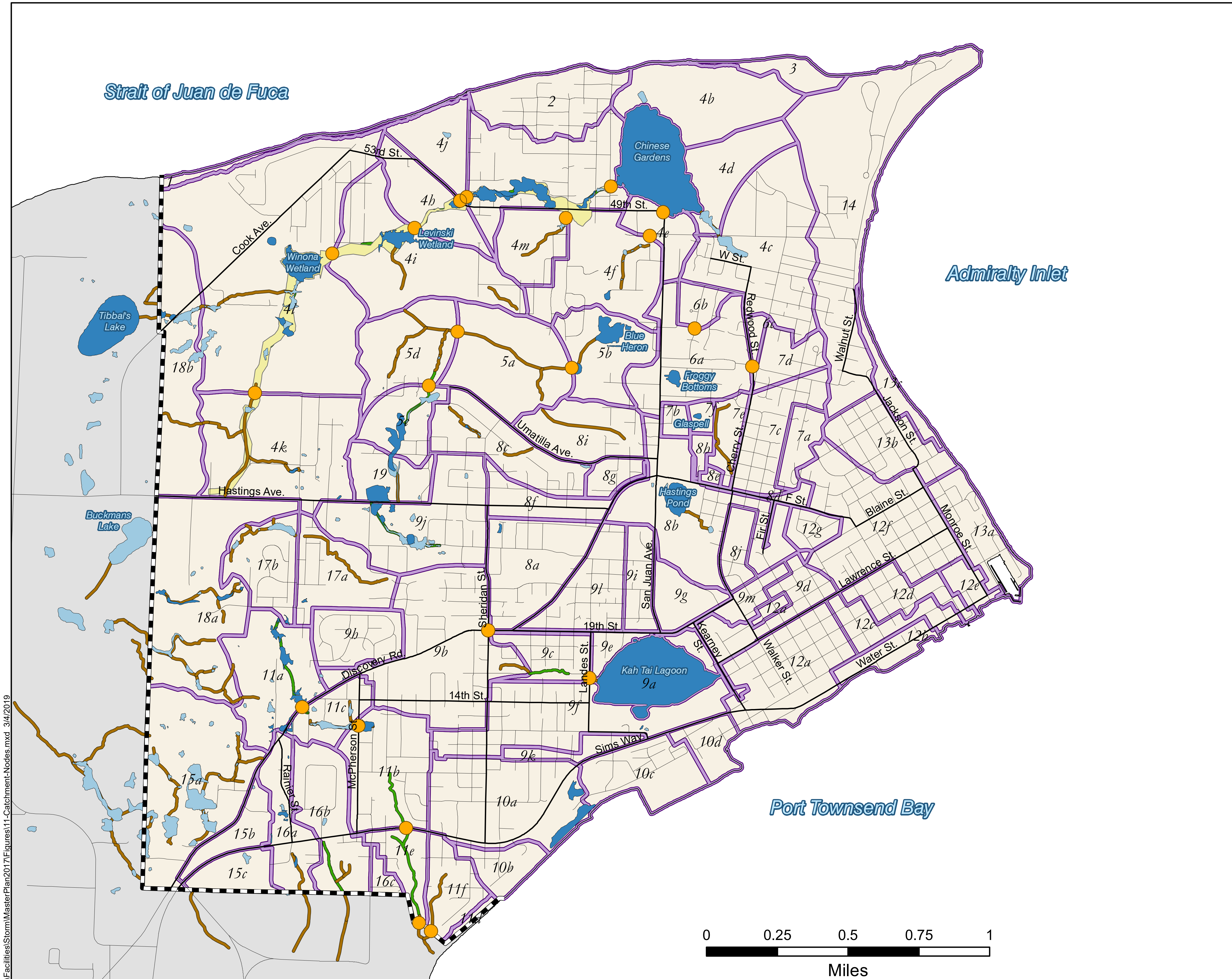
				Pervious (ac.)		
Catchment	Total Area (ac.)	Impervious (ac.)	Percent Impervious	Hydrologic Soil Type A - Forest	Hydrologic Soil Type C - Forest	Hydrologic Soil Type D - Forest
13c	18.8	9.9	52.6%	8.7	0.2	0.0
14.00	193.6	23.6	12.2%	151.5	18.5	0.0
15a	131.7	40.3	30.6%	72.8	17.1	0.6
15b	24.6	10.1	40.9%	10.2	4.4	0.0
15c	24.0	8.7	36.2%	8.9	6.4	0.0
16a	42.9	20.3	47.1%	22.7	0.0	0.0
16b	62.7	22.1	35.2%	40.6	0.0	0.0
16c	7.5	4.6	61.2%	2.9	0.0	0.0
17a	53.7	24.1	44.9%	29.6	0.0	0.0
17b	46.4	18.0	38.9%	28.3	0.0	0.0
18a	141.6	47.7	33.7%	80.9	13.0	0.0
18b	84.6	28.1	33.2%	56.5	0.0	0.0

3.1.3 Estimating Runoff Potential

As described in previous sections, the City has: low rainfall depth and intensity when compared to elsewhere in western Washington, areas of relatively low runoff soils and land cover, and small catchments with poorly defined natural drainage paths. These factors converge to result in a relatively narrow range of peak flow rates, which often means that similar drainage infrastructure is needed in many different locations. Modeling the entire system would be costly; a generalized modeling approach can address much of the City's system need. To define this need and confirm the expectation that similar runoff results can be found across the city, some generalized runoff modeling was performed.

The land cover conversion analysis results, previously described in this section, are input into the hydrologic model to find future peak runoff potential from the basin. The location at which this peak flow rate occurs is described as "key locations" in the drainage system. In some catchments, the peak flow rate is the entire runoff potential from the catchment, with no specific geographic location. An example would be in Catchment 1, which has runoff that generally flows toward the Strait of Juan de Fuca and discharges at multiple points. In the catchments where there is a defined location at which all of the runoff is directed, a "node" is defined as the specific location of the calculated peak flow rate, as shown on Figure 11. Table 3-4 lists the catchment area name, total catchment area in acres, percentage of existing and future impervious area, and distribution of land cover.

Existing and future peak runoff for the 2-, 10-, 25-, and 100-year events were determined at the catchment nodes shown on Figure 11 (unless there is no node, which means that the peak runoff rate is total runoff potential from the entire basin). These modeling results will be used to define potentially impacted areas. The future peak flows for the 25-year event will be used to assess drainage conveyance needs in the roadway system, notably where the road drainage becomes the main flow path in the basin. The 25-year peak flows will be used to assess potential impacts from future development to CDCs and KDs as defined in Section 4. A comparison between existing (Table 3-5a) and future (Table 3-5b) conditions for selected events (2-, 10-, 25-, and 100-year storm events) is also used to assess wetland receiving waters, notably in Basins 4 through 9. The peak runoff modeling results for Existing and Future Conditions are shown in Tables 3-5a and Table 3-5b, respectively.



Catchment Nodes

Figure 11

Catchment Nodes

Features

- Catchments
- Wetlands
- Potential Wetlands
- 100 Year Flood
- Critical Drainage Corridors
- Key Drainageways
- City Limits

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Table 3-4. Buildable Area – Impervious Comparison

		Existing Impervious (ac.)			Future Impervious (ac.)		
Catchment	**Total Area (ac.)**	**ROW**	**Buildable Area**	**Total Impervious Percent**	**ROW**	**Buildable Area**	**Total Impervious Percent**
1	12.8	0.0	0.0	0.0%	1.0	0.0	7.6%
2	62.7	13.7	5.6	30.7%	15.8	20.0	57.2%
3	19.1	0.0	0.0	0.1%	0.0	0.0	0.1%
4a	46.5	0.0	0.0	0.0%	0.1	0.0	0.3%
4b	80.3	0.1	0.3	0.5%	0.2	0.9	1.3%
4c	122.4	15.0	7.8	18.7%	16.7	18.6	28.9%
4d	47.4	0.1	0.1	0.4%	0.1	0.1	0.5%
4e	26.7	4.6	1.6	23.2%	5.0	6.4	42.7%
4f	83.7	8.5	6.1	17.4%	9.6	30.4	47.7%
4g	107.6	17.5	5.7	21.5%	25.7	25.3	47.3%
4h	46.4	2.8	0.3	6.6%	4.5	3.7	17.7%
4i	114.2	7.2	2.6	8.6%	18.6	22.3	35.8%
4j	38.0	2.3	0.6	7.8%	2.4	13.0	40.7%
4k	129.9	13.9	1.7	12.0%	24.9	31.3	43.2%
4l	314.8	22.9	5.6	9.1%	45.8	74.4	38.2%
4m	38.4	3.7	1.3	12.9%	7.2	10.3	45.4%
5a	85.7	1.5	0.3	2.1%	7.2	25.2	37.7%
5b	54.8	2.6	2.8	9.9%	3.4	17.9	38.8%
5c	36.9	3.1	1.4	12.1%	5.5	6.1	31.5%
5d	61.4	1.8	0.4	3.6%	9.1	13.8	37.3%
6a	80.4	18.4	6.3	30.6%	21.3	25.5	58.1%
6b	14.6	3.6	1.2	32.8%	4.2	4.7	60.8%
6c	5.8	0.9	0.5	23.2%	1.4	1.4	48.9%
7a	19.6	3.4	1.1	23.2%	4.4	5.2	49.2%
7b	7.4	0.0	1.1	15.5%	0.0	3.9	52.4%
7c	48.5	16.5	4.6	43.4%	17.8	15.0	67.6%
7d	26.0	7.1	2.5	36.6%	7.5	8.0	59.6%
7e	18.8	1.4	1.0	12.8%	1.6	7.2	47.0%
7f	6.6	0.1	0.2	4.2%	0.1	2.2	35.4%
8a	70.8	13.7	4.4	25.6%	15.4	23.6	55.0%
8b	107.3	14.2	5.9	18.7%	16.0	25.1	38.3%
8c	61.9	12.3	4.2	26.6%	14.9	18.9	54.6%
8d	8.0	3.4	0.5	48.0%	3.5	2.0	68.8%
8e	2.7	0.6	0.3	35.8%	0.6	1.1	64.1%
8f	31.9	9.6	2.6	38.3%	11.4	9.2	64.6%

Table 3-4. Buildable Area – Impervious Comparison (continued)

		Existing Impervious (ac.)			Future Impervious (ac.)		
Catchment	**Total Area (ac.)**	**ROW**	**Buildable Area**	**Total Impervious Percent**	**ROW**	**Buildable Area**	**Total Impervious Percent**
8g	13.9	3.1	1.1	29.9%	3.5	4.4	56.5%
8h	5.7	0.3	1.1	25.2%	0.4	3.1	60.0%
8i	50.6	4.7	1.4	12.2%	8.1	15.0	45.7%
8j	18.4	4.3	1.3	30.0%	5.1	5.6	58.0%
8k	32.6	2.8	1.0	11.9%	5.0	7.3	37.5%
9a	46.4	0.0	0.0	0.0%	1.9	0.0	4.1%
9b	137.7	34.6	10.3	32.6%	41.1	41.9	60.3%
9c	30.5	8.6	2.5	36.2%	10.1	9.0	62.3%
9d	39.0	13.6	3.8	44.6%	14.0	12.8	68.7%
9e	13.8	5.8	0.7	47.0%	6.4	2.3	62.5%
9f	108.8	24.2	7.6	29.2%	32.0	24.9	52.3%
9g	26.2	0.4	6.7	27.2%	0.4	6.7	27.2%
9h	39.9	7.4	2.8	25.7%	7.6	14.6	55.8%
9i	25.1	7.2	5.9	52.5%	8.2	11.6	78.9%
9j	99.6	16.3	2.1	18.5%	19.3	25.7	45.2%
9k	15.9	3.3	4.9	51.4%	3.8	9.1	80.8%
9l	49.3	16.4	2.7	38.8%	18.0	13.3	63.6%
9m	17.1	7.0	10.1	99.9%	7.1	13.7	121.5%
10a	103.9	24.7	2.5	26.2%	28.1	25.0	51.1%
10b	23.5	3.9	3.1	29.8%	4.2	8.7	54.8%
10c	51.0	2.2	2.3	8.9%	2.8	19.5	43.6%
10d	21.4	5.2	0.2	25.3%	5.5	5.8	52.9%
11a	72.1	2.0	8.1	14.1%	7.3	24.6	44.4%
11b	76.7	17.8	1.8	25.6%	20.7	18.1	50.6%
11c	28.8	5.5	0.0	19.0%	6.4	5.6	41.7%
11d	3.7	0.0	1.1	30.6%	0.0	1.1	30.7%
11e	26.7	4.4	3.8	30.8%	5.8	7.9	51.3%
11f	33.6	6.3	11.2	52.2%	7.4	19.8	81.0%
12a	86.6	32.9	4.3	42.9%	34.5	22.0	65.3%
12b	20.1	4.3	4.7	44.8%	5.0	8.8	68.5%
12c	26.9	10.9	4.1	55.9%	11.2	9.2	76.2%
12d	30.8	13.0	1.4	46.9%	13.2	7.2	66.2%
12e[1]	13.5	3.6	13.5	100.0%	3.8	16.6	151.6%
12f	112.2	38.6	1.5	35.7%	38.9	26.2	58.0%
12g	14.3	2.0	4.3	44.5%	2.1	8.7	74.9%
13a	44.8	5.4	5.5	24.3%	5.9	17.9	53.0%

Table 3-4. Buildable Area – Impervious Comparison (continued)

		Existing Impervious (ac.)			Future Impervious (ac.)		
Catchment	Total Area (ac.)	ROW	Buildable Area	Total Impervious Percent	ROW	Buildable Area	Total Impervious Percent
13b	51.9	15.9	0.9	32.5%	16.4	11.5	53.8%
13c	18.8	0.6	5.9	34.7%	2.2	8.2	55.4%
14.00	193.6	10.3	0.9	5.8%	12.5	10.0	11.7%
15a	131.7	5.1	0.3	4.1%	9.5	33.1	32.3%
15b	24.6	4.0	0.2	17.1%	4.6	7.0	46.8%
15c	24.0	1.3	1.6	12.4%	1.5	7.6	37.9%
16a	42.9	6.7	4.6	26.3%	9.5	13.4	53.4%
16b	62.7	8.3	0.5	14.1%	10.6	16.2	42.9%
16c	7.5	1.6	2.1	48.8%	2.0	3.8	77.9%
17a	53.7	7.0	3.8	20.1%	9.3	18.7	52.2%
17b	46.4	5.8	2.6	18.0%	6.4	14.4	44.9%
18a	141.6	5.0	0.5	3.9%	6.7	43.9	35.7%
18b	84.6	2.9	0.0	3.4%	6.5	23.0	34.8%

[1] Impervious area and impervious percent were changed to full basin area.

Table 3-5a. Peak Runoff at Nodes or for Total Catchment – Existing[1]

	Existing Runoff (cfs)																			
Storm Event	**Basin 1**	**Basin 2**	**Basin 3**	**Basin 4a**	**Basin 4b**	**Basin 4c**	**Basin 4d**	**Basin 4e**	**Basin 4f**	**Basin 4g**	**Basin 4h**	**Basin 4i**	**Basin 4j**	**Basin 4k**	**Basin 4l**	**Basin 4m**	**Basin 5a**	**Basin 5b**	**Basin 5c**	**Basin 5d**
2-Year	0.02	2.25	0.06	0.01	0.23	3.68	0.08	0.78	2.12	2.77	0.30	1.32	0.40	1.83	3.70	0.60	0.24	0.82	0.53	0.28
10-Year	0.11	3.45	0.30	0.01	1.13	5.65	0.33	1.19	3.24	4.24	0.72	2.35	0.61	3.10	7.13	0.92	0.45	1.26	0.85	0.47
25-Year	0.15	3.94	0.43	0.02	1.65	6.56	0.50	1.41	3.84	4.57	1.09	3.54	0.75	4.63	10.80	1.10	0.61	1.41	0.97	0.57
100-Year	0.20	4.65	0.56	0.09	2.12	7.76	0.62	1.68	4.55	5.43	1.22	3.77	0.90	4.98	11.34	1.31	0.98	1.78	1.18	0.89
Storm Event	**Basin 6a**	**Basin 6b**	**Basin 6c**	**Basin 7a**	**Basin 7b**	**Basin 7c**	**Basin 7d**	**Basin 7e**	**Basin 7f**	**Basin 8a**	**Basin 8b**	**Basin 8c**	**Basin 8d**	**Basin 8e**	**Basin 8f**	**Basin 8g**	**Basin 8h**	**Basin 8i**	**Basin 8j**	**Basin 8k**
2-Year	2.62	0.44	0.16	0.54	0.23	2.32	1.11	0.31	0.04	2.25	2.24	2.10	0.43	0.11	1.21	0.41	0.24	0.71	0.74	0.49
10-Year	4.05	0.68	0.26	0.83	0.34	3.54	1.70	0.48	0.06	3.44	3.43	3.20	0.65	0.17	1.85	0.62	0.36	1.06	1.13	0.82
25-Year	4.86	0.78	0.30	1.00	0.36	3.90	1.84	0.54	0.07	4.20	4.06	3.80	0.70	0.18	2.19	0.66	0.39	1.13	1.35	1.21
100-Year	5.67	0.96	0.35	1.19	0.41	4.63	2.15	0.64	0.07	5.03	4.82	4.51	0.83	0.20	2.59	0.75	0.44	1.27	1.60	1.32
Storm Event	**Basin 9a**	**Basin 9b**	**Basin 9c**	**Basin 9d**	**Basin 9e**	**Basin 9f**	**Basin 9g**	**Basin 9h**	**Basin 9i**	**Basin 9j**	**Basin 9k**	**Basin 9l**	**Basin 9m**	**Basin 10a**	**Basin 10b**	**Basin 10c**	**Basin 10d**	**Basin 11a**	**Basin 11b**	**Basin 11c**
2-Year	0.01	4.90	1.15	1.91	0.63	3.26	1.44	1.42	1.63	2.07	1.25	1.81	2.63	2.44	0.94	1.31	0.49	2.05	1.84	0.62
10-Year	0.02	7.53	1.75	2.93	0.97	5.01	2.19	2.17	2.44	3.20	1.91	2.76	3.97	3.75	1.43	2.00	0.76	3.14	2.82	0.95
25-Year	0.02	8.86	2.08	3.29	1.05	5.91	2.37	2.58	2.61	4.48	2.06	3.03	4.25	4.95	1.58	2.55	1.03	3.90	3.75	1.30
100-Year	0.19	10.54	2.47	3.89	1.20	7.00	2.73	3.07	2.92	5.22	2.42	3.59	4.79	5.95	1.88	3.07	1.22	4.67	4.50	1.54
Storm Event	**Basin 11d**	**Basin 11e**	**Basin 11f**	**Basin 12a**	**Basin 12b**	**Basin 12c**	**Basin 12d**	**Basin 12e**	**Basin 12f**	**Basin 12g**	**Basin 13a**	**Basin 13b**	**Basin 13c**	**Basin 14**	**Basin 15a**	**Basin 15b**	**Basin 15c**	**Basin 16a**	**Basin 16b**	**Basin 16c**
2-Year	0.23	1.21	2.74	3.24	1.23	1.63	1.24	1.29	3.72	1.09	1.88	1.72	1.22	2.91	0.82	0.59	0.55	1.75	0.98	0.49
10-Year	0.35	1.86	4.19	5.00	1.88	2.49	1.89	1.97	5.70	1.67	2.89	2.63	1.85	4.90	2.04	0.90	0.84	2.68	1.68	0.74
25-Year	0.39	2.16	4.53	5.87	2.07	2.75	2.24	2.13	6.83	1.79	3.37	3.17	2.01	7.29	3.09	1.09	0.99	3.18	2.51	0.81
100-Year	0.46	2.56	5.28	6.98	2.46	3.26	2.66	2.41	8.15	2.04	3.98	3.79	2.39	7.90	3.47	1.31	1.18	3.77	2.70	0.96
Storm Event	**Basin 17a**	**Basin 17b**	**Basin 18a**	**Basin 18b**																
2-Year	1.46	1.19	0.78	0.50																
10-Year	2.23	1.82	2.29	1.52																
25-Year	2.86	2.34	3.48	2.30																
100-Year	3.43	2.82	4.10	2.75																

[1]Note: The peak rates shown are for the total runoff generated by the catchment only. The actual peaks at the nodes that include upstream accumulated and routed drainage are not included in this table.

Table 3-5b. Peak Runoff at Nodes or for Total Catchment – Future[1]

	Future Runoff (Full Buildout, cfs)																			
Storm Event	**Basin 1**	**Basin 2**	**Basin 3**	**Basin 4a**	**Basin 4b**	**Basin 4c**	**Basin 4d**	**Basin 4e**	**Basin 4f**	**Basin 4g**	**Basin 4h**	**Basin 4i**	**Basin 4j**	**Basin 4k**	**Basin 4l**	**Basin 4m**	**Basin 5a**	**Basin 5b**	**Basin 5c**	**Basin 5d**
2-Year	0.21	4.39	0.06	0.01	0.27	5.65	0.08	1.41	6.11	6.20	0.73	4.14	0.42	4.80	10.14	1.84	1.39	2.52	1.31	1.75
10-Year	0.32	6.71	0.30	0.01	1.16	8.60	0.34	2.14	9.37	9.45	1.13	6.36	0.64	7.33	15.51	2.82	2.14	3.90	2.01	2.69
25-Year	0.39	7.27	0.43	0.02	1.74	9.32	0.50	2.35	10.07	10.14	1.59	7.45	0.77	8.71	18.52	3.05	2.56	4.42	2.25	3.01
100-Year	0.47	8.38	0.56	0.09	2.17	11.09	0.62	2.79	11.55	11.54	1.84	8.81	0.92	10.33	22.10	3.53	3.00	5.57	2.84	3.80
Storm Event	**Basin 6a**	**Basin 6b**	**Basin 6c**	**Basin 7a**	**Basin 7b**	**Basin 7c**	**Basin 7d**	**Basin 7e**	**Basin 7f**	**Basin 8a**	**Basin 8b**	**Basin 8c**	**Basin 8d**	**Basin 8e**	**Basin 8f**	**Basin 8g**	**Basin 8h**	**Basin 8i**	**Basin 8j**	**Basin 8k**
2-Year	5.03	0.82	0.42	1.19	0.75	4.17	1.99	0.63	0.08	5.42	5.34	4.14	0.61	0.18	2.56	0.90	0.32	1.85	1.22	1.11
10-Year	7.76	1.26	0.64	1.81	1.13	6.40	3.03	0.96	0.13	8.27	8.16	6.32	0.94	0.27	3.91	1.35	0.48	2.77	1.86	1.71
25-Year	8.69	1.41	0.72	1.95	1.20	6.88	3.25	1.04	0.14	8.94	8.83	6.83	1.01	0.29	4.24	1.44	0.51	2.96	2.02	2.02
100-Year	10.94	1.78	0.91	2.32	1.34	7.88	3.70	1.20	0.15	10.51	10.24	8.04	1.16	0.32	4.90	1.62	0.57	3.31	2.40	2.40
Storm Event	**Basin 9a**	**Basin 9b**	**Basin 9c**	**Basin 9d**	**Basin 9e**	**Basin 9f**	**Basin 9g**	**Basin 9h**	**Basin 9i**	**Basin 9j**	**Basin 9k**	**Basin 9l**	**Basin 9m**	**Basin 10a**	**Basin 10b**	**Basin 10c**	**Basin 10d**	**Basin 11a**	**Basin 11b**	**Basin 11c**
2-Year	0.01	9.86	2.34	3.58	1.00	7.36	1.44	3.24	2.72	4.68	2.06	3.42	3.31	6.42	1.69	4.73	1.65	3.28	4.84	1.35
10-Year	0.02	15.05	3.57	5.48	1.52	11.25	2.20	4.95	4.08	7.18	3.13	5.25	4.96	9.76	2.58	7.24	2.51	5.03	7.37	2.07
25-Year	0.02	16.26	3.86	5.90	1.63	12.18	2.38	5.35	4.35	8.25	3.35	5.64	5.29	10.66	2.78	7.81	2.71	5.80	8.06	2.37
100-Year	0.19	19.12	4.51	6.78	1.85	14.08	2.73	6.25	4.88	9.73	3.81	6.46	5.93	12.66	3.20	8.98	3.19	6.85	9.57	2.79
Storm Event	**Basin 11d**	**Basin 11e**	**Basin 11f**	**Basin 12a**	**Basin 12b**	**Basin 12c**	**Basin 12d**	**Basin 12e**	**Basin 12f**	**Basin 12g**	**Basin 13a**	**Basin 13b**	**Basin 13c**	**Basin 14**	**Basin 15a**	**Basin 15b**	**Basin 15c**	**Basin 16a**	**Basin 16b**	**Basin 16c**
2-Year	0.23	1.94	3.87	6.66	2.11	2.65	2.24	2.07	7.81	1.86	4.14	3.55	1.83	4.11	2.47	1.01	0.86	2.98	2.77	0.84
10-Year	0.35	2.97	5.92	10.16	3.24	4.06	3.42	3.10	11.95	2.81	6.34	5.41	2.80	6.33	3.79	1.55	1.32	4.56	4.26	1.28
25-Year	0.39	3.21	6.34	10.98	3.47	4.37	3.70	3.33	12.90	3.00	6.84	5.85	3.02	8.63	4.96	1.74	1.48	4.92	4.99	1.37
100-Year	0.46	3.80	7.23	12.87	3.98	5.02	4.37	3.72	15.29	3.38	7.86	6.96	3.46	10.25	5.97	2.06	1.75	5.84	5.91	1.57
Storm Event	**Basin 17a**	**Basin 17b**	**Basin 18a**	**Basin 18b**																
2-Year	2.33	2.47	2.06	1.29																
10-Year	3.58	3.79	3.45	2.19																
25-Year	4.21	4.24	5.11	3.28																
100-Year	4.99	5.02	5.57	3.52																

[1]Note: The peak rates shown are for the total runoff generated by the catchment only. The actual peaks at the nodes that include upstream accumulated and routed drainage are not included in this table.

3.1.4 Catchments with Largest Increase Potential

The existing and future peak runoff determined in Table 3-5a and Table 3-5b above provide an indicator of where the highest potential impacts could occur or where there are priorities for further evaluation or improvements. Table 3-6 shows the peak 25-year runoff rates under existing and future conditions and the percent change. The highest potential changes shown can provide a basis for prioritizing other improvements that may be identified in Section 4.

Table 3-6. Potential Change in Peak Flows by Catchment Area

Catchment Number	Existing Peak 25-year Flow (cfs)	Future Peak 25-year Flow (cfs)	Percent Change	Rank (highest change)
1	0.2	0.4	160%	10
2	3.9	7.3	84%	33
3	0.4	0.4	0%	82
4a	0.0	0.0	0%	83
4b	1.7	1.7	5%	77
4c	6.6	9.3	42%	72
4d	0.5	0.5	2%	79
4e	1.4	2.3	67%	52
4f	3.8	10.1	162%	8
4g	4.6	10.1	122%	13
4h	1.1	1.6	45%	69
4i	3.5	7.4	111%	19
4j	0.7	0.8	3%	78
4k	4.6	8.7	88%	29
4l	10.8	18.5	71%	46
4m	1.1	3.0	177%	6
5a	0.6	2.6	317%	2
5b	1.4	4.4	214%	4
5c	1.0	2.3	133%	12
5d	0.6	3.0	427%	1
6a	4.9	8.7	79%	42
6b	0.8	1.4	81%	39
6c	0.3	0.7	140%	11
7a	1.0	2.0	96%	25
7b	0.4	1.2	233%	3
7c	3.9	6.9	76%	44
7d	1.8	3.3	77%	43
7e	0.5	1.0	90%	27
7f	0.1	0.1	106%	22
8a	4.2	8.9	113%	18
8b	4.1	8.8	117%	15
8c	3.8	6.8	80%	40
8d	0.7	1.0	43%	70

Table 3-6. Potential Change in Peak Flows by Catchment Area (continued)

Catchment Number	Existing Peak 25-year Flow (cfs)	Future Peak 25-year Flow (cfs)	Percent Change	Rank (highest change)
8e	0.2	0.3	59%	56
8f	2.2	4.2	93%	26
8g	0.7	1.4	118%	14
8h	0.4	0.5	31%	74
8i	1.1	3.0	162%	9
8j	1.3	2.0	50%	62
8k	1.2	2.0	67%	51
9a	0.0	0.0	0%	84
9b	8.9	16.3	84%	36
9c	2.1	3.9	86%	32
9d	3.3	5.9	79%	41
9e	1.0	1.6	55%	60
9f	5.9	12.2	106%	21
9g	2.4	2.4	0%	81
9h	2.6	5.4	108%	20
9i	2.6	4.4	67%	50
9j	4.5	8.2	84%	35
9k	2.1	3.4	63%	54
9l	3.0	5.6	86%	31
9m	4.2	5.3	25%	75
10a	4.9	10.7	115%	16
10b	1.6	2.8	76%	45
10c	2.6	7.8	206%	5
10d	1.0	2.7	164%	7
11a	3.9	5.8	49%	65
11b	3.8	8.1	115%	17
11c	1.3	2.4	82%	37
11d	0.4	0.4	0%	80
11e	2.2	3.2	48%	66
11f	4.5	6.3	40%	73
12a	5.9	11.0	87%	30
12b	2.1	3.5	67%	49
12c	2.7	4.4	59%	57
12d	2.2	3.7	65%	53
12e	2.1	3.3	56%	59
12f	6.8	12.9	89%	28
12g	1.8	3.0	68%	48
13a	3.4	6.8	103%	23
13b	3.2	5.8	84%	34
13c	2.0	3.0	50%	64
14	7.3	8.6	18%	76
15a	3.1	5.0	61%	55
15b	1.1	1.7	59%	58

Table 3-6. Potential Change in Peak Flows by Catchment Area (continued)

Catchment Number	Existing Peak 25-year Flow (cfs)	Future Peak 25-year Flow (cfs)	Percent Change	Rank (highest change)
15c	1.0	1.5	50%	63
16a	3.2	4.9	55%	61
16b	2.5	5.0	99%	24
16c	0.8	1.4	70%	47
17a	2.9	4.2	47%	67
17b	2.3	4.2	81%	38
18a	3.5	5.1	47%	68
18b	2.3	3.3	42%	71

3.2 Stormwater System Operation and Maintenance

Proper operation and maintenance of the stormwater system is necessary to prolong life and effectiveness of the system as well as reduce the potential for flooding and improve water quality. There are several sources and guidelines as well as direct experience used to develop the City's stormwater practices.

Ecology provides guidance on best management practices (BMPs) for municipal operations in the Stormwater Management Manual for Western Washington (SWMMWW). This manual was developed in response to federal requirements and tailored to conditions in the Pacific Northwest.

Below are the recommended BMPs from the SWMMWW the City of Port Townsend uses for guidance for stormwater system maintenance.

- Maintenance of Public and Private Utility Corridors and Facilities
- Maintenance of Roadside Ditches
- Maintenance of Stormwater Drainage and Treatment Systems
- Spills of Oil and Hazardous Substances
- Urban Streets
- Recommendations for Management of Street Wastes.

The operation and maintenance of the stormwater system is funded by a stormwater utility fund and includes 3.55 full time equivalents (FTEs) distributed amongst several employees. This number is likely to increase as the stormwater system is extended or enhanced, increasing the need for maintenance.

Maintenance of the stormwater system includes:

- Cleaning, repairing and replacing ditches, swales, and storm drains;
- Cleaning and maintaining catch basins;
- Filter inspection and cleaning;
- Street sweeping to improve water quality;
- Maintaining stormwater ponds and infiltration galleries;
- Vegetation control;
- Repairing roadways damaged by stormwater;
- Checking for illicit discharges to the stormwater system;
- Stormwater utility locates; and
- Emergency response.

The City owns and operates the equipment necessary for most stormwater system maintenance such as vacuum truck for removing debris from catch basins, a street sweeper, dump trucks, various heavy equipment and related tools and implements.

The City of Port Townsend has developed a process over the years to identify, track and schedule stormwater system operation and maintenance activities. Listed below are current elements and activities.

3.2.1 Asset Identification

Most all stormwater system assets have been identified or are in the process of being identified and mapped and are available electronically and summarized in Table 3-7. Mapping includes the location of catch basins, culverts, detention ponds, biofiltration swales, infiltration trenches, drain pipe, rain gardens, compost filters and roadside ditches. Roadside areas that do not have adequate drainage are also noted. Data can be accessed electronically with a computer or device or available in printed map sets. Streets, roadways, trails and open space are all considered part of the stormwater system.

3.2.2 Level of Service

The level of service is measured by frequency and labor requirements as suggested by Department of Ecology guidelines and is listed in Table 3-8 for the City of Port Townsend.

3.2.3 Reporting

Most all work is issued via work order and reported and coded to the utility on timesheets. Summary reports can be generated from work orders and timesheets to update the level and cost of service.

Table 3-7. Existing Inventory of Public Facilities

Facility Type	Quantity	Measurement Unit
	Streets Swept	
Street Swept	30	Miles
Total All Roads	94	Miles
Catch Basins	1,468	Each
Maintenance Holes	114	Each
Infiltration Trenches/Perforated Pipes	0.9	Miles
Solid Pipes	25	Miles
Swales	4.1	Miles
Detention Ponds/Retention	7	Each
Culverts	3,183	Linear Feet (LF)
Storm Filters	7	Each
Stormwater Pump Facilities	2	Each

Table 3-8. Maintenance Frequency and Personnel

Facility Type	Frequency	Level of Effort
Street Sweeping		
Downtown	52 times/year	1 Maintenance Worker, 1 Sweeper
Arterials	12 times/year	1 Maintenance Worker, 1 Sweeper
Catch Basin		
Cleaning	1 time/year	2 Maintenance Workers, 1 Vactor, 1 truck
Repair/Replace	1 time/3o years	3 Maintenance Workers1 Backhoe, 1 Dumptruck, 1 truck Traffic Control
Maintenance Holes		
Cleaning	1 time/year	2 Maintenance Workers, 1 Vactor, 1 truck
Repair/Replace	1 time/30 years	3 Maintenance Workers1 Backhoe, 1 Dumptruck, 1 truck Traffic Control
Infiltration Trenches		
Cleaning	1 time/year	2 Maintenance Workers, 1 Vactor, 1 truck
Repair/Replace	1 time/15 years	3 Maintenance Workers, 1 Backhoe, 1 Dumptruck, 1 truck Traffic Control
Pipes		
Flushing/Vactor	1 time/3 years	2 Maintenance Workers, 1 Vactor, 1 truck
Repair	1time/50 years	3 Maintenance Workers 1 Backhoe, 1 Dump truck, 1 truck Traffic Control
Swales		
Vegetation/Cleaning	4 time/year	2 Maintenance Workers, 1 Vactor, 1 truck
Repair/Replace	1 time/10 years	3 Maintenance Workers, 1 Backhoe, 1 Dumptruck
Detention Ponds/Retention		
Control Structure		
Cleaning	1 time/year	2 Maintenance Workers, 1 Vactor, 1 truck
Repair/Replace	1 time/30 years	3 Maintenance Workers, 1 Backhoe, 1 Dump truck, 1 truck
Pond		
Cleaning/Vegetation	3 times/year	1 Maintenance Worker, 1 Weed Whip
Remove Sediment	1 time/5 years	3 Maintenance Workers, 1 Backhoe, 1 Dump truck, 1 truck
Ditches		
Vegetation Control	3 times/year	2 Maintenance Workers, 1 Mower
Clean, Reshape, Remove Sediment	1 time/5 years	4 Maintenance Workers, 1 Backhoe, 2 Dump trucks
Culverts		
Clean	1 time/3 years	2 Maintenance Workers, 1 Vactor, 1 truck
Clean Inlets	2 times per year	2 Maintenance Workers, 1 truck

4. BASIN PLANNING

4.1 Planning Objectives

Stormwater planning needs and objectives were discussed with City staff and the task force during early phases of the project. Technical assessments of the physical setting and watersheds were made, as described in Section 2. Section 3 describes existing conditions and development potential. This section describes the findings and recommended approaches to addressing existing and potential impacts to the drainage and natural systems, based on the analysis in Chapter 3.

The following sections describe the systems and needs for which approaches have been developed to maintain, protect, control, and upgrade natural and built stormwater systems, including:

- Assessing drainage connectivity and providing for protection of the natural and built drainage system;
- Identifying potential impacts to drainage systems, natural drainage courses, and wetlands, and techniques for reducing impact from future development (i.e., using LID to the maximum practicable extent);
- Defining future road drainage guidelines;
- Identifying potential future impacts to the natural drainage system; and
- Identifying roadway water quality improvements in the right-of-way.

4.2 Drainage Connectivity

The City has been divided into 19 drainage basins, originally delineated using the boundaries in the 1987 Plan, and updated based on better topographic information, the roadside drainage network, and the drainage flow path in existing pipes and swales (Figure 12). Each of the numbered basins has a final disposition or discharge to a receiving water or location, except basin 17, which drains to basin 9. Figure 2 shows the numbered basins and their disposition and Table 4-1 lists the basin number and the discharge point. Several basins directly runoff or are conveyed via storm sewers to the Salish Sea without entering natural drainage paths or wetlands. Two receiving waters, Kah Tai Lagoon and Chinese Gardens, also discharge to the Salish Sea.

Table 4-1. Basins and Disposition or Discharge Point

Receiving Water[1] or Discharge Point	Basin Number	Note
Salish Sea, direct	1, 2, 3, 10, 12, 13, 14	Sheet flow or storm sewer, often via multiple discharge points
Ravines, unnamed channel	11, 16	Flows to points outside of city limits
Chinese Gardens	4	
Kah Tai Lagoon	9	Basin 17 flows through Basin 9 to Kah Tai Lagoon
Closed wetland or groundwater	5[2], 6, 7, 8, 19	Here is no surface water outlet from these basins to the ocean
Jefferson County	15, 17, 18	Ultimate disposition was not determined

[1] Receiving Water—a named or known "water of the state" or the Salish Sea.

[2] Basin 5 can connect to Basin 4 if the water level rises high enough. There is no record of it doing so.

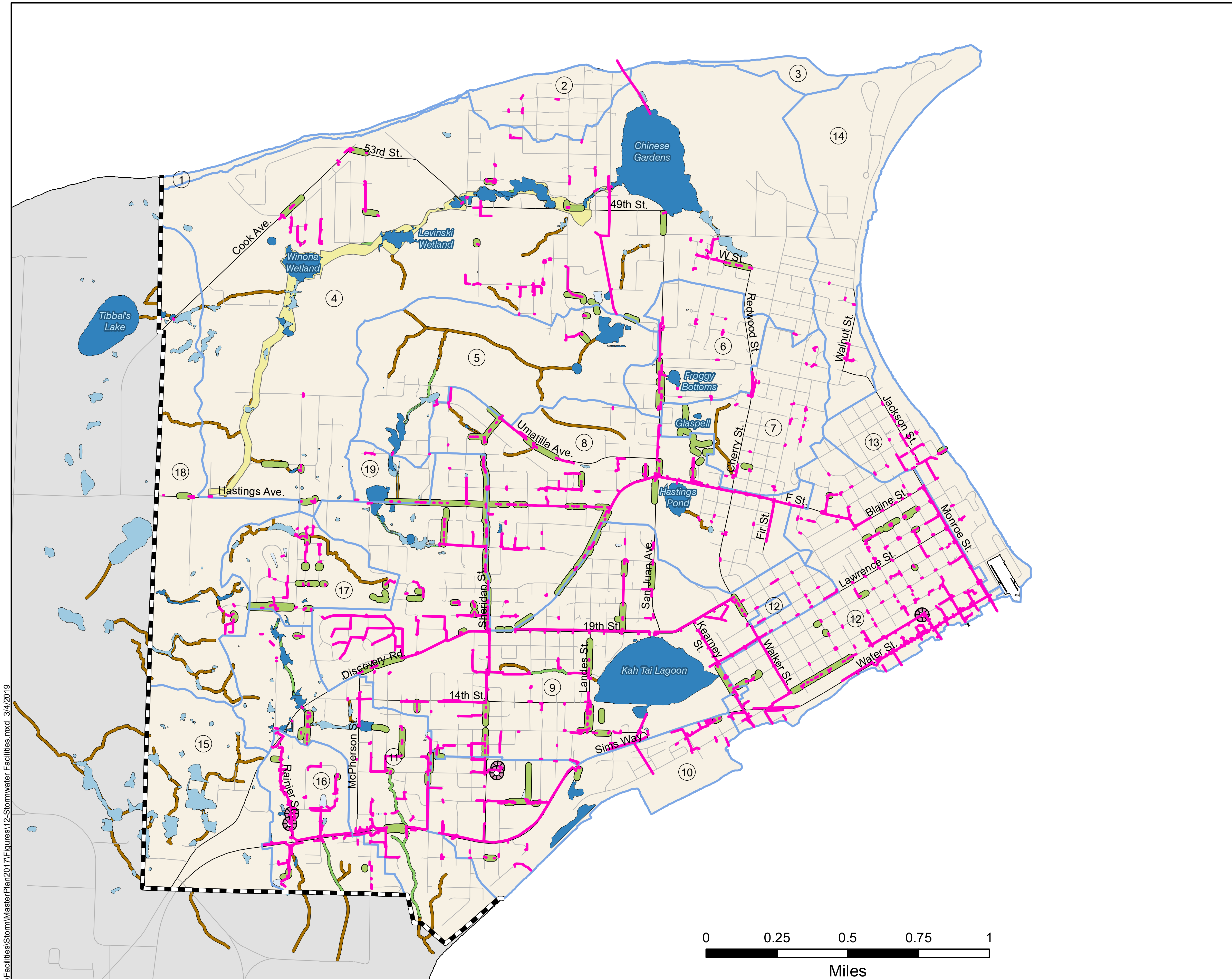
4.2.1 Drainage System Hierarchy

A key objective of the Plan is to define, provide, and protect a connected and well-defined built and natural drainage system. One challenge of doing so in Port Townsend is the almost complete lack of natural drainage systems such as streams and rivers. Without obvious natural watercourses and with the extensive land pre-platting that has occurred, the flow paths to collect and carry stormwater to the ocean are not well-structured and, in many cases, have no outlet to the ocean. Special measures are needed to define and protect the built and natural drainage system. Consequently, a hierarchy to define the drainage network was developed to describe its components and provide measures for protecting, controlling, or improving a segment in a way that is consistent with its position in the network and hierarchy. The recommended protection measures may include new or modified ordinances and standards identifying mitigation or protection measures outlined in development guidance materials.

A system with four "levels" to define the drainage network was developed (Figure 13). Like a stream ordering system, the highest level provides the backbone or trunk of the system (the highest order in the hierarchy), while each subsequent level typically drains to the next higher numbered level in the system. For Port Townsend, the levels are defined as follows:

Level 1 Receiving Locations – Level 1 are the terminus for each basin and includes all natural waters (usually named), "waters of the state" or "waters of the United States". Level 1 are the "Receiving Waters" and includes the Salish Sea (Strait of Juan de Fuca, Admiralty Inlet, and Port Townsend Bay); Chinese Gardens; Kah Tai Lagoon; named wetlands in Basins 5, 6, 7, and 8 (Blue Heron, 35th Street Park, Froggy Bottoms, Glasbell, and Hastings Pond); the basin 5 terminus to groundwater; and the Quimper Wildlife Corridor (as defined by the 100-year floodplain (see Figure 4). The extent or limits of a Level 1 water is the ordinary high-water line.

Level 2 Natural Drainage – Level 2 includes natural, piped, or planned main connectors to the Level 1 receiving locations for stormwater. They are the branches that connect to the trunk, often natural paths, delivering runoff to Level 1 waters. Generally, they are located at the lowest point of the basins, or along a main road in the basin. All Level 2 waters drain to or connect with Level 1 waters. The Level 2 Natural Drainage hierarchy is divided into two types: Level 2a CDCs and Level 2b KDs. CDCs are protected through the City's CAO. The KDs are regulated through the Stormwater Plan and the City's Engineering Design Standards. They are both important connecting features of the City's stormwater drainage network (see Figure 13).



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Stormwater Facilities
Figure 12

Stormwater Infrastructure

- Stormwater Pipes
- Swales
- Stormwater Filters
- Stormwater Ponds

Features

- Drainage Basins
- Wetlands
- Potential Wetlands
- 100 Year Flood
- Critical Drainage Corridors
- Key Drainageways
- City Limits

Stormwater System	
Stormwater Features	**Quantity**
Catchbasins	1,468
Maintenance Holes	114
Storm Filters	4
Solid Pipe	25 Miles
Perforated Pipe	0.9 Miles
Swales	4.1 Miles
Concrete Gutters	1.6 Miles

Stormwater System Levels

Figure 13

Levels

(1) Receiving Locations

(2a) Critical Drainage Corridors

(2b) Key Drainageways

(3) Flow Path Connections

(4a) Arterial & Collector Conveyance

(4b) Local Access Conveyance

Features

Drainage Basins

City Limits

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Level 2a and 2b routes were determined for this Plan by following the apparent center line of flow paths using the topographic map of the city and connecting to Level 1 waters. In some instances, the Level 2a CDCs cross built areas or roads; the CDC is considered continuous. The Level 2b KDs can follow a constructed drainage path, usually a road drainage system, for part of its path.

Level 2a CDCs – Level 2a areas are defined in the City's Critical Area Ordinance and includes natural low areas and depressions in the landscape, often linear, and are characterized as a year-round or intermittent naturally flowing watercourse which exhibits but is not limited to one or more of the following characteristics:

a. A stream or watercourse formed by nature or modified by humans;

b. Generally consisting of a defined channel with a bed for a substantial portion of its length on the lot; and

c. Perched ponds, ravines or other natural drainage features.

All CDCs (Level 2a drainage) are continuous and unbroken from its starting point downstream to its connection with a Level 1 water. To provide network continuity for the purposes of this SMP, a CDC or Level 2a water is considered continuous over and through wetlands that are encountered.

Level 2b KDs – Level 2b areas includes *natural* low areas and depressions in the landscape, to where water would flow if enough runoff was generated by a storm, but moving water is not routinely seen or has not been observed. In some instances, the Level 2b is a constructed drainage feature, for example a road drainage system, for part of its path. Level 2b waters generally drain to or connect with Level 1 receiving locations.

Level 3 Connecting Drainage Paths and Infrastructure – Level 3 includes flow paths that connect the built environment with the Level 1 waters or Level 2a and 2b drainageways. They provide continuity and connectivity for drainage created by the roadways and land development to the natural topographic flow paths. Level 3 drainage tends to be local and relatively short segments that include formal (man-made ditches and storm sewers) and informal (poorly defined) flow paths and channels. Level 3 segments are not depicted on a figure, as they are ongoing and newly defined elements of the mapped drainage system when identified and described. Level 3 segments can be defined by the city at any time when a detailed drainage analysis or review is made for new development. The long-term objective of defining and identifying Level 3 segments is for the city to gain control via easement or right-of-way to allow for protection, improvement, operation and maintenance of those segments. The Level 3 connectors may need to be constructed by new developments, through off-site mitigation, where no connection between a Level 2 or Level 4 exists.

Level 4a and 4b Constructed Drainage System – Level 4 includes the constructed drainage systems in the road rights-of-way. Level 4 represents the constructed drainage infrastructure that follows the roadway system and is either well-defined by ditches, swales, curbs, storm sewers and culverts or less well-defined roadside drainage. Level 4 has been divided into Level 4a and 4b; Level 4a represents a defined network of key constructed drainage pathways along major roads (e.g., arterials and collectors) and Level 4b represent the rest of the road network (e.g., local access and neighborhood roads) where the roadway drainage may be poorly defined or non-existent. Level 4 roadway drainage provides the primary disposition for site drainage for development. Level 4 should connect to a higher Level for disposition to a receiving water.

4.2.2 Drainage System Connectivity

The 19 basins were additionally broken down into catchment areas as shown on Figure 11. These areas were defined by topography and the configuration and disposition of the drainage system as currently understood and mapped. The CDCs and KDs (Levels 2a and 2b) provide a foundation for the network of natural drainage patterns defined by topography and provide connectivity to Level 1 receiving waters. The built drainage is almost completely located within the roadway network (Level 4). The network shown in the hierarchy system shows connectivity, but it does not indicate the size, capacity, or performance of the drainage system. To do so would require intensive data collection and modelling which is outside the scope of this analysis and is not needed to provide guidance to inform the planning effort.

Figures 8 and 13 show the catchment areas and associated KDs. The location of the peak flow rate in each drainage path is indicated at the downstream end where it discharges into a different catchment.

4.2.3 Drainage System Protection

The purpose of the drainage system definition and connectivity system described above was to provide a framework for analysis, protection, planning, and operations. Higher level systems (e.g., Level 1 and 2) may need greater protection; lower level systems (e.g., Level 3 and 4) need more improvements and maintenance. The following is general outline of key drainage resources needing protection and an approach to evaluating those protections.

Level 1 Receiving Waters

Protection:

Most or all Level 1 receiving waters have protections through the Shoreline Management Plan, critical areas ordinances, and floodplain management.

Guidelines:

Ordinance and Code should have language to protect the conveyance, flood control, water quality, and hydrologic aspects of the resource (Port Townsend Municipal Code [PTMC] 19.05).

Provide measures for mitigating and providing the conveyance, flood control, and water quality aspects of Level 1 at road crossings in unopened rights-of-way

Evaluation and Improvements:

Review protection guidelines

Prepare guidance for providing conveyance, flood control, and water quality mitigation measures when impacts to Level 1 resource cannot be avoided.

Level 2 Natural Drainage via Critical Drainage Corridors or Key Drainageways

Protection:

Critical Drainage Corridors are protected by the critical areas ordinance.

Key Drainageways are defined and regulated by stormwater standards.

Guidelines:

CDC Ordinance and Code should have language to protect the conveyance, flood control, water quality, and hydrologic aspects of the resource (PTMC 19.05).

KD should identify and protect the conveyance, flood control, water quality, and hydrologic aspects of the resource, and provide measures to quantify and mitigate unavoidable impacts. Key Drainageways may be modified by development provided the functionality is maintained.

Evaluation and Improvements:

Review and update KD maps as needed.

Provide definition, standards and review guidelines; prepare process for evaluating modifications; and prepare standards for mitigating unavoidable impacts to Level 2 resources; and prepare guidance for providing the conveyance and water quality aspects of Level 2 resources.

Level 3 Connecting Drainage

Protection:

Level 3 drainage connections should be identified and protected through easements, fee purchase, or other related permission to maintain and protect drainage connectivity.

Guidelines:

Create requirement and approach to identify Level 3 connections during the development review process.

Identify and catalogue Level 3 connections for prioritization and protection.

Evaluation and Improvements:

Review and update Level 3 connections maps or list as needed.

Prioritize Level 3 connections for protection.

Level 4 Constructed Drainage System

Protection:

Level 4 drainage is included in rights-of-way; no further ownership or regulation is needed.

Standards for right-of-way use are needed.

Guidelines:

Create or update right-of-way use permits.

Use sizing guidelines prepared in Section 4 for pipe size, ditch size, and minimum drainage requirements.

Prepare Level 4b development requirements and funding strategy.

Prepare development review and fees for Level 4b program.

Evaluation and Improvements:

Inventory pipe and ditch deficiencies in Level 4a.

Prioritize Level 4a upgrade or repair needs.

Prioritize Level 4b upgrade and repair needs.

Prepare a strategy for regular improvements in Level 4a and 4b.

4.2.4 Evaluating Potential Capacity Needs and Impacts

In Section 3, basin characteristics were identified to estimate existing and future runoff in the basins. Tables 3-5a (existing peak runoff) and 3-5b (future peak runoff) show the results of the modeling. The analysis is used to determine two planning needs: where are there expected impacts due to existing and future development and what pipe and ditch capacity is needed for roadway drainage. Details of runoff modeling and conveyance capacity analysis are presented in Appendix D. The impact analysis and drainage capacity were evaluated by modeling the catchment areas for the existing and future (uncontrolled) runoff (see Tables 3-5a and 3-5b). The peak flows shown occur at the catchment area nodes shown on Figure 11. Use of these data for drainage capacity and impact analysis are described in the following sections.

4.2.4.1 Drainage Capacity

Drainage capacity refers to the size and configuration of the conveyance ways and drainage systems for conveying stormwater to receiving waters, including the Level 1, 2, and 4 drainage paths. Modeling the entire city drainage system would be a very costly task and is rarely done in smaller cities. Modeling the Level 1 and Level 2a and 2b (CDCs and KD) for *drainage capacity* has limited utility as the corridors are very large relative to the flows, although an impact analysis is important and described below in Section 4.2.5. In lieu of modeling all of the Level 4 drainage paths and systems, a generalized runoff and capacity analysis was completed to provide information on pipe sizing under normal conditions. The results are not expected to vary greatly from one location in the City to another due the low rainfall, similar roadside conditions, and relatively insensitivity of standard pipe sizing to small flow differences.

The approach taken to evaluating drainage capacity is to consider the typical “long path” of drainage within a catchment basin and use that as a basis for the peak flows expected in any drainage system in the catchment. The peak runoff from the catchment was determined for different design storms, with the understanding that the runoff from the entire catchment would always be greater than or equal to the runoff from the longest drainage segment in the drainage area. Table 3-5b shows the peak runoff for future uncontrolled runoff generated by a catchment.

To evaluate drainage needs, standard pipe slopes and roadside ditch configurations were considered. The minimum pipe size allowed by current City Code (Engineering Design Standards) is 12-inches. The standard roadside ditch has a bottom width between 2- and 8-feet with 3:1 slide slopes. Table 4-2a shows the capacity of the standard minimum allowable pipes per slope percentage. Figure 14a is a graphic representation of Table 4-2a, or “look-up table” which is used to select a pipe size when the peak flow and slope are known. To use Figure 14a, enter the x-axis with the conveyance or existing ditch slope and move vertically to the intercept with the peak design flow. The region of this intercept indicates the pipe size needed. Table 4-2b shows the capacity of different ditch widths per slope percentage. Figure 14b is a “look-up table” for ditch width and is used the same way as Figure 14a.

Table 4-2a. Pipe Capacity for Reaches of Different Slopes

Slope (percent)	Capacity of 12" Pipe[1] (cfs)	Capacity of 18" Pipe (cfs)
0-2	5.0	14.9
2-4	7.1	21.0
4-6	8.7	25.7
6-8	10.1	29.7
8-10	11.3	33.2

[1] This value is the minimum capacity of the standard required drainage conveyance systems

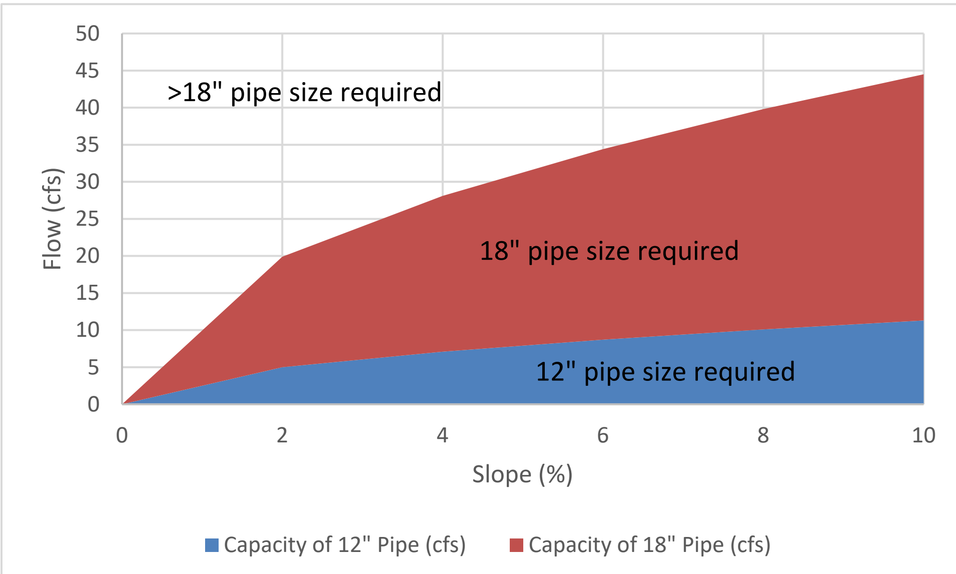


Figure 14a. Pipe Capacity "Look Up Table"

Table 4-2b. Ditch Capacity for Reaches of Different Slopes

Slope (percent)	Capacity of 2-foot[1] Ditch (cfs)	Capacity of 4-foot ditch (cfs)	Capacity of 6-foot ditch (cfs)	Capacity of 8-foot ditch (cfs)
0-2	1.8	3.2	4.7	6.1
2-4	2.5	4.6	6.6	8.7
4-6	3.1	5.6	8.1	10.6
6-8	3.6	6.4	9.3	12.3
8-10	4.0	7.2	10.4	13.7

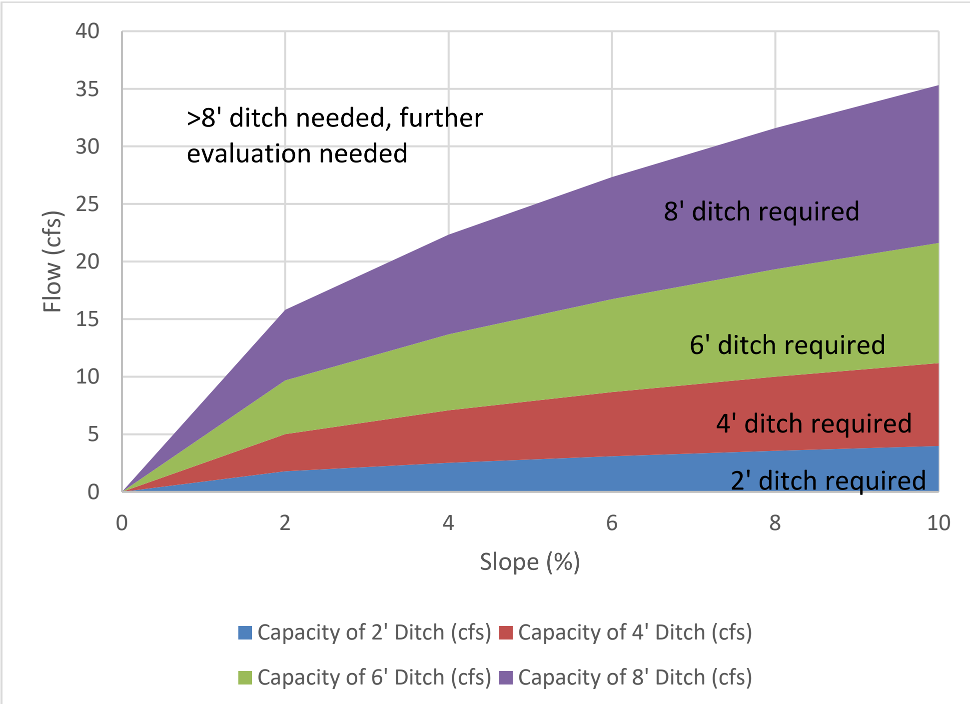
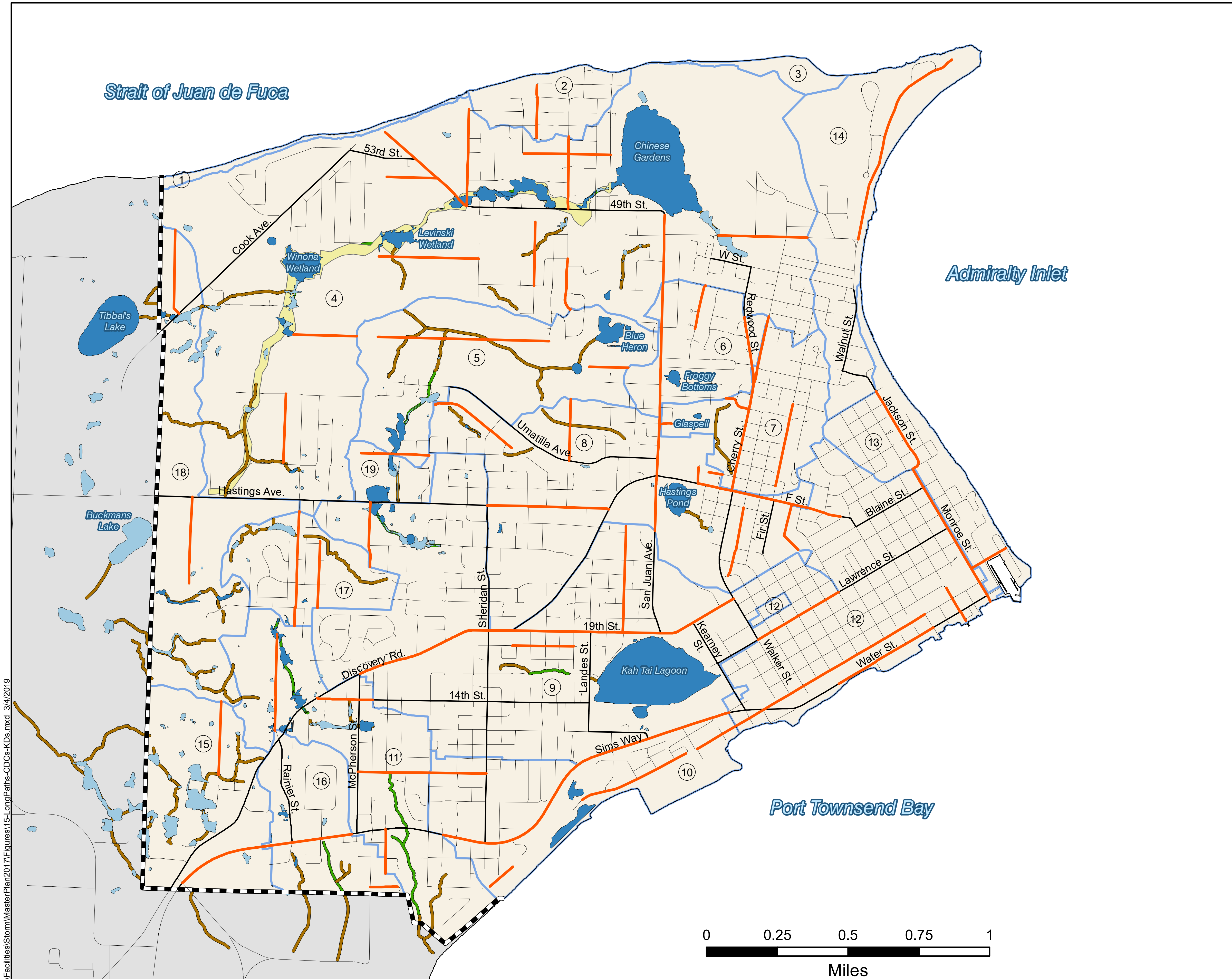


Figure 14b. Ditch Capacity "Look up Table"

4.2.4.2 Standard Drainage System Sizing

When designing or improving drainage in the roadway system, such as the Level 4 drainage system, the peak expected flow rate and channel slope are needed to design the pipe or ditch sizes needed. The City has standard minimum sizes for pipes (12-inch) and ditches (2-foot bottom), therefore many of roadways will use the minimum conveyance sizes. The drainage system capacity should include future conditions, which are not always known by persons proposing pipes in the right-of-way or the City when improvements are needed.

Table 4-3 shows the 25-year peak flows expected in all catchments under future uncontrolled conditions. This would be the largest peak flow expected at any location in the catchment except for reaches that pass through the catchment that have accumulated upstream flows (Figure 15). A reach is the primary path in which runoff is collected and conveyed in a catchment to the next downstream catchment and reach. The flow rate in a reach with an upstream catchment is higher than the flows generated by the catchment alone. Therefore, if the largest design peak flow in a catchment is smaller than the minimum allowable pipe or ditch capacity, no additional calculations need to be made to size conveyance systems in the roadside channels. The rows noted in Table 4-3 indicated by "Yes" means that the maximum expected stormwater flow in the catchment can be handled by the minimum sizes, and therefore no further evaluation of potential capacity is needed. The slope used for each catchment is estimated from available topographic mapping provided by the City at the locations shown on Figure 15. Note that the 2-foot ditch width fails in a majority of catchments. It is recommended that the 2-foot minimum ditch no longer be used unless site or project-specific calculations are made to demonstrate that it provides adequate capacity.



Long Paths, CDCs & KDs

Figure 15

Roadways

Features

Drainage Basins

Wetlands

Potential Wetlands

100 Year Flood

Critical Drainage Corridors

Key Drainageways

City Limits

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Table 4-3. Catchment Area Peak flows and Maximum Required Drainage Conveyance

Catchment Node	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Pass Criteria for 12" Pipe	Pass Criteria for 2' Ditch	Pass Criteria for 4' Ditch	Pass Criteria for 6' Ditch	Pass Criteria for 8' Ditch
1	4.0%	0.4	Yes	Yes	Yes	Yes	Yes
2	4.4%	7.3	Yes	No	No	Yes	Yes
3	4.0%	0.4	Yes	Yes	Yes	Yes	Yes
4a	4a is a wetland						
4b	4.0%	1.7	Yes	Yes	Yes	Yes	Yes
4c	2.9%	9.3	No	No	No	No	No
4d	4.0%	0.5	Yes	Yes	Yes	Yes	Yes
4e	2.3%	2.3	Yes	Yes	Yes	Yes	Yes
4f	2.5%	10.1	No	No	No	No	No
4g	2.0%	10.1	No	No	No	No	No
4h	5.3%	1.6	Yes	Yes	Yes	Yes	Yes
4i	1.7%	7.4	No	No	No	No	No
4j	2.0%	0.8	Yes	Yes	Yes	Yes	Yes
4k	1.5%	8.7	No	No	No	No	No
4l	3.6%	18.5	No	No	No	No	No
4m	9.0%	3.0	Yes	Yes	Yes	Yes	Yes
5a	2.1%	2.6	Yes	No	Yes	Yes	Yes
5b	1.0%	4.4	Yes	No	No	Yes	Yes
5c	2.0%	2.3	Yes	Yes	Yes	Yes	Yes
5d	6.7%	3.0	Yes	Yes	Yes	Yes	Yes
6a	2.0%	8.7	No	No	No	No	Yes
6b	1.3%	1.4	Yes	Yes	Yes	Yes	Yes
6c	1.2%	0.7	Yes	Yes	Yes	Yes	Yes
7a	1.3%	2.0	Yes	No	Yes	Yes	Yes
7b	3.3%	1.2	Yes	Yes	Yes	Yes	Yes
7c	1.7%	6.9	No	No	No	No	No
7d	4.8%	3.3	Yes	No	Yes	Yes	Yes
7e	1.7%	1.0	Yes	Yes	Yes	Yes	Yes
7f	1.0%	0.1	Yes	Yes	Yes	Yes	Yes
8a	2.8%	8.9	No	No	No	No	No
8b	4.4%	8.8	Yes	No	No	No	Yes
8c	4.3%	6.8	Yes	No	No	Yes	Yes
8d	6.9%	1.0	Yes	Yes	Yes	Yes	Yes
8e	3.3%	0.3	Yes	Yes	Yes	Yes	Yes
8f	6.2%	4.2	Yes	No	Yes	Yes	Yes
8g	4.0%	1.4	Yes	Yes	Yes	Yes	Yes

Table 4-3. Catchment Area Peak flows and Maximum Required Drainage Conveyance (continued)

Catchment Node	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Pass Criteria for 12" Pipe	Pass Criteria for 2' Ditch	Pass Criteria for 4' Ditch	Pass Criteria for 6' Ditch	Pass Criteria for 8' Ditch
8h	4.0%	0.5	Yes	Yes	Yes	Yes	Yes
8i	1.8%	3.0	Yes	No	Yes	Yes	Yes
8j	0.4%	2.0	Yes	No	Yes	Yes	Yes
8k	1.0%	2.0	Yes	No	Yes	Yes	Yes
9a	9a is a wetland						
9b	2.1%	16.3	No	No	No	No	No
9c	4.8%	3.9	Yes	No	Yes	Yes	Yes
9d	5.2%	5.9	Yes	No	No	Yes	Yes
9e	4.5%	1.6	Yes	Yes	Yes	Yes	Yes
9f	0.7%	12.2	No	No	No	No	No
9g	6.7%	2.4	Yes	Yes	Yes	Yes	Yes
9h	2.0%	5.4	Yes	No	No	Yes	Yes
9i	2.4%	4.4	Yes	No	Yes	Yes	Yes
9j	1.5%	8.2	No	No	No	No	No
9k	1.4%	3.4	Yes	No	No	Yes	Yes
9l	2.4%	5.6	Yes	No	No	Yes	Yes
9m	4.7%	5.3	Yes	No	Yes	Yes	Yes
10a	5.4%	10.7	No	No	No	No	No
10b	3.3%	2.8	Yes	No	Yes	Yes	Yes
10c	0.8%	7.8	No	No	No	No	No
10d	1.3%	2.7	Yes	No	Yes	Yes	Yes
11a	0.7%	5.8	No	No	No	No	Yes
11b	2.2%	8.1	No	No	No	No	Yes
11c	1.3%	2.4	Yes	No	Yes	Yes	Yes
11d	1.3%	0.4	Yes	Yes	Yes	Yes	Yes
11e	1.0%	3.2	Yes	No	No	Yes	Yes
11f	7.3%	6.3	Yes	No	Yes	Yes	Yes
12a	3.4%	11.0	No	No	No	No	No
12b	0.2%	3.5	Yes	No	No	Yes	Yes
12c	3.4%	4.4	Yes	No	Yes	Yes	Yes
12d	7.0%	3.7	Yes	No	Yes	Yes	Yes
12e	1.4%	3.3	Yes	No	No	Yes	Yes
12f	3.9%	12.9	No	No	No	No	No
12g	8.0%	3.0	Yes	Yes	Yes	Yes	Yes
13a	7.5%	6.8	Yes	No	No	Yes	Yes
13b	8.9%	5.8	Yes	No	Yes	Yes	Yes
13c	4.0%	3.0	Yes	Yes	Yes	Yes	Yes

Table 4-3. Catchment Area Peak flows and Maximum Required Drainage Conveyance (continued)

Catchment Node	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Pass Criteria for 12" Pipe	Pass Criteria for 2' Ditch	Pass Criteria for 4' Ditch	Pass Criteria for 6' Ditch	Pass Criteria for 8' Ditch
14	3.3%	8.6	No	No	No	No	Yes
15a	4.7%	5.0	Yes	No	Yes	Yes	Yes
15b	4.7%	1.7	Yes	Yes	Yes	Yes	Yes
15c	0.9%	1.5	Yes	Yes	Yes	Yes	Yes
16a	0.1%	4.9	Yes	No	No	No	Yes
16b	1.7%	5.0	No	No	No	No	Yes
16c	2.5%	1.4	Yes	Yes	Yes	Yes	Yes
17a	6.3%	4.2	Yes	No	Yes	Yes	Yes
17b	3.0%	4.2	Yes	No	Yes	Yes	Yes
18a	3.4%	5.1	Yes	No	No	Yes	Yes
18b	4.1%	3.3	Yes	No	Yes	Yes	Yes

4.2.4.3 Drainage System Sizing for Non-Standard Catchments

Table 4-4 lists the catchment areas where the 25-year peak flow in the catchment exceeds the minimum pipe or ditch size capacity (catchments with “no” in Table 4-3) and may require a larger culvert or ditch section for drainage in the catchment. The required screening-level pipe or ditch size is shown. It should be noted that the longest path of drainage for this analysis may not include all of the drainage from the catchment, and the peak flows are actually lower. When applying the screening-level data to a specific catchment or drainage path, Table 4-3 should be reviewed to determine if pipe up-sizing is needed. Figure 14a or 14b can be used if reduced peak flows are known. Generally, if the proportion of the catchment actually draining to the pipe or ditch location is known, the peak flows shown in Table 4-3 can be adjusted by that proportion. In catchments that exceed the maximum ditch width of 8 feet, the ditch should be piped using the size shown.

In addition, the peak flows shown are for uncontrolled future runoff. In reality, individual sites will be infiltrating runoff to the maximum practical extent and larger developments will control flows, so the actual accumulated peak flows will be lower. The approach to on-site controls to the maximum practicable extent is shown in Appendix F. Site and project-specific analysis can be used for sizing; however, future conditions should be applied and the same modeling assumptions used.

Table 4-4. Drainage Facility Size Estimates for Drainage Paths Exceeding Minimum Conveyance Sizing

Catchment	Future 25-year Peak Flow (cfs)	Pass Criteria for 12" Pipe or 2’ Ditch?	Predicted Pipe Size (in)	Minimum Ditch bottom Size
2	7.3	No		6.4
4c	9.3	No	15	10.2
4f	10.1	No	15	12.0
4g	10.1	No	18	13.4
4i	7.4	No	15	10.6
4k	8.7	No	18	13.4

Table 4-4. Drainage Facility Size Estimates for Drainage Paths Exceeding Minimum Conveyance Sizing (continued)

Catchment	Future 25-year Peak Flow (cfs)	Pass Criteria for 12" Pipe or 2' Ditch?	Predicted Pipe Size (in)	Minimum Ditch bottom Size
4l	18.5	No	18	18.5
5a	2.6	No		3.1
5b	4.4	No		8.1
6a	8.7	No	15	11.5
7a	2.0	No		3.0
7c	6.9	No	15	9.9
7d	3.3	No		2.5
8a	8.9	No	15	9.9
8b	8.8	No		7.7
8c	6.8	No		6.0
8f	4.2	No		2.8
8i	3.0	No		3.9
8j	2.0	No		5.7
8k	2.0	No		3.5
9b	16.3	No	18	21.3
9c	3.9	No		3.0
9d	5.9	No		4.6
9f	12.2	No	24	27.7
9h	5.4	No		7.0
9i	4.4	No		5.1
9j	8.2	No	15	12.6
9k	3.4	No		5.2
9l	5.6	No		6.6
9m	5.3	No		4.3
10a	10.7	No	15	8.5
10b	2.8	No		2.6
10c	7.8	No	18	16.5
10d	2.7	No		4.2
11a	5.8	No	15	13.0
11b	8.1	No	15	10.2
11c	2.4	No		3.7
11e	3.2	No		5.8
11f	6.3	No		6.2
12a	11.0	No	15	11.2
12b	3.5	No		14.7
12c	4.4	No		4.2

Table 4-4. Drainage Facility Size Estimates for Drainage Paths Exceeding Minimum Conveyance Sizing (continued)

Catchment	Future 25-year Peak Flow (cfs)	Pass Criteria for 12" Pipe or 2' Ditch?	Predicted Pipe Size (in)	Minimum Ditch bottom Size
12d	3.7	No		2.3
12e	3.3	No		5.0
12f	12.9	No	15	12.3
13a	6.8	No		4.4
13b	5.8	No		3.4
14	8.6	No	15	8.8
15a	5.0	No		4.1
16a	4.9	No		29.5
16b	5.0	No	15	7.0
17a	4.2	No		2.8
17b	4.2	No		4.3
18a	5.1	No		5.0
18b	3.3	No		2.7

4.2.4.4 Drainage System Sizing for Basin Reaches

Most of the 19 basins in the plan are defined around a principal drainage course that can convey stormwater runoff to the receiving waters. The drainage reaches, defined and named for the catchment in which they convey stormwater, are connected together and convey stormwater, adding the cumulative flows from upstream of the catchment nodes (see Figure 11). Figure 15 shows the drainage path for connected reaches.

Table 4-5 lists the peak flows at node points (see Figure 11) at the downstream end of the reach in the catchment for which it is named and the catchments contributing runoff to these nodes. This information is used for sizing culverts that are placed in the longer, connected reaches (usually CDCs and KDs), such as at road crossings, or for storm drains and roadside ditches in the road drainage system that conveys area-wide runoff. It should be noted that the culvert sizes shown are for uncontrolled future development flow and that actual flows in the future may be lower. Also, the flow rates can be used to size different types of structures.

Table 4-5. Peak Flows in Reaches for Structure Sizing

Reach/Node	Catchments Contributing to Node	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Predicted Pipe Size (in)	Required Channel Width (ft)
4k	4k	7.4%	8.7	12	<1.0
4l	4k, 4l	3.6%	27.2	24	2.8
4i	4k, 4l, 4i	1.7%	34.6	30	6.8
4h	4k, 4l, 4i, 4h	5.3%	36.2	24	3.3
4j	4k, 4l, 4i, 4h, 4j	2.0%	37.0	30	6.7

Table 4-5. Peak Flows in Reaches for Structure Sizing (continued)

Reach/Node	Catchments Contributing to Node	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Predicted Pipe Size (in)	Required Channel Width (ft)
4g	4k, 4l, 4i, 4h, 4j, 4g	2.0%	47.1	30	8.9
4f	4f	0.5%	10.1	24	2.8
4e	4e, 4f	2.5%	12.4	18	<1.0
5c	5c	3.3%	2.3	12	<1.0
5d	5c, 5d	6.7%	5.3	12	<1.0
5a	5c, 5d, 5a	2.1%	7.9	15	<1.0
7e	7a, 7c, 7e, 7d	1.7%	13.1	18	<1.0
8b	8b	4.2%	8.8	15	<1.0
8c	8c	1.0%	6.8	18	<1.0
8i	8i	3.0%	3.0	12	<1.0
9b	9j, 9h, 9b	2.1%	29.9	24	4.9
9c	9j, 9h, 9b, 9c	4.1%	33.7	24	3.6
9e	9l, 9e	4.1%	7.3	12	<1.0
11a	11a	0.7%	5.8	18	<1.0
11c	11a, 11c	1.3%	8.2	18	<1.0
11b	11a, 11c, 11b	2.2%	16.3	24	1.7
11e	11a, 11c, 11b, 11e	1.0%	19.5	24	4.5
11f	11f	7.3%	6.3	12	<1.0
16a	16a	7.0%	4.9	12	<1.0
16b	16b	1.5%	5.3	15	<1.0

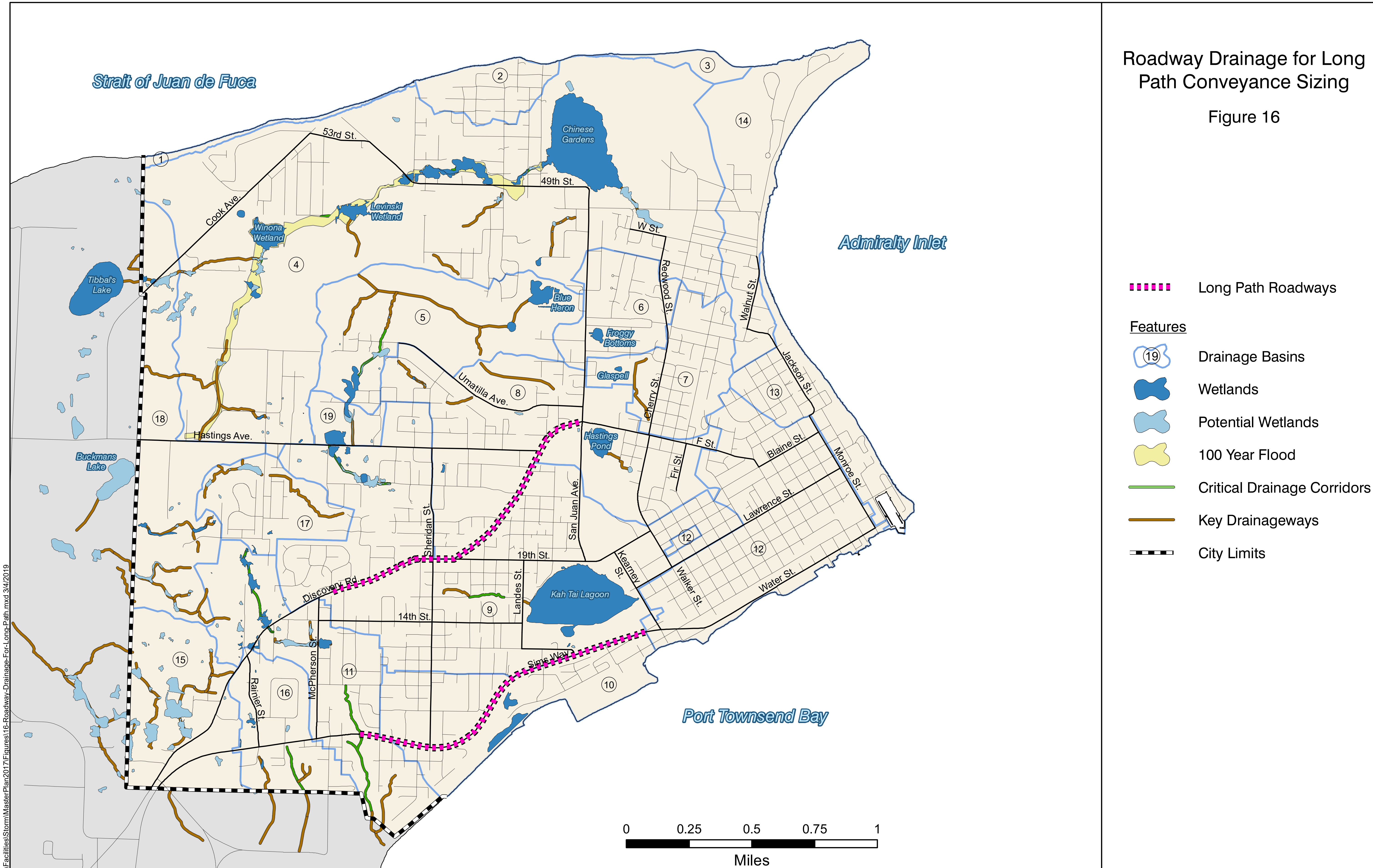
This analysis was also used to evaluate the largest potential threats to the roadway drainage system that carries area-wide runoff. For reaches in catchments with long segments in the built system, additional analysis was prepared to determine where future runoff would exceed the minimum ditch and pipe thresholds (Figure 16). Segments where the ditch or pipe size would increase are shown in Table 4-6

Table 4-6. Peak flows in Reaches for Long-Path Conveyance Sizing

Node	Catchments Contributing to Node	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Predicted Pipe Size (in)	Predicted Ditch Size (ft)
9h	9h	2.0%	5.4	15	<1.0
9b	9h, 9b	2.1%	21.6	24	3.1
8a/ 9l	9h, 9b, 8a, 9l	2.8%	36.2	24	5.2
8f	9h, 9b, 8a, 9l, 8f	6.2%	40.4	24	3.5
10a	10a	5.4%	10.7	15	<1.0
9k	10a, 9k	1.4%	14	24	2.0
10c	10a, 9k, 10c	1.4%	21.8	24	4.2
10d	10a, 9k, 10c, 10d	1.4%	24.5	24	4.9

Roadway Drainage for Long Path Conveyance Sizing

Figure 16



The greatest threats to the overall drainage system can be predicted by finding the node points with the greatest peak flow change that could occur with full development. Table 4-7 shows the greatest percent change in peak flows at the key node points. Table 4-5 can be used for sizing future drainage structures at full build-out.

Table 4-7. Peak Flow Increase at Key Nodes due to future Development

Node	Catchments Contributing to Node	Estimated Slope (ft/ft)	Existing 25 year (cfs)	Future 25-year Peak Flow (cfs)	Percent change
4k	4k	7.4%	3.8	8.7	56%
4l	4k, 4l	3.6%	15.4	27.2	43%
4i	4k, 4l, 4i	1.7%	19.0	34.6	45%
4h	4k, 4l, 4i, 4h	5.3%	20.1	36.2	44%
4j	4k, 4l, 4i, 4h, 4j	2.0%	20.8	37.0	44%
4g	4k, 4l, 4i, 4h, 4j, 4g	2.0%	25.4	47.1	46%
4f	4f	0.5%	3.8	10.1	62%
4e	4e, 4f	2.5%	5.2	12.4	58%
5c	5c	3.3%	1.0	2.3	57%
5d	5c, 5d	6.7%	1.5	5.3	72%
5a	5c, 5d, 5a	2.1%	2.2	7.8	72%
7e	7a, 7c, 7e, 7d	1.7%	7.3	13.1	44%
8b	8b	4.2%	4.1	8.8	53%
8c	8c	1.0%	3.8	6.8	44%
8i	8i	3.0%	1.1	3.0	63%
9b	9j, 9h, 9b	2.1%	15.9	29.9	47%
9c	9j, 9h, 9b, 9c	4.1%	18.0	33.7	47%
9e	9l, 9e	4.1%	4.1	7.3	44%
11a	11a	0.7%	3.9	5.8	33%
11c	11a, 11c	1.3%	5.2	8.2	37%
11b	11a, 11c, 11b	2.2%	8.9	16.3	45%
11e	11a, 11c, 11b, 11e	1.0%	11.1	19.5	43%
11f	11f	7.3%	4.5	6.3	29%
16a	16a	7.0%	3.2	4.9	35%
16b	16b	1.5%	2.5	5.3	53%

4.2.5 Drainageway Potential Impact Assessment

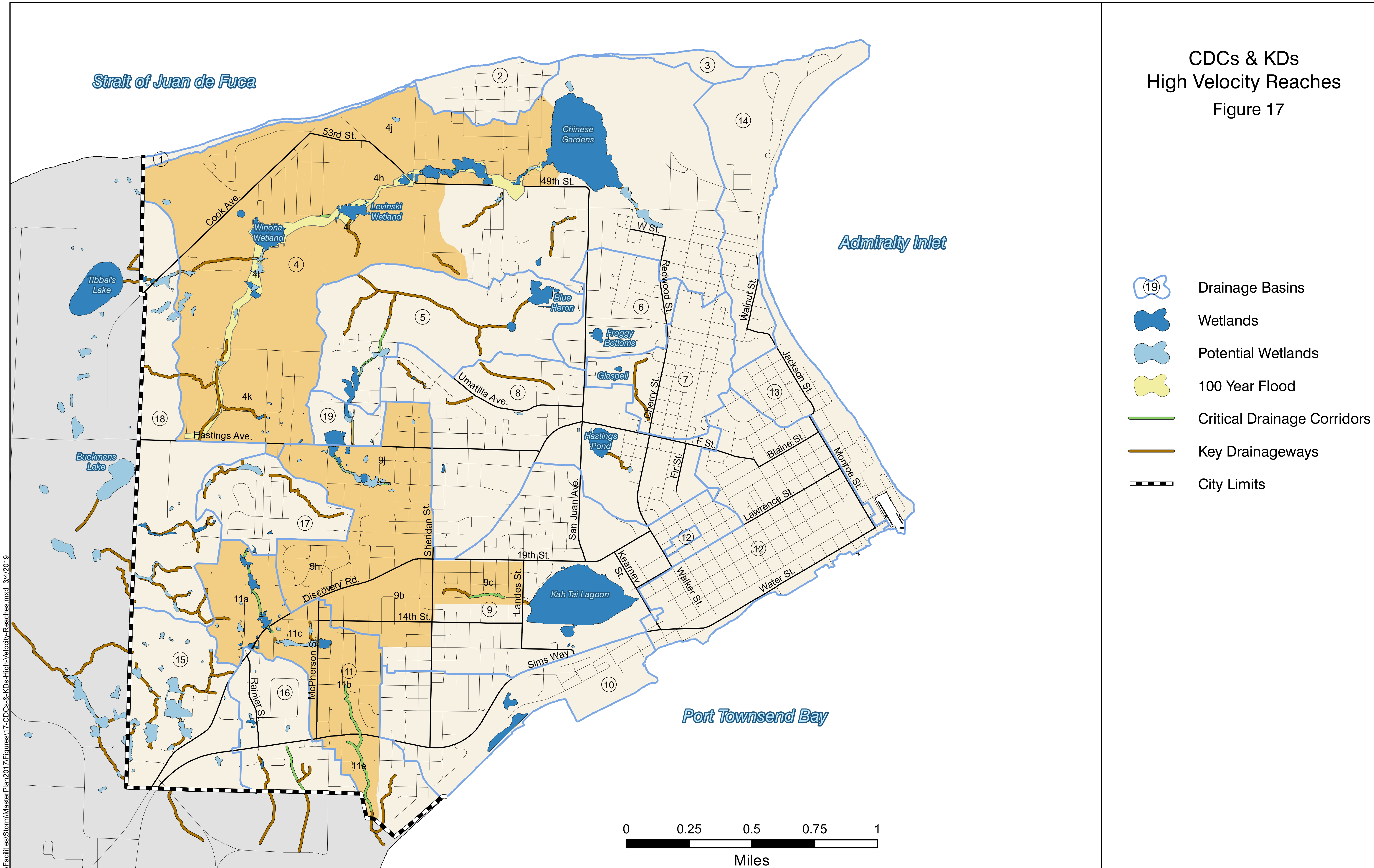
Because there are no streams or typical natural drainageways in the City, it is difficult to use metrics commonly used for evaluating potential impacts such as flow-frequency increases or stream hydrology changes (i.e., pulse counts and duration, flashiness indices). The existing natural drainage system, represented in the City by Levels 1, 2a (CDCs) and 2b (KDs) were evaluated to determine if future physical impacts to the natural drainage system could be expected due to anticipated growth and buildout. The metric chosen for screening CDCs and KDs is based on the potential for exceeding channel erosion thresholds that could cause the natural earthen channels found in the CDCs and KDs to erode (USDA 2007). If future uncontrolled peak flows exceed the velocity threshold for the 25-year peak flow, those affected CDCs and KDs are included in the Section 6 implementation plan as needing additional hydrologic evaluation (i.e., peak flows may be lower due to stormwater controls or they nearly meet the 25-year threshold) or are threatened by future development and may require additional basin controls.

For the analysis, a typical standard CDC or KD channel section was defined (10-foot bottom, 3:1 side slopes, 1-foot flow depth as shown in Appendix D) and reach-specific slopes were used. Channel reaches that exceed the selected velocity threshold of 3.75 feet/second at the respective flow return frequency are shown in Table 4-8 and Figure 17. The detailed channel conveyance and erosion analysis is provided in Appendix D. The reaches not shown on the table but included in Figure 17 all pass the threshold value.

Table 4-8. CDC and KD Velocity Thresholds

Reach	Catchments Contributing to Reach	Estimated Slope (ft/ft)	Future 25-year Peak Flow (cfs)	Estimated Velocity for 10-year Storm Event (ft/sec)	Estimated Velocity for 25-year Storm Event (ft/sec)	Estimated Velocity for 50-year Storm Event (ft/sec)	Estimated Velocity for 100-year Storm Event (ft/sec)
4l	4k, 4l	5.2%	27.2	4.21	4.47	4.59	4.74
4i	4k, 4l, 4i	1.2%	34.6	2.80	2.96	2.74	3.13
4h	4k, 4l, 4i, 4h	1.2%	36.2	2.84	3.00	3.07	3.17
4g	4k, 4l, 4i, 4h, 4j, 4g	6.5%	47.1	5.50	5.79	5.93	6.11
5d	5c, 5d	7.8%	5.3	2.69	2.82	2.94	3.06
5a	5c, 5d, 5a	1.9%	7.9	1.73	2.09	2.15	2.24
5b	5c, 5d, 5a	1.6%	7.9	1.88	1.98	2.04	2.12
9c	9j, 9h, 9b, 9c	8.5%	39.4	5.47	5.65	5.76	5.97
11b	11a, 11c, 11b	3.6%	16.3	3.18	3.32	3.38	3.51
11e	11a, 11c, 11b, 11e	5.2%	19.5	3.83	3.98	4.06	4.22

The reaches shown which exceed the 25-year 3.75 feet/second velocity threshold were further examined for their location in the system and their actual potential threat. The Basin 4 reaches (4l and 4g) have fairly steep segments that account for the velocity failure. The change in runoff from development is moderate (see Table 3-6) and there is extensive storage in wetlands throughout the system. This is a lower priority for future analysis of additional stormwater controls or a regional system. Reaches 9c and 11e have a higher potential for future impacts and are included in the implementation plan as higher priority for additional analysis or regional controls. The remaining CDCs and KDs should continue to be inspected and reviewed for observed impacts.



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4.2.6 Potential Impacts to Closed System Wetlands

Depending on their size and the relative size of the drainage area, wetlands may be sensitive to impervious surface changes in the basin. The drainage basins with discharges to wetlands—Basins 4 through 9—were assessed for potential impacts from new development. The analysis approach was based on the 2005 SWMMWW Appendix 1-D and is summarized in Appendix D. New impervious surfaces increase runoff to wetlands, potentially affecting peak stages and stage duration that can change the wetland. Wetlands with surface outlets are less likely to change, while closed wetlands with no surface outlet are more susceptible to change.

For the wetland impact potential analysis, an impact level of 1-foot increase was used, and the area of new impervious surface in the basin that would result in this change was determined. The results are shown in Table 4-9. Basins 6 and 8 show that potential impacts from new basin development could occur. The wetland (Froggy Bottoms) in Catchment 6a has an outlet, so the potential for impact is lessened. The approach to further evaluating potential impacts or mitigation of impacts is to reduce allowable new development in those areas, provide additional controls through infiltration potential, increase the protection area around the wetland to allow it to increase in size, or provide for a high-level overflow of the wetlands—as is available in the Basin 6 wetland. Figure 18 shows the potential increased footprint for wetlands in basins 5, 6, 7, and 8 at full buildout with no development controls.

Table 4-9. Potentially Impacted Wetlands

Wetland Name	Wetland Area (ac.)	Allowable Additional Impervious Percent	Estimated Future Impervious Percent Change
Wetland 4a	46.5	30	>30
Wetland 5b	5.2	5	>70
Wetland 6a	1.3	3	>70
Wetland 7f	0.9	2	>40
Wetland 8b	5.3	5	>40
Wetland 9a	46.4	37	>30

4.3 Drainage System Stormwater Improvements

The existing constructed drainage system is predominantly part of the road system, which collects and conveys runoff from roadways and development to natural drainage areas and receiving waters. Figure 15 shows the key drainage paths and Table 3-5 shows the estimated peak flow rates at catchment node points (see Figure 11). In addition to drainage capacity, the roadway drainage system is also the predominant location for existing incidental stormwater quality via runoff flowing through existing grassy ditches or swales. As described in the previous section, modeling the entire drainage system for capacity was not completed due to the relative homogeneity of the drainage areas and subsequent runoff rates (see Table 3-5). Instead "typical" conveyance size for the design storm flow capacity was defined and the findings can be applied to all drainage conveyance channels or ditches.

The prioritization for future implementation will be made by City staff based on known needs. For example, the first priority is to upgrade roadside "ditches" to properly performing swales based on conveyance needs and road condition. Often inadequate roadside drainage leads to premature road failure. Level 4a roadways have not been assessed for existing capacity, which would be done by applying the catchment flow results to each drainage reach. Generally, culverts must be a minimum of

12-inches in all systems except Discovery Road, Sims Way, and Hastings Avenue or ditches less than the sizes indicated would be considered deficient.

Water quality sizing and the typical water quality roadway ditch section is smaller than that needed for the peak conveyance flow. Upgrades to meet the minimum conveyance capacity will address water quality. Road improvements are usually required to retrofit for flow control and water quality; having funding available to achieve this will be a key part of the implementation plan. If new storm sewers are proposed or constructed in Level 4a or 4b road segments, water quality treatment for that roadway segment will be required per the Manual, usually in the form of bioretention or modular treatment.

The Level 4b road system will also need upgrades, although their role is to provide local drainage to other levels, not to provide regional drainage. Consequently, the maximum design flow rates are expected to be smaller. The minimum pipe size is 12-inches, which can handle all likely peak flows from the Level 4b roadways (see Table 4-3). The minimum standard ditch section for conveyance is also approximately the same as the required biofiltration section for these flows, therefore treatment will be provided.

4.4 Roadway Inventory for Upgrade Opportunities

The Level 4a roadways were inventoried to determine where space was available for future drainage or water quality improvements could be made. The inventory includes information on right-of-way and pavement width, sidewalks, curb and gutter or ditch, and existing swales. Additional information for each roadway segment is included in Appendix E.

Future Impact Estimate
Wetland Footprints

Figure 18

Features

Wetlands

Potential Wetlands

N

0 100 200 300 400

Feet

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5. CAPITAL PROJECTS PLAN

Capital projects are identified in basin plans to describe, estimate, and provide a basis for design of proposed constructed facilities to address the stormwater needs identified in the plan. Most stormwater capital project plans include:

- Solutions for chronic, known flooding and drainage problems;
- Typical concept designs and unit costs for improvements, such as roadway conveyance and water quality retrofitting;
- Regional or neighborhood stormwater management facilities to support existing and future development;
- Basin-specific stormwater retrofit projects to retroactively address stormwater impacts from existing development;
- Basin planning studies; and
- Capital acquisition, such as land or equipment

Preliminary engineering is prepared for the constructed capital projects to develop planning-level cost assumptions for programming and planning these projects. The implementation plan to prioritize and schedule the capital projects is described in Section 6.

5.1 Proposed Capital Projects

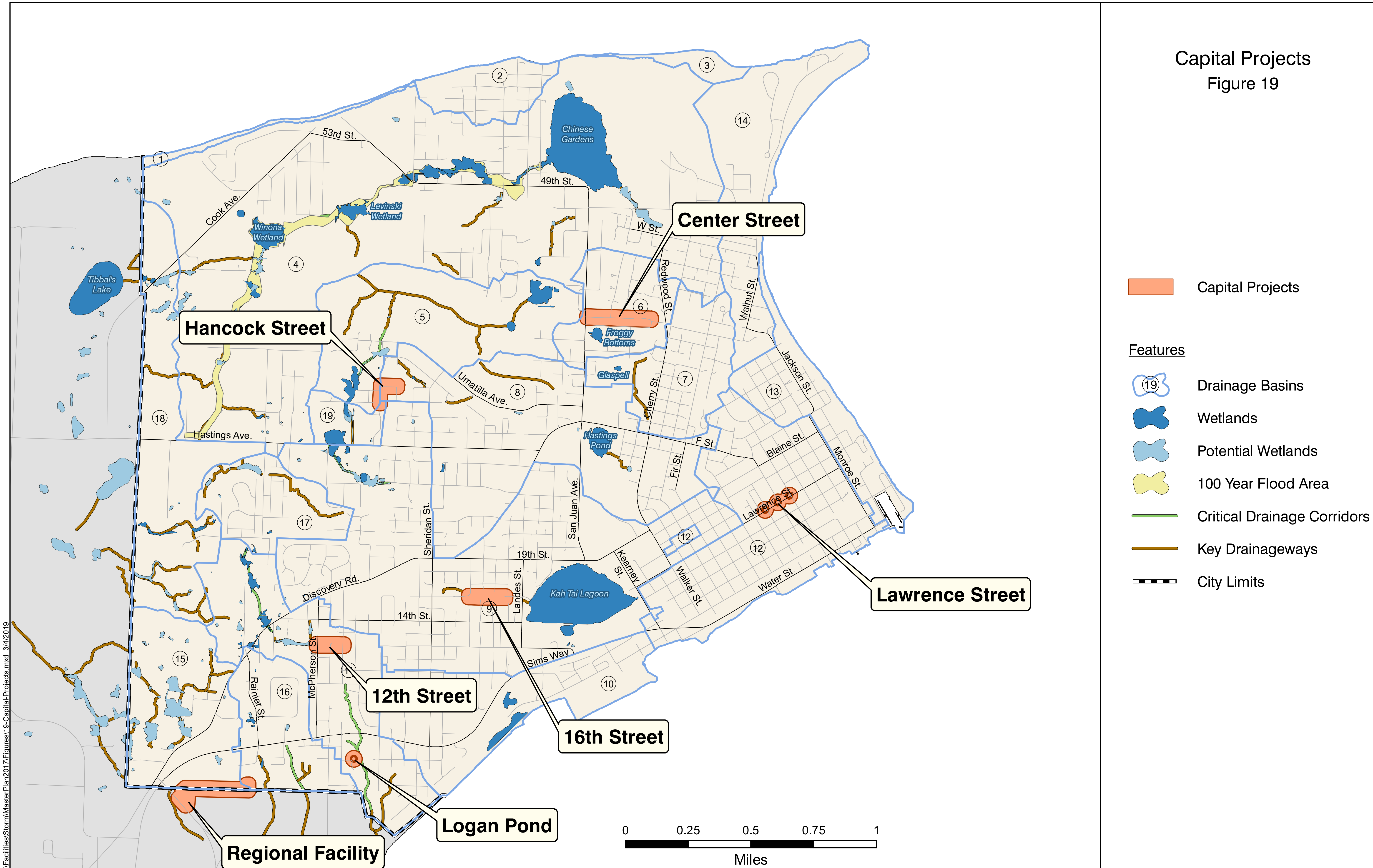
A meeting between Parametrix and the City on June 20, 2017, revealed several known problem areas in varied locations within the city limits. Five capital projects were identified by the City to be included in the Plan, covering some of the typical categories listed above (Figure 19). Each problem area was visited in the field on November 2, 2017 to collect data to aid in determining appropriate solutions. Preliminary solutions were designed using information gathered in the field and in discussions with the City.

A brief description of the problem and proposed solution for each project is shown in Table 5-1. Project plan sheets showing the preliminary design approach and planning-level costs are provided in Appendix G.

The total project costs are based on the conceptual plan layouts shown in Appendix G. Material quantities, labor, mobilization costs (approximately 15 percent of subtotal), traffic control costs (a minimum of 2 percent of the subtotal), and erosion and sedimentation control (a minimum of 2 percent of the subtotal) were estimated. In addition, environmental permitting and documentation, administration, and design and management costs have been considered. Lastly, a contingency factor of 30 percent has been added to the final cost.

Table 5-1. Capital Projects

Project No. and Title		Estimated Cost	Problem Description	Proposed Solution
1	16th Street – Sheridan Street to Landes Street	$187,000	Site consists of an undeveloped right-of-way. Stormwater from Sheridan Street, 14th Street, and 16th Street is conveyed through a closed system to an outfall located at 16th Street and Gise Street, where severe erosion has occurred in 16th Street.	Install a closed conveyance system along the 17th Street Right-of-way between Gise Street and Hill Street while maintaining some flow in the 16th Street corridor.
2	12th Street ROW, Logan Street, and 14th Street	$614,000	Several flooding issues occur near the wetland located at McPherson Street and the 12th Street right-of-way and at 14th and McPherson Streets.	Construct roadside bioswales to convey drainage from between McPherson St and Logan St to a new storm sewer pipe that will convey stormwater south along Thomas St to an existing wetland. Runoff on 14th St from Logan St to Rosecrans St will be conveyed through proposed bioswales directing runoff to an existing conveyance system that discharges to a critical drainage area on 16th St and Gise St. Additionally, an existing swale from the 12th St ROW will be connected to a proposed closed storm system that will convey stormwater south to an existing conveyance system before discharge to a CDC.
3	Center Street – San Juan Avenue to Olympic Avenue	$432,000	There exists a low point (sump) condition along Center St between San Juan Ave and Spruce St, along with a lack of well-developed roadside drainage infrastructure, which creates flooding issues.	Construct roadside drainage ditches and culverts per a standard roadway section with closed conveyance to a wetland located south of Cedar Street.
4	Hancock Street and 32nd Street	$188,000	Poor drainage exists along Hancock Street and in the intersection of Hancock Street and 32nd Street. Ponding occurs in roadway. Catch basin connected to sanitary sewer system exists, and City intends to separate.	Construct bioswales per standard roadway section with a proposed culvert beneath 32nd Street to convey drainage north and west to a critical drainage area. Stormwater currently captured by an existing catch basin tied existing sanitary system at 31st Street and Hancock Street to be conveyed west along 31st Street to critical drainage area.
5	Lawrence Street at intersections of Polk Street, Taylor Street, and Tyler Street	$858,000	Storm sewer catch basins located on Lawrence Street at the intersections of Polk Street, Taylor Street, and Tyler Street are currently directly connected to sanitary sewer system. City intends to separate stormwater from sanitary sewer system.	Construct new stormwater conveyance system with trunk-line running north along Lawrence Street with lateral pipes and catch basins to collect stormwater on both sides of Lawrence Street. A downstream capacity analysis is necessary to verify the practicability of this approach.
6	Rainier Street Regional Stormwater Project		Underway in 2019	
7	Logan Street Stormwater Pond Overflow		Underway in 2019	
	Total Cost	**$2,279,000**		


Capital Projects
Figure 19
Capital Projects
Features
Drainage Basins
Wetlands
Potential Wetlands
100 Year Flood Area
Critical Drainage Corridors
Key Drainageways
City Limits
Center Street
Hancock Street
Lawrence Street
12th Street
16th Street
Logan Pond
Regional Facility
Chinese Gardens
Levinski Wetland
Winona Wetland
Tibbal's Lake
Froggy Bottoms
Glaspell
Hastings Pond
Kah Tai Lagoon
53rd St.
49th St.
Cook Ave.
W St.
Redwood St.
Walnut St.
Jackson St.
Umatilla Ave.
Cherry St.
Hastings Ave.
F St.
Blaine St.
Monroe St.
Fir St.
San Juan Ave.
Sheridan St.
Lawrence St.
19th St.
Kearney St.
Walker St.
Water St.
Discovery Rd.
Landes St.
14th St.
McPherson St.
Sims Way
Rainier St.
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Miles
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5.2 Proposed Recurring Capital Projects

The plan has considered the potential need for drainage improvements in the Level 4a and 4b road systems. Deficiencies and priorities in these systems will be developed by an on-going and regular evaluation by City maintenance and engineering staff. Funds to make repairs are needed to address the program developed by staff. A lump cost was identified; the funding is identified in Table 5-2.

Table 5-2. Other Built Capital Projects

	Project Title	Estimated Cost total over 6 years	Distribution
1	Roadside Conveyance Improvements – Major Collectors and Minor Arterials (Level 4a)	$300,000	Allocate $300,000 every 6 years starting in 2021, to align with street upgrade projects.
2	Roadside Conveyance Improvements – Local Access Streets (level 4b)	$100,000	Allocate $100,000 every 6 years starting in 2022.
	Total Cost	**$400,000**	

6. IMPLEMENTATION

The implementation plan summarizes specific plan actions, capital projects, policy needs, an implementation schedule, and an itemized cost for each item. There are few outside drivers to plan implementation, therefore it is likely to be executed as resources are applied or come available. Plan costs for capital projects are estimated and a suggested annual cost for implementing recurring projects and upgrades is provided. However, no final timeline is included for delivery of capital projects because available funding stream information is still under evaluation and is not available.

6.1 Capital Plan Priorities and Schedule

Capital projects are identified in basin plans to address known flooding problems; capital improvements, upgrades or repairs; new facilities, such as regional stormwater ponds or retrofitting projects; land purchase and protection; and restoration or mitigation. The SWMP is primarily addressing flooding problems and future projects to improve street drainage. Table 6-1 shows the relative ratings and ranking for implementation priority.

6.1.1 Capital Projects for Existing Flood Control

The Capital Projects Plan includes 20 proposed capital projects. These projects include repair and minimization of existing flooding problem areas; new regional facilities for retrofitting and new development; and upgrades to existing facilities. The projects were ranked and prioritized according to four categories:

- Area benefitted—the number of parcels or land area served
- Need/severity—the need for the solution or project to facilitate other work and the seriousness of the problem
- Cost—low or no cost or many benefits for cost
- Opportunity—the project is ready to go, the land is owned by the City, and there are no concerns or issues with implementation

Table 6-1. Capital Projects Rankings and Priority

Item Number	Project Number	Project Name	Area Benefitted	Need or Severity	Cost/Benefit	Opportunity or Constraints	Rank Total	Rank
6.1.1	1	16th Street – Sheridan Street to Landes Street	MED	HIGH	MED	LOW	8	3
6.1.2	2	12th Street ROW, Logan Street, and 14th Street	LOW	HIGH	LOW	LOW	6	7
6.1.3	3	Center Street – San Juan Avenue to Olympic Avenue	MED	LOW	HIGH	MED	8	3
6.1.4	4	Hancock Street and 32nd Street	LOW	MED	MED	MED	7	6

Table 6-1. Capital Projects Rankings and Priority (continued)

Item Number	Project Number	Project Name	Area Benefitted	Need or Severity	Cost/Benefit	Opportunity or Constraints	Rank Total	Rank
6.1.5	5	Lawrence Street at intersections of Polk Street, Taylor Street, and Tyler Street	MED	MED	MED	MED	8	3
6.1.6	6	Rainier Street Regional Stormwater Project	HIGH	MED	HIGH	MED	10	1
6.1.7	7	Logan Street Stormwater Pond Overflow	HIGH	LOW	MED	HIGH	9	2

N/A means projects not ranked.

6.1.2 Non-Capital Recurring Projects

Non-capital recurring projects, in the context of this plan, means minor, local, ongoing improvements, upgrades, repairs, and replacements of the drainage system. They are often completed as part of a larger project or are identified by a complaint. In addition, it can include systematic improvements or upgrades to a part of the system that has been neglected or is changing due to new development. An example of this is the Level 4b roadway network.

The analyses prepared in Section 4 identified future drainage system need on 4a and 4b roadways, on continuous reaches of roadway drainage, crossings for long drainage reaches, and potential impacts on CDCs and KDs. The analysis identified threats and areas for additional study; specific needs and found problem areas was outside the scope of this plan. However, planning for future needs based on the identified deficiencies is included in this implementation plan.

Table 6-2. Summary of the Roadway Drainage Improvement Plan

Item No.	Plan Section No.	Action	What it is	Quantity	Effort and Cost	Timeline Priority
6.1.8	4.2.4	Future system upgrades in Level 4a	Provide a fund to make roadway drainage improvements when acute problems occur in the Level 4a system	3 drainage upgrades per year that require new pipes or structures.	Moderate	Annual
6.1.9	4.2.4	Future system upgrades in Level 4b	Provide a fund to make roadway drainage improvements when acute problems occur in the Level 4a system	500 feet of ditch drainage upgrades per year and 500 feet of 12” pipe per year.	Moderate	Annual
6.1.10	4.2.3	Future system upgrades in Level 1-2	Provide a plan and fund to make drainage improvements when acute problems occur	1 Plan.	Low	Annual

Table 6-2. Summary of the Roadway Drainage Improvement Plan (continued)

Item No.	Plan Section No.	Action	What it is	Quantity	Effort and Cost	Timeline Priority
6.1.11	4.2.4.4	Long-path road drainage upgrade analysis	Review the structures and ditch in the long-path drainage systems. Prepare a needs assessment and add to Capital Projects Plan	One study	Low	Early and Moderate
6.1.12	4.2.4.4	Long-path road drainage upgrades	Implement identified capital projects; up to 4 anticipated	1 drainage upgrade per year	High	Annual starting in Year 5; Moderate
6.1.13	4.2.5	CDC and KD impact mitigation analysis	Review the 4 CDCs or KDs with potential impacts. Identify actual threat and prepare scenarios for mitigation	One study	Low	Early and Moderate
6.1.14	4.2.5	CDC and KD impact mitigation	Implement study results	One Plan	High	Year 3 and Low
6.1.15	4.2.6	Closed Wetland System impact and mitigation analysis	Review the 4 wetlands with potential impacts. Identify actual threat and prepare scenarios for mitigation	One study	Moderate	Year 3 and Moderate
6.1.16	4.2.6	Closed Wetland System impact mitigation	Implement study results	One Plan	High	Year 5 and Low

6.2 Stormwater Control Standards and Policies

Basin planning is used to assess existing and future threats to the City's ability to provide a level of service to the community to protect the resource, minimize flooding and drainage problems, and maintain safety. The nature of most threats are new development that increases runoff; changes in flow paths and capacity; and/or a degrading and failing existing system that is not properly maintained. This section describes measures to protect the existing system from new development.

6.2.1 Stormwater Control from New Development

Runoff from new development is usually controlled by using a system to minimize runoff changes from a site or by constructing stormwater controls that serve multiple sites, such as a subdivision or regional stormwater facility. Most stormwater in western Washington in National Pollution Discharge Elimination System (NPDES) Municipal Permit communities is controlled by following Ecology's SWMMWW or an approved equivalent manual, which applies to new development or significant redevelopment proposals. The City is using the 2005 SWMMWW (the City is not an NPDES community). A review comparing the 2005 and 2014 SWMMWWs was made and the findings are shown in Appendix H. We recommend that the City continue to use the 2005 SWMMWW for new development and redevelopment that triggers review under the manual.

As described earlier, the City has areas with platted lots, often 5,000 square feet in size and rights-of-way that are not developed. Proposed development or redevelopment of these lots may or may not exceed SWMMWW thresholds for stormwater control. As described in the analysis in Section 4, uncontrolled development of these areas does result in increased flows and can cause impacts. These areas should control runoff to the maximum extent practicable (MEP). Policies and guidelines for landowners with development projects that do not trigger SWMMWW thresholds are included in Appendix F.

6.2.2 Drainage System Protection

Receiving waters (Level 1), Critical Drainage Corridors, and Key Drainageways (Level 2) were defined in Section 4. These are areas that could be impacted by future uncontrolled stormwater or direct impacts to their conveyance pathway. The following describes protection for Level 1 and 2 drainage, example guidelines, and measures for protecting these resources.

Level 1 Receiving Waters

Protection:

- Most or all Level 1 receiving waters have protections through critical areas ordinances and floodplain management.

Guidelines:

- Ordinance and Code should have language to protect the conveyance, flood control, water quality, and hydrologic aspects of the resource.
- Provide measures for mitigating and providing conveyance, flood control, and water quality aspects of Level 1 at road crossings in unopened rights-of-way.

Evaluation and Improvements:

- Review ordinances and protection guidelines
- Prepare guidance for providing conveyance, flood control, and water quality measures when Level 1 resource impacts cannot be avoided.

Level 2 Natural Drainage via Critical Drainage Corridors or Key Drainageways

Protection:

- CDC are protected by the critical areas ordinance

- Key Drainageways are defined and protected through the stormwater code Guidelines:
  - CDC Ordinance and Code should have language to protect the conveyance, flood control, water quality, and hydrologic aspects of the resource.
  - KD should identify and protect the conveyance, flood control, water quality, and hydrologic aspects of the resource and provide measures to quantify and protect or mitigate unavoidable impacts.

Evaluation and Improvements:

- Review and update KD maps as needed.
- Review and update the stormwater code to incorporate the regulatory framework for protection and regulation of the KDs.
- Review and update the Engineering Design Standards (EDS) to reflect guidelines in this Plan.
- Provide review ordinances guidelines.
- Prepare process for evaluating modifications and standards for mitigating and providing the conveyance, flood control, and water quality aspects of Level 2 at road crossings in unopened rights-of-way

Level 3 drainage connections, as described in Section 4.1, also need identification and protection measures, as described below.

Level 3 Connecting Drainage

Protection:

- Level 3 drainage connections should be identified and protected through easements, fee purchase, or other related permission to maintain and protect drainage connectivity

Guidelines:

- Create requirement and approach to identify Level 3 connections during site plan review.
- Identify and catalogue Level 3 connections for prioritization and protection

Evaluation and Improvements:

- Prioritize Level 3 connections for protection.

Level 4 drainage, which is collection and conveyance in the existing (and future) road system, requires standards for allowable modifications, crossing standards, conveyance sizing for new roads, and guidance for defining and upgrading deficient systems. Measures for defining and protecting this drainage level include:

Level 4 Constructed Drainage System

Protection:

- Level 4 drainage is included in rights-of-way; no further ownership or regulation is needed.
- Standards for right-of-way use permits

Guidelines:

- Update right-of-way use permits if needed.
- Use sizing guidelines prepared in Section 4 for pipe size, ditch size, and minimum drainage requirements.
- Prepare Level 4b development requirements and funding strategy.
- Prepare development review and fees for Level 4b program.
- Review and update the EDS to reflect guidelines in this Plan.

Evaluation and Improvements:

- Inventory pipe and ditch deficiencies in Level 4a.
- Prioritize Level 4a upgrade or repair needs.
- Prioritize Level 4b upgrade and repair needs.
- Prepare a strategy for regular improvements in Level 4a and 4b.

Table 6-3. Summary of Stormwater Control and Drainage Protection

Item No.	Plan Section No.	Action	What it is	Benefit	Effort and Cost	Timeline Priority
6.2.1	4.2.3	Adopt basin plan	Guidance for stormwater management, policy, land use recommendations, and capital projects.	Establish basin specific City approaches and priorities.	Moderate	Early and High
6.2.2		Continue to use 2005 Ecology Manual	The stormwater manual for new development and redevelopment	In use and is applicable and appropriate to City system	None; existing action	N/A
6.2.3		Adopt guidance for individual lot stormwater controls	Adopt "maximum extent practicable" stormwater controls focused on sites below the stormwater manual threshold	Stormwater controls will be applied that are commensurate with MEP and address pre-platted lots	Low	Early and High
6.2.4	4.2.3	Adopt drainage level designations as defined in the SWMP in codes and standards	A hierarchy to define the drainage network to provide for protecting, controlling, or improving a segment	Streamline development process	Moderate	Early and High
6.2.5	4.2.3	Update codes and standards to implement protection measures for Level 2b Key Drainageways	Align Level 2b waters with the stormwater plan recommendations	Have a process for regulating Level 2b (KDs)	Moderate	Early and High
6.2.6	4.2.3	Implement identification, protection measures, and prioritization for Level 3 drainage	Level 3 system connects the built system drainage to the natural drainage system	Connectivity will be maintained	Moderate	Year 1 and Moderate
6.2.7	4.2.3	Implement guidelines, permits, inventory, prioritization, and	Level 4 drainage provides the built system drainage	Connectivity will be maintained, drainage provided for all development,	High	Year 1 and Moderate

Table 6-3. Summary of Stormwater Control and Drainage Protection (continued)

Item No.	Plan Section No.	Action	What it is	Benefit	Effort and Cost	Timeline Priority
		funding measures for Level 4 drainage	via the road network	a system for upgrades is provided		
6.2.8	4.2.4	Adopt drainage capacity analysis and design tools	An analysis of the general capacity and drainage sizing requirements for roadway drainage	Design calculations and drainage needs are standardized across the city; sizing is consistent for future buildout	Low	Early and High

6.2.3 Drainage System Review and Upgrades

The existing constructed drainage system is predominantly part of the road system, which collects and conveys runoff from roadways and development to natural drainage areas and receiving waters. Drainage capacity refers to the size and configuration of the conveyance ways and drainage systems for conveying stormwater to receiving waters, including the Level 1, 2, and 4 drainage paths. The capacity of the existing system was evaluated under future development conditions and the findings are provided in Section 4. This section provides a summary of actions for continued evaluation and upgrades to the system to repair existing deficiencies, inspect for ongoing problems, and prepare for future capacity.

Table 6-4. Summary of Drainage System Review and Upgrades

Item No.	Plan Section No.	Action	What it is	Benefit	Effort and Cost	Timeline Priority
6.2.10	4.2.4.4	Review capacity analysis in Table 4-5 and 4-6 for existing system deficiencies	Analyses for the drainage network were evaluated. Deficiencies can be documented.	Plan for upgrades before flooding occurs now or in the future	Moderate	Year 2 and Moderate
6.2.11	4.2.4.4	Review capacity analysis in Table 4-7 for drainage nodes with the greatest potential for increase and future impacts	Analyses for future peak flows from future development were determined. The highest potential for future drainage needs can be seen	Plan for upgrades before flooding occurs now or in the future	Moderate	Year 4 and Moderate
6.2.12	4.2.5	Prepare alternative analysis for protecting potential future impacts on CDCs and KDs from future development	Threats to the CDCs and KDs from accumulated future drainage increase were defined in Table 4.8. A plan to address alternatives is needed	Plan for protection and or avoidance before flooding or impacts occur.	High	Year 4 and Moderate
6.2.13	4.2.5	Inspect CDCs and KDs for observable impacts	Threats calculated are theoretical. Actual threats could be observed and may need earlier protection. A hierarchy to define the drainage network to provide for protecting, controlling, or improving a segment	Avoiding severe impacts will be more cost-effective than repairing them	Low	Early and Moderate

Table 6-4. Summary of Drainage System Review and Upgrades (continued)

Item No.	Plan Section No.	Action	What it is	Benefit	Effort and Cost	Timeline Priority
6.2.14	4.2.6	Prepare alternative analysis for protecting potential future impacts on wetlands defined in Table 4-9	Threats to some receiving water wetlands from accumulated future drainage were defined in Table 4.9. A plan to address alternatives is needed	Plan for protection and or avoidance before flooding or impacts occur.	High	Year 4 and Moderate
6.2.15	4.3	Implement guidelines, permits, inventory, prioritization, and funding measures for Level 4 drainage	Level 4 drainage provides the built system drainage via the road network	Connectivity will be maintained, drainage provided for all development, a system for upgrades is provided	High	Year 1 and Moderate

6.2.4 Other Drainage System Protection Measures

The future impacts analysis evaluated the potential stormwater runoff changes due to the full potential buildout of all private developable lands and unopened right-of-way. The timeline for full-build-out was not considered; consequently, applying a timeline or priority for new or upgraded infrastructure is not included. Priorities will be made by City staff based on ongoing observations and the capacity is provided by the identified scope of needs outlined in the plan.

The calculations for future runoff provided in Section 4 do not consider the benefits of stormwater measures required by the Ecology Manual, thus the results are conservative and more protective than the standard. Development and buildout of individual lots are generally under the stormwater control requirement thresholds in the manual, although City code will require infiltration and control to the maximum extent practicable, therefore these results are also conservative.

Reductions in allowable land use changes or changed thresholds for required stormwater controls are other measures the City can take to control future stormwater impact potential. The greatest potential for change in stormwater runoff due to new, uncontrolled development is show in Table 3-6. These data could provide a basis for where allowable land use or additional controls could be focused.

Potential stormwater runoff increase due solely to climate change were not evaluated. While increased storm size and annual precipitation is expected (see Section 2.4), the impacts of this change on the systems will vary. In general, the level of service may be reduced. However, the drainage system pipe and ditch sizes are not sensitive to small changes in peak runoff, therefore the need to increase drainage system sizes should be made on a project by project basis, using the tools provided in Section 4.2.

Drainage structure impacts due to rising sea level were outside the scope of this study and no other existing drainage infrastructure analyses were completed.

Table 6-5. Summary of Other Drainage System Protection Measures

Item No.	Plan Section No.	Action	What it is	Benefit	Effort and Cost	Timeline Priority
6.2.16		Review areas with large expected runoff changes using Table 3-6.	Investigate if future allowable land use with large potential runoff changes are compatible with the existing drainage system or natural system capacity.	Control impacts by reducing land use or providing additional controls when needed to protect infrastructure or natural resources	Moderate	Year 5 and Moderate
6.2.17		Model the catchment peak flows and drainage conveyance capacity (Tables 4-4 through 4-8) using future rainfall projections considering climate change	Future peak flows from future development may be higher due to climate change and may require added capacity.	Plan for upgrades before flooding occurs now or in the future	High	Year 5 and Moderate
6.2.18		Review drainage infrastructure (built and natural) that could be impacted by higher sea levels	CDCs and KDs, storm drainage systems near the ocean, and low elevation wetlands could be impacted and cause flooding	Plan for protection and or avoidance before flooding or impacts occur.	High	Year 5 and High

6.3 Funding and Resources

6.3.1 Capital Projects

Table 6-7 includes the cost distribution plan for the initial implementation years. Additional Information and years is provided in Appendix I. Table 6-8 provides a summary of when staff resources are needed for implementation.

Table 6-7. Summary Cost Plan – Capital (2019-2024)

Item No.	Title	Total Cost	2019	2020	2021	2022	2023	2024
6.1.6	Rainier Street Regional Stormwater Project	$ 808,000.00	$ 808,000.00					
6.1.7	Logan Street Stormwater Pond Overflow	$ 50,000.00	$10,000.00	$ 50,000.00				
6.1.1	16th Street – Sheridan Street to Landes Street	$210,000.00			$ 60,000.00	$ 150,000.00		
6.1.2	12th Street ROW, Logan Street, and 14th Street	$ 550,000.00						
6.1.8	Future system upgrades in Level 4a - Implement	$ 600,000.00			$300,000.00			
6.1.9	Future system upgrades in Level 4b - Implement	$ 200,000.00				$100,000.00		
6.1.4	Hancock Street and 32nd Street	$ 180,000.00						
6.1.3	Center Street – San Juan Avenue to Olympic Avenue	$ 400,000.00						
6.1.5	Lawrence Street at intersections of Polk Street, Taylor Street, and Tyler Street	$ 850,000.00						

Table 6-8. Summary Cost Plan - Resources

Item No.	Title	Total Effort	2019	2020	2021	2022	2023	2024
6.2.1	Prepare Basin Plans		X					
6.2.3	Adopt guidance for individual lot stormwater controls		X					
6.2.4	Adopt drainage level designations as defined in the SWMP		X					
6.2.8	Adopt drainage capacity analysis and design tools		X					
6.2.5	Review and implement protection measures for Level 2b receiving waters		X					
6.1.9	Future system upgrades in Level 4b – Plan			X				
6.1.10	Future system upgrades in Level 1-2 - Plan			X				
6.1.11	Long-path road drainage upgrade analysis			X				
6.1.13	CDC and KD impact mitigation analysis			X				
6.2.15	Implement guidelines, permits, inventory, prioritization, and funding measures for Level 4 drainage			X				
6.2.13	Inspect CDCs and KDs for observable impacts			X				
6.2.6	Implement identification, protection measures, and prioritization for Level 3 drainage			X				
6.2.10	Review capacity analysis in Tables 4-5 and 4-6 for existing system deficiencies				X			
6.1.15	Closed Wetland System impact					X		
6.2.11	Review capacity analysis in Table 4-7 for drainage nodes with the greatest potential for increase and future impacts					X		
6.2.12	Prepare alternative analysis for protecting potential future impacts on CDCs and KDs from future development					X		

Table 6-8. Summary Cost Plan – Resources (continued)

Item No.	Title	Total Effort	2019	2020	2021	2022	2023	2024
6.2.14	Prepare alternative analysis for protecting potential future impacts on wetlands defined in Table 4-9					X		
6.2.16	Review areas with large expected runoff changes using Table 3-6						X	
6.2.17	Review areas with large expected runoff changes using Table 3-6						X	
6.2.18	Review drainage infrastructure (built and natural) that could be impacted by higher sea levels						X	

6.4 Summary Implementation Plan

The Basin Plan Program elements have been summarized in an implementation schedule in order of anticipated priority and timeline in Table 6-9. This is recommended for planning purposes to determine the relative costs and effort levels that may need to be applied. It is anticipated that some elements may be moved up the list because of changing needs or opportunities that arise and may need to be delayed over a longer time frame due to lack of available resources. Table 6-10 shows the 2019-2029 Capital Program if a $6.00 surcharge and development fee are applied.

Table 6-9. Summary Implementation Schedule

Time	Item Number	Action	Effort	Timeline Priority
First Actions	6.2.1	Adopt Basin Plan	Moderate	High
	6.2.3	Adopt guidance for individual lot stormwater controls	Low	High
	6.2.4	Adopt drainage level designations as defined in the SWMP	Moderate	High
	6.2.9	Adopt drainage capacity analysis and design tools	Low	High
	6.2.5	Update Codes for Level 2b Key Drainageways	Moderate	Moderate
Year 0-1 (2019)	6.1.6	Implement Rainier Street Regional Stormwater Project	High	High
	6.2.6	Review and implement protection measures for Level 3 Drainage	Moderate	Moderate
	6.1.8	Future system upgrades in Level 4a - Plan	Moderate	Moderate
	6.1.9	Future system upgrades in Level 4b – Plan	Moderate	Moderate
	6.1.10	Future system upgrades in Level 1-2 - Plan	Low	Low
	6.1.11	Long-path road drainage upgrade analysis	Moderate	Low
	6.1.13	CDC and KD impact mitigation analysis	Moderate	Low

Table 6-9. Summary Implementation Schedule (continued)

Time	Item Number	Action	Effort	Timeline Priority
	6.2.15	Implement guidelines, permits, inventory, prioritization, and funding measures for Level 4 drainage	High	Moderate
	6.2.13	Inspect CDCs and KDs for observable impacts	Low	Moderate
	6.2.7	Implement identification, protection measures, and guidelines for Level 4 drainage	High	Moderate
Year 2 (2020)	6.1.8	Future system upgrades in Level 4a - Implement	Moderate	Moderate
	6.1.7	Logan Street Stormwater Pond Overflow	High	High
	6.1.9	Future system upgrades in Level 4b - Implement	Moderate	Moderate
	6.1.10	Future system upgrades in Level 1 - Implement	Low	Low
Year 3 (2021)	6.1.1	16th Street – Sheridan Street to Landes Street	High	High
	6.1.8	Future system upgrades in Level 4a - Implement	Moderate	Moderate
	6.2.10	Review capacity analysis in Tables 4-5 and 4-6 for existing system deficiencies	Moderate	Moderate
	6.1.9	Future system upgrades in Level 4b - Implement	Moderate	Moderate
	6.1.10	Future system upgrades in Level 1 - Implement	Low	Low
Year 4 (2022)	6.1.1	16th Street – Sheridan Street to Landes Street (cont.)	High	High
	6.1.14	CDC and KD impact mitigation – Implement study results	High	Low
	6.1.15	Closed Wetland System impact	Moderate	Moderate
	6.1.8	Future system upgrades in Level 4a - Implement	Moderate	Moderate
	6.1.9	Future system upgrades in Level 4b - Implement	Moderate	Moderate
	6.1.10	Future system upgrades in Level 1 - Implement	Low	Low
	6.2.11	Review capacity analysis in Table 4-7 for drainage nodes with the greatest potential for increase and future impacts	Moderate	High
	6.2.12	Prepare alternative analysis for protecting potential future impacts on CDCs and KDs from future development	Moderate	Moderate
	6.2.14	Prepare alternative analysis for protecting potential future impacts on wetlands defined in Table 4-9	High	Moderate
Year 5 (2023)	6.1.3	Center Street – San Juan Avenue to Olympic Avenue	High	High
	6.1.5	Lawrence Street at intersections of Polk Street, Taylor Street, and Tyler Street	High	High
	6.1.12	Long-path road drainage upgrades	High	Moderate
	6.1.8	Future system upgrades in Level 4a - Implement	Moderate	Moderate
	6.1.9	Future system upgrades in Level 4b - Implement	Moderate	Moderate

Table 6-9. Summary Implementation Schedule (continued)

Time	Item Number	Action	Effort	Timeline Priority
	6.1.10	Future system upgrades in Level 1 - Implement	Low	Low
	6.1.16	Closed Wetland System impact mitigation	High	Low
	6.2.16	Review areas with large expected runoff changes using Table 3-6.	Moderate	High
	6.2.17	Review areas with large expected runoff changes using Table 3-6.	High	Moderate
	6.2.18	Review drainage infrastructure (built and natural) that could be impacted by higher sea levels	High	High
Year 6 Plus	6.1.2	12th Street ROW, Logan Street, and 14th Street	High	High
	6.1.4	Hancock Street and 32nd Street	High	High

Table 6-10. Updated CIP with $6 Surcharge and Development Fee

Project Title	Total Project Cost	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029-2039
Stormwater General Projects												
Stormwater General Repairs/Upgrades		$ 120,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00
Capital Projects												
16th Street - Sheridan Street and Landes Street	$ 210,000.00	$ -	$ -	$ -	$ 60,000.00	$ 150,000.00	$ -	$ -	$ -	$ -	$ -	$ -
Hancock Street and 32nd Street	$ 180,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 180,000.00
Center Street - San Juan Avenue to Olympic Avenue	$ 400,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 125,000.00	$ 275,000.00	$ -	$ -	$ -
12th Street Right-of-way, Logan Street and 14th Street	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Inflow/Infiltration Removal - Lawrence Street at the intersections of Polk Street, Taylor Street and Tyler Street	$ 850,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 300,000.00	$ 550,000.00
Rainier Street Regional Stormwater Project	$ 808,000.00	$ 808,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Logan Street Stormwater Pond Overflow	$ 60,000.00	$ 10,000.00	$ 50,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Basin 8 - Wetland Overflow (Hastings Pond)	$ 250,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000.00
Basin 7 - Wetland Overflow (Glasbell Property)	$ 300,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 300,000.00
Basin 5 - Wetland Overflow (Behind Blue Heron Middle School)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Basin Planning												
Basin Planning Studies	$ 250,000.00	$ -	$ -	$ -	$ 50,000.00	$ -	$ -	$ -	$ 50,000.00	$ -	$ -	$ 150,000.00
Existing Street Stormwater Improvements												
Major Collectors and Minor Arterials	$ 600,000.00	$ -	$ -	$ 300,000.00	$ -	$ -	$ -	$ -	$ -	$ 300,000.00	$ -	$ -
Local Access Streets	$ 200,000.00	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -	$ 100,000.00	$ -
Stormwater Management Plan Updates												
Stormwater Management Plan	$130,000.00	$30,000.00	$ -	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -
	Total Per Year	$ 968,000.00	$ 100,000.00	$ 350,000.00	$ 260,000.00	$ 200,000.00	$ 150,000.00	$ 175,000.00	$ 375,000.00	$ 350,000.00	$ 450,000.00	$ 1,480,000.00

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Appendix A

Kickoff Meetings

Port Townsend 2017 Stormwater Management Plan (SWMP)

Project Kick-off Meeting

June 20, 2017 9:30 AM – 4:30 PM

9:30 – 9:45	Introductions and roles; meeting purpose	Group
9:45– 10:00	Project summary	Samantha and Paul
10:00-10:30	Scope, Schedule, and Communications	Paul
10:30-11:30	Project needs and information brainstorming	Paul leads Group
11:30-12:30	Working lunch	Group
12:00 -12:30	Project Vision and Mission (part of working lunch)	Group
12:30 -1:00	Project risk review	Group
1:00 – 2:00	Operations, maintenance, information, and systems	City staff
2:00 – 2:45	Problem area and priority project review	City staff
2:45 – 4:30	Field review of problem areas and key features	City staff
4:30	Adjourn	

SURFACE WATER PROGRAM VISION AND MISSION STATEMENTS

Vision

A fully functional, achievable, and sustainable stormwater system that is integrated into the landscape, supports envisioned growth, protects residents, and nurtures the environment.

Mission

- Safeguard public safety and minimize property damage
- Improve quality of stormwater runoff
- Prepare, implement and update a comprehensive plan to evaluate, measure, protect, design, and construct a system for current and future needs
- Use appropriate, technologically sound, and cost-effective stormwater control solutions
- Define and protect the natural and built drainage systems
- Consider, accommodate, and direct future development
- Protect and improve existing water quality
- Correct existing drainage and stormwater management problems
- Protect, upgrade, and optimize the existing stormwater infrastructure
- Define appropriate measures to manage, optimize, and protect the roadway drainage and stormwater system
- Operate, inspect, maintain, and repair the City's existing stormwater infrastructure to continue effective operation
- Protect wetlands, marine waters, and habitat
- Proactively address the City's surface water needs for all existing and future customers and accommodate system growth and expansion.
- Control temporary impacts from construction

- Consider and account for future changes in sea level and climate change
- Develop strategies to resolve existing flooding problems
- Determine the City staff and funding needed to accomplish the program mission
- Create an outreach plan that informs and engages residents to participate and stokes the willingness to work together

MEETING NOTES

City of Port Townsend

Stormwater Management Plan

Things that you do well

- Coordinated and cooperative
- Do well with what you have
- Stormwater is not noticed and cared about
- WSU and Mater Gardeners coordinate and provide funding support
- Community interest in caring for stormwater facilities
- Low rain, no streams
- Attractive community
- Good GIS

MEETING NOTES

City of Port Townsend

Stormwater Management Plan

<u>Notes</u>

- Higher intensity and stormwater compatibility
- What does stormwater need to serve?
- What are stormwater utility expectations for delivery?
- Design facilities for climate change
- Design selection for lifecycle/maintenance
- Good CIP list
- Streets/stormwater undermaintained
- Setting thresholds for redevelopment
- Retrofitting to maximum extent practical (redevelopment)
- Opportunistic stormwater management/retrofitting
- Develop regulations – policy decisions
- Public property use – use natural drainage systems
- Integrated stormwater facilities – integrated into landscape
- What is a "critical drainage corridor" (CDC)?
- Should standards be changed?
- Utility crossings of CDC
- CDC should be better defined – different policy and standards
- Infill development – what should the stormwater standards be? Thresholds?
- What should single lot standards be?
- NPDES?
- Follow up/follow through on stormwater construction and implementation
- Inflow and infiltration into sanitary sewer
- Storm discharges to sanitary sewer
- Community and City maintenance of LID/GSI
- Skills/equipment/funding for stormwater maintenance

- Should LID maintenance selection match funding for stormwater maintenance?
- Existing stormwater BMPs in special FHA
- Plan review and system capacity
- Critical areas – stormwater facilities are regional
- Skills (engineers, contractors) to implement
- Demand for LID/GSI in the wrong locations
- Picking LID/GSI – how?
- Learning and experience on past LID/GSI – next project
- 2005 stormwater manual
- No stream
- Stormwater fee $25/month (last increased 4-5 years ago, 3,000 ft ERU, no discount, port not included)
- Pet waste – some EDU
- No IDDE

RISK REGISTER

City of Port Townsend Stormwater Management Plan

Potential Risks Identified (at kickoff meeting)	Likelihood	Impact	Mitigation
Samantha moves away	H	H	Keep other City staff members engaged (and plan is too good to miss)
Staff priorities change	H	H	Provide timelines and critical path for timely input.
Stormwater/land use incompatible	H	H	This is a key plan element for consideration
Inadequate data – delays, incomplete	H	H	Identify potential data gaps in early project phase – during map and data review (by July 14)
Allocation of problems (existing pushed to new)	H	H	This is a key plan element for consideration
Geologic uncertainty	H	H	Develop plan contingencies
Citizen challenges	H	M	Stakeholder review group
Projects (CIP) are not implementable (pre-plats, cost, land, geology)	M	H	
Development constraints are large	M	H	
Plan too complex or unimplementable, daunting	M	H	
Samantha/staff time	M	M	
Inconsistencies created	M	M	
Adoption/review process	M	M	
BAS issues (schedule)	M	M	
Climate change	M	M	
Site design standards incompatible with stormwater needs due to cost	M	M	
GMA goals not met	L	H	
Stormwater utility fee controversy	L	M	
Changes in leadership	L	M	
Land constraints on waterfront	L	M	

MEETING NOTES

City of Port Townsend

Stormwater Management Plan

Stakeholders

- Hospital
- WSU Extension
- Beach Watchers
- Marine resource community
- Olympic Environmental Council
- Puget Sound Partnership
  - Local integrating organization (Strait and Hood Canal)
- Contractors and landscapers
- Wetlands/critical areas consultants
- Realtors
- Friends of Kah-Tai
- Developers
- Jefferson County Land Trust
- Climate Action Committee
- Master Builder Association
- City Departments
  - Engineering/Capital Projects
  - Planning
  - Operations
  - Parks
  - Finance
  - Administration
  - Attorney
- Jefferson County Health Department (sampling)
- Washington State Department of Ecology
- Design engineers/geotechs

Appendix B

Public Input Process

City of Port Townsend's Stormwater Management Plan Communication Plan

The Mission Statement for the Stormwater Management Plan is to develop *a fully functional, achievable, and sustainable stormwater system that is integrated into the landscape, supports envisioned growth, protects residents, and nurtures the environment.* To achieve this, good communication throughout the Stormwater Management Plan adoption process is important. This project communication plan identifies who needs what information, when they need the information and how that information is provided.

The Stormwater Management Plan is a functional plan which addresses existing stormwater system conditions; the operation and maintenance of existing conditions and capacity for adding new facilities; identifying capital project needs; and how to finance capital and operational costs. Stormwater management is about drainage and flooding, as well as water quality. The City has a range of soil types from hard pan to sandy soils which impact stormwater solutions. The City intends to plan for surface water management as a whole – integrating a preservation of water resources through natural systems approach where possible while protecting environmental values and public health. The process will include comparison on 2005 and 2012 DOE Stormwater Manual and recommended concurrent amendments to the City's development regulations/Engineering Design Standards to ensure public and private projects achieve the City's adopted level of service standard (e.g., A level of conveyance, detention, and treatment that meets the Department of Ecology (DOE) Stormwater Manual adopted by the City or as defined in the City's Stormwater Master Plan).

The adoption schedule is to have a draft Stormwater Management Plan before City Council by December 2017. In order to achieve this schedule, there will be a series of task force meetings; a public open house and a Comprehensive Plan concurrency meeting with the Planning Commission in addition to internal City staff meetings with our stormwater consultant team. After the task force meetings and the public open house a draft plan will be created which will incorporate the input and comments from both internal and external meetings.

GOALS

The overarching goals of the Communications Program (Program) are to:

- Review external and internal communications needs for the Stormwater Management Plan; including required step approvals of the plan prior to City Council first reading. Create and outline the communication steps with internal staff and consultants.

- Describe how decisions are made (Operating Guidelines) and how those decisions are communicated internally and externally.
- Document how project information (i.e. schedule, budget, risk, change) is communicated with the task force, the public, City Council, internal staff, and consultants.
- Describe the frequency of updates and method of communication (email, phone, web, etc.).

Communication Needs

This communications plan identifies needs for "external" communications (i.e., communication with the task force and the public) and "internal" communications (i.e., communications between city staff and the consultant team).

External Communications

- The City will form an administrative technical advisory task force (task force) group. The interest groups which will be targeted to be on the task force are below.
    - Architect/Designer
    - WSU Extension
    - Beach Watchers
    - Marine Resource Committee
    - Olympic Environmental Council
    - Puget Sound Partnership
        - Local integrating organization (Strait and Hood Canal)
    - Contractors and landscapers
    - Wetlands/critical areas consultants
    - Friends of Kah-Tai
    - Developers
    - Jefferson County Land Trust
    - Climate Action Committee
    - Master Builder Association
    - City Departments
        - Engineering/Capital Projects
        - Planning
        - Operations
        - Parks
        - Finance
        - Administration
        - Attorney
    - Jefferson County Health Department (sampling)
    - Washington State Department of Ecology
    - Local 2020
    - Admiralty Audubon Society

- Port of Port Townsend
- Environmental Health
- Design engineers/geotechs

External Communication Methods

PUBLIC COMMUNICATIONS TOOLS AND TASKS

- The table below provides the outline for the public process for the Stormwater Management Plan.
- Potential communication tools for messaging the Stormwater Management Plan
  - Utility Newsletter – Monthly newsletter with message from the Mayor and updates from City departments – mailed in utility bills and available on line ~~and~~
  - Capital Projects and Public Works Projects Webpage; also captured on the City website
  - Specialized print collateral such as brochures, maps
  - City Websites – Includes Official City Website "CityofPT.us," City Library website "PTPublicLibrary.org."
  - City website calendar of City meetings
  - Public Access Television Station – PTTV
  - KPTZ – local community radio station (for news & emergency communication)
  - Press Releases and media advertisements – display ads. (PT Leader, Peninsula Daily News, KPTZ)
  - Town meetings including both city-wide education and special neighborhood meetings for Capital Projects
  - Live streamed and archived City Council and Planning Commission posted meetings and agenda materials
  - Posted agendas for City Advisory Boards
  - Speak Up PT – Civic Engagement site for Surveys, Forums, Citizen Ideas, Discussions and eComment on meetings

Who; identify agencies, stakeholders, businesses, the public, etc.	What event?	What information will be provided?	How will information be provided?	When will the information be provided?	With what frequency ?	Responsible Party
Task Force	Task Force #1 Open Public Meeting (i.e. public can attend but not comment)	Existing stormwater conditions, comparison on 2005 and 2012 DOE Stormwater Manual	Packets will be mailed and/ or emailed to the task force group	Late-August 2017	Twice	Samantha, Paul and Julie
PUBLIC COMMENT	N/A	Public to comment on the scoping of the project	City website	Late-August	Once – for 2-week long comment period	Samantha
Task Force	Task Force #2 Open Public Meeting (i.e. public can attend but not comment)	Re-cap of task force meeting #1 and public open house, Capital project review and financing	Packets will be mailed and/ or emailed to the task force group	Early October 2017	One time	Samantha, Paul and Julie
Public	Open House Presentation /Open House combination ?	Maps of existing stormwater priorities to be ranked by the public, gather public input on stormwater issues	Boards and comment sheets will be provided at the meeting	September 2017	One time	Samantha, Paul and Julie
PUBLIC COMMENT		Public Comment on the draft Stromwater Plan	City website	Late-October	One – for a 2-week long comment period	Samantha
SEPA Submission	Submit SEPA to DSD Department	SEPA Checklist, back-up, mailing list and money	Hard copy to front desk of DSD	Late-October/early November 2017	Once	Samantha
Planning Commission	Planning Commission Public Hearing	Draft Stormwater Management Plan for a Consistency Review to the Comprehensive Plan	Packets will be given to the Clerk's Office to distribute to the Planning Commission	November 2017	One time	Samantha

Who; identify agencies, stakeholders, businesses, the public, etc.	What event?	What information will be provided?	How will information be provided?	When will the information be provided?	With what frequency?	Responsible Party
City Council	City Council Workshop	Draft Stormwater Management Plan; summary of comments from Stakeholder meetings 1 and 2 and public open house; public comment letters	Packets will be given to the Clerk's Office to distribute to the City Council	November 2017	One time	Samantha, Paul and Julie
City Council	City Council Business Meeting – Public Hearing	Draft Stormwater Management Plan with comments from the CC Workshop	Packets will be given to the Clerk's Office to distribute to the City Council	December 2017	One time	Samantha
City Council	City Council Business Meeting	Final Stormwater Management Plan	Packets will be given to the Clerk's Office to distribute to the City Council	January or February 2018	One time	Samantha
Dept. of Commerce	Preliminary Review and 60-day review	Send Stormwater Plan after submit SEPA and a Final after adopted by City Council	Email	Late October/Early November and January/February 2018	Twice	Samantha

Internal Communication Methods

Operating Guidelines

- For project team meetings Parametrix will set the agenda and take and distribute notes.
- For stakeholder groups and open houses City will provide the agenda and do notes (no minutes will be taken at the stakeholder meetings. Parametrix will provide information as outlined in the table below.

Team Protocol

- Identify key decision makers and authority levels by position.
- Parametrix will provide deliverables as outlined in their Scope of Work.
- Identify a document management (including email) protocol for sharing, storing and archiving project documents. For example; project documents will be stored in a common project folder on the office "public works" drive. Identify a responsible party.

- City Clerk's office will take minutes at the Planning Commission and Council Meetings. City staff with technical assistance from Parametrix will prepare the planning commission and city council packets. City staff will prepare the agenda bill(s) and ordinance(s) for the City Council meetings.

Reporting

The following example identifies the deliverables and internal communication needs of the project manager and the consultant.

What, identify the deliverable.	**How will the information be provided?**	**When will the information be provided?**	**With what frequency?**	**Party responsible for delivery.**	**Party responsible for accepting**
Progress Reports	pdf via email	Beginning of the Month?	Monthly	Paul, Parametrix	Samantha, City
Public Engagement	Pdfs via email 3 maps, questionnaire and handouts	Prior to the Stakeholder Meetings and/or Public Open House	3 Times	Paul, Parametrix	Samantha, City
Project Schedule	pdf	Project status meetings	Monthly	Paul, Parametrix	Samantha, City
Working Draft for SWMP for City Staff to review	MS Word	November 2017	Once	Paul, Parametrix	City Staff through Samantha
Council Draft for SWMP	MS Word or pdf?	December 2017	Once	Paul, Parametrix	City Staff and Council

Implementation Process

After the Stormwater Management Plan is adopted then an implementation process will start. The implementation process may include the following, this is not intended to be an all-inclusive list.

- Development Services Department and Public Works Department Staff training on the contents of the Stormwtaer Management Plan
- Development Review Staff training on how the regulations have changed with the newly adopted Stormwater Management Plan
- Review, sign-off and "go-live" of stormwater development handouts created during the Stromwater Management Plan process from the LEAN group and sponsors.
- Feedback from the public on stormwater regulation changes and how they are being implemented through development review.

STORMWATER MANGEMENT PLAN TASK FORCE GROUP

Task Force Participant Contact Information	Name	Atlernative
Architect/Designer	Simon Little	Richard Berg
WSU Extension	Bob Simmons	
Beach Watchers	Cheryl Lowe	
Marine Resource Committee	Cheryl Lowe	
Olympic Environmental Council	Darlene S.	Nan Evans?
Puget Sound Partnership	John Cambalik	
Local integrating organization (Strait and Hood Canal)		
Contractors	Tim Johnson	
Landscapers	Matt Berberich	
Wetlands/critical areas consultants	Fred Weinmann	
Friends of Kah-Tai	General Account	
Developers	Fred Kimball	Suzanne Tyler
Jefferson County Land Trust	Richard Tucker	
Climate Action Committee	Cindy Jayne	
Master Builder Association	Brent Davis	
City Engineering/Capital Projects	Samantha Harper	
City Engineering/Capital Projects	Dave Peterson	
City Engineering - Development Review	Brandon Maxwell	Scott Studeman
City Planning Department	Judy Surber	
City Planning Department	John McDonagh	
City Public Works Operations	Dave Zellar	
City Public Works Operations	Larry Grewell	
City Parks	Alex Wiseniewski	
City Finance	Nora Mitchell	Sheila Danielson
Jefferson County Health Department (sampling)	Michael Dawson	
Washington State Department of Ecology	Rick Marz	
Local 2020	Cindy Jayne	
Admiralty Audubon Society	Debbie Janke	Bill Vogt
Port of Port Townsend	Sam Gibboney	
Environmental Health	Susan Porto	
Design engineers/geotechs	Harold Andersen	

City of Port Townsend

Capital Projects & Engineering
250 Madison, Suite 2R
Port Townsend, WA 98368
360-379-5096 Fax 360-385-7675

August 17, 2017

Dear Ladies and Gentlemen:

Congratulations. You have been selected to join a Technical Advisory Task Force for the Stormwater Management Plan. Below is a brief project description, purpose of the committee, time commitment, and options for the first meeting date.

The Stormwater Management Plan is a functional plan which addresses existing stormwater system conditions; the operation and maintenance of existing facilities and capacity for adding new facilities; identifying capital project needs; and how to finance capital and operational costs. Stormwater management is about drainage and flooding, as well as water quality. The City has a range of soil types from hard pan to sandy soils which impact stormwater solutions. The City intends to plan for surface water management as a whole – integrating a preservation of water resources through natural systems approach where possible while protecting environmental values and public health. The process will include comparison of 2005 and 2012 DOE Stormwater Manual and recommended concurrent amendments to the City's development regulations/Engineering Design Standards to ensure public and private projects achieve the City's adopted level of service standard.

The purpose of the Task Force is to receive a wide variety of perspectives on the City's stormwater utility and input on the creation and adoption of the City's Stormwater Management Plan. The first task force meeting will focus on existing stormwater conditions, and comparison of 2005 and 2012 DOE Stormwater Manual. A public open house will be held after input from the Task Force is incorporated (between the first and second meetings). The second task force meeting will focus on re-cap of task force meeting number 1 and public open house, Capital project review and financing.

The time commitment for Task Force members is two meetings (week of August 28, 2017 and first part of October 2017, date to be determined).

We are planning on a four hour meeting the week of August 28th. Please respond to this invitation with your time and date preference from the list below.

- Tuesday (8/29) 9:00am – 1:00pm
- Tuesday (8/29) 1:00pm – 5:00pm

- Wednesday (8/30) 9:00am – 1:00pm
- Wednesday (8/30) 1:00pm – 5:00pm
- Thursday (8/31) 9:00am – 1:00pm
- Thursday (8/31) 1:00pm – 5:00pm

The materials to be discussed will be sent out in a separate correspondence.

Thank you for participation.

Sincerely,

Samantha Harper, PE
Assistant City Engineer

AGENDA

Stormwater Management Plan - Advisory Task Force
Workshop 1 | August 30, 2017 | Cotton Building, 607 Water Street, Port Townsend

1:00 – 1:15 **Welcome and Agenda**

1:15 – 1:30 **Introductions**

1:30 – 1:45 **Meeting Purpose and Goal**

1:45 – 2:45 **Brainstorming and Input**

2:45 – 3:00 **Break**

3:00 – 4:00 **Project Scope, Framework, and Schedule**

4:00 – 4:15 **Stormwater Manual Review**

4:15 – 4:30 **Communications and Outreach**

4:30 – 5:00 **Meeting Summary**

5:00 **Adjourn**

SURFACE WATER PROGRAM VISION AND MISSION STATEMENTS

Vision

A fully functional, achievable, and sustainable stormwater system that is integrated into the landscape, supports envisioned growth, protects residents, and nurtures the environment.

Mission

- Safeguard public safety and minimize property damage
- Improve quality of stormwater runoff
- Prepare, implement and update a comprehensive plan to evaluate, measure, protect, design, and construct a system for current and future needs
- Use appropriate, technologically sound, and cost-effective stormwater control solutions
- Define and protect the natural and built drainage systems
- Consider, accommodate, and direct future development
- Protect and improve existing water quality
- Correct existing drainage and stormwater management problems
- Protect, upgrade, and optimize the existing stormwater infrastructure
- Define appropriate measures to manage, optimize, and protect the roadway drainage and stormwater system
- Operate, inspect, maintain, and repair the City's existing stormwater infrastructure to continue effective operation
- Protect wetlands, marine waters, and habitat
- Proactively address the City's surface water needs for all existing and future customers and accommodate system growth and expansion.
- Control temporary impacts from construction

- Consider and account for future changes in sea level and climate change
- Develop strategies to resolve existing flooding problems
- Determine the City staff and funding needed to accomplish the program mission
- Create an outreach plan that informs and engages residents to participate and stokes the willingness to work together

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
General				
Inside cover page	ES-i and ES-ii		Added an Executive Summary	Summarized the reasons for the update, the uses of the manual and provided information on the public involvement process.
All Volumes			Renumbered Tables and Figures	Renumbered all tables and figures in all Volumes. The new numbers coordinate tables and figures to the section of the Volume where they are located. (Eg. Figure 2.4.2 is the second figure in Section 2.4, Table 4.1.3 is the third table in Section 4.1).
Volume I Minimum Technical Requirements and Site Planning				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-26		Update incorrect or outdated code references.	Revised incorrect or outdated code references, such as the RCW and WAC.
Chapter 1 - Introduction	1-1 through 1-26		Minor language changes.	Revised for clarity and removed outdate language in Sections 1.2, 1.4, 1.5.1, 1.6.10.
Section 1.5.4 Flow Control BMPs	1-5		Minor language changes.	Revised language for changes made in *Appendix I-D Guidelines for Wetlands when Managing Stormwater.*
Section 1.5.5 On-site Stormwater Management BMPs	1-6		Additional guidance provided.	Language added to categorize On-site Stormwater Management BMPs, including LID BMPs.
Section 1.6.4 The Puget Sound Action Agenda	1-11 through 1-13		Significant revisions to remove outdated guidance and to add new guidance. Section renamed.	Removed references and guidance related to the Puget Sound Water Quality Management Plan and replaced with guidance on the Puget Sound Action Agenda.
Section 1.6.5 Phase I - NPDES and State Waste Discharge Stormwater Permits for Municipalities	1-13 through 1-14	Yes	Additional guidance provided and outdated guidance removed.	Added guidance referring Phase I Municipal Stormwater Permittees to Appendix 1 of the permit for more information on the requirements for their stormwater program requirements.
Section 1.6.6 Phase II - NPDES and State Waste Discharge Stormwater Permits for Municipalities	1-14	Yes	Additional guidance provided and outdated guidance removed.	Added guidance referring Phase II Municipal Stormwater Permittees to Appendix 1 of the permit for more information on the requirements for their stormwater program requirements.
Section 1.6.7 Municipalities Not Subject to the NPDES Stormwater Municipal Permits	1-14		Guidance removed.	Removed outdated references to the Puget Sound Water Quality Management Plan. Section renamed.
Section 1.6.8 Industrial Stormwater General Permit	1-14 through 1-15	Yes	Revised to coordinate with the current Industrial Stormwater General Permit	Revised to provide an overview of the requirements of the current Industrial Stormwater General Permit and their relationship to the BMPs in the manual.
Section 1.6.9 Construction Stormwater General Permit	1-15 through 1-16	Yes	Revised to coordinate with the current Construction Stormwater General Permit	Revised to provide an overview of the requirements of the current Construction Stormwater General Permit and their relationship to the BMPs in the manual.
Section 1.6.15 Underground Injection Control Authorizations	1-18 through 1-19		Significant revisions to add guidance.	Added language to refer to Ecology's website and to define UIC well.
Chapter 2 - Minimum Requirements for New Development and Redevelopment				
Chapter 2 - Minimum Requirements for New Development and Redevelopment	2-1 through 2-46		Minor language changes.	Revised for clarity and removed outdated language in the introduction and in Sections 2.1, 2.2, 2.5.3, and 2.5.10.
Chapter 2 - Minimum Requirements for New Development and Redevelopment	2-1 through 2-46	Yes	Revised language.	Revised definitions, requirements, supplemental guidance, etc. to correspond to the changes in the Municipal Stormwater Permits and for new LID requirements.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 2.1 Relationship to the Puget Sound Action Agenda	2-2		Added guidance. Section renamed.	Removed outdated references to the Puget Sound Water Quality Management Plan. Section renamed and focuses on relationship of the manual to the municipal stormwater permits.
Section 2.3 Definitions Related to Minimum Requirements	2-5 through 2-9	Yes	Added and revised definitions.	Added definitions for a few terms used previously but not previously defined. Other terms have a revised definition or a new definition (hard surfaces, LID, converted vegetation) because of the new low impact development (LID) guidance and requirements in the Municipal Stormwater Permits.
Section 2.4 Applicability of the Minimum Requirements	2-9 through 2-16	Yes	Revised the thresholds for determining which minimum requirements apply to new development and redevelopment. Revised supplemental guidelines.	Changes include: the replacement of "impervious" surfaces with "hard" surfaces, the application of minimum requirements #6 - #9 to replaced hard surfaces at new development sites, the deletion of the word "native" from the land conversion threshold.
Section 2.5.1 Minimum Requirement #1: Preparation of Stormwater Site Plans	2-16	Yes	Revised requirements and objective.	Added a new statement for the site plan to use site-appropriate development principles to retain native vegetation and minimize impervious surfaces to the extent feasible.
Section 2.5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)	2-17 through 2-26	Yes	Reorganized and revisions to: thresholds, general requirements, construction SWPPP elements, objective, and supplemental guidelines.	Changes include: revisions to the construction SWPPP elements to correspond with the Construction Stormwater General Permit, the addition of element #13 that requires the protection of LID Best Management Practices, and revision of element #12 to include responsibilities for an inspector or CESCL depending on the size of the project.
Section 2.5.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls	2-27 through 2-28	Yes	Minor additions.	Added clarification for peak discharges using 15 minute time steps.
Section 2.5.5 Minimum Requirement #5: On-site Stormwater Management	2-28 through 2-32	Yes	Multiple revisions for new low impact development (LID) requirements.	Changes include: the new LID performance standard and list options based on project size and location. The lists are divided into three land use types: lawn and landscaped areas; roofs, and other hard surfaces. Projects implementing the list option must select the first feasible BMP for each land use type. Some of the BMPs included in the lists are: rain gardens, permeable pavements, bioretention, soil quality and depth, full and partial dispersion methods, full downspout infiltration and perforated stub-outs.
Section 2.5.6 Minimum Requirement #6: Runoff Treatment	2-33 through 2-35	Yes	Revisions to the thresholds, Water Quality Design Flow Rate, and supplemental guidelines.	Revisions made to acknowledge the use of permeable pavements and the related new definitions. The intent is to continue to capture the same size and types of projects as previously. More accurate definitions for water quality design storm volume and flow rate.
Section 2.5.7 Minimum Requirement #7: Runoff Flow Control	2-35 through 2-40	Yes	Revisions to the thresholds and supplemental guidelines.	Revisions to acknowledge the use of permeable pavements and the related new definitions. Clarifications about the surfaces that the requirement applies to, and the use of the 0.10 /0.15 cfs threshold. The intent is to capture the same size and types of projects as previously.
Section 2.5.8 Minimum Requirement #8: Wetlands Protection	2-40 through 2-41	Yes	Revisions to the applicability, thresholds, standard requirement, additional requirements, and supplemental guidelines.	Revisions correspond to the significantly revised *Appendix I-D Guidelines for Wetlands when Managing Stormwater* .

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 2.8 Exceptions/Variances	2-45 through 2-46	Yes	Additional guidance provided.	Changed and added language to be consistent with the requirements in Appendix 1 of the 2007 municipal stormwater permits.
Chapter 3 - Preparation of Stormwater Site Plans				
Chapter 3 - Preparation of Stormwater Site Plans	3-1 through 3-17	Yes	Significant changes to incorporate procedures necessary for LID implementation.	Revised for clarity and removed outdate language in the introduction and in section 3.1.7.
Section 3.1.1 Step 1 - Collect and Analyze Information on Existing Conditions	3-2 through 3-7	Yes	Additional guidance provided and outdated guidance removed.	Additional guidance details the information necessary for site analysis, and in particular for LID site design. Split into subsections based on whether Min. Requirements 1 - 5 apply, or Min. Requirements 1 - 9 apply.
Sections 3.1.2 to 3.1.4	3-7 through 3-8	Yes	Guidance added.	References to on-site BMPs added and preliminary determination of applicable minimum requirements.
Section 3.1.5 Step 5 - Prepare a Permanent Stormwater Control Plan	3-8 through 3-12	Yes	Revisions to all subsections of Developed Site Hydrology of the Permanent Stormwater Control Plan.	Significant changes to describe how to prepare the Permanent Stormwater Control Plan that incorporates LID features. Separate guidance for projects subject to Min. Requirements 1 - 5 and projects subject to Min. Requirements 1 - 9.
Section 3.1.6 Step 6 - Prepare a Construction Stormwater Pollution Prevention Plan	3-13 through 3-14	Yes	Minor language changes.	Changes for clarification and to remove repetitive language.
Section 3.1.7 Step 7 - Complete Stormwater Site Plan	3-14 through 3-16	Yes	Reference to needed soils report and addition of Declaration of Covenants and Grants of Easement.	Soils reports are necessary part of LID decisions. Declarations of Covenants and Grants of Easement are necessary mechanisms to identify LID features, establish maintenance requirements and government access for inspections of privately maintained stormwater BMPs and facilities.
Section 3.2.2 Final Corrected Plan Submittal	3-17		Guidance added.	Added several LID BMPs that require the submission of as-builts.
Chapter 4 - BMP and Facility Selection Process for Permanent Stormwater Control Plans				
Section 4.2 BMP and Facility Selection Process	4-1 through 4-4		Revised language, proposed replacing the language in *Step V: Select Treatment Facilities* with a reference to Chapter 2 of Volume V.	Revisions and new language especially in Step III for guidance on modeling threshold discharge areas. Minor revisions to correspond with the changes in the Municipal Stormwater Permits and for new LID requirements. Ecology replaced the language in *Step V: Select Treatment Facilities* with a reference to Chapter 2 of Volume V.
Appendix I-A Guidance for Altering the Minimum Requirements Through Basin Planning				
Appendix I-A Guidance for Altering the Minimum Requirements Through Basin Planning	A-1 through A-3		Additional guidance provided.	Added language for clarity on use of Basin Planning for addressing retrofit needs and for developing an alternative flow control strategy.
Appendix I-B Rainfall Amounts and Statistics				
Appendix I-B Rainfall Amounts and Statistics	B-1 through B-5		Removed introductory language and background information on the Water Quality Design Storm and Water Quality Design Flow Rate.	Removed background and outdated information for brevity. Renamed the appendix and retained the rainfall tables.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Appendix I-D Guidelines for Wetlands when Managing Stormwater				
Appendix I-D Guidelines for Wetlands when Managing Stormwater	D-1 through D-18	Yes	Multiple revisions for the use and/or the protection of Wetlands when managing stormwater.	Rewritten to remove outdated information, clarify concepts, and approach the protection and use of wetlands through controlling discharges to wetlands. Total discharges to wetlands must not deviate by more than 20% on a single event basis, and must not deviate by more than 15% on a monthly basis.
Appendix I-E Flow Control-Exempt Surface Waters				
Appendix I-E Flow Control-Exempt Surface Waters	E-1 through E-4	Yes	Added and deleted Exempt Surface Waters.	List edited to add additional waters based on specific requests and analyses, and to remove reference to a creek in Eastern WA.
Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices				
Appendix I-F Basins with 40% or more total impervious area since 1985	F-1	Yes	Added Map	Map shows basins which potentially qualify for use of existing land cover as the pre-developed land cover for flow control purposes. See reference in Min. Requirement #7.
Glossary and Notations				
Glossary and Notations	Glossary-1 through Glossary-47		Added and revised definitions.	There are a few terms, used previously but not defined, for which a definition has been added. A handful of other terms have a revised definition, and there are new terms, because of the new low impact development (LID) guidance and requirements in the Municipal Stormwater Permits.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume II Construction Stormwater Pollution Prevention				
Chapter 1 - Introduction Construction Stormwater Pollution Prevention				
Chapter 1 - Introduction Construction Stormwater Pollution Prevention	1-1 through 1-9		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Section 1.3 How to Use This Volume	N/A		This section was removed. The information in this section is now included in Sections 1.2.	Removed this section by combining it with Section 1.2 to eliminate duplicate language.
Section 1.3 Thirteen Elements of Construction Stormwater Pollution Prevention	1-3	Yes	Renamed.	Revised to incorporate a new element, Protect Low Impact Development BMPs.
Figure 1.5.1	1-6		Replaced.	Replaced older figure with an updated one.
Chapter 2 - Regulatory Requirements				
Chapter 2 - Regulatory Requirements	2-1 through 2-6		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Information covered in Volume I, Section 1.6 Relationship of the Manual to Federal, State, and Local Regulatory Requirements was removed.
Chapter 2 - Regulatory Requirements	2-1 through 2-6	Yes	Multiple revisions to coordinate the manual to the Washington State General Stormwater Permits.	Revised this chapter to update this information for revisions to the Stormwater General Permits (including the Municipal, Construction, and Industrial Permits).
Section 2.1 and Section 2.2	2-2 through 2-4	Yes	Section 2.1 The Construction Stormwater General Permit and Section 2.2 Construction Stormwater Pollution Prevention Plans now replace the previous Sections 2.1 and 2.2.	Replaced these sections to remove invalid information or duplicate information. Sections 2.1 and 2.2 now go into detail about the relationship of Volume II to the Construction Stormwater General Permit and the requirements for a Stormwater Site Pollution Prevention Plan.
Chapter 3 - Planning				
Chapter 3 - Planning	3-1 through 3-32		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Information covered in Volume I, Section 1.6 Relationship of the Manual to Federal, State, and Local Regulatory Requirements was removed.
Section 3.2 and Section 3.3	3-4 through 3-32		Previous Sections 3.2 and 3.3 have been reversed.	Moved The Construction SWPPP Requirements, previously in Section 3.3 to Section 3.2 for clarity. The Step-By-Step Procedure now follows in Section 3.3. Please note that the Construction Stormwater Pollution Prevention Plan Checklist is still located in Section 3.3.
Section 3.3.3 (Previously Section 3.2.3) Step 3 - Construction SWPPP Development and Implementation	3-8 through 3-32	Yes	Multiple revisions to the Construction SWPPP Elements.	Revised The Construction SWPPP Elements, described in Section 3.3.3 to coordinate with the Construction Stormwater General Permit, Municipal Stormwater Permits, and the Construction BMPs in Chapter 4. Each element now contains an Additional Guidance section that has information not required by the permits. Added Element #13 Protect Low Impact Development BMPs.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Chapter 4 - Best Management Practices Standards and Specifications				
Chapter 4 - Best Management Practices Standards and Specifications	4-1 through 4-128		Added approved equivalent BMPs Sections.	Refers to Ecology's website for BMPs that have been approved as equivalent.
Section 4.1 Source Control BMPs	4-1 through 4-2	Yes	Added Table 4.1 Source Control BMPs by SWPPP Element	Ecology added Table 4.1 Source Control BMPs by SWPPP Element to show how the BMPs listed in Section 4.1 relate to the SWPPP Elements.
BMP C103: High Visibility Fence	4-6		This BMP now includes high visibility silt fence. Multiple revisions for plain language, clarity, and brevity.	Added high visibility silt fence because it meets the intent of BMP C103. Ecology revised this chapter to use simpler and clearer language.
BMP C104: Stake and Wire Fence	N/A		This BMP was removed.	Removed this BMP because BMP C103: High Visibility Fence meets the intent of this BMP in a safer and more commonly used manner.
BMP C105: Stabilized Construction Entrance / Exit	4-7 through 4-9		Additional guidance provided and outdated guidance removed.	Added and removed guidance for this BMP based on comments received and field experience.
BMP C106: Wheel Wash	4-9 through 4-11		Additional guidance provided and outdated guidance removed.	Added guidance to clarify that wheel wash wastewater shall not discharge to surface or ground water.
Figure 4.1.2 - Wheel Wash	4-11		Figure was updated	Updated figure to provide more details of a typical Wheel Wash.
BMP C120: Temporary and Permanent Seeding	4-13 through 4-19		Multiple revisions for plain language, clarity, and brevity. Additional guidance provided and removed.	Revised and reorganized this BMP to use simpler and clearer language. Moved some guidance to BMP C121: Mulching or BMP C125: Top soiling. Ecology added and removed additional guidance for this BMP based on comments received and field experience.
BMP C121: Mulching	4-19 through 4-21		Additional guidance provided.	Added minimum mulch thickness based on field experience and comments. Ecology added guidance previously found in BMP C120: Temporary and Permanent Seeding to this BMP.
Table 4.1.8	4-21		Additional guidance provided.	Added Wood Straw and Wood Straw Mulch to the table.
BMP C122: Nets and Blankets	4-22 through 4-25		Multiple revisions for plain language, clarity, and brevity.	Revised this BMP to use simpler and clearer language.
BMP C123: Plastic Covering	4-25 through 4-27		Additional guidance provided and outdated guidance removed.	Removed the use of plastic sheeting over seeded areas because other coverings (such as compost and straw) are preferable. Ecology added and removed guidance for this BMP based on comments received and field experience.
BMP C124: Sodding	4-27 through 4-28		Additional guidance provided and outdated guidance removed.	Provided a link to composting guidance and removed old reference to compost specification.
BMP C125: Top soiling / Composting	4-29 through 4-32		Additional guidance provided and outdated guidance removed.	Added guidance previously found in BMP C120: Temporary and Permanent Seeding to this BMP. Ecology added and removed guidance for this BMP based on comments received and field experience.
BMP C150: Materials on Hand	4-42 through 4-43		Suggested measures and quantities removed.	Removed measures and quantities because measures and quantities should be based on the size of the construction site.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
BMP C151: Concrete Handling and BMP C152: Sawcutting and Surface Pollution Prevention	4-43 through 4-45	Yes	Additional guidance provided.	Added guidance to coordinate this BMP with the requirements of the Construction Stormwater General Permit and to make it clear that Concrete spillage or concrete discard to surface waters of the State is prohibited.
BMP C154: Concrete Washout Area	4-48 through 4-53		Added this BMP.	Added this BMP to provide additional guidance for concrete washout areas.
BMP C160: Certified Erosion and Sediment Control Lead	4-54 through 4-55		Additional guidance provided and outdated guidance removed.	Minimum Requirements for ESC Training and Certification Courses has been removed. Ecology plans on issuing separate, updated guidance in the near future.
BMP C161: Payment of Erosion Control Work	N/A		This BMP was removed.	Removed this BMP because it is not applicable to the full range of projects needing to perform Erosion and Sediment Control Work.
BMP C180: Small Project Construction Stormwater Pollution Prevention	N/A	Yes	This BMP was removed.	Removed this BMP because of changes in threshold requirements in both the Municipal Stormwater General Permits and Construction Stormwater General Permit.
Section 4.2 Runoff Conveyance and Treatment BMPs	4-57	Yes	Added Table 4.2 Runoff Conveyance Treatment BMPs by SWPPP Element	Added Table 4.2 Runoff Conveyance Treatment BMPs by SWPPP Element to show how the BMPs listed in Section 4.2 relate to the SWPPP Elements.
BMP C207: Check Dams	4-74 through 4-77		Additional guidance provided.	Added guidance for this BMP based on comments received and field experience.
BMP C220: Storm Drain Inlet Protection	4-78 through 4-79		Additional guidance provided.	Added guidance for inlet protection of lawn and yard drains and based on comment received and field experience.
BMP C230: Straw Bale Barrier	N/A		This BMP was removed.	Removed this BMP because this BMP has been proven to be ineffective.
BMP C233: Silt Fence	4-90 through 4-95		Multiple revisions for plain language, clarity, and brevity.	Revised and reorganized this BMP to use simpler and clearer language.
BMP C235: Wattles	4-96 through 4-99		Renamed from Straw Wattles.	Renamed this BMP to include wattles made from compost or other materials.
BMP C236: Vegetated Spray Fields	4-100 through 4-102		Added this BMP.	Added this new BMP for dewatering, Construction SWPPP Element #10.
BMP C250: Construction Stormwater Chemical Treatment	4-112 through 4-120		Additional guidance provided.	Added guidance for this BMP, previously available online, to coordinate with the Chemical Technology Assessment Protocol (CTAPE) program.
BMP C251: Construction Stormwater Filtration	4-120 through 4-124		Additional guidance provided.	Added sizing criteria for this BMP, previously available online.
BMP C252: High pH Neutralization Using CO_2	4-125 through 4-127		Added this BMP.	Added this BMP, previously available online, to provide guidance on neutralizing high pH through the use of CO_2.
BMP C253: pH Control for High pH Water	4-128 through 4-129		Added this BMP.	Added this BMP, previously available online, to provide additional guidance for neutralizing high pH.
Appendix II-B Background Information on Chemical Treatment	B-1 through B-3		Multiple revisions to coordinate with BMP C252 and BMP C53.	Revised this appendix to coordinate with the new information provided in BMP C252 and in BMP C253.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume III Hydrologic Analysis and Flow Control Design / BMPs				
Chapter 2 - Hydrologic Analysis				
Chapter 2 - Hydrologic Analysis	2-1 through 2-17		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Outdated guidance was replaced.
Section 2.2 Western Washington Hydrology Model	2-4 through 2-9		Section 2.2 split into multiple subsections.	Section 2.2 split into multiple subsections for clarity and for referencing purposes.
Section 2.2 Western Washington Hydrology Model	2-4 through 2-9		Additional guidance provided.	Added guidance on upcoming Western Washington Hydrology Model (WWHM) changes.
Section 2.2.2 Assumptions made in creating the WWHM	2-5 through 2-8		Additional guidance provided.	Added guidance on precipitation data and upcoming WWHM changes.
Section 2.2.3 Guidance for flow-related standards	2-8 through 2-9	Yes	Additional guidance provided and outdated guidance removed for Minimum Requirements (MR).	Added guidance for MR #5 which now includes an LID Performance Standard. Revised the guidance for MR#8 to reflect the changes made in Volume I, Appendix 1-D.
Chapter 3 - Flow Control Design				
Chapter 3 - Flow Control Design	3-1 through 3-109		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Chapter 3 - Flow Control Design	3-1	Yes	Update text for consistency with revised Min Req'mt #5 and LID	Added references to Minimum Requirement #5, bioretention and permeable pavements in introductory section.
Section 3.1 Roof Downspout Controls	3-1 through 3-18	Yes	Update text & figure for consistency with revised Min Req'mt #5	Text and figures updated to indicate priorities for handling roof runoff.
Section 3.1 Roof Downspout Controls	3-1 through 3-3	Yes	Update text for consistency with revised Min Req'mt #5	Updated references to revised roof downspout BMPs and Rain Gardens in the introductory section.
Section 3.1.1 Roof Downspout Full Infiltration (BMP T5.10A)	3-4 through 3-10	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min.Req'ment #5 and feasibility criteria. Needed better clarity in design guidance
Section 3.1.2 Downspout Dispersion Systems	3-11 through 3-16	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min. Req'ment #5 and feasibility criteria. Improved clarify in design guidance and computer modeling. Added guidance for design criteria for dispersion trenches and splashblocks.
Section 3.1.3 Perforated Stub-out Connections	3-17 through 3-18	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min. Req'ment #5 and feasibility criteria. Updated design guidance.
Section 3.2 Detention Facilities	3-19 through 3-64		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Section 3.2 Detention Facilities	3-35		Updated references.	Updated Maintenance narrative to refer to Appendix IV-G Management of Street Wastes in Volume IV.
Section 3.3 Infiltration Facilities for Flow Control and Treatment	3-65 through 3-102		Section significantly rewritten.	Made significant changes to all sub-sections. Section pertains primarily to design of centralized infiltration facilities. Certain sections also apply to distributed bioretention facilities as indicated in text.
Section 3.3.1 Purpose	3-65	Yes	Revised guidance and reference LID.	Expanded purpose statement and clarified in regard to the types of facilities covered in Section 3.3. Added references to Bioretention and Permeable Pavement sections.
Section 3.3.2 Description	3-65	Yes	Additional guidance provided including Min Req'mt #5.	Made clarifications and added language for complying with MR#5. Added guidance for oil control and pre-treatment facilities.
Section 3.3.3 Applications	3-66		Additional guidance provided.	Minor text change
Section 3.3.4 Steps for Design of Infiltration Facilities	3-68 through 3-71	Yes	Revised several steps for new infiltration rate guidance and the new LID performance standard.	Revised Step 2 to include guidance for meeting MR#5. Significantly revised Step 5 for the new guidance provided in section 3.3.6. Revised Step 6 for clarity and for meeting MR#5. Revised Step 7 for clarity.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 3.3.5 Site Characterization Criteria	3-72 through 3-75		Revised guidance on subsurface characterization, soil testing, and infiltration receptor. Removed guidance for hydrogeologic investigation and figure 3.27, USDA Textural Triangle.	Multiple changes to subsurface characterization include added guidance on groundwater monitoring wells and the use of grain size analysis method for estimating infiltration rates. Deleted infiltration rate determination sub-section due to redundancy with next section.
Section 3.3.6 Design Saturated Hydraulic Conductivity - Guidelines and Criteria	3-75 through 3-83		Revisions for determining the saturated hydraulic conductivity (infiltration rate). Section renamed.	Replaced "Infiltration Rate" with "Saturated Hydraulic Conductivity" throughout section. Updated the guidelines and criteria for determining saturated hydraulic conductivity. Added guidance on pilot infiltration testing (PIT), and soil grain size analysis. Revised correction factors for PIT results and soil grain size method. Removed options based on USDA Soil Texture Classification and D10 grain size.
Section 3.3.7 Site Suitability Criteria (SSC)	3-83 through 3-86		Additional guidance provided and outdated guidance removed.	Updated references, removed unneeded guidance, revised limits on infiltration rates, added a minimum organic content for treatment, amended drawdown guidance, and verification testing.
Section 3.3.8 Steps for Designing Infiltration Facilities - Detailed Approach	3-86 through 3-90		Multiple revisions. Previous steps 1-4 removed. Multiple steps revised. Added groundwater mounding analysis step.	Removed steps to select location, estimate volume of stormwater, develop a trial infiltration facility geometry, conduct a geotechnical investigation, and determine the saturated hydraulic conductivity; instead refers to steps 1-5 in section 3.3.4. Revised Figure 3.27 for updated guidance. Revised guidance for adjusting the preliminary design infiltration rate. Added a step for groundwater mounding analysis. Added guidance for conducting performance testing.
Section 3.3.9 General Design, Maintenance, and Construction Criteria for Infiltration Facilities	3-90 through 3-94		Additional guidance provided and outdated guidance removed.	Added guidance for sizing for flow control, pretreatment design criteria, and maintenance. Made wording clarifications to guidance.
Section 3.4 Site Procedures for Bioretention and Permeable Pavement Use	3-103 through 3-109	Yes	Added this section for bioretention and permeable pavement.	Added guidance re field tests, computer modeling, and implementation for bioretention / rain gardens and permeable pavement.
Appendix III-A Isopluvial Maps for Design Storms				
Appendix III-A Isopluvial Maps for Design Storms	A-1		Added link to website.	Added a link to a website where isopluvial maps are available.
Appendix III-B Western Washington Hydrology Model - Information, Assumptions, and Computation Steps				
Appendix III-B Western Washington Hydrology Model - Information, Assumptions, and Computation Steps	B-1 through B-13	Yes	Additional guidance provided and outdated guidance removed.	Added guidance on current and upcoming versions of WWHM. Added guidance for the modeling on LID elements and wetlands. Removed outdated computation steps.
Appendix III-C Washington State Department of Ecology Low Impact Development Design and Flow Modeling Guidance				
Appendix III-C Washington State Department of Ecology Low Impact Development Flow Modeling Guidance	C-1 through C-13	Yes	Additional guidance provided and outdated guidance removed.	Text in regard to design guidance removed. All design guidance moved to Volume V. Two sets of modeling guidance provided. One for WWHM 3, and one for upcoming WWHM 2012.
Appendix III-D Procedure for Conducting a Pilot Infiltration Test				
Appendix III-D Procedure for Conducting a Pilot Infiltration Test	N/A		Appendix removed.	Procedures for conducting the PIT have been included within the proposed text on “Design Infiltration Rate Determination” in sections 3.3.6.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume IV Source Control BMPs				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-5		Minor language changes.	Revised for clarity and removed outdated language.
Section 1.3 How to Use this Volume	1-2		Additional guidance provided and outdated guidance removed.	Added new guidance regarding the Industrial Stormwater General Permit (ISWGP), Boatyard General Permit (BGP), and Sand and Gravel General Permit (S&GP) and the inclusion of "applicable" BMPs from this volume in Industrial Stormwater Pollution Prevention Plans (Industrial SWPPPs).
Section 1.5 Treatment BMPs for Specific Pollutant Sources	1-3	Yes	Additional guidance provided and outdated guidance removed.	Added new guidance clarifying the requirements regarding treatment BMPs for facilities covered under the ISWGP (or other General Stormwater Permits).
Section 1.6.1 Applicable (Mandatory) BMPs	1-3 through 1-4		Additional guidance provided and outdated guidance removed.	Added new guidance describing the use of applicable (mandatory) BMPs in regards to the ISGP, BGP, and S&GP. Section renamed to make it clearer that applicable BMPs are Mandatory for permittees under the ISWGP and BGP.
Section 1.6.2 Recommended BMPs	1-4	Yes	Additional guidance provided.	Added guidance regarding facilities covered under the ISWGP that trigger a corrective action.
Chapter 2 - Selection of Operational and Structural Source Control BMPs				
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-66		Numbered BMPs.	Added numbers in the "S400" series to BMPs in Volume IV.
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-66		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language, and removed outdated references.
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-2		Additional guidance provided and outdated guidance removed.	Added new guidance describing the use of applicable (mandatory) BMPs in regards to the ISGP, BGP, and S&GP. Added guidance regarding facilities covered under the ISWGP that trigger a Level 1 or 2 corrective action.
Section 2.1 Applicable (Mandatory) Operational Source Control BMPs	2-2 through 2-6		Additional guidance provided and outdated guidance removed.	Revised wording to clarify where this Section applies. Revised several BMPs for clarity and to coordinate with the ISWGP. Significant changes include the addition of vacuum sweeping and pressure washing, spill prevention and cleanup, visual inspections and record keeping.
Section 2.2 Pollutant Source Specific BMPs	2-7 through 2-66		Additional guidance provided and outdated guidance removed. Minor formatting revisions.	Revised wording to clarify where this Section applies. Added new text on ISWGP requirements. Added guidance regarding facilities covered under the ISWGP that trigger a Level 1 or 2 corrective action. Changed the title format for the BMPs to match the other volumes and added a numbering system to the BMPs.
S401 BMPs for the Building, Repair, and Maintenance of Boats and Ships	2-7 through 2-9		Additional guidance provided and several BMPs clarified.	Clarified guidance describing the requirements under the BGP and ISGP regarding boatyard activities. Revised BMPs to use simpler and clearer language.
S402 BMPs for Commercial Animal Handling Areas	2-10		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language.
S403 BMPs for Commercial Composting	2-10 through 2-12		Additional guidance provided and outdated guidance removed.	Revised language because solid waste regulations prohibit discharge of compost leachate. Revised BMPs to use simpler and clearer language, and removed outdated references.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
S405 BMPs for Deicing and Anti-Icing Operations - Airports and Streets	2-13 through 2-14		Additional guidance provided and outdated guidance removed.	Revised language to coordinate with the ISGP. Removed outdated references.
S414 BMPs for Maintenance and Repair of Vehicles and Equipment	2-32 through 2-34	Yes	Revision for consistency with the ISGP	Updated "applicable BMP" guidance for handling of liquids in scrap vehicles to align with ISGP.
S416 BMPs for Maintenance of Roadside Ditches	2-35 through 2-37		Additional guidance provided and updated references.	Additional guidance provided for the handling of ditch cleanings.
S423 BMPs for Recyclers and Scrap Yards	2-45 through 2-46		Updated reference to guidance.	Updated the reference to guidance for Vehicle Recyclers.
S424 BMPs for Roof/Building Drains at Manufacturing and Commercial Buildings	2-46 through 2-47		Added reference to guidance.	Added a references to Volume V and Ecology publications for BMPs.
S426 BMPs for Spills of Oil and Hazardous Substances	2-48 through 2-49		Additional guidance provided and outdated guidance removed.	Revised several BMPs for clarity and to coordinate with the ISWGP.
S430 BMPs for Urban Streets	2-58 through 2-59		Additional guidance provided.	Clarified that facilities not under the ISWGP may consider some water use in street cleaning.
S431 BMPs for Washing and Steam Cleaning Vehicles / Equipment / Building Structures	2-60 through 2-62	Yes	Additional guidance provided and outdated guidance removed.	Added guidance to clarify that the ISWGP prohibits the discharge of process wastewater to ground water or surface water. Removed outdated guidance.
Figure 2.15 - Uncovered Wash Area	N/A		Figure Deleted	Figure was unclear and the existing text provided a better description of the required controls.
S432 BMPs for Wood Treatment Areas	2-63 through 2-64		Additional guidance provided and several BMPs clarified.	Clarified guidance describing which NPDES permit(s) regulate wood treatment areas. Revised BMPs to use simpler and clearer language.
S433 BMPs for Pools, Spas, Hot Tubs and Fountains	2-64 through 2-66		Additional guidance provided.	Added this BMP to provide further guidance consistent with BMPs within this volume.
Appendix IV-A Urban Land Uses and Pollutant Generating Sources				
Appendix IV-A Urban Land Uses and Pollutant Generating Sources	A-1 through A-24		Minor language changes.	Edits for clarity and to replace and revise guidance documents and WAC references.
Commercial Composting - SIC 2875	A-14		Additional guidance provided	Added "Potential Pollutant Generating Sources"
Appendix IV-B Stormwater Pollutants and Their Adverse Impact				
Appendix IV-B Stormwater Pollutants and Their Adverse Impact	B-1 through B-2		Minor language changes. Removed Table.	Minor language changes for clarity. Removed the outdated Table in Appendix IV-B.
Appendix IV-C Recycling/Disposal of Vehicle Fluids/Other Wastes				
Appendix IV-C Recycling/Disposal of Vehicle Fluids/Other Wastes	C-1		Minor language changes.	Minor language changes for clarity.
Appendix IV-D Regulatory Requirements That Impact Stormwater Programs				
Appendix IV-D Regulatory Requirements That Impact Stormwater Programs	D-1 through D-9		Minor language changes.	Edits for clarity and to replace and revise guidance documents and WAC references.
Appendix IV-E NPDES Stormwater Discharge Permits				
Appendix IV-E NPDES Stormwater Discharge Permits	E-1 through E-7	Yes	Additional guidance provided and outdated guidance removed.	Edits to make guidance consistent with the most recent industrial and municipal stormwater permits.
Appendix IV-G Recommendations for Management of Street Wastes				
Appendix IV-G Recommendations for Management of Street Wastes	G-1 through G-15		Multiple revisions for plain language, clarity, and brevity. Additional guidance provided and outdated guidance removed.	Removed outdated guidance and added new guidance in the contamination in Street Waste Solids subsection. Reorganized the disposal of street waste liquids subsection, no major content changes. Minor revisions to the Site Evaluation subsection.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume V Runoff Treatment BMPs				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-4		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language, and removed outdated references.
Section 1.4.3 Treatment Methods	1-2 through 1-4		Additional guidance provided and outdated guidance removed.	Revised guidance for oil/water separation, pretreatment, infiltration, filtration, emerging technologies, and on-line systems. Added Bioretention as a treatment method.
Chapter 2 - Treatment Facility Selection Process				
Chapter 2 - Treatment Facility Selection Process	2-1		Additional guidance provided.	Added paragraph on emerging technology options.
Section 2.1 Step-by-Step Selection Process for Treatment Facilities	2-1 through 2-9		Minor revisions to the steps. Revised description of surface waters triggering enhanced treatment.	Revised selection process steps for clarity and to remove outdated information. Revised the Treatment Facility Selection Flow Chart for revised guidance throughout Volume V. Revised description of surface waters triggering enhanced treatment for accuracy.
Figure 2.1.1	2-3		Revised list of options.	Some treatment BMP options removed, emerging technologies added, one BMP renamed. Added a note for Phosphorous facilities that require Enhanced Treatment.
Section 2.2 Other Treatment Facility Selection Factors	2-9 through 2-11		Removed the subsection on Pollutants of Concern, the Suggested Treatment Options Table, and Ability of Treatment Facilities Table.	Removed the Suggested Treatment Options Table and Ability of Treatment Facilities Table because they provided limited usefulness and removed the associated subsection, Pollutants of Concern.
Chapter 3 - Treatment Facility Menus				
Chapter Introduction Paragraph	3-1		Additional guidance provided.	Added paragraph on emerging technology options.
Section 3.2 Oil Control Menu	3-2 through 3-3		Revised list of options.	Removed catch basin inserts and added emerging stormwater treatment technologies. To date, no catch basin inserts have been approved though the TAPE process but Ecology has approved one emerging technology. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.3 Phosphorous Treatment Menu	3-3 through 3-4		Revised list of options.	Removed amended sand filter (no design criteria have been developed for this treatment), and media filter, added emerging stormwater treatment technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.4 Enhanced Treatment Menu	3-5 through 3-7		Multiple revisions to remove outdated guidance and to provide new guidance. Revised list of options. Revised waters triggering enhanced treatment consistent with Chapter 2.	Revised the performance goal for dissolved metals. Removed Amended Sand Filter. Added "vegetated" to "Compost Amended "Vegetated" Filter Strip. Removed "rain garden" for consistency with proposal to distinguish between "bioretention" and "rain gardens." Replaced "Ecology Embankment" with "Media Filter Drain." Added emerging technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.5 Basic Treatment Menu	3-7 through 3-9		Minor language changes for clarity. Revised list of options.	Removed "rain garden" for consistency with proposal to distinguish between "bioretention" and "rain gardens." Replaced "Ecology Embankment" with "Media Filter Drain". Added Compost-amended Vegetated Filter Strip. Removed Bio-infiltration Swale. Added emerging technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Chapter 4 - General Requirements for Stormwater Facilities				
Section 4.1.1 Water Quality Design Storm Volume	4-1	Yes	Inserted updated modeling guidance.	New guidance more accurately describes how volume is determined by computer models.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 4.1.2 Water Quality Design Flow Rate	4-1 through 4-2		Minor language changes for clarity.	Revised language for clarity.
Section 4.1.3 flows Requiring Treatment	4-2 through 4-4		Minor language changes for clarity. Changes to incorporate new terms.	Replaced "impervious" surfaces with "hard" surfaces in coordination with general changes in terminology. Added guidance regarding pollution-generating hard surfaces, pollution-generating impervious surfaces, and pollution-generating pervious surfaces.
Section 4.6 Maintenance Standards for Drainage Facilities	4-31 through 4-53	Yes	Added new tables within overall set of operation and maintenance standards	Changed "StormFilter" to "Manufactured Media Filters", added information from WSDOT on Media Filter Drains and Compost Amended Vegetated Filter Strips. Minor additions to the recommended maintenance tables added. Added placeholders for Bioretention and permeable pavement pending completion of the development of LID maintenance standards grant.
Chapter 5 - On-Site Stormwater Management				
Section 5.1 Purpose	5-1		Additional guidance provided.	Add reference to expanded BMP options and LID Manual to acknowledge the expansion of Chapter 5 and source of additional design details (LID Manual).
Section 5.2 Application	5-1	Yes	Additional guidance provided.	Revised application to refer specifically to Minimum Requirements #5, #6, and #7.
Section 5.3 Best Management Practices for On-Site Stormwater Management	5-1 through 5-2		Additional clarifying guidance provided. Full list of BMPs provided.	Expanded the list of BMPs in sections 5.3.1 and 5.3.2. Revised language and references for clarity.
Section 5.3.1 On-site Stormwater Management BMPs	5-3 to 5-39	Yes	Amend existing BMP's add new BMP's	Downspout infiltration moved to Volume III. Revised BMP T5.11 Concentrated Flow Dispersion and BMP T5.12 Sheet Flow Dispersion. Updated figures. Added BMP T5.14A Rain Gardens and BMP T5.14B Bioretention but details are in Volume V of Chapter 7. Added BMP T5.15 Permeable Pavements, BMP T5.16 Tree Retention and Tree Planting, BMP T5.16 Vegetated Roofs, BMP T5.18 Reverse Slope Sidewalks, BMP T5.19 Minimal Excavation Foundations, BMP T5.20 Rainwater Harvesting. Revised BMP T5.30 Full Dispersion by incorporating details from previous Appendix III-C.
Section 5.3.2 Site Design BMPs	5-39 through 5-42		Deleted Full Dispersion and section *5.3.3 Other Practices*	Moved Full Dispersion into Section 5.3.1 because the Municipal Stormwater Permits make it a necessary option in MR #5. Clarifying statement added in BMP T5.40.
Chapter 6 - Pretreatment				
Section 6.1 Purpose	6-1		Minor language changes.	Removed "and media filtration" in first bullet for clarity.
Section 6.2 Application	6-1		Additional guidance provided.	Added discussion that there are emerging technologies approved for pretreatment.
Section 6.3 Best Management Practices (BMPs) for Pretreatment	6-1		Additional guidance provided.	Added reference to Chapter 12.
Chapter 7 - Infiltration and Bioretention Treatment Facilities				
Section 7.1 Purpose	7-1		Changed bioinfilltration to bioretention.	Updated listed BMPs and made minor revisions to text.
Sections 7.2 General Considerations	7-1		Additional guidance provided.	Renamed this Section and added information regarding Bioretention and Rain Gardens.
Sections 7.3 Applications	7-1 through 7-2		Additional guidance provided.	Renamed this Section and added information for the BMPs discussed in this chapter.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 7.4 and BMPs 7.10 & 7.20	7-2		Updated references to Volume III	Design details for these BMPs remain in Volume III.
BMP T 7.30 Bioretention Cells, Swales, and Planter Boxes	7-3 through 7-25		Replaced Bio-infiltration Swale with Bioretention Cells, Swales, and Planter Boxes.	Added detailed guidance, design criteria, infeasibilty criteria and figures for Bioretention Cells, Swales, and Planter Boxes.
BMP T7.40 Compost-amended Vegetated Filter Strips (CAVFS)	7-25 through 7-29		Transferred this BMP from Chapter 9.	Added guidance and design criteria for Compost-Amended Vegetated Filter Strips. Treatment via infiltration through amended soils.
Chapter 8 - Sand Filtration Treatment Facilities				
Chapter 8 - Filtration Treatment Facilities	8-1 through 8-39		Changed title and introduced minor language changes for clarity.	Revised name from Sand Filtration to just Filtration.
8.1 Purpose	8-1		Revised guidance.	Revised the purpose to apply to both sand and media filtration facilities.
8.2 Description	8-1		Additional guidance provided.	Added reference to Media Filter Drain to description.
Section 8.3 Performance Objectives	8-2		Included new technologies	Added Media Filter Drain to list of approved technologies. Clarified objective for sand filters.
Section 8.4 Applications and Limitations	8-2		Revised guidance.	Revised to include media filter drains.
Section 8.5 Best Management Practices (BMPs) for Sand Filtration / BMP T8.10 Sand Filter Basin	8-2 to 8-15		Renamed and reorganized section. Additional guidance provided.	Added design criteria for sand filter basins. reorganized section so that previous sections 8.5, 8.6, 8.7, & 8.8 become subsections under BMP T8.10.
BMP T8.11 Large Sand Filter Basin	8-16 through 8-17		Separated out BMP previously reference within BMP T8.10	BMP T8.11 Large Sand Filter Basin was described in the prior manual under BMP T8.10 Sand Filter Basin. The Large Sand Filter was given a separate BMP for clarity.
BMP T8.20 Sand Filter Vault	8-17 through 8-23		Additional guidance provided.	Added design criteria, construction criteria, and maintenance criteria for sand filter vault.
BMP T8.40 Media Filter Drain	8-24 through 8-38		Added this BMP.	Added design criteria for new Media Filter Drain (MFD) option (previously referred to as Ecology Embankment). Text matches WSDOT Highway Runoff Manual.
Chapter 9 - Biofiltration Treatment Facilities				
Chapter 9 - Biofiltration Treatment Facilities	9-1 through 9-26		Minor language changes for clarity.	Minor language changes for clarity throughout the chapter.
Section 9.4 Best Management Practices	9-1 through 9-26		Additional guidance provided and outdated guidance removed.	Revised list of BMPs. Revised Sizing Criteria table for clarity.
BMP T9.50 Narrow Area Filter Strip	N/A		Removed this BMP.	No design criteria exists for this BMP to validate basic treatment. Designers should refer to Basic Filter Strip.
Chapter 10- Wetpool Facilities				
BMP T10.10 Wet Pond	10-1 through 10-17		Minor language changes for clarity.	First cell must be lined to be consistent with liner requirements in Chapter 4. Added cell requirements for consistency with design criteria for 2-cell ponds. Definition of WQ Design Storm Volume amended.
Chapter 11 - Oil and Water Separators				
BMP T11.10 API (Baffle type) Separator Bay	11-8 through 11-9		Corrected formula.	Corrected Stokes Law equation for rise rate.
BMP T11.11 Coalescing Plate (CP) Separator Bay	11-10 through 11-11		Corrected formula.	Corrected the equation to calculated the projected (horizontal) surface area of plates.
Chapter 12 - Emerging Technologies				
Chapter 12 - Emerging Technologies	12-1 through 12-6		Replaced sections 12.1 through 12.5 with new guidance.	Replaced sections 12.1 through 12.5 to provide new guidance on the Technology Assessment Protocol (TAPE) review and approval process.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 12.6 Examples of Emerging Technologies for Stormwater Treatment and Control	N/A		Removed examples of emerging technologies.	Removed examples of emerging technologies. Added some examples previously listed throughout this volume.
Appendix V-B Recommended Procedures for ASTM D 2434				
Appendix V-B Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes.	B-1 through B-2		Additional guidance provided.	Added Recommended Modifications to ASTM D 2434. The results of this test for saturated hydraulic conductivity can be influenced by how the general procedures in the ASTM method are implemented. This appendix lays out more specific procedures to help with consistency in evaluating soils used for bioretention.
Appendix V-C Geotextile Specifications				
Appendix V-C Geotextile Specifications	C-1 through C-3		Revised Guidance.	Corrected several test procedures and geotextile property requirements.
Appendix V-E Recommended Bioretention Plant Species				
Appendix V-E Recommended Newly Planted Tree Species	E-1 through E-5		New appendix pertinent to BMP T5.16	Lists of species from City of Seattle guidance.

VARIES	TIER 1	NATURAL DRAINAGE AND WATER BODIES • Admiralty Inlet • Port Townsend • Kah Tai Lagoon • Chinese Gardens • Floodplains • Wetlands
GREEN	TIER 2	CRITICAL DRAINAGE AREAS • Natural Topography and Land Forms
PINK	TIER 3	CREATED DRAINAGE CONNECTIONS • Controlled Connections between Tier 4 and 1 or 2
PURPLE	TIER 4 A. Main Roads B. Other Public Roads	ROAD DRAINAGE • Public Street Drainage

City of Port Townsend

Stormwater Management Plan Public Open House

Date: Tuesday, September 26, 2017

Location: Cotton Building, 607 Water Street, Port Townsend

Be part of the Stormwater Management Plan public process. Come and give your input on the City's proposed Stormwater Capital Improvement projects, the Stormwater Utilities Vision Statement and more.

For more information on and about the Stormwater Management Plan please visit the City's Stormwater Management Plan website https://stormwatermanagementplan.wordpress.com/ While you are viewing the website provide your email at the bottom of the main page and follow the process.

Tell us what is important to you when creating the Stormwater Management Plan

The City is in the process of preparing a Stormwater Management Plan.

The scope of the Plan includes going over existing conditions of the City's Stormwater infrastructure, identifying Stormwater capital projects, outlining changes to the Engineering Design Standards (EDS) Chapter 4 Stormwater and the Municipal Code Title 13 Article IV, and financing for the Stormwater utility including capital projects. The review of the EDS and the municipal code will include reviewing the development guidelines and regulations.

Are there topics you are wondering if the City will cover? Please let us know. Send your comments and suggestions to sharper@cityofpt.us by Wednesday September 27, 2017. Also sign-up on the City's Stormwater Management Plan website to receive updates on the project. The website is https://stormwatermanagementplan.wordpress.com/ There will also be more opportunities to comment throughout the Stormwater Management Plan process.

AGENDA

Stormwater Management Plan - Advisory Task Force
Workshop 2 | November 2, 2017 | Cotton Building, 607 Water Street, Port Townsend

2:00 – 2:15 **Welcome and Agenda**

2:15 – 2:30 **Introductions**

2:30 – 2:45 **Meeting Purpose and Goal**

2:45 – 3:15 **Recap from Task Force Meeting #1**

3:15 – 3:30 **Go over public comment to date**

3:30 – 3:45 **Brief overview of the proposed Stormwater Capital Improvement Program (CIP)**

3:45 – 4:15 **Financing**

4:15 – 4:30 **Development Standards**

4:30 – 5:00 **Meeting Summary**

5:00 **Adjourn**

Comment method	Date	Comment	Response
Written	9/26/2017	#1 I have a concern about putting this wet weather stream underground. It has value for everything from insects to larger wildlife and now support 100+ year old Douglas Firs. I expect a project where large equipment works thru the now semi wild ravine will meet with resistance from residents whose property adjoin the ravine (locally known as Kah Tai Creek).	
Written	9/26/2017	Pettygrove 43rd Street to 47th Street Area floods, pipe connection to storm pipe going to Chinese gardens #2 on CIP Map	
Written	9/26/2017	Generally, I favor diverting more fresh water runoff into the Kah Tai Lagoon Nature Park. That is provided it is filtered through sufficient bio swales to remove oil and other containments. There seems to be a protentional site for expanded inflow at the east southeastern end where a small wetland already exist.	
Written	9/26/2017	The corner of 47th & Jackman is still flooding and Jackman road surface is showing the impact. We still get water run off. My crawl space is finally dry, but I pump the water down hill. There is still a storm water fee we pay every month and receive no benefit.	
Written	9/26/2017	Please see Comment Map #5: I would like the City to consider & discuss the potential negative impact of adopting the 2014 Storm water Regs (Vs. 2005) on the cost of housing. The 2014 Stormwater Manual was written for very high Density truly Urban areas such as Seattle/ Tacoma. Cities of the scale of Port Townsend are not required to adopt these regs because they are not written for this Cities small size & Relative Low Density.	
Written	9/26/2017	I live at the Kearney St. Apts. And have observed the tremendous amount of storm water that flows down through the neighborhood carving out new channels in dirt roads (1) which is the one that accesses the Police Station from Gaines St (2) the one that is situated behind Crossroads Music Store (& ends at Kearney) and the (3) one between the apartments complex on Walker & Lawrence - and three houses to the NW. The water that flows down the "Police Station Road" carries so much dirt and it flows through the shrubs on the bank above the Kearney St Parking Lot. * *It takes out the stones in the stone wall on Kearney! Point is - All of that water, which carries a lot of grease, and oil from parking lots and streets, ends up... Where? in Kah Tai? In the Bay? I believe I was told on one occasion when I asked about this, that there is a "holding area" - under the sidewalk on Kearney to the East of Sims Way, but it can overflow and empty through that pipe which empties (more & more often) into the Bay. I would really like to understand how this storm water system works in our neighborhood. In connection with this -- we need to understand the "hydraulics" of Kah Tai Lagoon- Should the pipe that allows it, the tide, to moderate the level and water type in the lagoon is repaired more fresh or more salty? I think we have been ignoring that issue, yet it will greatly affect the ability of the lagoon to handle runoff in the future.	

Comment method	Date	Comment	Response
E-mail	9/27/2017	Hi Samantha, Please note that i am concerned that new and more restrictive Storm Water Management requirements will exacerbate the Affordable Housing Crisis in Port Townsend... Please send me the Draft SW Plan Narrative and Drawings that was shown at your workshop Yesterday... I was unable to attend... also, please add me to the Email list that will keep me informed Of the timeline of the process.. I was unable to access the website referenced in the newspaper.... Thank you Vern Garrison 360-301-2009	Hello Vern, Here is the link that I promised to send following our discussion this morning. https://stormwatermanagementplan.wordpress.com/ Let me know if you have difficulty accessing from this link. Joanna Sanders, MMC | City Clerk
E-mail	9/28/2017	I have just recently learned of plans to contain Kai Tai Creek in a pipe. I cannot remotely understand why the city would want to spend needed funds on a project that will totally disrupt the neighborhood ruin a very natural area, and to most of us in the area, serve absolutely no purpose. The city must have a secret fund salted away that it doesn't know what to do with. Please reconsider this. Thank you, Mark Henthorn, 1805 Wilson, Port Townsend	
E-mail	9/27/2017	This is to inform you that I am against putting Kah Tai Creek in a pipe. I've lived at 928 14th St since 2004 & greatly cherish the trees on Castle Hill. Many would have to fall to pipe that creek. It also would be a terrific mess and annoyance for those who live along the creek. In addition, there have been no visible problems with the creek since work was done a few years ago on the lower portion. Finally, it's a natural drainage that starts near my house & flows down the unused right of way for 16th St. Why not wait till the street is actually put in to do any drainage changes? The money would be much better spent on fixing the many, many potholes in this city, rather than tearing up natural vegetation that soaks up lots of pollutants before they hit the lagoon & its wildlife. I could go on - - - To my mind there are many arguments against this proposed project & I've seen nothing supporting it nor any need for it. Will there be a hearing on this? Your response will be appreciated. Mike Morrissey 928 14th St	
E-mail	9/27/2017	Dear city of P.T. I just heard about the city plan to place kai tai creek into a pipe instead of letting it be what it is....a really nice in town riparian corridor. I think rather then spend millions(no doubt) to channel the creek the city should save money by the simple expediency of making that drainage into a wildlife corridor. It strikes me as a vase of needless infrastructure. Got extra money? Spend it on maintance rather then development. Aron uchitelle 1435 gise	

Comment method	Date	Comment	Response
E-mail	9/27/2017	Hello Samantha.....please add my name to the list of people who want to participate in the review of the storm water regulations of the City of Port Townsend. The new regulations of the 2014 SWMMWW DOE Manual to not provide sufficient alternatives to areas like the City of PT which have no rivers or natural streams. And most of the wetlands are no more than periodic wet basins that very quickly dissipate into the upper soils of the area. Please put me on the notice list. Thanks for your help. Michael J. Anderson PE & PLS	
E-mail	9/27/2017	I just heard from neighbors that the city is planning to put Kah Tai Creek in a pipe so it isn't free-flowing anymore. I want to go on record that I am vehemently opposed to this plan. Thank you, Todd Jensen 1735 Wilson St. PT	
E-mail	9/27/2017	Samantha, My name is Nathan Land and I live at 1524 Sheridan Street. In response to the staff update to the storm water management plan discussed in the Port Townsend Planning Commission regular session on September 14, I would like to suggest that Kai Tai creek not be put into a drainage pipe between Gise Street and Hill Street. Instead, the city should not modify the flow of the creek, allowing it to remain a free-flowing creek. In PTMC 19.05.100, there is a proposed amendment to the code that would require surface drainage to be directed away from landslide and erosion areas when the surface drainage meets a set of drainage and geomorpohological criteria consistent with SMP DR6.8.2. I claim that this amendment is unethical, because it is placing the property value of a small number of homes above the very rare existing natural surface aquifers in the area. Further, I claim that the area between Gise and Hill street should be protected by the very same part of the municipal code, 19.05.100.E.2.C, which states that existing vegetation in surface drainage areas should remain undisturbed. If this is a case where the vegetation has been disturbed or is insufficient, then I claim it is a reasonable argument to state that instead of installing a drainage pipe, revegation with native species would be more appropriate. There are very few natural creeks on the quimper peninsula, and putting this creek into pipe will effectively kill the creek permanently. I understand that from a stormwater management engineering perspective, a pipe is an effective way to drain overflow water. However, from a biological perspective, the creek has more inherent value as a diffuse drainage method and provides enumerable benefits to wildlife and soil quality. We are stewards of this land, and we have a responsibility to ensure that we do not destroy natural processes in an attempt to anticipate a possible risk to property value of a small number of homes as a result of stormwater flooding. Please do not approve amendment 19.05.100.E.2.B.v to the PTMC. Thanks very much, Nathan Land.	

Comment method	Date	Comment	Response
E-mail	9/27/2017	hi there city of port townsend, in regards to the pipe from gise to kah tai. i live on gise and 14th. i understand progress. i also know that the precious green belts in this town have incredible value to wild life and to making this town special. i would like more information on what swath of destruction is proposed and more about the issue as an impacted tax paying citizen. thanks, zo wohlhaupter	
E-mail	9/27/2017	Please reconsider the idea of piping the creek from Gise down. The development along that area has already minimized the wildlife corridor and this will definitely limit even further the movement of the deer in particular. There will be even more deer getting into people's gardens causing even more demand on the city government to do something about the problem. Limiting the availability of open water will probably result on more work for you guys in the end. Thanks for considering this concern. Laurette Gilbert	
E-mail	9/27/2017	To: The City of Port Townsend From: Heida Diefenderfer, 1524 Sheridan St, PT Date: 26 Sept 2017 The Quimper Peninsula has very few natural surface water sources. One of those is in our neighborhood: Kai Tai Creek. It should be protected, not put in a pipe. The source itself is degraded and would benefit from the establishment of native plants in the area. We are against the draft plan to put Kai Tai Creek into a pipe in the vicinity of Gise to Hill Streets in Port Townsend. I would appreciate receiving confirmation that my comment has been received in a timely manner. Please add me to the list for updates to the plan and let me know when the next version is due. Thank you very much. Heida	
E-mail	9/27/2017	Mr Sharper, I currently live on hill st and I'm on the receiving end of much of the downhill storm water from Gise. Even with that, I oppose the cities plan to pipe the water from Gise to Hill. For one thing, once you've paid for the installation (big bucks) then you have to maintain (big bucks) forever. Look at the 16th, Hill St drain. That is a quagmire of problems. The city has spent a fortune on this project over time. I know because I see your trucks there a lot, clearing out dirt in drains. It's also a huge liability. An alternative, how about having a series of rain gardens that would be cheaper to install; imagine, beauty and minimal maintenance costs. It would also keep a free flow of runoff that could be managed or changed if needed. I also think that the city could have done a better job in communicating with affected neighborhoods. I didn't get any info on this project for comment, or know about the deadline for comment. Do not put in pipe,please! Thanks, Dave Sterritt 1636 Hill St 360 821-8790	
E-mail	9/27/2017	Please keep the creek free! I live near this creek. My son and neighborhood kids have grown up around it playing in it. I personally have lived in this neighborhood for twenty years and in the last couple years have watched every available lot be purchased and slated for development. I see no reason to bury this creek any more than out already is other than so land can be developed right up to it. As our town is transforming let's make choices that keep this not only a livable community but one that retains it's physical beauty of natural spaces. For is that not why so many people want to move here? SAVE KAH TAI CREEK!!	

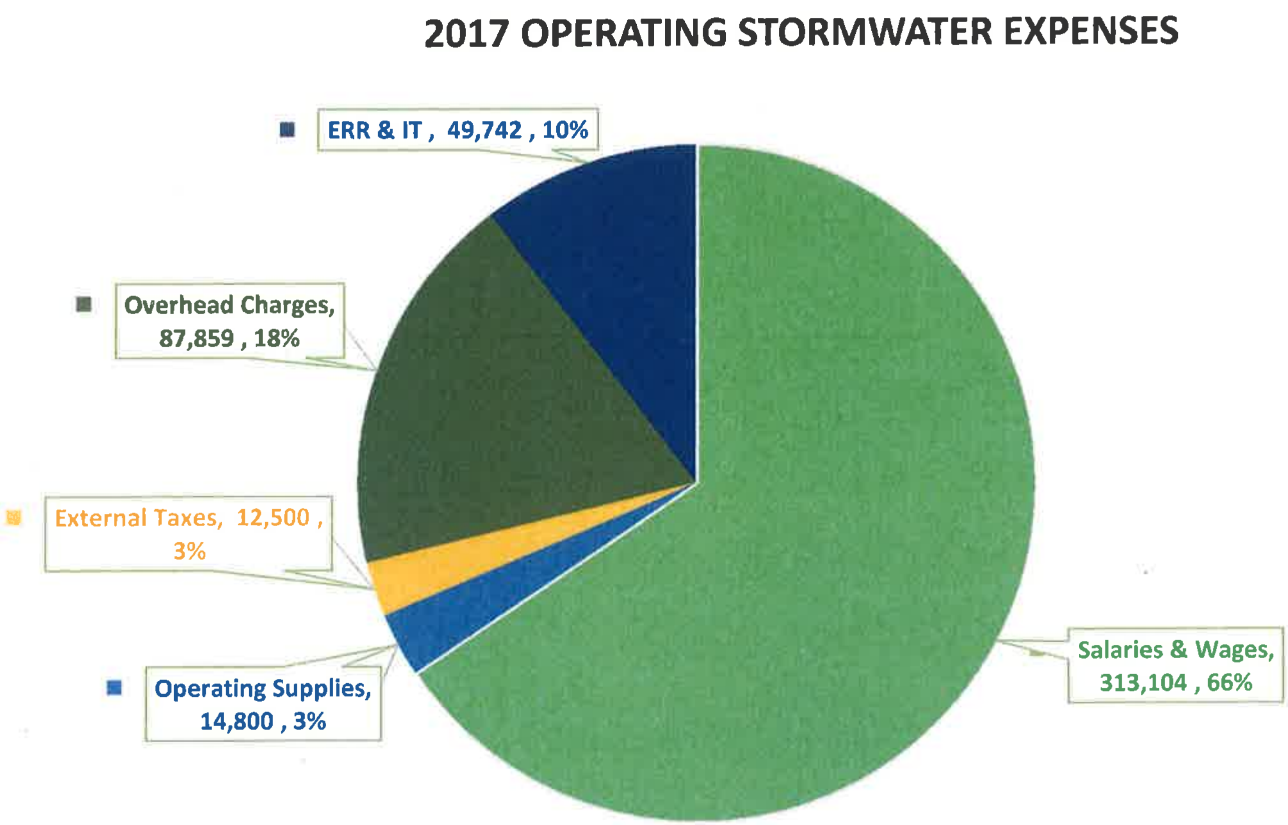
2016 SWMP Update Comments

Comment method	Date	Comment	Response
E-mail	9/27/2017	I would request that the city of PT keep the stormwater from gise st. to hill st free flowing and NOT pipe it. Patrick Hinton 1805 Gise st.	
E-mail	9/26/2017	I am opposed to the unwise suggestion that Kah Tai Creek be run into a pipe underground from Gise to Hill streets. Ecologically the presence of the free flowing water maintains a wild natural space around it which acts as a green belt for wildlife and a sediment trap for runoff water. Aesthetically, it brings the sound and sight of flowing water to the surrounding area. It is a beauty and grace for the neighborhood. I suspect the city is being influenced by developers who see the building lots that would be created by destroying the creek. Resist this influence. Port Townsend is not that desperate for building lots. Thank you for your attention to this. Sincerely Kristin Smith 360 301 5128 1715 and 1708 Gise Street	
E-mail	9/26/2017	Dear Sir, I live on Gise and 18 th St and have lived here for 25 years. My children were raised here and played in that creek when they were young. I cant understand why you want to put the creek in a pipe. If you do leave it alone and let the plants and animals use it as it was intended to be used then some day down the road, some other small children will grow up knowing what a creek sounds like and the joy they can find in nature. For the sake of those children leave the creek alone it has been here far longer than you have! Thank you , Jay Pine 1723 Gise St.	
E-mail	9/26/2017	Hi, I live at 1607 Gise and just heard the city is planning on piping Kai tai creek. I'm really opposed to that, given the bird life especially that the flowing water supports, even storm water. Is there a way not to make that choice that would still work for city storm water management? So many cities are daylighting streams that it seems a shame and shortsighted for PT to go backwards. I hope the city will reconsider. Sincerely, Julie Van Pelt	
E-mail	9/26/2017	We live only one block from this intermitant creek,but we enjoy it when it flows and see no need to put it in a pipe, save our tax dollars for some other project! Jerry Gilbert, 935 18th Street, PT, ps we have owned our house here for over 40 years always at this same address.	

Comment method	Date	Comment	Response
E-mail	9/26/2017	Samantha: The City's Shoreline Management Program (SMP) is incorporated into the Comprehensive Plan. Both clearly require use of the Department of Ecology's Stormwater Management Manual for Western Washington (SWMMW). I think the pending functional plan, EDS, flood code, and Critical Areas Ordinance should do so as well, at least until DOE certifies the local plan as equivalent. As for specific stormwater projects, I would like the city to end all untreated stormwater discharges into those shoreline areas already identified in the SMP. Good luck with your important project. Nancy Dorgan	
E-mail	9/26/2017	My husband attended the public open house for the City of Port Townsend Stormwater Management Plan and came home with some very distressing news. He was told one of the top priorities is to put Kah Tai Creek in a pipe from Gise Street to Hill Street. Please don't do that. It is a wildlife corridor and has 100 year old trees growing. I do not know of any neighbors that have been flooded by Kah Tai Creek in recent history. We live at 1709 Gise Street, one block from Kah Tai Creek and often cross over Kah Tai Creek on Holcomb Street. Please don't destroy our neighborhood creek. Sincerely, Rosemary Sikes 1709 Gise Street 360-385-0307	
E-mail	9/26/2017	Hi Joanna, I didn't find the scoping notice posted with in the 2017 folder on-line. Would you email me a copy? Thanks. Nancy	Hello Nancy, I am not aware of any scoping notice at this point. Samantha Harper is the City engineer responsible for this project and might be able to answer specific questions and I am copying her on this message. There is information at the Stormwater Management Plan project page. https://stormwatermanagementplan.wordpress.com/ If you do not believe this satisfies your request, please let me know. Joanna Sanders, MMC | City Clerk

Existing Stormwater System	
Stormwater Features	**Quantity**
Catchbasins	1,468
Maintenance Holes	114
Storm Filters	4
Solid Pipe	25 Miles
Perforated Pipe	0.9 Miles
Swales	4.1 Miles
Concrete Gutters	1.6 Miles

2018 - 2023 Stormwater CIP List				
1999 Project No.	**Description**	**2017 Site Visit Map**	**2017 CIP? (Select 10)**	**Importance (High/Med/Low)**
ACQUISITIONS				
4-8	Winona Wetland Property Acquisition - Purchased in 1995			On-going
9-2	Hastings to 25th Thomas to Hancock - wetland and critical drainage protection property			
9-2	Hancock/25th/Sheridan, Pasture - combine with # 4 under Acquisitions			
STORMWATER PROJECTS				
Localized Flooding				
9-20	16th Street - Sheridan to Landes		X	H
4-21	Drainage Cooridor between 49th St. and 50th St. and Jackman St. to Gise St.			
11-3	12th St right-of-way from McPherson to Logan and Logan Street from 10th to 12th Sts.		X	M
8-6	Golf Course Pond - Needs flow control on the upper elevation			
-	Center St San Juan to Olympic Ave. - Flooding/drainage problem	C	X	M
-	Hancock Street and 32nd Street - Flooding Issues - 31st Street storm water tied into the sewer		X	M
Improve Conveyance				
11-4	McPherson/9th, Stormwater to SSMH tie-in is north of 9th Street			
-	14th Street McPherson Street to Rosecrans Street		X	M
-	Logan Street Stormwater Pond overflow - cross street is 3rd Street		X	in the 2018 budget
-	Pacific Street - Tremont Street to Milo Street - need storm pipe to Froggy Bottoms			
Stormwater Tie Into the Sewer System				
-	Storm tied in to sewer on Lawrence Street at Polk Street, Tyler Street and Taylor Street		X	
Improve Treatment through Retrofit				
-	Garfield Street Bioswales - Could be part of the removing storm to sewer tie-in on Lawrence Street	D		
Regional Stormwater Systems				
-	Regional Stormwater Facility for Rainier Street Commercial Corridor		X	in progress
Existing system improvements				
-	Major Collector and Minor Arterials (Purple Roads) Stormwater Improvements			On-going
-	Local Access Street (Brown Roads) Stormwater Improvements			On-going


2017 OPERATING STORMWATER EXPENSES
ERR & IT , 49,742 , 10%
Overhead Charges, 87,859 , 18%
External Taxes, 12,500 , 3%
Operating Supplies, 14,800 , 3%
Salaries & Wages, 313,104 , 66%


Revenue to Expenses
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Dollars
2015
2016
2017
2018
Year
Revenue
Expenses

Stormwater Management Plan Briefing

City Council Meeting

December 11, 2017

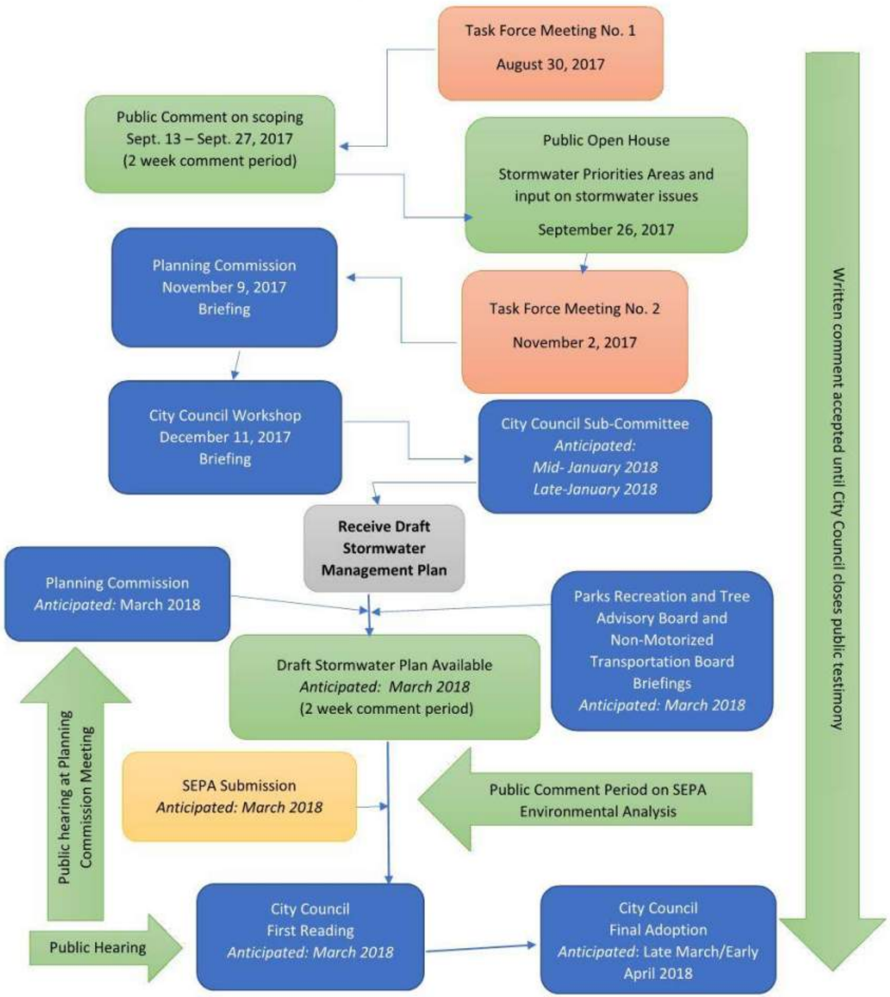
City of Port Townsend

Purpose for tonight

1. Stormwater Plan Implementation Process and What is next
2. Briefing on key concepts and technical issues and unique Stormwater features

City of Port Townsend

City of Port Townsend Stormwater Management Plan Communication Flow Chart
Updated 12/11/2017



City of Port Townsend

Project Initiation

Stormwater Utility Vision Statement

A fully functional, achievable, and sustainable stormwater system that is integrated into the landscape, supports envisioned growth, protects residents, and nurtures the environment.

City of Port Townsend

Data Collection and Review

City of Port Townsend

Unique Stormwater, Drainage Conditions and Considerations in PT

- No “streams”
- Low Rainfall
- Historic Platting

City of Port Townsend

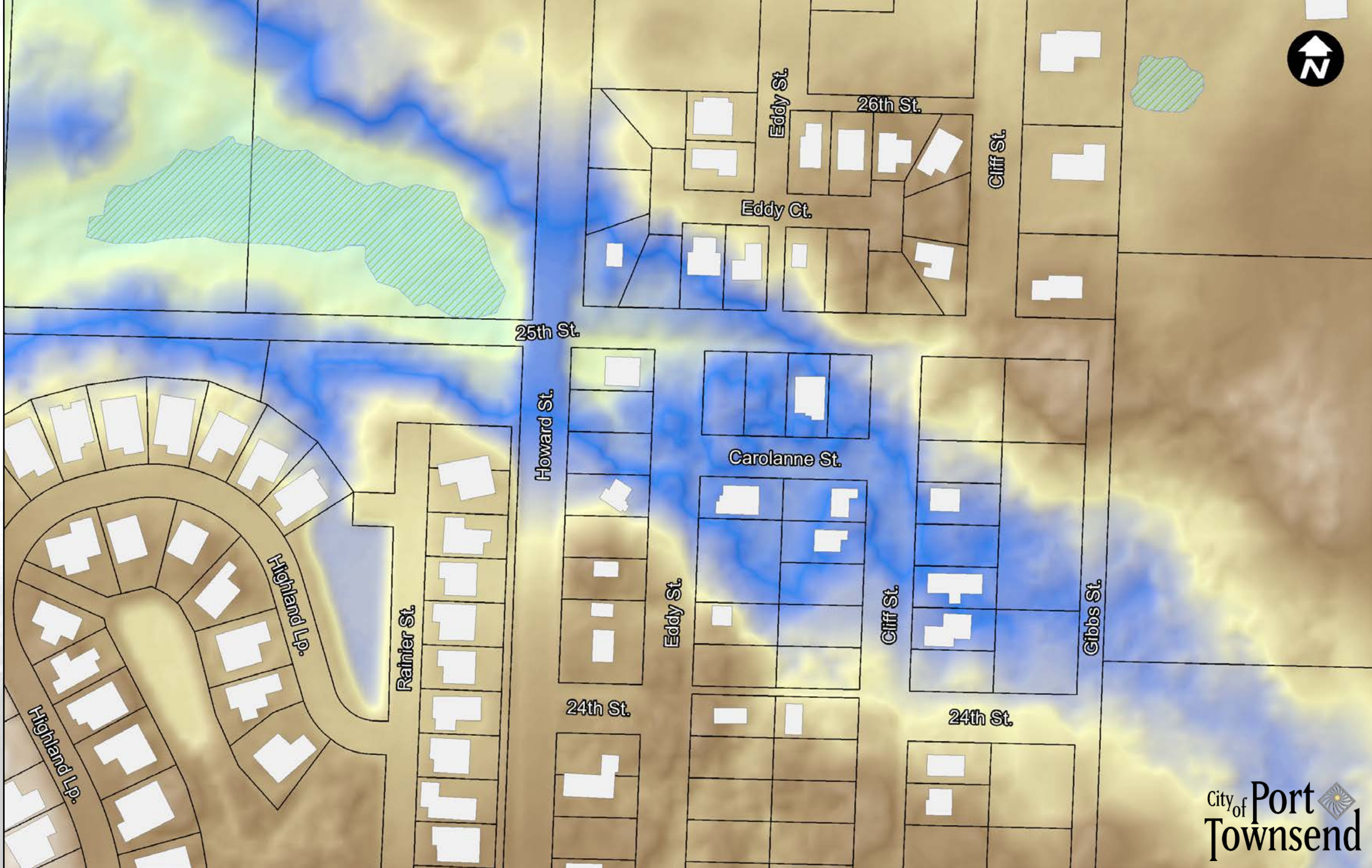
Stormwater Management Needs

- Last plan adopted in 1980s
- Drainage system assessment
- Updated instructions for developers and builders
- Capital Projects
- Road drainage improvements

Tiering Map Legend

- **Tier 1 – BLUE** – Water Bodies and Receiving Waters
- **Tier 2 – GREEN** – Critical Drainage Corridors
- **Tier 3 – PINK** – Created Drainage Connections
- **Tier 4 – PURPLE** – Roadways

City of Port Townsend



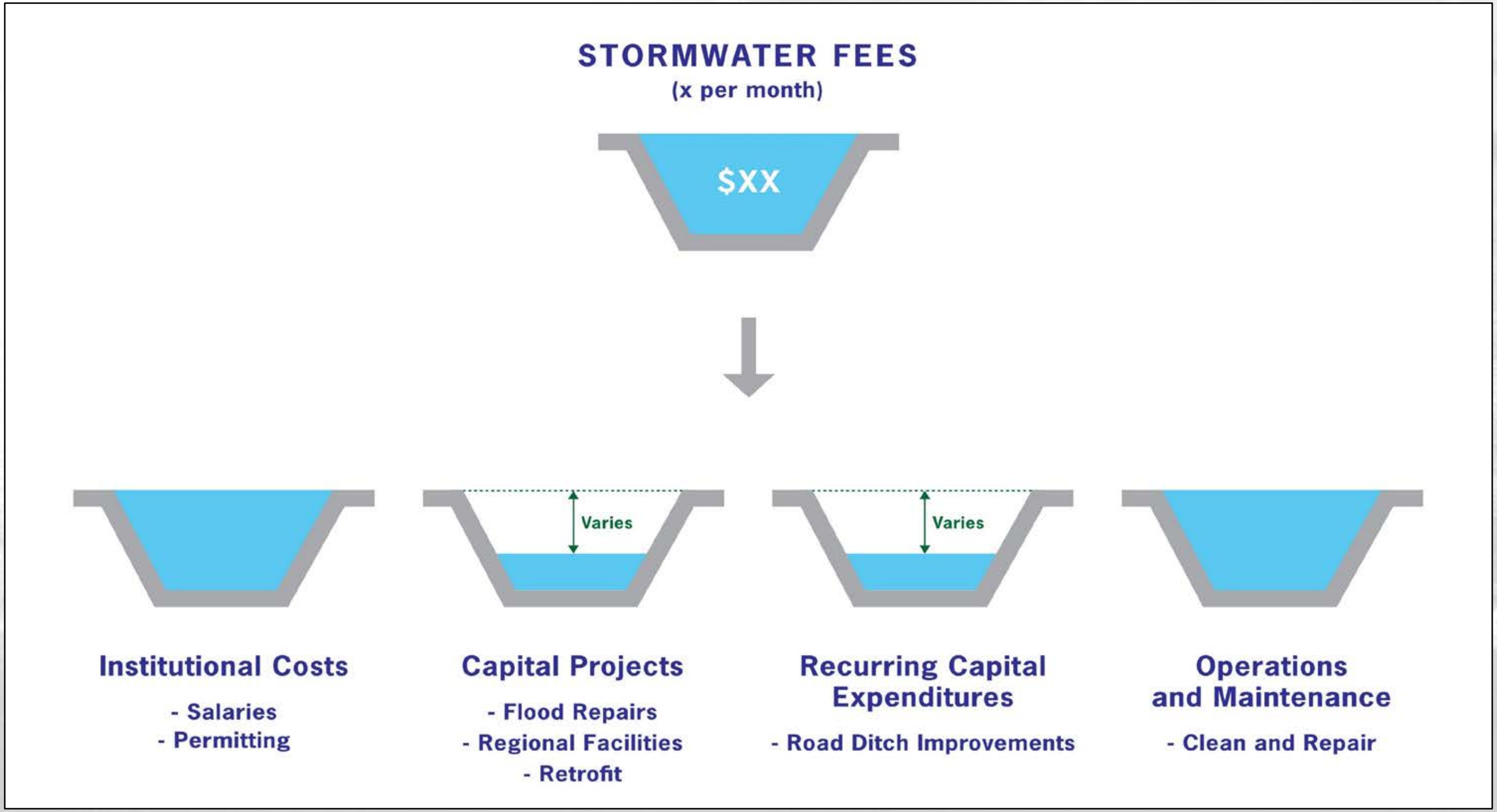
N
26th St.
Eddy St.
Cliff St.
Eddy Ct.
25th St.
Howard St.
Carolanne St.
Highland Lp.
Rainier St.
Eddy St.
Cliff St.
Gibbs St.
24th St.
24th St.
Highland Lp.
City of Port Townsend

Updated Instructions for Developers

- New materials will be provided to direct applicants
- Propose to keep the same Ecology Manual in use
  - 2005 Department of Ecology's Stormwater Management Manual for Western Washington (ECY SWMM) and the 2012 ECY SWMM comparison

City of Port Townsend

Capital Improvement Projects and Funding



City of Port Townsend

Assessment of Stormwater System

Discovery Road – Road side Swale

F Street – Curb and Gutter

City of Port Townsend

Assessment of Stormwater System Deficiencies and Needs

Landes Street

Hastings Avenue

Assessment of Stormwater System Deficiencies and Needs

Sheridan Street

14th Street

City of Port Townsend

Assessment of Stormwater System Deficiencies and Needs

P Street

3rd Street & Rosecrans Street

City of Port Townsend

Assessment of Stormwater System Deficiencies and Needs

Sheridan Street

Hancock Street & 31st Street

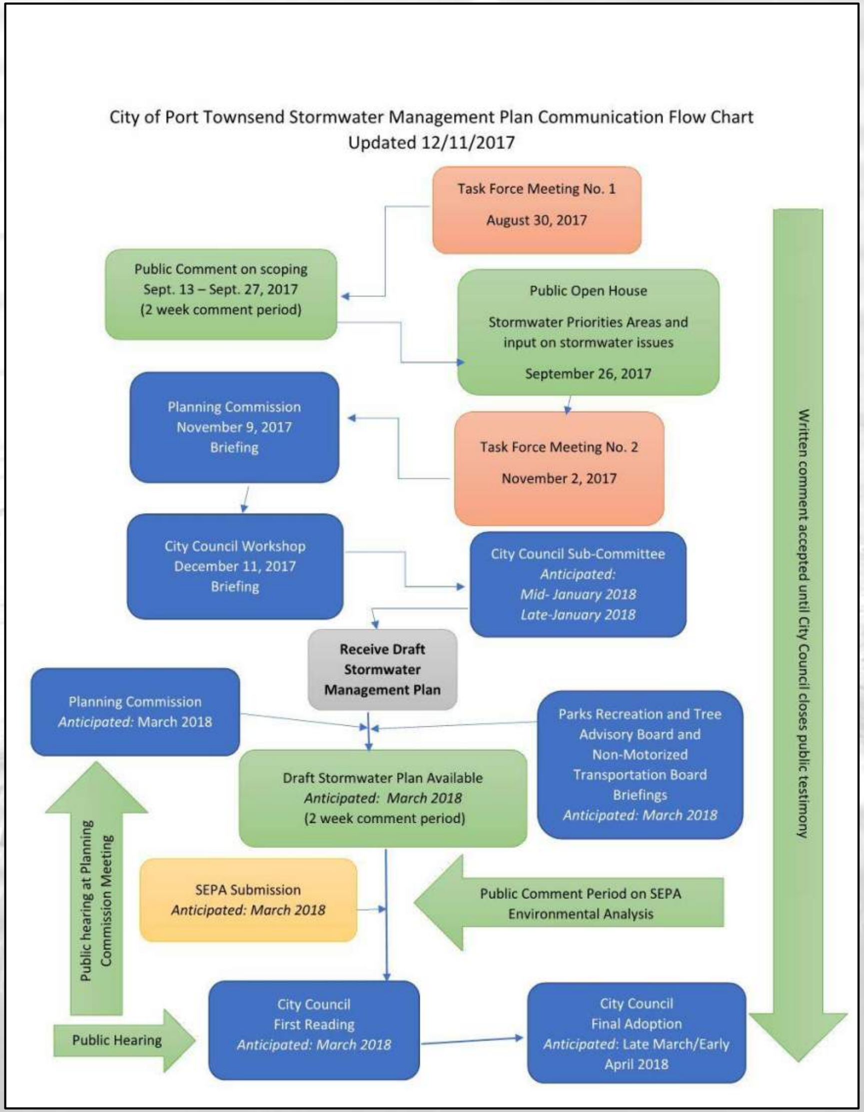
City of Port Townsend

Assessment of Stormwater System Deficiencies and Needs

49th Street & Landes Street

Haines Street

Next Steps



City of Port Townsend

PORT TOWNSEND COUNCIL AD HOC COMMITTEE ON THE STORMWATER MANAGEMENT PLAN AGENDA
CITY HALL COUNCIL CHAMBERS, 540 WATER STREET

Business Meeting **01:18 p.m.** **January 10, 2018**

I. Call to Order

II. Election of Chair

III. Overview of the City's Current Stormwater System

Critical drainage corridor language and codes

Parametrix Memo 120717

Stormwater Manual Comparison 2005-2012

Stormwater Manual Comparison 2012-2014

Protected Drainage Infrastructure

Stormwater Acronyms Flipchart

V. Overview of the Proposed Tiering Map Concept

Tiering 2018-01-09

Catchment Areas

Shaded-Relief 2018-01-09

Storm Utility San Juan and F 2018-01-09

Stormwater CIP & Problem Areas

Tiering Flipchart Map

Tiering Explanation Flipchart

Regional Conveyance and Treatment Projects

VII. Public Comment (agenda items only)

VI. Proposed Stormwater Policies

PTMC 19.05 Critical Areas

IV. Proposed Capital Projects

1999 SWMP Acquisitions and Stormwater Projects

2018-2023 Stormwater CIP List

VIII. Set agenda for next meeting

IX. Adjourn

Americans with Disabilities Act
In compliance with the Americans with Disabilities Act, those requiring accommodation for this meeting should notify the City Clerks Office at least 24 hours prior to the meeting at (360) 379-5083.

Hearing Assistance Available

CITY OF PORT TOWNSEND
MINUTES OF THE COUNCIL AD HOC COMMITTEE ON THE STORMWATER MANAGEMENT PLAN OF JANUARY 10, 2018

CALL TO ORDER

The Council Ad Hoc Committee for the Stormwater Management Plan met in regular session on Wednesday, January 10, 2018 at 1:32 p.m. in City Hall Council Chambers. The meeting was called to order by the City Clerk Joanna Sanders. Members present at roll call were Ariel Speser, Pamela Adams and Robert Gray.

Staff members present were: Assistant City Engineer Samantha Harper, City Engineer David Peterson, Paul Fendt of Parametrix, Senior Planner/Planning Manager Judy Surber, City Clerk Joanna Sanders.

ELECTION OF CHAIR

Ariel Speser was nominated and appointed Chair by unanimous vote.

OVERVIEW OF THE CITY'S CURRENT STORMWATER SYSTEM

Paul Fendt of Parametrix pointed out uniqueness of Port Townsend reviewing the Shaded-Relief map for runoff consistent with topography. He explained geology and topography of Port Townsend and the lack of streams. Samantha Harper reviewed catchment area map showing stormwater discharge to wetlands as a result of topography. Staff reviewed the Storm Utility Map of F Street and San Juan showing critical drainage corridors. Some discussion ensued with staff explaining the current stormwater catch basins and pipes. Paul Fendt then drew a map showing a cross-section of the road to explain water flow. He pointed out the focus should be on the network of water flows. When asked about pervious and impervious surfaces, Mr. Fendt provided an explanation of surface water, ground water and deep groundwater.

OVERVIEW OF THE PROPOSED TIERING MAP CONCEPT

Showing the Stormwater CIP and Problem Areas map and tiering map, Mr. Fendt explained the tiering system: Tier 1 Public Waters (Blue), Tier 2 Critical Drainage Corridors (Green), Tier 3 Connection BTW Built and Natural Protected Drainage Infrastructure (Pinks), and through Tier 4 Public Roadways (Purple). There was additional discussion about areas that do and do not drain well and where additional drainage systems might be needed.

Referring to the earlier draft of the draft tiering map, Mr. Fendt reviewed critical drainage areas to be addressed in the plan. He noted that the map would be changing to improve what is reflected.

PUBLIC COMMENT (AGENDA ITEMS ONLY)

PROPOSED STORMWATER POLICIES

Ms. Surber reviewed Chapter 19.05 of the Port Townsend Municipal Code and how the City addresses development in critical drainage corridors. Staff also responded to questions about development scenarios in critical areas. Mr. Fendt reviewed the proposed policy language provided. Staff is ultimately looking for policy direction to recommend to Council before a proposal is presented.

At 3:05 p.m., the meeting recessed for the purposes of a break.
At 3:10 p.m., the meeting resumed.

PROPOSED CAPITAL PROJECTS

Mr. Fendt and Ms. Harper reviewed the list of capital projects in order to receive guidance on priorities. The Committee was asked to review the list of capital projects and plan to provide input at the next meeting. In reviewing the purple areas on the tiering map, Mr. Fendt explained different approaches to funding these capital needs for improving drainage. When asked what the City's responsibility is for these improvements, Mr. Fendt said it is a policy direction with the question being how far to go to address water quality coming from the roadways. Committee guidance would help staff and the consultant develop a specific stormwater management program. If development involves a new road, then the City is mandated to address storm water under the State's Stormwater Manual. If retrofitting an existing roadway, the City is not mandated to address stormwater runoff. Staff was also asked how this planning process would fit with the rate study. Staff explained that cost of improvements would be part of the stormwater management plan, while how to fund those improvements and the options would be a separate discussion.

SET AGENDA FOR NEXT MEETING

The date of the next meeting was set for January 24 at 1:30 p.m. No agenda was discussed.

ADJOURN

There being no further business, the meeting adjourned at 3:35.

Attest:

Joanna Sanders, MMC
City Clerk

PORT TOWNSEND CITY COUNCIL AD HOC COMMITTEE ON THE STORMWATER MANAGEMENT PLAN AGENDA
CITY HALL COUNCIL CHAMBERS, 540 WATER STREET

Business Meeting **10:00 a.m.** **February 14, 2018**

I. Call to Order

II. Approval of Minutes â€“ January 24, 2018

012418

III. Stormwater Management Plan Policies

a. Stormwater Funding and System Needs

Tier 4 Edge Inventory 2018-02-08

Stormwater Funding 2018

Road Inventory 012318

180214 CC Adhoc Meeting Presentation

2017 Operating Stormwater Budget

IV. Public Comment (agenda items only)

V. Set agenda for next meeting (Tentative dates: Feb. 21 or 28)

VI. Adjourn

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Hearing Assistance Available

CITY OF PORT TOWNSEND
MINUTES OF THE COUNCIL AD HOC COMMITTEE ON THE STORMWATER MANAGEMENT PLAN OF JANUARY 24, 2018

CALL TO ORDER

The Council Ad Hoc Committee for the Stormwater Management Plan met in regular session on Wednesday, January 24, 2018 at 1:32 p.m. in City Hall Council Chambers. Chair Ariel Speser called the meeting to order at 1:32 p.m. The other member present was Robert Gray. Pamela Adams was excused.

Staff members present were: Assistant City Engineer Samantha Harper, City Engineer David Peterson, Paul Fendt of Parametrix, Senior Planner/Planning Manager Judy Surber, and City Clerk Joanna Sanders.

APPROVAL OF MINUTES - JANUARY 10, 2018

There was unanimous approval of the January 10 minutes as written.

STORMWATER MANAGEMENT PLAN POLICIES

Critical Drainage Corridors

Paul Fendt explained the Critical Drainage Corridor Map as provided. A goal of the plan is to update the critical drainage areas. He noted the map was updated by him and edited by City staff. On the map, areas in green reflect critical drainage areas; blue receiving water, which includes wetlands and storm ponds; and yellow indicates the critical drainage corridors as they exist today. There was some discussion about how staff uses these yellow areas. Staff explained that the mapping is a trigger to the applicant and requires further evaluation.

Mr. Fendt explained the City is defining these critical drainage corridors and their significance as part of the drainage system/network. If a critical drainage corridor determination is made, then those areas would be identified, protected, and require closer review when a development is proposed. He explained how those functions and values are reviewed. Part of the planning process includes drafting language for how these areas would be protected. He stressed that this means identifying areas so all staff and landowners are aware and then putting standards in place to protect the areas.

There was some discussion of critical drainage corridors. Mr. Fendt referred to the tiering map to further clarify. Staff reiterated that the current mapping is only an indicator and a field investigation would be conducted to determine if a critical drainage corridor is present. The amount of buffering is largely dependent on the proposed level of development.

Potential Water Quality Retrofit Projects

Mr. Fendt explained Ecology regulations. Phase II regulations are for populations above 10,000 and they issue Mitigated Permit Determination of Significance (MPDS) permits. The City does not yet meet that threshold and at this point, the City can decide whether it wants to begin a proactive program to prioritize areas in need of drainage improvements and create a reserve fund for retrofitting roads, etc. It can decide whether there are certain areas of intensive development where it wants to manage stormwater and add rain gardens as an example. Creating a priority project list might help City apply for grant funds.

Mr. Fendt then referred to the Road Inventory handout and explained the color coding and cost estimates summarized on page 4. When thinking about areas needing retrofitting, he showed examples of roadway treatment alternatives. The sewer rate study could address funding priorities and a fund created for drainage repair on purple roads (referring to color tiering map). These color segments will eventually get applied to the map and could then depict priority projects on which to focus as funding becomes available.

Plan for the â€œBrownâ€ RoadÂ`

Mr. Fendt referred to drawings to explain funding alternatives for capital projects, arterial collectors (purple roads), and side streets and neighborhood streets (brown roads). There was discussion of existing requirements for stormwater.

Additional Unlisted Capital Improvement Projects

Referring to the Capital Improvement projects list, Staff inquired if the committee had other additions. Some discussion ensued about 31st Street, which staff indicated would be one project listed in brown. Mr. Fendt urged distinguishing between public and private drainage problems. Staff also pointed out that new development guidelines are currently available.

2005 and 2012 Department of Ecology Stormwater Management Manual for Western Washington

Ms. Speser summarized her understanding of these manuals and Staff's recommendation to use the 2005 manual. Staff concurred and noted that by using the 2005 manual, the City can still implement elements of the 2012 manual such as low impact design. Working with a consultant can help the City consider local geography and soils along with best available science for the specific conditions that exist.

Public Process

Ms. Harper reviewed public comment received to date. Public comment would be summarized at the public hearing before City Council. Responding to public comment about the Kah Tai drainage corridor, staff said they do not believe there would be any plan to put pipe in the intermittent and free flowing ravines or disturb them.

PUBLIC COMMENT (AGENDA ITEMS ONLY)

Ron Sikes spoke about Kah Tai Creek as a critical drainage corridor.

Debbie Jahnke spoke about citizen comments provided so far. She asked to review all functions not just stormwater functions and urged creating policy related to vegetation and habitat.

Julie Jaman spoke about public landscaping to help with functioning stormwater systems.

SET AGENDA FOR NEXT MEETING

Next meeting topics: Additional committee feedback and discussion, including criteria for drainage. Begin to work on code language and more discussion of Tier 3 areas. The tentative date for the next meeting was February 14 from 10-12 or 1:30 as an alternative.

ADJOURN

There being no further business, the meeting adjourned at 3:31 p.m.

Attest:

Joanna Sanders, MMC
City Clerk

PORT TOWNSEND COUNCIL AD HOC COMMITTEE ON THE STORMWATER MANAGEMENT PLAN AGENDA
CITY HALL COUNCIL CHAMBERS, 540 WATER STREET

Business Meeting **01:33 p.m.** **January 24, 2018**

I. Call to Order

II. Approval of Minutes - January 10, 2018

011018

III. Stormwater Management Plan Policies

A. Critical Drainage Corridors

Site Drainage

Draft-Critical-Drainage-Areas-2018-1-24-Workshop

Additional Handout - Stormwater System Cross Section Enlarged

Additional Handout - Stormwater System Cross Section

Additional Handout - Copy of Road Inventory 012318

B. Potential Water Quality Retrofit Projects

C. Plan for the â€œBrownâ€. RoadÂ

D. Additional Unlisted Capital Improvement Projects

Draft CIP List

E. 2005 and 2012 Department of Ecology Stormwater Management Manual for Western Washington

Parametrix Stormwater Manual Comparison Memo

2005-2012 Stormwater Manual Comparison

2012-2014 Stormwater Manual Comparison

F. Public Process

IV. Public Comment (agenda items only)

V. Set agenda for next meeting

VI. Adjourn

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Joanna Sanders, MMC
City Clerk

PORT TOWNSEND COUNCIL AD HOC COMMITTEE ON THE STORMWATER MANAGEMENT PLAN AGENDA
CITY HALL COUNCIL CHAMBERS, 540 WATER STREET

Business Meeting **01:32 p.m.** **February 28, 2018**

I. Call to Order

II. Approval of Minutes â€“ February 14, 2018

021418 Draft Minutes

III. Stormwater Management Plan Policies

A. Stormwater Development Regulations

Critical drainage corridor language and codes DRAFT

Guide Site Drainage DRAFT

Tier 4 Edge Inventory 2018-02-08

B. Critical Drainage Corridors

IV. Public Comment (agenda items only)

V. Set agenda for next meeting

VI. Adjourn

Americans with Disabilities Act
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Hearing Assistance Available

City of Port Townsend

Memo

TO: Planning Commission
FROM: Samantha Harper, Assistant City Engineer
DATE: March 16, 2018 MEETING DATE: March 22, 2018
RE: **Stormwater Management Plan & Critical Drainage Corridors**

Background: The City is drafting a Stormwater Management Plan - a functional plan which addresses existing stormwater system conditions; the operation and maintenance of existing facilities and capacity for adding new facilities; identifying capital project needs; and potential funding methods for financing of capital and operational costs. Stormwater management is about drainage and flooding, as well as water quality. The City has a range of soil types from hard pan to sandy soils which impact stormwater solutions. The City intends to plan for surface water management as a whole – integrating a preservation of water resources through natural systems approach where possible while protecting environmental values and public health. The process will include comparison of 2005 and 2012 DOE Stormwater Manual and recommended concurrent amendments to the City's development regulations/Engineering Design Standards to ensure public and private projects achieve the City's adopted level of service standard.
In addition to the functional plan, staff is assessing the need for updates to PTMC Chapter 13.32 Stormwater Management Requirements.

On November 9, 2017, Planning Commission received a briefing including a proposed tiered map identifying key areas of the City's stormwater system. Commissioners discussed issues related to the Plan including addressing climate change and development costs and fees. Packets are available via the City website at: http://cityofpt.us/video.html

In January and February of 2018, staff worked with the Council Sub-Committee.

A draft plan is anticipated in April 2018.

Relationship to Other Plans: The City is in the process of updating the Critical Areas Ordinance. Planning Commission has expressed concern that the Stormwater Management Plan may compromise existing protections to Critical Drainage Corridor (CDC) standards and stormwater regulations/design standards. On February 22, 2018 Development Services staff provided a Draft Outline of March 22 Stormwater Consistency discussion (Attachment D to the 2/22/18 packet) as a framework for review of existing vs. proposed stormwater implementation. The outline includes Comprehensive Plan Goals and

Policies related to stormwater management and critical drainage corridors. Commissioners provided the following feedback:

1) Add *Land Use Policies 7.1 - 7.4* to Attachment D.
2) Provide the following additional information for the March 22 packet:
   A. Draft of the Stormwater Management Plan – whole document if possible, key chapters at a minimum
   B. Map: Critical Drainage Corridors
   C. Map: Stormwater tiering
   D. Consultant's memo assessing 2005 SWMM vs. 2014 version
   E. Draft regulatory language for the CDC - and where will this be codified?
   F. If codified in Chapter 13 – will it come to the PC for review and recommendation?

March 22: The March 22 meeting will focus on items A-D above and the completed Outline of March 22 Stormwater Consistency discussion (Attachment *). Draft regulatory language for CDCs is still pending, however, staff has provided a Summary of the Proposed Changes (Attachment *) for discussion. Draft chapters from the Stormwater Management Plan are not being provide, however, staff has provided a matrix of how the Stormwater Management Plan will be consistent with the Comprehensive Plan.

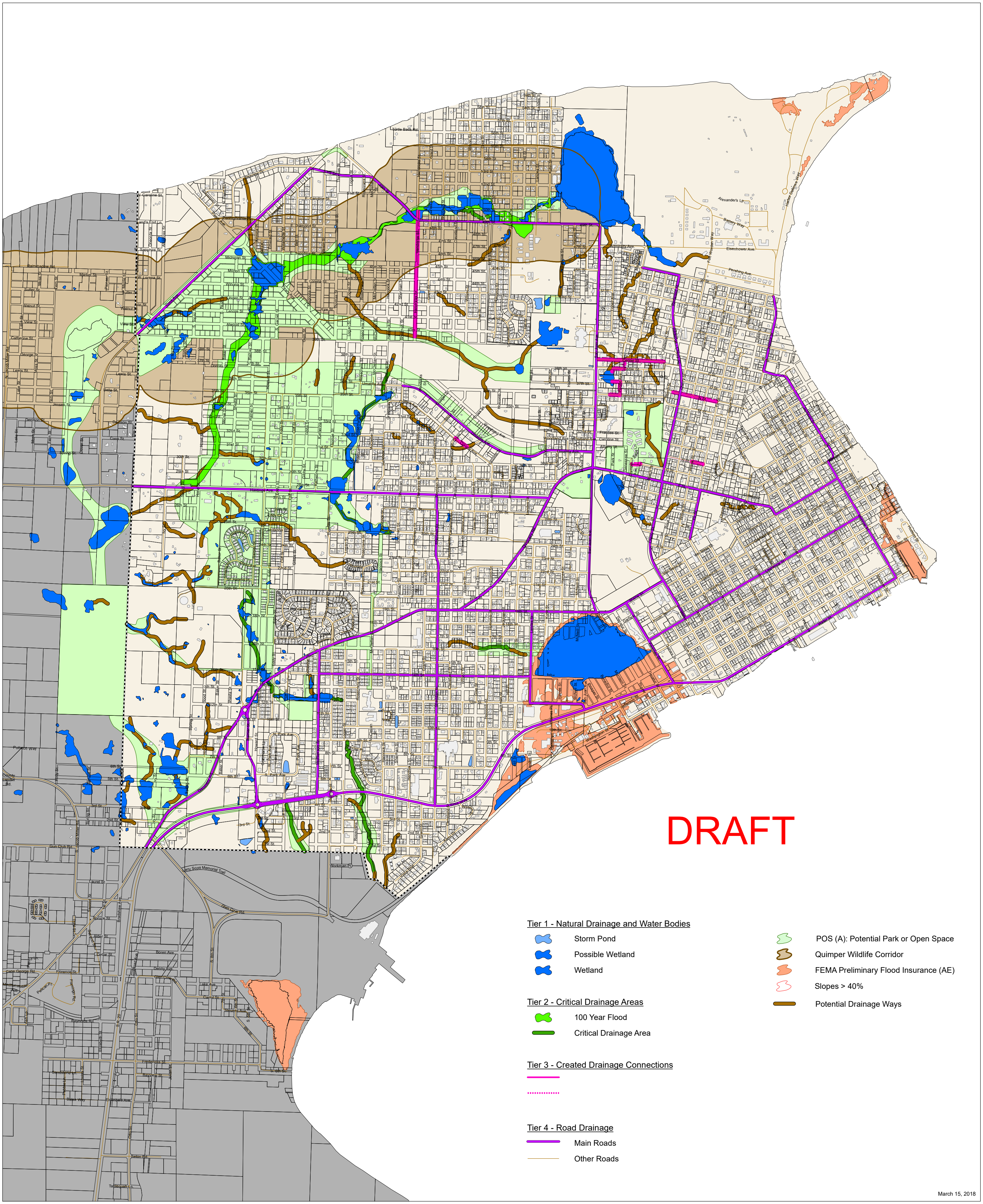
Recommendation: No action is required of the Planning Commission at this time. Staff seeks questions and feedback in preparation of the upcoming public hearings.

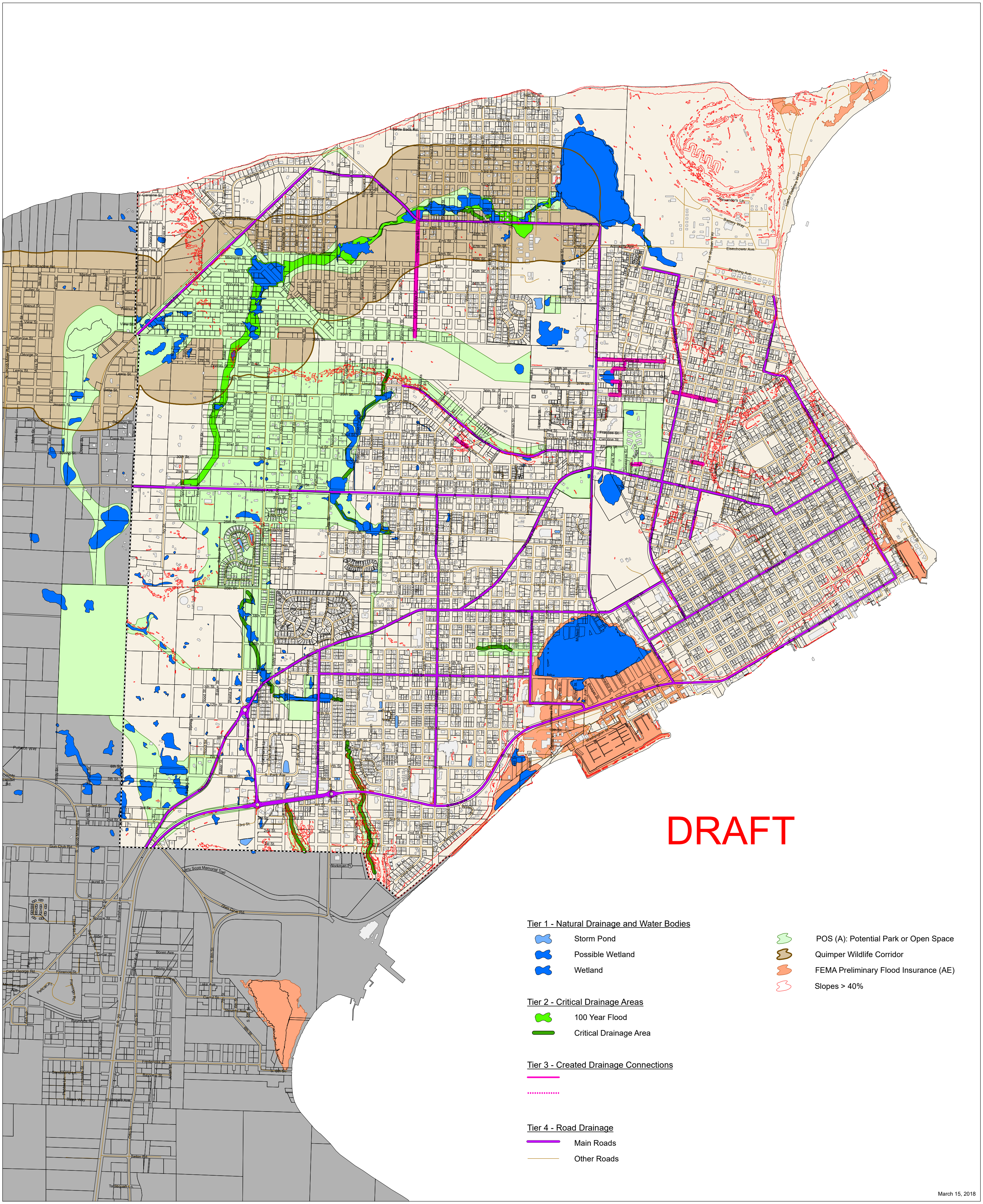
Next Steps:

**	Special Meeting – CDC Draft Language?
April 12, 2018	Critical Areas Update – Public Hearing
May 10, 2018	Stormwater Management Plan Concurrency review - Public Hearing

Attachments

Attachment A – Open Space, Critical Areas and Stormwater Tiering Map
Attachment B - Open Space, Critical Areas without Potential Drainage Ways and Stormwater Tiering Map
Attachment C – PTMC 19.05.090 Summary of Amendments for Critical Area 3 – Frequently Flooded Areas and Critical Drainage Corridors
Attachment D – Summary of Consistency Review between the Stormwater Management Plan and the Comprehensive Plan
Attachment E – Department of Ecology Stormwater Management Manual Technical Memo Comparison
Attachment F – Department of Ecology's Summary Table of what changed from the 2005 to the 2012 Stormwater Management manual
Attachment G- Department of Ecology's Summary Table of what changed from the 2012 to the 2014 update of the Stormwater Management manual


DRAFT
Tier 1 - Natural Drainage and Water Bodies
Storm Pond
Possible Wetland
Wetland
POS (A): Potential Park or Open Space
Quimper Wildlife Corridor
FEMA Preliminary Flood Insurance (AE)
Slopes > 40%
Potential Drainage Ways
Tier 2 - Critical Drainage Areas
100 Year Flood
Critical Drainage Area
Tier 3 - Created Drainage Connections
Tier 4 - Road Drainage
Main Roads
Other Roads
March 15, 2018


DRAFT
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March 15, 2018

SUMMARY OF PROPOSED AMENDMENTS TO PTMC TITLE 19.05.090 CRITICAL AREA 3 – FREQUENTLY FLOODED AREAS AND CRITICAL DRAINAGE CORRIDORS

Amended Sections	Summary of Revision	Notes
19.05.020 Definitions.	“Critical drainage corridors” or “area” Remove characteristic 3 in its entirety: “Watercourses which exhibit the above characteristics and have been channelized or piped;”	This characteristic is redundant.
19.05.090 Critical Area 3 – Frequently Flooded Areas and Critical Drainage Corridors.	A. Purpose	**Staff Recommends:** Separate the purpose for frequently flooded areas and critical drainage corridors as they are regulated differently, frequently flooded areas are regulated by federal and state law and critical drainage corridors are regulated by local regulations.
	B.2. Classification. Remove “from local knowledge about regular flooding occurrence in certain areas or the potential for flooding if existing drainage is modified.”	**Staff Recommends:** Existing language is vague. Classification should be limited to available flood data (i.e., FEMA maps and the Polaris study for Drainage Basin 4). , Flood occurrences related to drainage will be addressed in the Stormwater Management Plan.
	C.2. Regulated Development. Add the required distance from the centerline of the CDC.	**Staff Recommends:** It is confusing to have the width of the CDC under E. Buffers and Setbacks. The width of the CDC should be specified in the Regulated Development Section.
	D. Performance Standards for Development. Add a performance standard to allow for drainage corridors to be crossed	**Staff Recommends:** There are cases where there is a need to cross a critical drainage corridor with roads, trails, and utilities. This would still meet the

		requirement of not filling in the CDC, but allows a little flexibility if there is development around a CDC.
	E. Buffers and Setbacks. Remove language in its entirety and replace with the following. There are no buffers or setback from CDCs.	**Staff Recommends:** Refer to Staff Recommends comments in C.2. Regulated Development.
	G. Special Reports. Add a sentence about who should design the utility crossing if one is proposed? Specify type of backfill?	**Under review:** Staff would like to continue to review criteria if a CDC is crossed.
	G Special Reports. Clarify content of report.	**Under review:** Would that be done by an engineer? Does that need hydraulic modeling? It that just looking at the upstream and downstream effects?

This table addresses the City's 2016 updated Comprehensive Plan Land Use Element and Utility Element Goals and Policies and compares them to the proposed Stormwater Management Plan (Functional Plan).

Land Use Element Goal/Policy	**Existing**	**Proposed**	**Assessment**[1]
Policy 7.1: Manage stormwater quantity in a way that approximates the **natural hydrologic characteristics** of the area while ensuring that all stormwater receives **adequate treatment** before discharge or infiltration. The **quality of stormwater** discharged from stormwater treatment facilities, such as ponds, drainage corridors, wetlands, salt water, etc. should be as close to the water quality present before human encroachments as possible.	• 2005 Ecology Stormwater Manual for Western Washington. • Development proposals must meet applicable requirements of PTMC 13.32 and EDS Chapter 4 Stormwater.	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • No change. • *New* guidance materials are being developed in conjunction with the stormwater management plan (SWMP) to assist home builders with site stormwater design.	Improves consistency The 2005 Manual uses and allows all current stormwater practices typically applied in the region for municipal stormwater control.
Policy 7.2: Ensure that public and private development projects are reviewed and conditioned in a manner consistent with the City's Stormwater Management Plan and the **Department of Ecology's Stormwater Management Manual for Western Washington.**	• 2005 Ecology Stormwater Manual for Western Washington. • Development proposals must meet applicable requirements of PTMC	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • No Change.	Improves consistency The 2005 Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control.

[1] Inconsistent, No change, Improves Consistency

Land Use Element Goal/Policy	Existing	Proposed	Assessment[1]
7.2.1: Continue to implement the **Department of Ecology's Stormwater Management Manual for Western Washington** as a guide for reviewing developments and requiring the use of best management practices for land clearing, **runoff affecting water quality, erosion, and sedimentation**.	13.32 and EDS Chapter 4 Stormwater	• *New* guidance materials are being developed in conjunction with the stormwater management plan (SWMP) to assist home builders with site stormwater design.	
Policy 7.3: Pursue strategies intended to reduce stormwater runoff to levels **not likely to cause flooding, significant erosion to natural drainage ways, or significant degradation of water quality.**	2005 Ecology Stormwater Manual for Western Washington.	2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management.	Improves Consistency The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control.
Policy 7.4: Encourage the use of a **natural drainage systems approach** to control stormwater from new developments. Where feasible, new developments should capitalize on natural drainage features **to hold and treat stormwater and pollutants** before they are carried down slope or **before they enter wetlands or other bodies of water**.	• 2005 Ecology Stormwater Manual for Western Washington. • PTMC 19.05 currently calls for the protection of critical drainage corridors (CDC), which are natural drainage paths in the landscape.	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • CDCs are proposed to be recategorized and updated in conjunction with the SWMP.	Improves consistency The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control, which include low impact development (LID) techniques.

Land Use Element Goal/Policy	Existing	Proposed	Assessment[1]
Goal 14: Protect and manage **stormwater quality** through the use of current design practices and standards to **minimize the impacts of land use development and stormwater runoff on natural systems, fish and wildlife habitat, and public health**.	2005 Ecology Stormwater Manual for Western Washington.	2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management.	Improves Consistency The 2005 Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control.
Policy 14.1: Review each public and private development project to ensure conformance with the standards of the City's Stormwater Management Plan, Engineering Design Standards, and the Department of Ecology's Stormwater Management Manual for Western Washington to ensure that **discharges of stormwater into ponds, drainage corridors, wetlands, groundwater, salt water, and other water bodies, do not result in a degradation of water quality.**	• The City has adopted the 2005 Ecology Stormwater Manual for Western Washington. • The City provides for stormwater review of applicable design proposals through Port Townsend Municipal code (PTMC) 13.32 Stormwater Management Requirements and Engineering Design Standards (EDS) Chapter 4 Stormwater	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • No Change. • *New* guidance materials are being developed in conjunction with the stormwater management plan (SWMP) to assist home builders with site stormwater design.	Improves consistency The City has adopted the 2005 Ecology Stormwater Manual for Western Washington. The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control.
Policy 14.2: Regularly update the Engineering Design Standards and the Stormwater Management Plan to maintain up-to-date practices and standards and to promote low impact development (LID) techniques that combine	• 2005 Ecology Stormwater Manual for Western Washington.	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management.	Improves consistency

Land Use Element Goal/Policy	Existing	Proposed	Assessment[1]
engineering with the **preservation of natural systems.**	• PTMC 19.05 currently calls for the protection of critical drainage corridors (CDC), which are natural drainage paths in the landscape.	• CDCs are proposed to be revised and updated in the SWMP and they will continue to be protected by ordinance for stormwater and conveyance functions, including water quality, flood control, and drainage.	
Goal 15: Manage stormwater quantity in a way that mimics nature (i.e., "**natural drainage systems"** approach).			
Policy 15.1: **Preserve natural surface and subsurface drainage systems to the maximum extent possible.**	• 2005 Ecology Stormwater Manual for Western Washington.	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • *New* guidance materials are being developed in conjunction with the SWMP to assist home builders with site stormwater design.	Improves consistency (Note: The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control.) The City will continue to encourage site development design to minimize project footprints and reserve natural areas of the sites while addressing the objective to meet infill and redevelopment objectives.
Policy 15.2: Pursue strategies intended to reduce stormwater runoff to levels not likely to cause **flooding, significant erosion to natural drainage ways**, or significant degradation of water quality.	• 2005 Ecology Stormwater Manual for Western Washington.	• 2005 Ecology Stormwater Manual for Western Washington and related guidance for stormwater quality management.	Improves consistency (Note: The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control). The City will continue

Land Use Element Goal/Policy	Existing	Proposed	Assessment[1]
		• *New* guidance materials are being developed in conjunction with the SWMP to assist home builders with reducing site runoff to the maximum extent practicable.	to encourage site development design to minimize project footprints and reserve natural areas of the sites. Commercial and subdivision sites will continue to be required to control stormwater to pre-settlement levels.
Policy 15.3: Ensure that stormwater quantity from new development does not exceed natural **historic flows**, unless regional facilities are in place that can accommodate the increased flows without detrimental impacts to other properties.	• 2005 Ecology Stormwater Manual for Western Washington. The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control, including flow control to natural historic flow rates. Regional facilities have been designed and constructed in selected locations and are available for use.	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • *New* guidance materials are being developed in conjunction with the SWMP to assist home builders with reducing site runoff to the maximum extent practicable.	Improves Consistency Commercial and subdivision sites will continue to be required to control stormwater to natural historic levels.
Policy 15.4: **Protect wetlands and other environmentally sensitive areas from flooding and increased runoff** from new development and land clearing activities.	• 2005 Ecology Stormwater Manual for Western Washington. The Manual uses and allows for all current stormwater practices typically applied in the region for municipal stormwater control.	• 2005 Ecology Stormwater Manual for Western Washington *and* related guidance for stormwater quality management. • In addition, CDCs are proposed to be recategorized and updated	Improves consistency

Land Use Element Goal/Policy	Existing	Proposed	Assessment[1]
	Specifically, Minimum Requirements #8 and #6 of the Ecology Manual are required to protect wetlands.	in conjunction with the SWMP.	
Goal 16: Maintain stormwater facilities to ensure their proper and intended function.			
Policy 16.1: Inspect and maintain stormwater facilities in accordance with the Best Management Practices of the Department of Ecology Stormwater Management Manual.	City-owned facilities are reviewed regularly by staff and routine maintenance is performed.	No change.	No change - The City is not required by permit to conduct these inspections as it is not a Phase 2 National Pollutant Discharge Elimination System (NPDES) community
Policy 16.2: Ensure that private property owners maintain stormwater facilities in accordance with Best Management Practices.	The City does not review private facilities.	No change.	No change - The City is not required by permit to conduct these inspections as it is not a Phase 2 National Pollutant Discharge Elimination System (NPDES) community
Policy 16.3: Allocate adequate resources to maintain stormwater facilities and natural drainage systems.	The City's Stormwater Utility Fund funds routine maintenance of its facilities.	The City includes funds in its stormwater program to provide routine maintenance of its facilities.	No change

Land Use Element Goal/Policy	Existing	Proposed	Assessment[1]
Goal 17: Provide financial resources to appropriately operate the Stormwater Utility and construct capital improvements.			
Policy 17.1: Maintain stormwater utility rates at a level appropriate to conduct necessary operations and maintenance activities and capital improvement projects.	The City's Stormwater Fund is funded through a monthly base rate and capital surcharge, these revenues fund both operations and capital projects.	The City is intending to review and assess its rates in 2018.	Improves consistency
Policy 17.2: Establish fees and charges to recover utility costs related to development and, where feasible, allocate costs to user classes to reflect the true cost to the utility.	Currently, the City does not have a fee or user charge system in place for new development.	The City is intending to review and assess its rates in 2018. The SWMP is contemplating connection approaches and potential funding methods.	Improves consistency
Policy 17.3: Pursue a wide variety of funding options, including low interest loans and state grants.	The City has and will continue to pursue stormwater grants and loans. Recently, the City is applying to be listed on the Puget Sound Near Term Action list for stormwater retrofitting of our existing major roadways.	Completion of the SWMP can improve the City's position for obtaining grants and loans.	Improves consistency

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TECHNICAL MEMORANDUM

DATE:	December 7, 2017
TO:	Samantha Harper, P.E.
FROM:	Julie Brandt, P.E.
SUBJECT:	Stormwater Manual Comparison
CC:	Paul Fendt, P.E.
PROJECT NUMBER:	553-2836-004 (01/04)
PROJECT NAME:	Stormwater Management Plan

1. INTRODUCTION

Port Townsend is developing a comprehensive stormwater management plan to improve the operation of the city's existing system and anticipate future needs. Part of the stormwater management plan development includes review and evaluation of the City's current stormwater standards and manuals. This technical memorandum compares the City's current adopted stormwater guidance manual against subsequent revisions implemented by the Washington State Department of Ecology (Ecology).

2. CURRENT CITY GUIDANCE MANUAL

The City adopted Ecology's 2005 Stormwater Management Manual for Western Washington (2005 SWMMWW) under Section 13.32.010.A of the Port Townsend Municipal Code (Stormwater Code). The Stormwater Code directs developers to use the 2005 SWMMWW for all clearing and grading activities, for erosion control during construction, and for permanent drainage system improvements; except that developments must comply with the following City requirements, which supersede the 2005 SWMMWW:

1. Section 2.6 – Optional guidance relating to financial liability and off-site analysis and mitigation
2. Engineering Design Standards
3. Stormwater Master Plan, and
4. Adopted drainage basin plans

The major elements included in the 2005 SWMMWW (and year the change was made) are:

1. Flow Control and Water Quality Treatment (2001):

   The thresholds for selection of Best Management Practices (BMPs) were expanded to require nearly all projects to apply appropriate flow control and runoff treatment BMPs, including on-site stormwater management techniques.

2. Duration Standard and Continuous Modeling (2001):

   The flow control requirements were increased to address both peak flows and duration of high flows, and calling for the use of continuous runoff models when available.

3. Enhanced Treatment (2001):

   Requirements were increased to result in higher levels of water quality treatment (enhanced treatment) for discharges from most industrial, commercial, and multifamily sites and arterials and highways.

4. Western Washington (2005):

   The geographic scope of the SWMMWW was expanded to apply previous requirements to all of Western Washington rather than Puget Sound only.

3. ECOLOGY REVISIONS

Subsequent to the City adoption of the 2005 SWMMWW, Ecology has published updates to the manual in 2012 and 2104. The major elements included in those updates (and year the change was made) are listed below in order of their relevance to Port Townsend. Summary tables published by Ecology that discuss all of the SWMMWW changes from 2012 and 2014 are included in Attachment 1.

1. Minimum Requirement 8 – Wetland Protection (2012):

   Most of Appendix I-D was rewritten to remove outdated information, clarify concepts, and update the requirements for protecting wetlands through controlling stormwater runoff discharges. Requirements were added dictating that total discharges to wetlands must not deviate by more than 20 percent on a single event basis and must not deviate by more than 15 percent on a monthly basis.

2. Puget Sound Action Agenda Terminology (2012):

   Outdated references and guidance related to the Puget Sound Water Quality Management Plan were removed and replaced with guidance on the Puget Sound Action Agenda.

3. Additional Basin Planning Guidance

   Appendix I-A was updated to clarify the guidance for altering the minimum requirements through basin planning, and language was added to address retrofit needs and alternative flow control strategies.

4. LID Requirements:

   - LID Performance Standard for Stream Protection (2012) – The new LID performance standard and BMP list options were added. The LID standard is based on project size, location, and BMP feasibility for projects that discharge to fresh waterbodies.

     Direct discharges to marine waterbodies through man-made conveyance systems are exempt from the LID standard as long as erosion and flooding are prevented.

   - LID Definition Consistency (2012) – Definitions were revised for terms relevant to the new low impact development (LID) guidance (hard surfaces, LID, converted vegetation) and requirements in the Municipal Stormwater Permits.

   - Hard Surface Threshold Changes (2012) – Thresholds and terminology were updated to determine which minimum requirements apply to new development and redevelopment, such as the replacement of "impervious" surfaces with "hard" surfaces, the application of minimum requirements #6 -#9 to replaced hard surfaces at new development sites, the deletion of the word "native" from the land conversion threshold.

- Updated Stormwater Site Plan Contents (2012) - Additional guidance was added regarding LID site design.
- Construction Stormwater Pollution Prevention (2012) – Construction stormwater management requirements were updated to protect LID BMPs
- Universal LID Language Clarification (2014) – Typos, spelling corrections, and terminology inconsistencies that resulted from the incorporation of the LID standard were address throughout the manual.
- Updated WWHM Software Guidance (2014) – Wording was revised to reflect recent upgrades to the Western Washington Hydrology Model (WWHM2012) to include LID simulation capabilities.

5. Historical Development Map (2012):

   To show which basins potentially qualify for use of existing land cover as the target for flow control purposes, a map was added depicting basins that have had 40 percent or more total impervious area since 1985. These basins are mainly comprised of areas between Everett and Tacoma east of Puget Sound and in the vicinity of Bremerton and Bainbridge Island.

6. NPDES Permit References (2012):

   - Guidance was added to refer Phase I and Phase II Municipal Stormwater Permittees to Appendix 1 of their respective general permits for more information on the requirements for their stormwater program requirements.
   - An overview was added regarding the requirements of the Industrial Stormwater General Permit and their relationship to the BMPs in the manual.
   - An overview was added regarding the requirements of the Construction Stormwater General Permit and their relationship to the BMPs in the manual.

4. RECOMMENDATION

The Ecology Manual was written to be reasonably applicable to a majority of landscapes and development scenarios found in western Washington. With the exception of the new wetland protection standard, the key recent SWMMWW revisions published by Ecology are not well-applied to Port Townsend development types, landscape, receiving water bodies, and precipitation regimes. The City is not now precluded from using the LID techniques described in the 2012 Manual and it could be expected that they would be used *when applicable and feasible* because they are often a preferred choice for circumstances where they would function in the landscape (e.g. good soils that infiltrate at high rates). Therefore, it is recommended that the City consider adoption of the updated wetland protection standard through the Municipal Code and continue use of the 2005 SWMMWW.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
General				
Inside cover page	ES-i and ES-ii		Added an Executive Summary	Summarized the reasons for the update, the uses of the manual and provided information on the public involvement process.
All Volumes			Renumbered Tables and Figures	Renumbered all tables and figures in all Volumes. The new numbers coordinate tables and figures to the section of the Volume where they are located. (Eg. Figure 2.4.2 is the second figure in Section 2.4, Table 4.1.3 is the third table in Section 4.1).
Volume I Minimum Technical Requirements and Site Planning				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-26		Update incorrect or outdated code references.	Revised incorrect or outdated code references, such as the RCW and WAC.
Chapter 1 - Introduction	1-1 through 1-26		Minor language changes.	Revised for clarity and removed outdate language in Sections 1.2, 1.4, 1.5.1, 1.6.10.
Section 1.5.4 Flow Control BMPs	1-5		Minor language changes.	Revised language for changes made in *Appendix I-D Guidelines for Wetlands when Managing Stormwater.*
Section 1.5.5 On-site Stormwater Management BMPs	1-6		Additional guidance provided.	Language added to categorize On-site Stormwater Management BMPs, including LID BMPs.
Section 1.6.4 The Puget Sound Action Agenda	1-11 through 1-13		Significant revisions to remove outdated guidance and to add new guidance. Section renamed.	Removed references and guidance related to the Puget Sound Water Quality Management Plan and replaced with guidance on the Puget Sound Action Agenda.
Section 1.6.5 Phase I - NPDES and State Waste Discharge Stormwater Permits for Municipalities	1-13 through 1-14	Yes	Additional guidance provided and outdated guidance removed.	Added guidance referring Phase I Municipal Stormwater Permittees to Appendix 1 of the permit for more information on the requirements for their stormwater program requirements.
Section 1.6.6 Phase II - NPDES and State Waste Discharge Stormwater Permits for Municipalities	1-14	Yes	Additional guidance provided and outdated guidance removed.	Added guidance referring Phase II Municipal Stormwater Permittees to Appendix 1 of the permit for more information on the requirements for their stormwater program requirements.
Section 1.6.7 Municipalities Not Subject to the NPDES Stormwater Municipal Permits	1-14		Guidance removed.	Removed outdated references to the Puget Sound Water Quality Management Plan. Section renamed.
Section 1.6.8 Industrial Stormwater General Permit	1-14 through 1-15	Yes	Revised to coordinate with the current Industrial Stormwater General Permit	Revised to provide an overview of the requirements of the current Industrial Stormwater General Permit and their relationship to the BMPs in the manual.
Section 1.6.9 Construction Stormwater General Permit	1-15 through 1-16	Yes	Revised to coordinate with the current Construction Stormwater General Permit	Revised to provide an overview of the requirements of the current Construction Stormwater General Permit and their relationship to the BMPs in the manual.
Section 1.6.15 Underground Injection Control Authorizations	1-18 through 1-19		Significant revisions to add guidance.	Added language to refer to Ecology's website and to define UIC well.
Chapter 2 - Minimum Requirements for New Development and Redevelopment				
Chapter 2 - Minimum Requirements for New Development and Redevelopment	2-1 through 2-46		Minor language changes.	Revised for clarity and removed outdated language in the introduction and in Sections 2.1, 2.2, 2.5.3, and 2.5.10.
Chapter 2 - Minimum Requirements for New Development and Redevelopment	2-1 through 2-46	Yes	Revised language.	Revised definitions, requirements, supplemental guidance, etc. to correspond to the changes in the Municipal Stormwater Permits and for new LID requirements.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 2.1 Relationship to the Puget Sound Action Agenda	2-2		Added guidance. Section renamed.	Removed outdated references to the Puget Sound Water Quality Management Plan. Section renamed and focuses on relationship of the manual to the municipal stormwater permits.
Section 2.3 Definitions Related to Minimum Requirements	2-5 through 2-9	Yes	Added and revised definitions.	Added definitions for a few terms used previously but not previously defined. Other terms have a revised definition or a new definition (hard surfaces, LID, converted vegetation) because of the new low impact development (LID) guidance and requirements in the Municipal Stormwater Permits.
Section 2.4 Applicability of the Minimum Requirements	2-9 through 2-16	Yes	Revised the thresholds for determining which minimum requirements apply to new development and redevelopment. Revised supplemental guidelines.	Changes include: the replacement of “impervious” surfaces with “hard” surfaces, the application of minimum requirements #6 - #9 to replaced hard surfaces at new development sites, the deletion of the word "native" from the land conversion threshold.
Section 2.5.1 Minimum Requirement #1: Preparation of Stormwater Site Plans	2-16	Yes	Revised requirements and objective.	Added a new statement for the site plan to use site-appropriate development principles to retain native vegetation and minimize impervious surfaces to the extent feasible.
Section 2.5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)	2-17 through 2-26	Yes	Reorganized and revisions to: thresholds, general requirements, construction SWPPP elements, objective, and supplemental guidelines.	Changes include: revisions to the construction SWPPP elements to correspond with the Construction Stormwater General Permit, the addition of element #13 that requires the protection of LID Best Management Practices, and revision of element #12 to include responsibilities for an inspector or CESCL depending on the size of the project.
Section 2.5.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls	2-27 through 2-28	Yes	Minor additions.	Added clarification for peak discharges using 15 minute time steps.
Section 2.5.5 Minimum Requirement #5: On-site Stormwater Management	2-28 through 2-32	Yes	Multiple revisions for new low impact development (LID) requirements.	Changes include: the new LID performance standard and list options based on project size and location. The lists are divided into three land use types: lawn and landscaped areas; roofs, and other hard surfaces. Projects implementing the list option must select the first feasible BMP for each land use type. Some of the BMPs included in the lists are: rain gardens, permeable pavements, bioretention, soil quality and depth, full and partial dispersion methods, full downspout infiltration and perforated stub-outs.
Section 2.5.6 Minimum Requirement #6: Runoff Treatment	2-33 through 2-35	Yes	Revisions to the thresholds, Water Quality Design Flow Rate, and supplemental guidelines.	Revisions made to acknowledge the use of permeable pavements and the related new definitions. The intent is to continue to capture the same size and types of projects as previously. More accurate definitions for water quality design storm volume and flow rate.
Section 2.5.7 Minimum Requirement #7: Runoff Flow Control	2-35 through 2-40	Yes	Revisions to the thresholds and supplemental guidelines.	Revisions to acknowledge the use of permeable pavements and the related new definitions. Clarifications about the surfaces that the requirement applies to, and the use of the 0.10 /0.15 cfs threshold. The intent is to capture the same size and types of projects as previously.
Section 2.5.8 Minimum Requirement #8: Wetlands Protection	2-40 through 2-41	Yes	Revisions to the applicability, thresholds, standard requirement, additional requirements, and supplemental guidelines.	Revisions correspond to the significantly revised *Appendix I-D Guidelines for Wetlands when Managing Stormwater* .

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 2.8 Exceptions/Variances	2-45 through 2-46	Yes	Additional guidance provided.	Changed and added language to be consistent with the requirements in Appendix 1 of the 2007 municipal stormwater permits.
Chapter 3 - Preparation of Stormwater Site Plans				
Chapter 3 - Preparation of Stormwater Site Plans	3-1 through 3-17	Yes	Significant changes to incorporate procedures necessary for LID implementation.	Revised for clarity and removed outdate language in the introduction and in section 3.1.7.
Section 3.1.1 Step 1 - Collect and Analyze Information on Existing Conditions	3-2 through 3-7	Yes	Additional guidance provided and outdated guidance removed.	Additional guidance details the information necessary for site analysis, and in particular for LID site design. Split into subsections based on whether Min. Requirements 1 - 5 apply, or Min. Requirements 1 - 9 apply.
Sections 3.1.2 to 3.1.4	3-7 through 3-8	Yes	Guidance added.	References to on-site BMPs added and preliminary determination of applicable minimum requirements.
Section 3.1.5 Step 5 - Prepare a Permanent Stormwater Control Plan	3-8 through 3-12	Yes	Revisions to all subsections of Developed Site Hydrology of the Permanent Stormwater Control Plan.	Significant changes to describe how to prepare the Permanent Stormwater Control Plan that incorporates LID features. Separate guidance for projects subject to Min. Requirements 1 - 5 and projects subject to Min. Requirements 1 - 9.
Section 3.1.6 Step 6 - Prepare a Construction Stormwater Pollution Prevention Plan	3-13 through 3-14	Yes	Minor language changes.	Changes for clarification and to remove repetitive language.
Section 3.1.7 Step 7 - Complete Stormwater Site Plan	3-14 through 3-16	Yes	Reference to needed soils report and addition of Declaration of Covenants and Grants of Easement.	Soils reports are necessary part of LID decisions. Declarations of Covenants and Grants of Easement are necessary mechanisms to identify LID features, establish maintenance requirements and government access for inspections of privately maintained stormwater BMPs and facilities.
Section 3.2.2 Final Corrected Plan Submittal	3-17		Guidance added.	Added several LID BMPs that require the submission of as-builts.
Chapter 4 - BMP and Facility Selection Process for Permanent Stormwater Control Plans				
Section 4.2 BMP and Facility Selection Process	4-1 through 4-4		Revised language, proposed replacing the language in *Step V: Select Treatment Facilities* with a reference to Chapter 2 of Volume V.	Revisions and new language especially in Step III for guidance on modeling threshold discharge areas. Minor revisions to correspond with the changes in the Municipal Stormwater Permits and for new LID requirements. Ecology replaced the language in *Step V: Select Treatment Facilities* with a reference to Chapter 2 of Volume V.
Appendix I-A Guidance for Altering the Minimum Requirements Through Basin Planning				
Appendix I-A Guidance for Altering the Minimum Requirements Through Basin Planning	A-1 through A-3		Additional guidance provided.	Added language for clarity on use of Basin Planning for addressing retrofit needs and for developing an alternative flow control strategy.
Appendix I-B Rainfall Amounts and Statistics				
Appendix I-B Rainfall Amounts and Statistics	B-1 through B-5		Removed introductory language and background information on the Water Quality Design Storm and Water Quality Design Flow Rate.	Removed background and outdated information for brevity. Renamed the appendix and retained the rainfall tables.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Appendix I-D Guidelines for Wetlands when Managing Stormwater				
Appendix I-D Guidelines for Wetlands when Managing Stormwater	D-1 through D-18	Yes	Multiple revisions for the use and/or the protection of Wetlands when managing stormwater.	Rewritten to remove outdated information, clarify concepts, and approach the protection and use of wetlands through controlling discharges to wetlands. Total discharges to wetlands must not deviate by more than 20% on a single event basis, and must not deviate by more than 15% on a monthly basis.
Appendix I-E Flow Control-Exempt Surface Waters				
Appendix I-E Flow Control-Exempt Surface Waters	E-1 through E-4	Yes	Added and deleted Exempt Surface Waters.	List edited to add additional waters based on specific requests and analyses, and to remove reference to a creek in Eastern WA.
Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices				
Appendix I-F Basins with 40% or more total impervious area since 1985	F-1	Yes	Added Map	Map shows basins which potentially qualify for use of existing land cover as the pre-developed land cover for flow control purposes. See reference in Min. Requirement #7.
Glossary and Notations				
Glossary and Notations	Glossary-1 through Glossary-47		Added and revised definitions.	There are a few terms, used previously but not defined, for which a definition has been added. A handful of other terms have a revised definition, and there are new terms, because of the new low impact development (LID) guidance and requirements in the Municipal Stormwater Permits.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume II Construction Stormwater Pollution Prevention				
Chapter 1 - Introduction Construction Stormwater Pollution Prevention				
Chapter 1 - Introduction Construction Stormwater Pollution Prevention	1-1 through 1-9		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Section 1.3 How to Use This Volume	N/A		This section was removed. The information in this section is now included in Sections 1.2.	Removed this section by combining it with Section 1.2 to eliminate duplicate language.
Section 1.3 Thirteen Elements of Construction Stormwater Pollution Prevention	1-3	Yes	Renamed.	Revised to incorporate a new element, Protect Low Impact Development BMPs.
Figure 1.5.1	1-6		Replaced.	Replaced older figure with an updated one.
Chapter 2 - Regulatory Requirements				
Chapter 2 - Regulatory Requirements	2-1 through 2-6		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Information covered in Volume I, Section 1.6 Relationship of the Manual to Federal, State, and Local Regulatory Requirements was removed.
Chapter 2 - Regulatory Requirements	2-1 through 2-6	Yes	Multiple revisions to coordinate the manual to the Washington State General Stormwater Permits.	Revised this chapter to update this information for revisions to the Stormwater General Permits (including the Municipal, Construction, and Industrial Permits).
Section 2.1 and Section 2.2	2-2 through 2-4	Yes	Section 2.1 The Construction Stormwater General Permit and Section 2.2 Construction Stormwater Pollution Prevention Plans now replace the previous Sections 2.1 and 2.2.	Replaced these sections to remove invalid information or duplicate information. Sections 2.1 and 2.2 now go into detail about the relationship of Volume II to the Construction Stormwater General Permit and the requirements for a Stormwater Site Pollution Prevention Plan.
Chapter 3 - Planning				
Chapter 3 - Planning	3-1 through 3-32		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Information covered in Volume I, Section 1.6 Relationship of the Manual to Federal, State, and Local Regulatory Requirements was removed.
Section 3.2 and Section 3.3	3-4 through 3-32		Previous Sections 3.2 and 3.3 have been reversed.	Moved The Construction SWPPP Requirements, previously in Section 3.3 to Section 3.2 for clarity. The Step-By-Step Procedure now follows in Section 3.3. Please note that the Construction Stormwater Pollution Prevention Plan Checklist is still located in Section 3.3.
Section 3.3.3 (Previously Section 3.2.3) Step 3 - Construction SWPPP Development and Implementation	3-8 through 3-32	Yes	Multiple revisions to the Construction SWPPP Elements.	Revised The Construction SWPPP Elements, described in Section 3.3.3 to coordinate with the Construction Stormwater General Permit, Municipal Stormwater Permits, and the Construction BMPs in Chapter 4. Each element now contains an Additional Guidance section that has information not required by the permits. Added Element #13 Protect Low Impact Development BMPs.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Chapter 4 - Best Management Practices Standards and Specifications				
Chapter 4 - Best Management Practices Standards and Specifications	4-1 through 4-128		Added approved equivalent BMPs Sections.	Refers to Ecology's website for BMPs that have been approved as equivalent.
Section 4.1 Source Control BMPs	4-1 through 4-2	Yes	Added Table 4.1 Source Control BMPs by SWPPP Element	Ecology added Table 4.1 Source Control BMPs by SWPPP Element to show how the BMPs listed in Section 4.1 relate to the SWPPP Elements.
BMP C103: High Visibility Fence	4-6		This BMP now includes high visibility silt fence. Multiple revisions for plain language, clarity, and brevity.	Added high visibility silt fence because it meets the intent of BMP C103. Ecology revised this chapter to use simpler and clearer language.
BMP C104: Stake and Wire Fence	N/A		This BMP was removed.	Removed this BMP because BMP C103: High Visibility Fence meets the intent of this BMP in a safer and more commonly used manner.
BMP C105: Stabilized Construction Entrance / Exit	4-7 through 4-9		Additional guidance provided and outdated guidance removed.	Added and removed guidance for this BMP based on comments received and field experience.
BMP C106: Wheel Wash	4-9 through 4-11		Additional guidance provided and outdated guidance removed.	Added guidance to clarify that wheel wash wastewater shall not discharge to surface or ground water.
Figure 4.1.2 - Wheel Wash	4-11		Figure was updated	Updated figure to provide more details of a typical Wheel Wash.
BMP C120: Temporary and Permanent Seeding	4-13 through 4-19		Multiple revisions for plain language, clarity, and brevity. Additional guidance provided and removed.	Revised and reorganized this BMP to use simpler and clearer language. Moved some guidance to BMP C121: Mulching or BMP C125: Top soiling. Ecology added and removed additional guidance for this BMP based on comments received and field experience.
BMP C121: Mulching	4-19 through 4-21		Additional guidance provided.	Added minimum mulch thickness based on field experience and comments. Ecology added guidance previously found in BMP C120: Temporary and Permanent Seeding to this BMP.
Table 4.1.8	4-21		Additional guidance provided.	Added Wood Straw and Wood Straw Mulch to the table.
BMP C122: Nets and Blankets	4-22 through 4-25		Multiple revisions for plain language, clarity, and brevity.	Revised this BMP to use simpler and clearer language.
BMP C123: Plastic Covering	4-25 through 4-27		Additional guidance provided and outdated guidance removed.	Removed the use of plastic sheeting over seeded areas because other coverings (such as compost and straw) are preferable. Ecology added and removed guidance for this BMP based on comments received and field experience.
BMP C124: Sodding	4-27 through 4-28		Additional guidance provided and outdated guidance removed.	Provided a link to composting guidance and removed old reference to compost specification.
BMP C125: Top soiling / Composting	4-29 through 4-32		Additional guidance provided and outdated guidance removed.	Added guidance previously found in BMP C120: Temporary and Permanent Seeding to this BMP. Ecology added and removed guidance for this BMP based on comments received and field experience.
BMP C150: Materials on Hand	4-42 through 4-43		Suggested measures and quantities removed.	Removed measures and quantities because measures and quantities should be based on the size of the construction site.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
BMP C151: Concrete Handling and BMP C152: Sawcutting and Surface Pollution Prevention	4-43 through 4-45	Yes	Additional guidance provided.	Added guidance to coordinate this BMP with the requirements of the Construction Stormwater General Permit and to make it clear that Concrete spillage or concrete discard to surface waters of the State is prohibited.
BMP C154: Concrete Washout Area	4-48 through 4-53		Added this BMP.	Added this BMP to provide additional guidance for concrete washout areas.
BMP C160: Certified Erosion and Sediment Control Lead	4-54 through 4-55		Additional guidance provided and outdated guidance removed.	Minimum Requirements for ESC Training and Certification Courses has been removed. Ecology plans on issuing separate, updated guidance in the near future.
BMP C161: Payment of Erosion Control Work	N/A		This BMP was removed.	Removed this BMP because it is not applicable to the full range of projects needing to perform Erosion and Sediment Control Work.
BMP C180: Small Project Construction Stormwater Pollution Prevention	N/A	Yes	This BMP was removed.	Removed this BMP because of changes in threshold requirements in both the Municipal Stormwater General Permits and Construction Stormwater General Permit.
Section 4.2 Runoff Conveyance and Treatment BMPs	4-57	Yes	Added Table 4.2 Runoff Conveyance Treatment BMPs by SWPPP Element	Added Table 4.2 Runoff Conveyance Treatment BMPs by SWPPP Element to show how the BMPs listed in Section 4.2 relate to the SWPPP Elements.
BMP C207: Check Dams	4-74 through 4-77		Additional guidance provided.	Added guidance for this BMP based on comments received and field experience.
BMP C220: Storm Drain Inlet Protection	4-78 through 4-79		Additional guidance provided.	Added guidance for inlet protection of lawn and yard drains and based on comment received and field experience.
BMP C230: Straw Bale Barrier	N/A		This BMP was removed.	Removed this BMP because this BMP has been proven to be ineffective.
BMP C233: Silt Fence	4-90 through 4-95		Multiple revisions for plain language, clarity, and brevity.	Revised and reorganized this BMP to use simpler and clearer language.
BMP C235: Wattles	4-96 through 4-99		Renamed from Straw Wattles.	Renamed this BMP to include wattles made from compost or other materials.
BMP C236: Vegetated Spray Fields	4-100 through 4-102		Added this BMP.	Added this new BMP for dewatering, Construction SWPPP Element #10.
BMP C250: Construction Stormwater Chemical Treatment	4-112 through 4-120		Additional guidance provided.	Added guidance for this BMP, previously available online, to coordinate with the Chemical Technology Assessment Protocol (CTAPE) program.
BMP C251: Construction Stormwater Filtration	4-120 through 4-124		Additional guidance provided.	Added sizing criteria for this BMP, previously available online.
BMP C252: High pH Neutralization Using CO_2	4-125 through 4-127		Added this BMP.	Added this BMP, previously available online, to provide guidance on neutralizing high pH through the use of CO_2.
BMP C253: pH Control for High pH Water	4-128 through 4-129		Added this BMP.	Added this BMP, previously available online, to provide additional guidance for neutralizing high pH.
Appendix II-B Background Information on Chemical Treatment	B-1 through B-3		Multiple revisions to coordinate with BMP C252 and BMP C53.	Revised this appendix to coordinate with the new information provided in BMP C252 and in BMP C253.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume III Hydrologic Analysis and Flow Control Design / BMPs				
Chapter 2 - Hydrologic Analysis				
Chapter 2 - Hydrologic Analysis	2-1 through 2-17		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Outdated guidance was replaced.
Section 2.2 Western Washington Hydrology Model	2-4 through 2-9		Section 2.2 split into multiple subsections.	Section 2.2 split into multiple subsections for clarity and for referencing purposes.
Section 2.2 Western Washington Hydrology Model	2-4 through 2-9		Additional guidance provided.	Added guidance on upcoming Western Washington Hydrology Model (WWHM) changes.
Section 2.2.2 Assumptions made in creating the WWHM	2-5 through 2-8		Additional guidance provided.	Added guidance on precipitation data and upcoming WWHM changes.
Section 2.2.3 Guidance for flow-related standards	2-8 through 2-9	Yes	Additional guidance provided and outdated guidance removed for Minimum Requirements (MR).	Added guidance for MR #5 which now includes an LID Performance Standard. Revised the guidance for MR#8 to reflect the changes made in Volume I, Appendix 1-D.
Chapter 3 - Flow Control Design				
Chapter 3 - Flow Control Design	3-1 through 3-109		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Chapter 3 - Flow Control Design	3-1	Yes	Update text for consistency with revised Min Req'mt #5 and LID	Added references to Minimum Requirement #5, bioretention and permeable pavements in introductory section.
Section 3.1 Roof Downspout Controls	3-1 through 3-18	Yes	Update text & figure for consistency with revised Min Req'mt #5	Text and figures updated to indicate priorities for handling roof runoff.
Section 3.1 Roof Downspout Controls	3-1 through 3-3	Yes	Update text for consistency with revised Min Req'mt #5	Updated references to revised roof downspout BMPs and Rain Gardens in the introductory section.
Section 3.1.1 Roof Downspout Full Infiltration (BMP T5.10A)	3-4 through 3-10	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min.Req'ment #5 and feasibility criteria. Needed better clarity in design guidance
Section 3.1.2 Downspout Dispersion Systems	3-11 through 3-16	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min. Req'ment #5 and feasibility criteria. Improved clarify in design guidance and computer modeling. Added guidance for design criteria for dispersion trenches and splashblocks.
Section 3.1.3 Perforated Stub-out Connections	3-17 through 3-18	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min. Req'ment #5 and feasibility criteria. Updated design guidance.
Section 3.2 Detention Facilities	3-19 through 3-64		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Section 3.2 Detention Facilities	3-35		Updated references.	Updated Maintenance narrative to refer to Appendix IV-G Management of Street Wastes in Volume IV.
Section 3.3 Infiltration Facilities for Flow Control and Treatment	3-65 through 3-102		Section significantly rewritten.	Made significant changes to all sub-sections. Section pertains primarily to design of centralized infiltration facilities. Certain sections also apply to distributed bioretention facilities as indicated in text.
Section 3.3.1 Purpose	3-65	Yes	Revised guidance and reference LID.	Expanded purpose statement and clarified in regard to the types of facilities covered in Section 3.3. Added references to Bioretention and Permeable Pavement sections.
Section 3.3.2 Description	3-65	Yes	Additional guidance provided including Min Req'mt #5.	Made clarifications and added language for complying with MR#5. Added guidance for oil control and pre-treatment facilities.
Section 3.3.3 Applications	3-66		Additional guidance provided.	Minor text change
Section 3.3.4 Steps for Design of Infiltration Facilities	3-68 through 3-71	Yes	Revised several steps for new infiltration rate guidance and the new LID performance standard.	Revised Step 2 to include guidance for meeting MR#5. Significantly revised Step 5 for the new guidance provided in section 3.3.6. Revised Step 6 for clarity and for meeting MR#5. Revised Step 7 for clarity.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 3.3.5 Site Characterization Criteria	3-72 through 3-75		Revised guidance on subsurface characterization, soil testing, and infiltration receptor. Removed guidance for hydrogeologic investigation and figure 3.27, USDA Textural Triangle.	Multiple changes to subsurface characterization include added guidance on groundwater monitoring wells and the use of grain size analysis method for estimating infiltration rates. Deleted infiltration rate determination sub-section due to redundancy with next section.
Section 3.3.6 Design Saturated Hydraulic Conductivity - Guidelines and Criteria	3-75 through 3-83		Revisions for determining the saturated hydraulic conductivity (infiltration rate). Section renamed.	Replaced "Infiltration Rate" with "Saturated Hydraulic Conductivity" throughout section. Updated the guidelines and criteria for determining saturated hydraulic conductivity. Added guidance on pilot infiltration testing (PIT), and soil grain size analysis. Revised correction factors for PIT results and soil grain size method. Removed options based on USDA Soil Texture Classification and D10 grain size.
Section 3.3.7 Site Suitability Criteria (SSC)	3-83 through 3-86		Additional guidance provided and outdated guidance removed.	Updated references, removed unneeded guidance, revised limits on infiltration rates, added a minimum organic content for treatment, amended drawdown guidance, and verification testing.
Section 3.3.8 Steps for Designing Infiltration Facilities - Detailed Approach	3-86 through 3-90		Multiple revisions. Previous steps 1-4 removed. Multiple steps revised. Added groundwater mounding analysis step.	Removed steps to select location, estimate volume of stormwater, develop a trial infiltration facility geometry, conduct a geotechnical investigation, and determine the saturated hydraulic conductivity; instead refers to steps 1-5 in section 3.3.4. Revised Figure 3.27 for updated guidance. Revised guidance for adjusting the preliminary design infiltration rate. Added a step for groundwater mounding analysis. Added guidance for conducting performance testing.
Section 3.3.9 General Design, Maintenance, and Construction Criteria for Infiltration Facilities	3-90 through 3-94		Additional guidance provided and outdated guidance removed.	Added guidance for sizing for flow control, pretreatment design criteria, and maintenance. Made wording clarifications to guidance.
Section 3.4 Site Procedures for Bioretention and Permeable Pavement Use	3-103 through 3-109	Yes	Added this section for bioretention and permeable pavement.	Added guidance re field tests, computer modeling, and implementation for bioretention / rain gardens and permeable pavement.
Appendix III-A Isopluvial Maps for Design Storms				
Appendix III-A Isopluvial Maps for Design Storms	A-1		Added link to website.	Added a link to a website where isopluvial maps are available.
Appendix III-B Western Washington Hydrology Model - Information, Assumptions, and Computation Steps				
Appendix III-B Western Washington Hydrology Model - Information, Assumptions, and Computation Steps	B-1 through B-13	Yes	Additional guidance provided and outdated guidance removed.	Added guidance on current and upcoming versions of WWHM. Added guidance for the modeling on LID elements and wetlands. Removed outdated computation steps.
Appendix III-C Washington State Department of Ecology Low Impact Development Design and Flow Modeling Guidance				
Appendix III-C Washington State Department of Ecology Low Impact Development Flow Modeling Guidance	C-1 through C-13	Yes	Additional guidance provided and outdated guidance removed.	Text in regard to design guidance removed. All design guidance moved to Volume V. Two sets of modeling guidance provided. One for WWHM 3, and one for upcoming WWHM 2012.
Appendix III-D Procedure for Conducting a Pilot Infiltration Test				
Appendix III-D Procedure for Conducting a Pilot Infiltration Test	N/A		Appendix removed.	Procedures for conducting the PIT have been included within the proposed text on “Design Infiltration Rate Determination” in sections 3.3.6.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume IV Source Control BMPs				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-5		Minor language changes.	Revised for clarity and removed outdated language.
Section 1.3 How to Use this Volume	1-2		Additional guidance provided and outdated guidance removed.	Added new guidance regarding the Industrial Stormwater General Permit (ISWGP), Boatyard General Permit (BGP), and Sand and Gravel General Permit (S&GP) and the inclusion of "applicable" BMPs from this volume in Industrial Stormwater Pollution Prevention Plans (Industrial SWPPPs).
Section 1.5 Treatment BMPs for Specific Pollutant Sources	1-3	Yes	Additional guidance provided and outdated guidance removed.	Added new guidance clarifying the requirements regarding treatment BMPs for facilities covered under the ISWGP (or other General Stormwater Permits).
Section 1.6.1 Applicable (Mandatory) BMPs	1-3 through 1-4		Additional guidance provided and outdated guidance removed.	Added new guidance describing the use of applicable (mandatory) BMPs in regards to the ISGP, BGP, and S&GP. Section renamed to make it clearer that applicable BMPs are Mandatory for permittees under the ISWGP and BGP.
Section 1.6.2 Recommended BMPs	1-4	Yes	Additional guidance provided.	Added guidance regarding facilities covered under the ISWGP that trigger a corrective action.
Chapter 2 - Selection of Operational and Structural Source Control BMPs				
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-66		Numbered BMPs.	Added numbers in the "S400" series to BMPs in Volume IV.
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-66		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language, and removed outdated references.
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-2		Additional guidance provided and outdated guidance removed.	Added new guidance describing the use of applicable (mandatory) BMPs in regards to the ISGP, BGP, and S&GP. Added guidance regarding facilities covered under the ISWGP that trigger a Level 1 or 2 corrective action.
Section 2.1 Applicable (Mandatory) Operational Source Control BMPs	2-2 through 2-6		Additional guidance provided and outdated guidance removed.	Revised wording to clarify where this Section applies. Revised several BMPs for clarity and to coordinate with the ISWGP. Significant changes include the addition of vacuum sweeping and pressure washing, spill prevention and cleanup, visual inspections and record keeping.
Section 2.2 Pollutant Source Specific BMPs	2-7 through 2-66		Additional guidance provided and outdated guidance removed. Minor formatting revisions.	Revised wording to clarify where this Section applies. Added new text on ISWGP requirements. Added guidance regarding facilities covered under the ISWGP that trigger a Level 1 or 2 corrective action. Changed the title format for the BMPs to match the other volumes and added a numbering system to the BMPs.
S401 BMPs for the Building, Repair, and Maintenance of Boats and Ships	2-7 through 2-9		Additional guidance provided and several BMPs clarified.	Clarified guidance describing the requirements under the BGP and ISGP regarding boatyard activities. Revised BMPs to use simpler and clearer language.
S402 BMPs for Commercial Animal Handling Areas	2-10		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language.
S403 BMPs for Commercial Composting	2-10 through 2-12		Additional guidance provided and outdated guidance removed.	Revised language because solid waste regulations prohibit discharge of compost leachate. Revised BMPs to use simpler and clearer language, and removed outdated references.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
S405 BMPs for Deicing and Anti-Icing Operations - Airports and Streets	2-13 through 2-14		Additional guidance provided and outdated guidance removed.	Revised language to coordinate with the ISGP. Removed outdated references.
S414 BMPs for Maintenance and Repair of Vehicles and Equipment	2-32 through 2-34	Yes	Revision for consistency with the ISGP	Updated "applicable BMP" guidance for handling of liquids in scrap vehicles to align with ISGP.
S416 BMPs for Maintenance of Roadside Ditches	2-35 through 2-37		Additional guidance provided and updated references.	Additional guidance provided for the handling of ditch cleanings.
S423 BMPs for Recyclers and Scrap Yards	2-45 through 2-46		Updated reference to guidance.	Updated the reference to guidance for Vehicle Recyclers.
S424 BMPs for Roof/Building Drains at Manufacturing and Commercial Buildings	2-46 through 2-47		Added reference to guidance.	Added a references to Volume V and Ecology publications for BMPs.
S426 BMPs for Spills of Oil and Hazardous Substances	2-48 through 2-49		Additional guidance provided and outdated guidance removed.	Revised several BMPs for clarity and to coordinate with the ISWGP.
S430 BMPs for Urban Streets	2-58 through 2-59		Additional guidance provided.	Clarified that facilities not under the ISWGP may consider some water use in street cleaning.
S431 BMPs for Washing and Steam Cleaning Vehicles / Equipment / Building Structures	2-60 through 2-62	Yes	Additional guidance provided and outdated guidance removed.	Added guidance to clarify that the ISWGP prohibits the discharge of process wastewater to ground water or surface water. Removed outdated guidance.
Figure 2.15 - Uncovered Wash Area	N/A		Figure Deleted	Figure was unclear and the existing text provided a better description of the required controls.
S432 BMPs for Wood Treatment Areas	2-63 through 2-64		Additional guidance provided and several BMPs clarified.	Clarified guidance describing which NPDES permit(s) regulate wood treatment areas. Revised BMPs to use simpler and clearer language.
S433 BMPs for Pools, Spas, Hot Tubs and Fountains	2-64 through 2-66		Additional guidance provided.	Added this BMP to provide further guidance consistent with BMPs within this volume.
Appendix IV-A Urban Land Uses and Pollutant Generating Sources				
Appendix IV-A Urban Land Uses and Pollutant Generating Sources	A-1 through A-24		Minor language changes.	Edits for clarity and to replace and revise guidance documents and WAC references.
Commercial Composting - SIC 2875	A-14		Additional guidance provided	Added "Potential Pollutant Generating Sources"
Appendix IV-B Stormwater Pollutants and Their Adverse Impact				
Appendix IV-B Stormwater Pollutants and Their Adverse Impact	B-1 through B-2		Minor language changes. Removed Table.	Minor language changes for clarity. Removed the outdated Table in Appendix IV-B.
Appendix IV-C Recycling/Disposal of Vehicle Fluids/Other Wastes				
Appendix IV-C Recycling/Disposal of Vehicle Fluids/Other Wastes	C-1		Minor language changes.	Minor language changes for clarity.
Appendix IV-D Regulatory Requirements That Impact Stormwater Programs				
Appendix IV-D Regulatory Requirements That Impact Stormwater Programs	D-1 through D-9		Minor language changes.	Edits for clarity and to replace and revise guidance documents and WAC references.
Appendix IV-E NPDES Stormwater Discharge Permits				
Appendix IV-E NPDES Stormwater Discharge Permits	E-1 through E-7	Yes	Additional guidance provided and outdated guidance removed.	Edits to make guidance consistent with the most recent industrial and municipal stormwater permits.
Appendix IV-G Recommendations for Management of Street Wastes				
Appendix IV-G Recommendations for Management of Street Wastes	G-1 through G-15		Multiple revisions for plain language, clarity, and brevity. Additional guidance provided and outdated guidance removed.	Removed outdated guidance and added new guidance in the contamination in Street Waste Solids subsection. Reorganized the disposal of street waste liquids subsection, no major content changes. Minor revisions to the Site Evaluation subsection.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume V Runoff Treatment BMPs				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-4		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language, and removed outdated references.
Section 1.4.3 Treatment Methods	1-2 through 1-4		Additional guidance provided and outdated guidance removed.	Revised guidance for oil/water separation, pretreatment, infiltration, filtration, emerging technologies, and on-line systems. Added Bioretention as a treatment method.
Chapter 2 - Treatment Facility Selection Process				
Chapter 2 - Treatment Facility Selection Process	2-1		Additional guidance provided.	Added paragraph on emerging technology options.
Section 2.1 Step-by-Step Selection Process for Treatment Facilities	2-1 through 2-9		Minor revisions to the steps. Revised description of surface waters triggering enhanced treatment.	Revised selection process steps for clarity and to remove outdated information. Revised the Treatment Facility Selection Flow Chart for revised guidance throughout Volume V. Revised description of surface waters triggering enhanced treatment for accuracy.
Figure 2.1.1	2-3		Revised list of options.	Some treatment BMP options removed, emerging technologies added, one BMP renamed. Added a note for Phosphorous facilities that require Enhanced Treatment.
Section 2.2 Other Treatment Facility Selection Factors	2-9 through 2-11		Removed the subsection on Pollutants of Concern, the Suggested Treatment Options Table, and Ability of Treatment Facilities Table.	Removed the Suggested Treatment Options Table and Ability of Treatment Facilities Table because they provided limited usefulness and removed the associated subsection, Pollutants of Concern.
Chapter 3 - Treatment Facility Menus				
Chapter Introduction Paragraph	3-1		Additional guidance provided.	Added paragraph on emerging technology options.
Section 3.2 Oil Control Menu	3-2 through 3-3		Revised list of options.	Removed catch basin inserts and added emerging stormwater treatment technologies. To date, no catch basin inserts have been approved though the TAPE process but Ecology has approved one emerging technology. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.3 Phosphorous Treatment Menu	3-3 through 3-4		Revised list of options.	Removed amended sand filter (no design criteria have been developed for this treatment), and media filter, added emerging stormwater treatment technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.4 Enhanced Treatment Menu	3-5 through 3-7		Multiple revisions to remove outdated guidance and to provide new guidance. Revised list of options. Revised waters triggering enhanced treatment consistent with Chapter 2.	Revised the performance goal for dissolved metals. Removed Amended Sand Filter. Added "vegetated" to "Compost Amended "Vegetated" Filter Strip. Removed "rain garden" for consistency with proposal to distinguish between "bioretention" and "rain gardens." Replaced "Ecology Embankment" with "Media Filter Drain." Added emerging technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.5 Basic Treatment Menu	3-7 through 3-9		Minor language changes for clarity. Revised list of options.	Removed "rain garden" for consistency with proposal to distinguish between "bioretention" and "rain gardens." Replaced "Ecology Embankment" with "Media Filter Drain". Added Compost-amended Vegetated Filter Strip. Removed Bio-infiltration Swale. Added emerging technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Chapter 4 - General Requirements for Stormwater Facilities				
Section 4.1.1 Water Quality Design Storm Volume	4-1	Yes	Inserted updated modeling guidance.	New guidance more accurately describes how volume is determined by computer models.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 4.1.2 Water Quality Design Flow Rate	4-1 through 4-2		Minor language changes for clarity.	Revised language for clarity.
Section 4.1.3 flows Requiring Treatment	4-2 through 4-4		Minor language changes for clarity. Changes to incorporate new terms.	Replaced "impervious" surfaces with "hard" surfaces in coordination with general changes in terminology. Added guidance regarding pollution-generating hard surfaces, pollution-generating impervious surfaces, and pollution-generating pervious surfaces.
Section 4.6 Maintenance Standards for Drainage Facilities	4-31 through 4-53	Yes	Added new tables within overall set of operation and maintenance standards	Changed "StormFilter" to "Manufactured Media Filters", added information from WSDOT on Media Filter Drains and Compost Amended Vegetated Filter Strips. Minor additions to the recommended maintenance tables added. Added placeholders for Bioretention and permeable pavement pending completion of the development of LID maintenance standards grant.
Chapter 5 - On-Site Stormwater Management				
Section 5.1 Purpose	5-1		Additional guidance provided.	Add reference to expanded BMP options and LID Manual to acknowledge the expansion of Chapter 5 and source of additional design details (LID Manual).
Section 5.2 Application	5-1	Yes	Additional guidance provided.	Revised application to refer specifically to Minimum Requirements #5, #6, and #7.
Section 5.3 Best Management Practices for On-Site Stormwater Management	5-1 through 5-2		Additional clarifying guidance provided. Full list of BMPs provided.	Expanded the list of BMPs in sections 5.3.1 and 5.3.2. Revised language and references for clarity.
Section 5.3.1 On-site Stormwater Management BMPs	5-3 to 5-39	Yes	Amend existing BMP's add new BMP's	Downspout infiltration moved to Volume III. Revised BMP T5.11 Concentrated Flow Dispersion and BMP T5.12 Sheet Flow Dispersion. Updated figures. Added BMP T5.14A Rain Gardens and BMP T5.14B Bioretention but details are in Volume V of Chapter 7. Added BMP T5.15 Permeable Pavements, BMP T5.16 Tree Retention and Tree Planting, BMP T5.16 Vegetated Roofs, BMP T5.18 Reverse Slope Sidewalks, BMP T5.19 Minimal Excavation Foundations, BMP T5.20 Rainwater Harvesting. Revised BMP T5.30 Full Dispersion by incorporating details from previous Appendix III-C.
Section 5.3.2 Site Design BMPs	5-39 through 5-42		Deleted Full Dispersion and section *5.3.3 Other Practices*	Moved Full Dispersion into Section 5.3.1 because the Municipal Stormwater Permits make it a necessary option in MR #5. Clarifying statement added in BMP T5.40.
Chapter 6 - Pretreatment				
Section 6.1 Purpose	6-1		Minor language changes.	Removed "and media filtration" in first bullet for clarity.
Section 6.2 Application	6-1		Additional guidance provided.	Added discussion that there are emerging technologies approved for pretreatment.
Section 6.3 Best Management Practices (BMPs) for Pretreatment	6-1		Additional guidance provided.	Added reference to Chapter 12.
Chapter 7 - Infiltration and Bioretention Treatment Facilities				
Section 7.1 Purpose	7-1		Changed bioinfilltration to bioretention.	Updated listed BMPs and made minor revisions to text.
Sections 7.2 General Considerations	7-1		Additional guidance provided.	Renamed this Section and added information regarding Bioretention and Rain Gardens.
Sections 7.3 Applications	7-1 through 7-2		Additional guidance provided.	Renamed this Section and added information for the BMPs discussed in this chapter.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 7.4 and BMPs 7.10 & 7.20	7-2		Updated references to Volume III	Design details for these BMPs remain in Volume III.
BMP T 7.30 Bioretention Cells, Swales, and Planter Boxes	7-3 through 7-25		Replaced Bio-infiltration Swale with Bioretention Cells, Swales, and Planter Boxes.	Added detailed guidance, design criteria, infeasibilty criteria and figures for Bioretention Cells, Swales, and Planter Boxes.
BMP T7.40 Compost-amended Vegetated Filter Strips (CAVFS)	7-25 through 7-29		Transferred this BMP from Chapter 9.	Added guidance and design criteria for Compost-Amended Vegetated Filter Strips. Treatment via infiltration through amended soils.
Chapter 8 - Sand Filtration Treatment Facilities				
Chapter 8 - Filtration Treatment Facilities	8-1 through 8-39		Changed title and introduced minor language changes for clarity.	Revised name from Sand Filtration to just Filtration.
8.1 Purpose	8-1		Revised guidance.	Revised the purpose to apply to both sand and media filtration facilities.
8.2 Description	8-1		Additional guidance provided.	Added reference to Media Filter Drain to description.
Section 8.3 Performance Objectives	8-2		Included new technologies	Added Media Filter Drain to list of approved technologies. Clarified objective for sand filters.
Section 8.4 Applications and Limitations	8-2		Revised guidance.	Revised to include media filter drains.
Section 8.5 Best Management Practices (BMPs) for Sand Filtration / BMP T8.10 Sand Filter Basin	8-2 to 8-15		Renamed and reorganized section. Additional guidance provided.	Added design criteria for sand filter basins. reorganized section so that previous sections 8.5, 8.6, 8.7, & 8.8 become subsections under BMP T8.10.
BMP T8.11 Large Sand Filter Basin	8-16 through 8-17		Separated out BMP previously reference within BMP T8.10	BMP T8.11 Large Sand Filter Basin was described in the prior manual under BMP T8.10 Sand Filter Basin. The Large Sand Filter was given a separate BMP for clarity.
BMP T8.20 Sand Filter Vault	8-17 through 8-23		Additional guidance provided.	Added design criteria, construction criteria, and maintenance criteria for sand filter vault.
BMP T8.40 Media Filter Drain	8-24 through 8-38		Added this BMP.	Added design criteria for new Media Filter Drain (MFD) option (previously referred to as Ecology Embankment). Text matches WSDOT Highway Runoff Manual.
Chapter 9 - Biofiltration Treatment Facilities				
Chapter 9 - Biofiltration Treatment Facilities	9-1 through 9-26		Minor language changes for clarity.	Minor language changes for clarity throughout the chapter.
Section 9.4 Best Management Practices	9-1 through 9-26		Additional guidance provided and outdated guidance removed.	Revised list of BMPs. Revised Sizing Criteria table for clarity.
BMP T9.50 Narrow Area Filter Strip	N/A		Removed this BMP.	No design criteria exists for this BMP to validate basic treatment. Designers should refer to Basic Filter Strip.
Chapter 10- Wetpool Facilities				
BMP T10.10 Wet Pond	10-1 through 10-17		Minor language changes for clarity.	First cell must be lined to be consistent with liner requirements in Chapter 4. Added cell requirements for consistency with design criteria for 2-cell ponds. Definition of WQ Design Storm Volume amended.
Chapter 11 - Oil and Water Separators				
BMP T11.10 API (Baffle type) Separator Bay	11-8 through 11-9		Corrected formula.	Corrected Stokes Law equation for rise rate.
BMP T11.11 Coalescing Plate (CP) Separator Bay	11-10 through 11-11		Corrected formula.	Corrected the equation to calculated the projected (horizontal) surface area of plates.
Chapter 12 - Emerging Technologies				
Chapter 12 - Emerging Technologies	12-1 through 12-6		Replaced sections 12.1 through 12.5 with new guidance.	Replaced sections 12.1 through 12.5 to provide new guidance on the Technology Assessment Protocol (TAPE) review and approval process.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 12.6 Examples of Emerging Technologies for Stormwater Treatment and Control	N/A		Removed examples of emerging technologies.	Removed examples of emerging technologies. Added some examples previously listed throughout this volume.
Appendix V-B Recommended Procedures for ASTM D 2434				
Appendix V-B Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes.	B-1 through B-2		Additional guidance provided.	Added Recommended Modifications to ASTM D 2434. The results of this test for saturated hydraulic conductivity can be influenced by how the general procedures in the ASTM method are implemented. This appendix lays out more specific procedures to help with consistency in evaluating soils used for bioretention.
Appendix V-C Geotextile Specifications				
Appendix V-C Geotextile Specifications	C-1 through C-3		Revised Guidance.	Corrected several test procedures and geotextile property requirements.
Appendix V-E Recommended Bioretention Plant Species				
Appendix V-E Recommended Newly Planted Tree Species	E-1 through E-5		New appendix pertinent to BMP T5.16	Lists of species from City of Seattle guidance.

2012-2014 SWMMWW Chart of Changes

See the 2012 to 2014 SWMMWW Redlines for full change details.

Location	Change	Reasoning or Comments
All Volumes	Updated date in footer	Date updated to reflect the manual's revision date
	Updated page numbers and Figure numbers as appropriate	Page and Figure numbers may have changed due to content insertion or deletion
	Updated Table of Contents as appropriate	Some page numbers may have changed due to content insertion or deletion
	Minor spelling corrections	examples include: groundwater changed to ground water; under-drain changed to underdrain
	Minor text clarifications	examples include: changing "the Department of Ecology" to "the Washington State Department of Ecology"; inserting and/or clarifying acronyms where appropriate
	Minor typographical errors	examples include changing "text" to test" and "lopers" to "loppers"
	Updates per previous errata	Updates per previously published errata to the 2012 SWMMWW have been incorporated
Volume I - Minimum Technical Requirements and Site Planning		
Volume I Acknowledgements	Minor language changes	Inserted text indicating the shorthand for "The Washington State Department of Ecology" is "Ecology", added Craig Doberstein to the acknowledgement list, reformated the acknowledgement list
Chapter 1 - Introduction		
Section 1.1 - Objective	corrected "Ground Waters" to "Groundwaters"	Although the rest of the manual uses the spelling "ground water" (two separate words), the spelling here was updated to be consistent with the WAC title referenced
Section 1.6.4 - The Puget Sound Action Agenda	Revised this section	Revision of this section reflects changes from the Puget Sound Partnership's 2008 Action Agenda to the Puget Sound Partnership's 2014/2015 Action Agenda
Chapter 2 - Minimum Requirements for New Development and Redevelopment		
Section 2.2 - Exemptions	Deleted sentence: "They are considered redevelopment."	These practices are not restricted to redevelopment projects. The bullets that follow this sentence properly indicate that how the surfaces are considered within new or redevelopment projects.
	Restored formatting for second bullet regarding extending the pavement edge.	Formatting error correction
Section 2.3 - Definitions	definitions have been moved from seciton 2.3 to the Glossary	definitions have been moved in an effort to consolidate and organize the SWMMWW
Section 2.5.2 - Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
	revised "with outfall to" to "that discharges to"	revision made per settlement agreement PCHB No. 12-097c
Section 2.5.5 - Minimum Requirement #5: On-Site Stormwater Management	Added Figure 2.5.1: MR5 Flow Chart	A flow chart to help determine MR5 requirements
Chapter 3 - Preparation of Stormwater Site Plans		
Section 3.1.1 - Step 1 - Site Analysis: Collect and Analyze Information on Existing Conditions	Added text: "Testing should occur between December 1 and April 1."	Clarification
	Under Projects required to meet MR 1-9: 2.c., revised cited clearances	Revised to be consistent throughout the manual
Section 3.1.2 - Step 2 - Prepare Preliminary Development Layout	Added text referring to LID manual for additional information	clarification
Appendix I-G - Glossary and Notations		
Glossary	Added a definition for "Biosolids"	Clarification
	Deleted the definition for "Commercial Agriculture"	The entry deleted was a duplicate entry and out of aphabetical order

Location	Change	Reasoning or Comments
Glossary	Deleted the definition for "Converted Vegetation (areas)"	The entry deleted was a duplicate entry and out of aphabetical order
	Commercial Agriculture definition - replaced the word "wholesale" with "commercial" within the definition	Clarification
	Amended definition for compost. Deleted composted mulch and composting.	Updated to correct WAC reference.
	Added a definition for "Discharge Point"	Added for consistency with proposed permit modification as part of a settlement under PCHB No. 12-093c and - 097c
	Updated freeboard definition	Reworded for clarification
	revised "Low Permeable Liner" definition	revised to be consistent with other text within the manual
	Added a definition for "Mulch"	Clarification
	Added definition for "outfall"	Added for consistency with proposed permit modification as part of a settlement under PCHB No. 12-093c and - 097c
	Deleted reference to Rain Garden Handbook in "Rain Garden" definition.	Ecology prefers users to first refer to the guidance within the SWMMWW
	Updated "receiving waters" definition	Revised for consistency with proosed permit modification as part of a settlement under PCHB No. 12-093c and - 097c
Volume II - Construction Stormwater Pollution Prevention		
Chapter 3 - Planning		
Section 3.3.3 - Step 3 - Construction SWPPP Development and Implementation	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
	revised "sites larger than 1 acre" to "applies only to sites that have coverage under the Construction Stormwater General Permit"	revised to clarify the intent of the original wording
	added wording to clarify that the LID Technical Guidance Manual is for additional informational purposes only	Clarification that the SWMMWW guidance overrules the LID Technical Guidance Manual if discrepancies are found
Chapter 4 - Best Management Practices Standards and Specifications		
Section 4.1 - Source Control BMPs	Table 4.1.1 updated to match Errata, and reformatted as a word table for ease in future revisions	See 10/14/2013 Errata
BMP C121: Mulching	Added a specification for coarse compost for use when the option of Composted Material is selected	Clarification
BMP C121, Table 4.1.8	Replaced the terms "composted mulch and compost" with terms consistent with WAC 173-350	Clarification
BMP C125: Topsoiling/Composting	Updated for consistency with BMP T5.13	Clarification
BMP C151: Concrete Handling	Updated sentence to clarify that concrete washout cannot be discharged to ground	Clarification
BMP C154: Concrete Washout Area	Updated sentence to clarify that concrete washout cannot be discharged to ground	Correction
	Removed wording telling volume of wash water typically used	Clarification

Location	Change	Reasoning or Comments
Section 4.2 - Runoff Conveyance and Treatment BMPs	Table 4.2.1 updated to match Errata, and reformatted as a word table for ease in future revisions	Clarification
BMP C200: Interceptor Dike and Swale	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
BMP C201: Grass-Lined Channels	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
BMP C204: Pipe Slope Drains	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
Volume III - Hydrologic Analysis and Flow Control BMPs		
Chapter 2 - Hydrologic Analysis		
Section 2.2 - Western Washington Hydrology Model	updated sentence to state that low impact development modeling capabilities have been added to WWHM2012	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
Section 2.2.1 - Limitation to the WWHM	Clarified that routing limitations in the earlier versions of WWHM (WWHM1 and WWHM2) have changed considerably. WWHM3 and WWHM2012 have much greater routing capability that allow them to model multiple facilities and wetlands	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
Section 2.2.2 - Assumptions Made in Creating the WWHM	Clarified that WWHM2012 now uses over 50 years of precipitation time series from more than 17 stations. Precipitation time series are in 15-minute time steps.	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
	Clarified that WWHM2012 now uses 15-minute precipitation time series in its computations to generate hydrographs and to calculate water quality design flows	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
	Clarified that the advanced user may change coefficient **Precipitation multiplication factor** where justified and approved by reviewing jurisdiction	Clarification
	Clarified that the advanced user may change coefficient **Pan evaporation coefficient** justified and approved by reviewing jurisdiction	Clarification
Section 2.2.3 - Guidance for Flow-Related Standards	Noted the updated capability to model flows to wetlands and analyze the daily and monthly flow deviations per MR 8 in WWHM2012	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
Section 2.3.2 - Runoff Parameters	Added footnote to Table 2.3.1 allowing modeling soils with a measured infiltration rate of less than 0.3 in/hr as Class C	Clarification

Location	Change	Reasoning or Comments
Chapter 3 - Flow Control Design		
Section 3.1 - Roof Downspout Controls	Updated wording that directs user to BMP design guidance within the SWMMWW instead of the Rain Garden handbook	Clarification
Section 3.1.1 - Downspout Full Infiltration Systems (BMP T5.10A)	Revised subsection title from "Flow Credit for Roof Downspout Full Infiltration" to "Runoff Modeling for Roof Downspout Full Infiltration"	Clarification
	revised sentence to clarify that clearance is measured to the seasonal high ground water table	Clarification
Section 3.1.2 - Downspout Dispersion Systems (BMP T5.10B)	Revised subsection title from "Flow Credit for Roof Downspout Dispersion" to "Runoff Modeling for Roof Downspout Dispersion"	Clarification
	Added modeling guidance where a dispersion trench is used with a vegetated flowpath of 25 to 50 feet.	Clarification
	removed footnote defining "Vegetative Flow Path"	
Section 3.2.1 - Detention Ponds	Added text to Emergency Overflow Spillway section to ensure a min 1 foot of freeboard in detention pond design	Clarification
	Updated Landscaping section to refer to BMP T5.13.	Clarification
	Added a reference to the Maintenance Tables in Volume V, removed the Maintenance Tables from this section	tables have been moved in an effort to consolidate and organize the SWMMWW
	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
Section 3.2.2 - Detention Tanks	Added a reference to the Maintenance Tables in Volume V, removed the Maintenance Tables from this section	tables have been moved in an effort to consolidate and organize the SWMMWW
Section 3.2.4 - Control Structures	Added a reference to the Maintenance Tables in Volume V, removed the Maintenance Tables from this section	tables have been moved in an effort to consolidate and organize the SWMMWW
Section 3.3.4 - Steps for the Design of Infiltration Facilities - Simplified Approach	Sentence added "Testing should occur between December 1 and April 1"	Clarification
Section 3.3.7 - Site Suitability Criteria (SSC)	Updated SSC-2 Ground Water Protection Areas per Errata	See 10/14/2013 Errata
	Corrected reference cited in SSC-6	Correction
Section 3.4.2 - Description	Removed reference to the LID Technical Guidance Manual for Puget Sound	Ecology wants users to first consider the design guidance within the SWMMWW.
	Revised wording to state design criteria "per BMP T5.14A" instead of the Rain Garden Handbook	Ecology wants users to first consider the design guidance within the SWMMWW.

Location	Change	Reasoning or Comments
Section 3.4.2 - Description	Added statement allowing infiltration through the side slopes to be modeled for facilities with side slopes 3H:1V or flatter	Clarification
Appendix III-B - Western Washington Hydrology Model - Information, Assumptions, and Computation Steps		
WWHM Information and Assumptions - Precipitation Data	Revised text to state that WWHM2012 uses 15-minutes precipitation time series	Clarification
WWHM Information and Assumptions - Soil Data	Added statement that soils tested at less than 0.3 in/hr may be modeled as Class C soil.	Clarification
	Clarified that type D soil is generally modeled as till and saturated soil category in WWHM is to be used for wetlands	Clarification
WWHM Information and Assumptions - Development Land Use Data	Updated text that conflicted with information elsewhere in the manual	Clarification
	Updated text that the Appendix C guidance was developed before WWHM2012 became available. WWHM2012 can model permeable pavements directly.	Clarification
WWHM Information and Assumptions - PERLND and IMPLND Parameter Values	Added statements concerning adjustment of LSUR, SLSUR, and NSUR by the model user	Clarification
	Added a paragraph explaining WWHM2012and WWHM3 provides 2 additional land slopes, flat and steep, to the existing moderate land slope for modeling purposes	Clarification
Appendix III-C - Washington State Department of Ecology Low Impact Development Flow Modeling Guidance		
Appendix III-C	Added a "Note" that the guidance in Appendix C was developed for use with WWHM3 before WWHM2012 became available.	Clarification
Part 1 C.2.3 - Partial Dispersion on Residential Lots and Commercial Buildings	Clarified guidance for consistency with text regarding modeling of partial dispersion options.	Clarification
Part 1 C.10.1 - Runoff Model Representation	Added guidance regarding modeling bioretention that has an underdrain	Clarification
Part 1 C.11.1 - Instructions for Roads on Zero to 2% Grade	Added guidance regarding modeling permeable pavement that has underdrains at the bottom of base course	Clarification
Part 1 C.11.2 - Instructions for Roads on Grades above 2%	Added guidance regarding modeling permeable pavement that has underdrains at the bottom of base course	Clarification
Part 2 Downspout Dispersion - BMP T5.10B	Inserted guidance for downspout dispersion modeling	Clarification
Part 2 Bioretention - BMP T7.30	Added modeling guidance on Bioretention with underlying perforated drain pipes	Clarification

Location	Change	Reasoning or Comments
Volume IV - Source Control BMPs		
Chapter 2 - Selection of Operational and Structural Source Control BMPs		
S403 BMPs for Commercial Composting	revised text to reflect updated regulations and guidance	Clarification
S411 BMPs for Landscaping and Lawn/Vegetation Management	Revised S411 BMP bullet point to clarify use of pesticides in Landscaping	Clarification
S430 BMPs for Urban Streets	deleted reference to Vol. V, Ch. 12 which no longer has information on sweepers	Clarification
S431 BMPs for Washing and Steam Cleaning Vehicles/Equipment/Building Structures	Revised text to reference updated guidance	Clarification
Appendix IV-G - Recommendations for Management of Street Wastes		
Contamination in Street Waste Solids	Total Copper added to Table G.4	Copper overlooked in previous editions
	Added note that the Interim Compost Guidelines are no longer effective. Retained for background info.	Clarification
Volume V - Runoff Treatment BMPs		
Chapter 2 - Treatment Facility Selection Process		
Section 2.1 - Step-by-Step Selection Process for Treatment Facilities	Step 5: revised "urban growth management area" to "urban growth area"	Clarification
Chapter 3 - Treatment Facility Menus		
Section 3.4 - Enhanced Treatment Menu	Revised "urban growth management area" to "urban growth area"	Clarification
	Bioretention: removed text directing reader to LID Manual for bioretention guidance. Text now directs reader to Chapter 7 only. (Text within Chapter 7 refers to the LID manual for additional guidance)	Clarification
Section 3.5 - Basic Treatment Menu	Deleted: "The goal also applies on an average annual basis to the entire annual discharge volume (treated plus bypassed)."	Clarification - See 10/14/2013 Errata
	Bioretention: removed text directing reader to LID Manual for bioretention guidance. Text now directs reader to Chapter 7 only. (Text within Chapter 7 refers to the LID manual for additional guidance)	Clarification
Chapter 4 - General Requirements for Stormwater Facilities		
Section 4.1.2 - Water Quality Design Flow Rate	(last sentence of section) Deleted reference to an average annual performance goal	Indefinite determination.
Section 4.1.4 - Minimum Treatment Facility Size	New section re minimum treatment facility size	Additional guidance provided on the minimum treatment facility size.

Location	Change	Reasoning or Comments
Section 4.6 - Maintenance Standards for Drainage Facilities	Updated Tables 21&22 with information from LID O&M Guidance document, with note that inspection and routine maintenance frequencies are recommended only.	Guidance added per PCHB No. 12-093c and - 097c
Chapter 5 - On-Site Stormwater Management		
Section 5.1 - Purpose	Added text clarifying that LID manual is for additional guidance only.	Clarification
Section 5.3.1 - On-Site Stormwater Management BMPs	Added bullet under Competing Needs on local codes	Clarification
BMP T5.11: Concentrated Flow Dispersion	Added modeling guidance for use of dispersion trench with flowpath of 25-50 feet	Additional guidance for runoff modeling
BMP T5.12: Sheet Flow Dispersion	Added modeling guidance for use of dispersion trench with flowpath of 25-50 feet	Additional guidance for runoff modeling
BMP T5.13: Post-Construction Soil Quality and Depth	Updated the compost specification requirement to be consistent with the Bioretention compost specification but allowing use of biosolids	Corrected WAC reference, made clarifications
BMP T5.14A: Rain Gardens	Revised Rain Garden Handbook reference to specify 2013 version	Clarification per PCHB No. 12-093c and - 097c
	Added a design guideline concerning use of composts	Additional Guidance for rain gardens
	Provided guidance for sizing rain gardens serving lawn/landscape areas in addition to impervious surfaces	Additional Guidance for rain gardens
	Provided guidance for underdrains in rain gardens	Additional Guidance for rain gardens
	updated the maintenance section to refer to both the Rain Garden Handbook and the Western Washington LID O&M Guidance Document	Additional Guidance for rain gardens
BMP T5.14B: Bioretention	Provided guidance for sizing bioretention facilities serving lawn/landscape areas in addition to impervious surfaces	Additional Guidance for bioretention facilities
BMP T5.15: Permeable Pavements	Revised guideline regarding the amount of impervious area draining to a pervious area	Clarification
	Revised infeasibility criterion for permeable pavement and roads re PCHB decision	Revised to implement PCHB No. 12-093c and -097c
	Deleted the second sentence of the infeasibility criterion addressing road sanding for snow and ice, Per PCHB ruling	Deleted per PCHB No. 12-093c and - 097c
	New text in regard to municipalities designating areas as infeasible and the data required	Clarification and additional guidance as directed by PCHB No. 12-093c and - 097c

Location	Change	Reasoning or Comments
BMP T5.15: Permeable Pavements	Revised 1st paragraph of "Design Guidelines" section to clarify that LID Manual is for additional guidance only, and that alternatives adopted by municipalities must not conflict with Ecology design criteria.	Clarification
	Removed reference to the LID manual in the "Base Material" section. The LID manual is already referenced as additional guidance in the opening paragraph.	Clarification
	"Wearing layer": updated infiltration rate in first sentence from 10 in/hr to 20 in/hr. The 10 in/hr rate was a typo and conflicted with information given later in this section.	Clarification
	Removed reference to the LID manual in the "Wearing Layer", "Pervious Concrete", and "Permeable Interlocking Concrete Pavement and Aggregate Pavers" sections. The LID manual is already referenced as additional guidance in the opening paragraph.	Clarification
	"Underdrains": Added a section regarding underdrains affecting the status of permeable pavements as LID BMPs	Additional Guidance for permeable pavements
	added a reference to Table 22 within Table 4.5.2 in Chapter 4 for maintenance guidance	Additional Guidance for permeable pavements
BMP T5.17: Vegetated Roofs	Added text clarifying that LID manual is for additional guidance only.	Clarification
BMP T5.30: Full Dispersion	Corrected section sub header name	Clarification, the guidance is not only for residential projects
	Corrected design requirements for residential projects text for clarity	Clarification
	Revised "urban growth management area" to "urban growth area"	Clarification
Chapter 7 - Infiltration and Bioretention Treatment Facilities		
BMP T7.30: Bioretention Cells, Swales, and Planter Boxes	Replaced Figure 7.4.1	Clarification
	Added Figure 7.4.1b	Clarification
	Added Figure 7.4.1c	Clarification
	New text in regard to municipalities designating areas as infeasible and the data required	Additional guidance to be consistent with directive of PCHB No. 12-093c and - 097c for permeable pavement
	Determining Bioretention soil mix infiltration rate: Updated Ksat Safety Factor language for consistency with WWHM.	Clarification

Location	Change	Reasoning or Comments
BMP T7.30: Bioretention Cells, Swales, and Planter Boxes	Design criteria for bioretention - updated text to clarify that LID manual is additional guidance only; under "curb cuts for roadside, driveway, and parking lot areas" - removed reference to LID manual because it is already referenced in the design criteria opening paragraph.	Clarification
	Added text to "ponding area" section describing surface areas when designing for MR5	For consistency w/Min. Requirement #5 and recommendation for size increase if draining pervious area
	Default Bioretention Soil Media: Multiple changes to the compost specification; and to incorporate a specification for fine compost	Changes needed to be consistent with updated WAC 173-350-220; Incorporated fine compost spec. to delete reference to LID Manual
	Design Criteria for Custom Bio Soil Mixes: Added text clarifing that custom mix does not need to meet gradation specification	Clarification
	Soil Depth: Removed guidance for 24" BSM depth	Additional Guidance for bioretention facilities. Local monitoring indicates phosphorus loss from media.
	Underdrain (optional): Added guidance for modeling bioretention with underdrains	Additional Guidance
	Added text to clarify that LID manual is additional guidance only.	Clarification
	Added statement that compost shall not include biosolids or manures	Clarification
BMP T7.40: Compost-Amended Vegetated Filter Strips	Soil Design Criteria: Emphasized exclusion of biosolids and manure from compost used for CAVFS	Clarification
	Maintenance: deleted bullets per Errata	Clarification - See 10/14/2013 Errata
BMP T8.30: Linear Sand Filter	Additional Design Criteria for Linear Sand Filters: corrected text	Correction
BMP T8.40: Media Filter Drain	Grass Strip: restricted compost to that used for Bioretention soil media	Clarification
Chapter 9 - Biofiltration Treatment Facilities		
BMP T9.10: Basic Biofiltration Swale	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
	Soil Criteria: SC-15: Restricted compost to that used for Bioretention soil media	Clarification
BMP T9.40: Basic Filter Strip	Corrected error in figure 9.4.9	Correction
Chapter 11 - Oil and Water Separators		
Section 11.6 - Design Criteria - General Considerations	Corrected Schueler citation from 1990 to 1992	Correction
BMP T11.11: Coalescing Plate (CP) Separator Bay	Clarification in design flowrate variable	Clarification

PORT TOWNSEND PLANNING COMMISSION REGULAR SESSION AGENDA
CITY HALL COUNCIL CHAMBERS, 540 WATER STREET

Business Meeting **06:30 p.m.** **March 22, 2018**

I. Call to Order

II. Roll Call

III. Acceptance of Agenda

IV. Approval of Minutes â€“ March 8, 2018

030818 Draft Minutes

V. General Public Comment - None

VI. Old Business

A. Stormwater Management Plan

Action: None. Discussion only.

032218 Staff Memo

Attachment A - Open Space and Critical Areas

Attachment B - Open Space and Critical Areas Without Potential Drainage Ways

Attachment C - PTMC 19.05.090 CDC Amendments

Attachment D - Stormwater Consistency

Attachment E - SWManualCompareTM_20171207

Attachment F - SWManualCompare_Atch1a_2012-2005

Attachment G - SWManualCompare_Atch1b_2012-2014

PTMC 19.05

B. Critical Drainage Corridors and Frequently Flood Areas

Action: None. Discussion only.

VII. New Business - None

VIII. Other Business - None

IX. Upcoming Meetings

Schedule

X. Communications

XI. Adjournment

Americans with Disabilities Act
In compliance with the Americans with Disabilities Act, those requiring accommodation for this meeting should notify the City Clerks Office at least 24 hours prior to the meeting at (360) 379-5083.

Hearing Assistance Available

Capital Projects & Engineering
250 Madison, Suite 2R
Port Townsend, WA 98368
360-379-5096 Fax 360-385-7675

MEMORANDUM

TO: City Council

FROM: Samantha Harper, P.E., Assistant City Engineer

CC: Stormwater Management Plan File

RE: Summary of Stormwater Management Briefing at City Council Workshop on April 9, 2018

DATE: April 4, 2018

City staff and the stormwater consultant last presented the Stormwater Management Plan (SWMP) to City Council on December 11, 2017. The presentation was a very broad overview of the Stormwater Utility, which included:

Proposed Stormwater Utility Vision Statement;
Public Process to Date;
Existing System Assessment;
Stormwater Uniqueness of Port Townsend;
Proposed Tiering Map; and
SWMP Next Steps.

City staff plans to provide City Council with a progress update including a summary of the City Council Ad-Hoc Committee for the SWMP meetings, Planning Commission and Parks, Recreation and Tree Advisory Advisory Committee briefings.

City staff will present a formal presentation at the City Council workshop on Monday, April 9, 2018.

Stormwater Management Plan Update

City Council Workshop

April 9, 2018

Goal of Tonight

- Provide update on status of the Stormwater Management Plan
- Increase familiarity with Stormwater Plan concepts
- Review current information
- Summarize meetings of Ad-hoc Committee on Stormwater Management Plan
- Summarize Planning Commission Briefing
- Next Steps

Stormwater and Drainage Conditions in Port Townsend are Unique

- No “streams”
  - Port Townsend has closed basins with wetlands and discharge to the Sound
  - DOE Stormwater Manual hydraulic modeling is for discharge to streams
- Low Rainfall
  - Hydraulic modeling does not always reflect actual conditions
- Hard pan soils in much of the City
  - Infiltration of Stormwater is often not feasible
- Historic Platting
  - Stormwater controls are often implemented one lot at a time

Stormwater Management Plan Goals

- Assess Existing Drainage system
  - Identify deficiencies
  - Identify existing flooding problems
- Develop approaches to protect and improve the drainage system
- Identify drainage basin and roadway drainage network connectivity
  - Use as a framework for planning future stormwater improvements.
- Develop a Capital Projects Plan
- Update standards and guidance for developers and builders
  - Site development information and review materials, including low impact development (LID) measures, infill, redevelopment, new site development, and water quality retrofits
- Address Water quality protection approaches

Goals for the Roadway Drainage Network

Discovery Road – Road side Swale

F Street – Curb and Gutter

Improved Roadway Drainage

Landes Street

Hastings Avenue

Assessment of Stormwater System Deficiencies and Needs

Sheridan Street – Swales needed

14th Street – shoulder maintenance

Assessment of Stormwater System Deficiencies and Needs – Local Flooding

Sheridan Street

Hancock Street & 31st Street

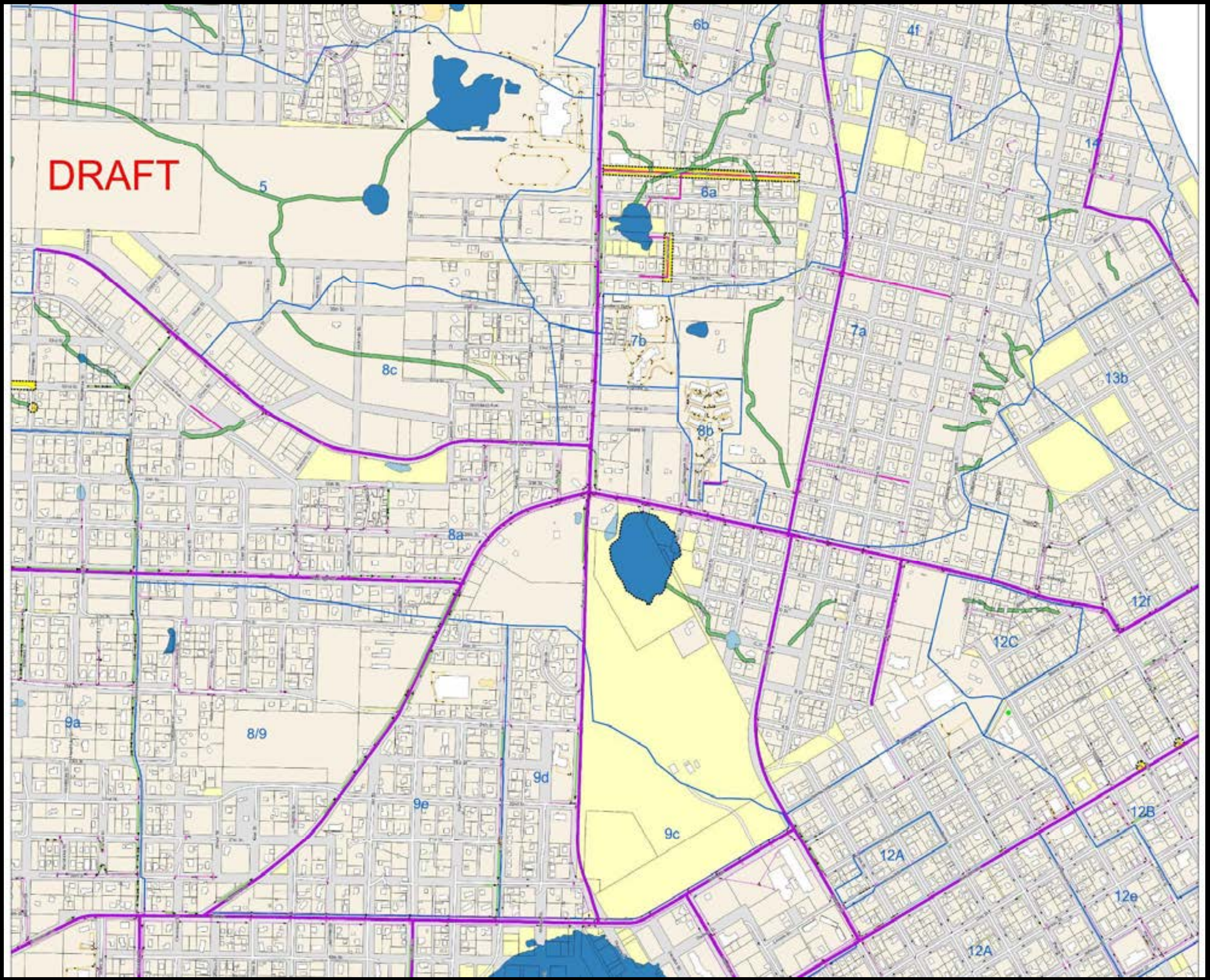
January 2018

City Council Adhoc Committee for Stormwater Management formed in order to:

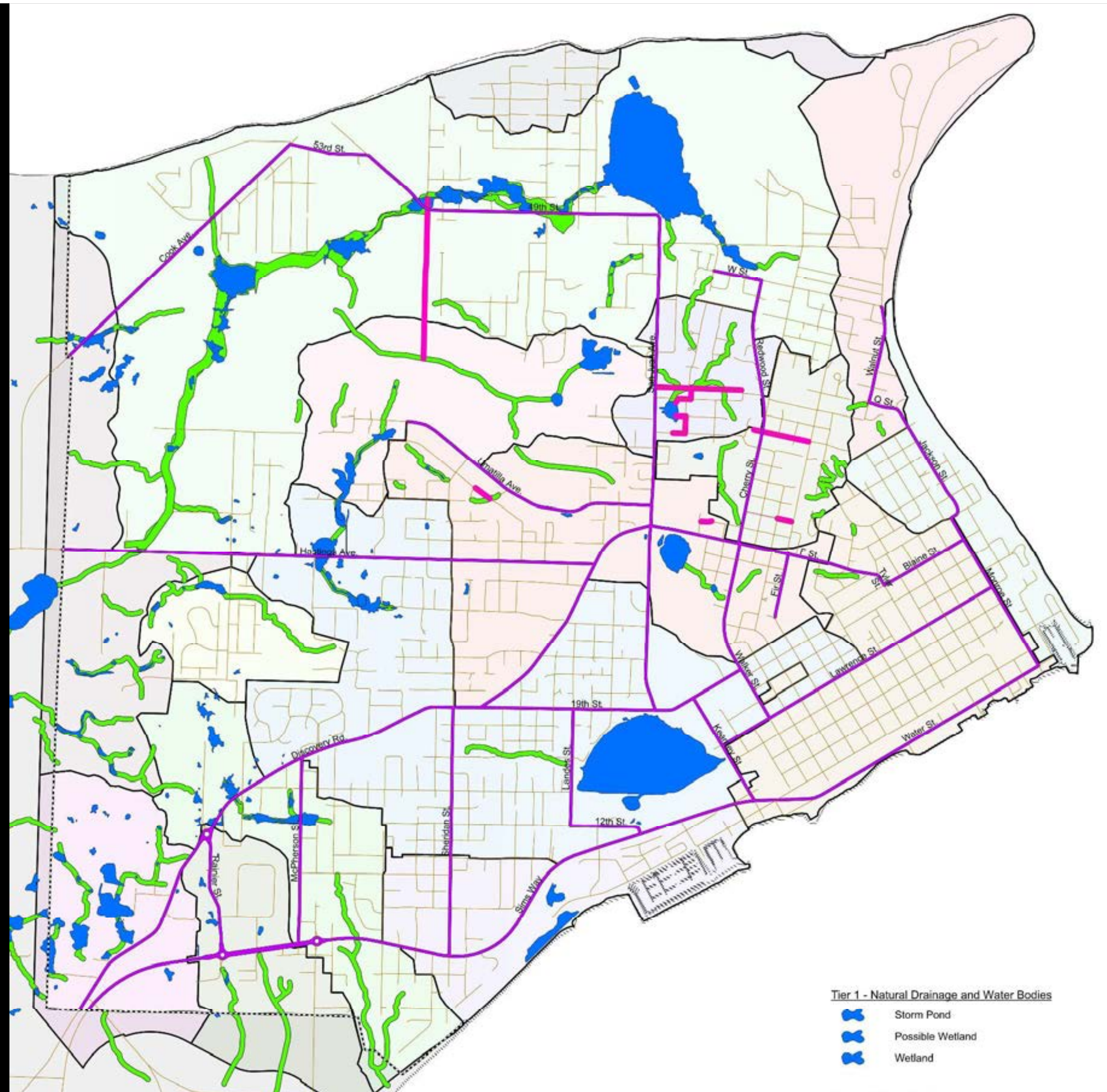
- Gain an understanding of the City's Stormwater Utility;
- How the policies in the plan will guide regulations; and
- Receive feedback and input on topics pertained within the Stormwater Management Plan

City Council Ad-Hoc Meeting No. 1

- Reviewed Existing Conditions



- Stormwater Drainage Basins
  - Closed basins
  - Receiving points for SW



Example Stormwater Capital Improvement Projects

Stormwater Tied into Sewer

- Lawrence Street at Polk Street, Tyler Street and Taylor Street

Regional Stormwater System

- Rainier Street Regional Stormwater Facility

Improve Conveyance

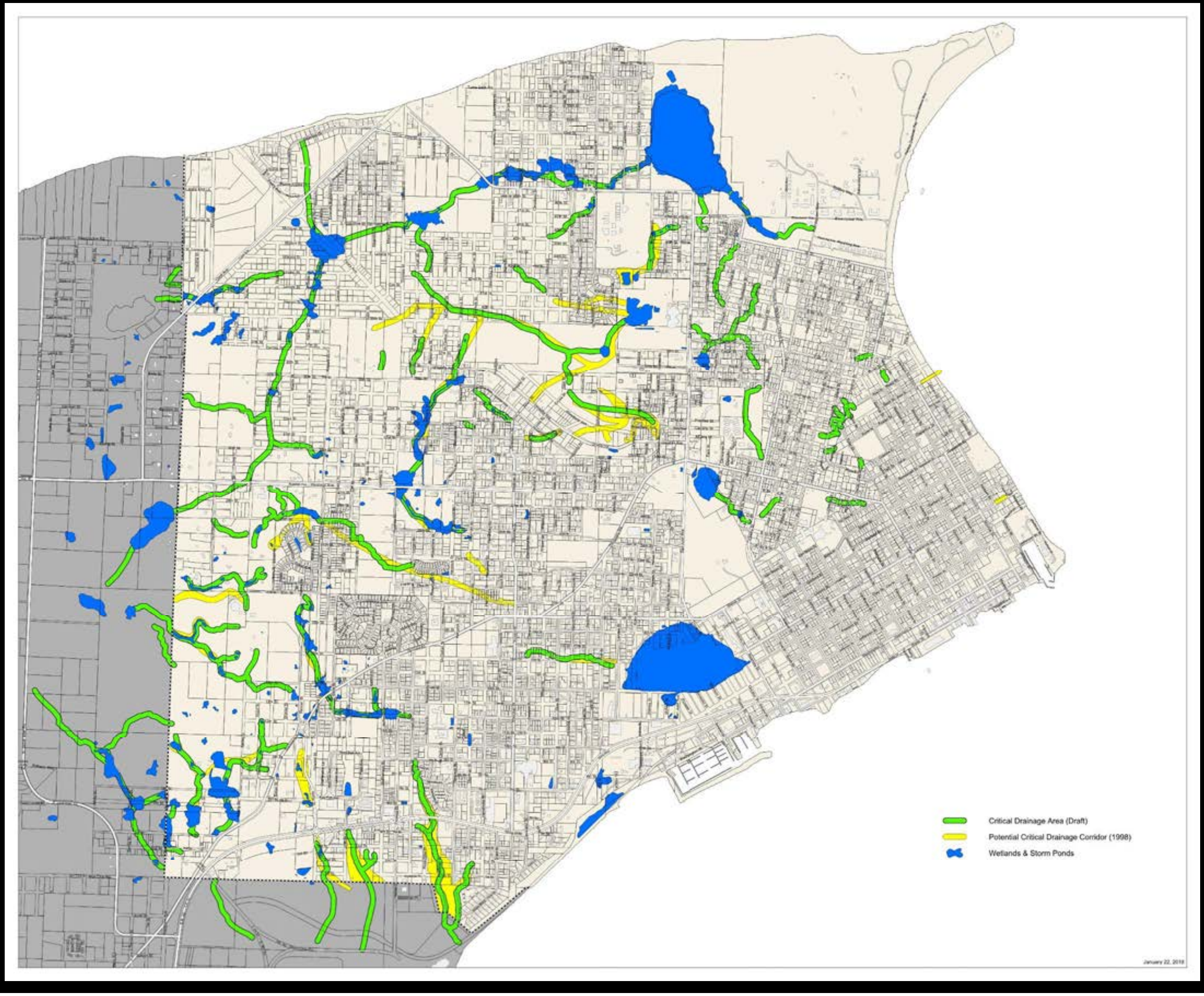
- Roadside Drainage along Major Roads
- 14 Street McPherson Street to Rosecrans Street

Localized Flooding

- Center Street – San Juan Ave. to Olympic Ave.
- Hancock Street and 32nd Street - at 31st Street stormwater tie into sewer

City Council Ad-Hoc Meeting No. 2

- Critical Drainage Corridors



Purple Roadway Inventory

Road Description	Unit in Linear Feet
Road with curb and gutter and sidewalks	31,394
Road with more than 25-ft wide road – no sidewalk or curb	38,986
Road width 40-ft or less – yes sidewalk no curb	6,580
Road width 50-ft or less – no curb	12,381
Total Purple Roads	89,341

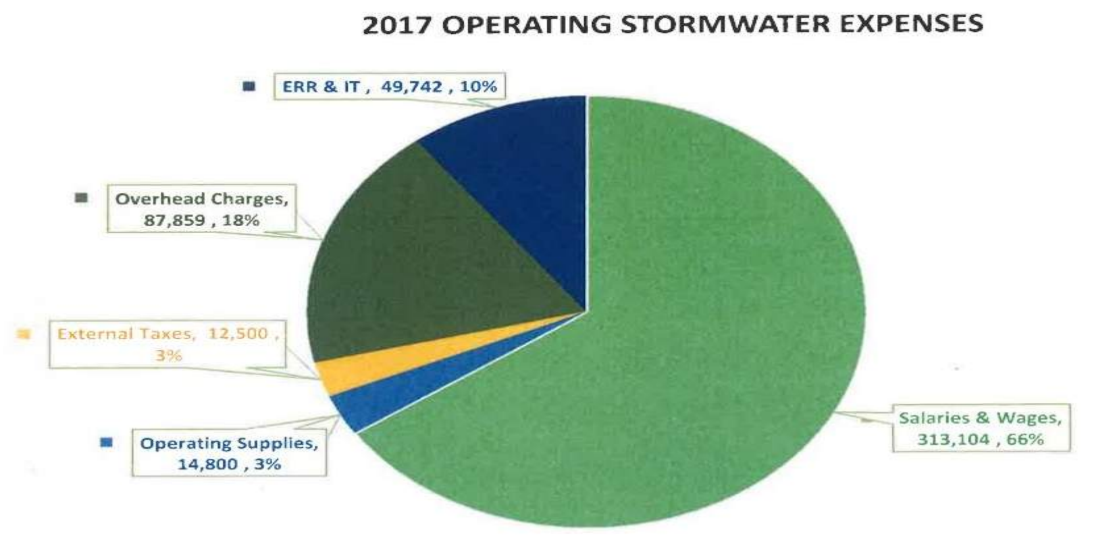
City Council Ad-Hoc Meeting No. 3

Existing Stormwater System

Stormwater Features	Quantity
Catch Basins	1,468
Maintenance Holes	114
Storm Filters	4
Solid Pipe	25 miles
Perforated Pipe	0.9 miles
Swales	4.1 miles
Concrete Gutters	1.6 miles

Replacement of Storm Filters

Shoulder Pulling Operation


2017 OPERATING STORMWATER EXPENSES
ERR & IT , 49,742 , 10%
Overhead Charges, 87,859 , 18%
External Taxes, 12,500 , 3%
Operating Supplies, 14,800 , 3%
Salaries & Wages, 313,104 , 66%

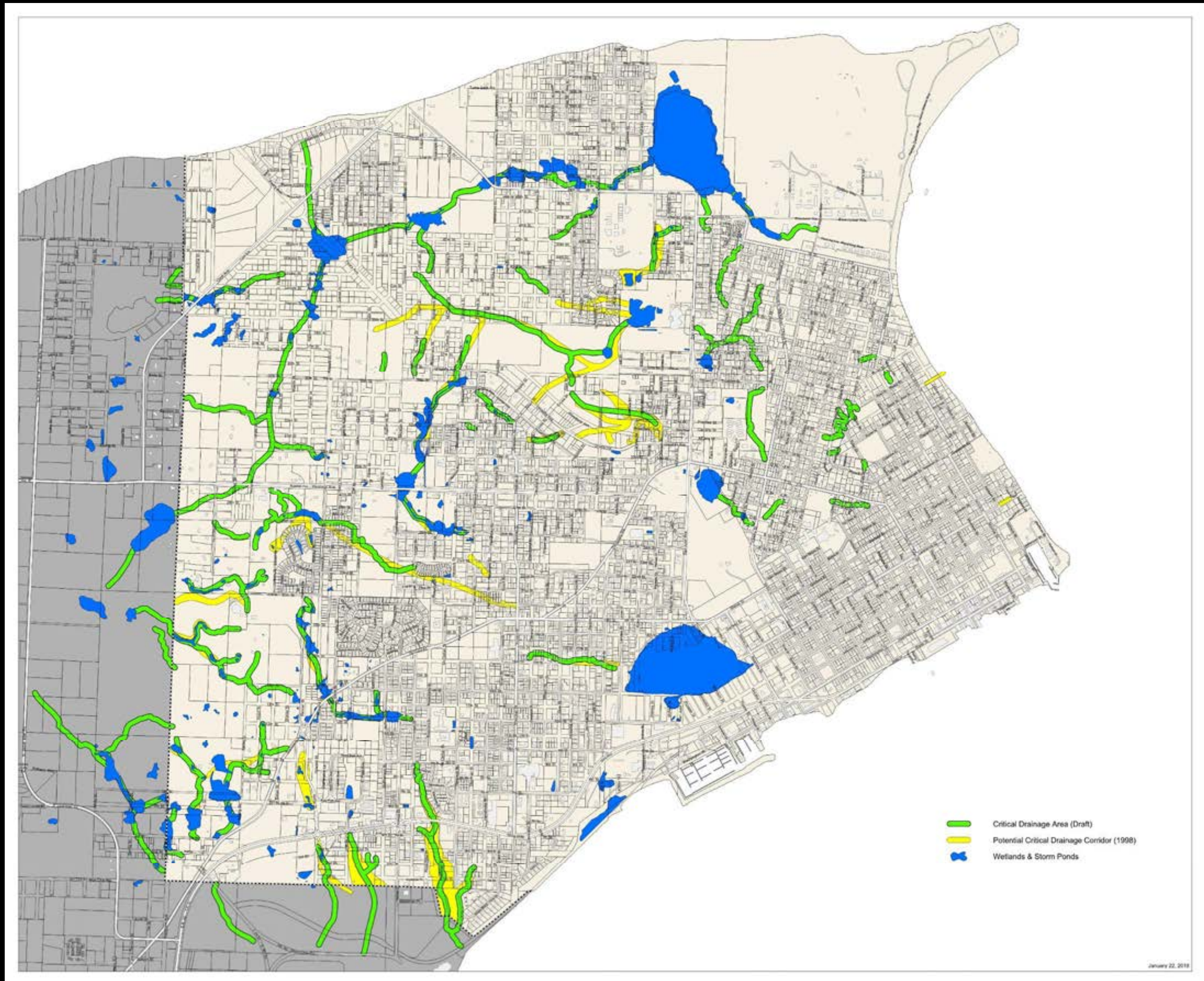

Revenue to Expenses
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Dollars
2015
2016
2017
2018
Year
Revenue
Expenses

City Council Ad-Hoc Meeting No. 4

Proposed Site Development Regulation Language

- Requirements for single lots, short plats and subdivisions and how the applicant ties into the proposed Tiering Stormwater System
- If fees are assessed on new development it was proposed to be a reduction system.
  - Example:
  1. Development with 100 percent infiltration and no discharge the applicant would receive a 50-percent discount from paying into a roadway drainage fund.
  2. Development with reduced or no infiltration the applicant would receive a 0-percent discount from paying into a roadway drainage fund.

- Critical Drainage Corridors



Outcome of the City Council Ad-Hoc Committee

- Overarching Outcomes:
  - Understanding of the stormwater utility from existing inventory, operations and maintenance, capital projects needs, systems needs and the future direction of the utility.
- Recommendations:
  - CDC placement in PTMC Title 19.05 or PTMC 13.32, staff to present to Planning Commission for their recommendation to City Council.
  - If new stormwater development fees are assessed, the reduction method approach was agreeable to the sub-committee members because it seemed logical, understandable and fair.
  - Staff recommended to keep the City Council Ad-Hoc Committee for Stormwater Management together for the upcoming stormwater rate analysis study

Planning Commission Meeting

Maps provided at meeting

Summary of Planning Commission

- Critical Area Ordinance could move on to Planning Commission Hearing.
- Planning Commission Briefing on April 26, 2018 for consistency review between the Comprehensive Plan and Stormwater Management Plan.
- Consistency Review Hearing on May 10, 2018.

Parks, Recreation and Tree Advisory Board Meeting

Maps provided at meeting

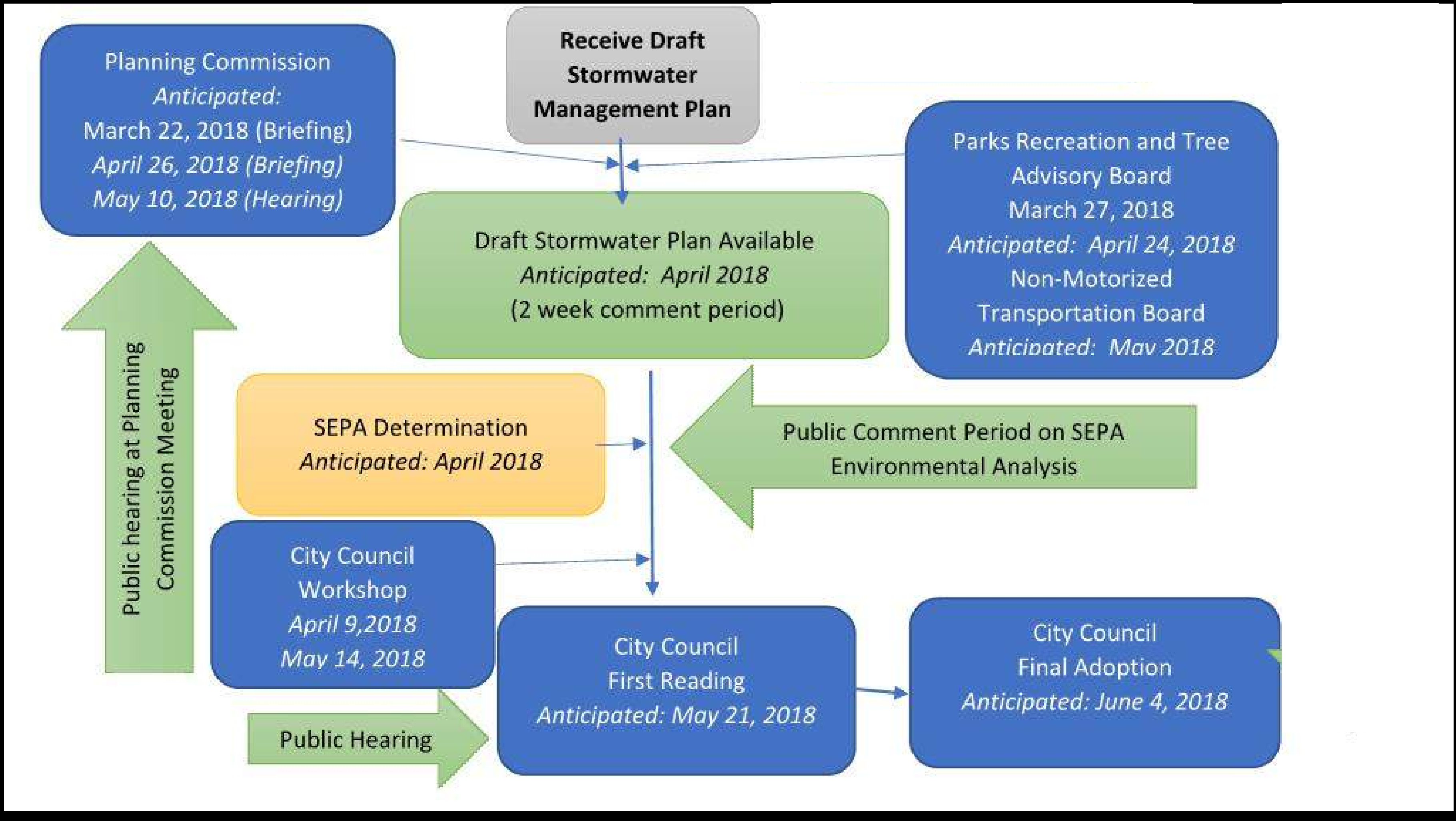
Summary of Parks, Recreation and Tree Advisory Board

- Will go back to the Parks, Recreation and Tree Advisory Committee's April meeting for consistency review between the Parks Plan and Stormwater Management Plan.

Recommendation:

- Put an Education component in the Stormwater Management Plan.

Next Steps



Planning Commission
Anticipated:
March 22, 2018 (Briefing)
April 26, 2018 (Briefing)
May 10, 2018 (Hearing)
Receive Draft Stormwater Management Plan
Parks Recreation and Tree Advisory Board
March 27, 2018
Anticipated: April 24, 2018
Non-Motorized Transportation Board
Anticipated: May 2018
Draft Stormwater Plan Available
Anticipated: April 2018
(2 week comment period)
Public hearing at Planning Commission Meeting
SEPA Determination
Anticipated: April 2018
Public Comment Period on SEPA Environmental Analysis
City Council Workshop
April 9,2018
May 14, 2018
Public Hearing
City Council First Reading
Anticipated: May 21, 2018
City Council Final Adoption
Anticipated: June 4, 2018

City of Port Townsend

Memo

TO: Planning Commission
FROM: Samantha Harper, Assistant City Engineer
DATE: June 7, 2018 MEETING DATE: June 14, 2018
RE: **Stormwater Management Plan Draft Review**

Background: The City is drafting a Stormwater Management Plan - a functional plan which addresses existing stormwater system conditions; the operation and maintenance of existing facilities and capacity for adding new facilities; identifying capital project needs; and potential funding methods for financing of capital and operational costs. Stormwater management is about drainage and flooding, as well as water quality. The City has a range of soil types from hard pan to sandy soils which impact stormwater solutions. The City intends to plan for surface water management as a whole – integrating a preservation of water resources through natural systems approach where possible while protecting environmental values and public health. The process will include comparison of 2005 and 2012 DOE Stormwater Manual and recommended concurrent amendments to the City's development regulations/Engineering Design Standards to ensure public and private projects achieve the City's adopted level of service standard.
In addition to the functional plan, staff will need to update PTMC Chapter 13.32 Stormwater Management Requirements.

On November 9, 2017, Planning Commission received a briefing including a proposed tiered map identifying key areas of the City's stormwater system. Commissioners discussed issues related to the Plan including addressing climate change and development costs and fees. Packets are available via the City website at: http://cityofpt.us/video.html

In January and February of 2018, staff worked with the Council Sub-Committee.

The March 22, 2018 Planning Commission briefing meeting, staff discussed the relationship between Critical Drainage Corridors (CDCs) and Drainage Ways and The Plan process to date. CDCs will remain within the Critical Area Ordinance and public works staffs is still working on the language for Drainage Ways, which will be regulated in Port Townsend Municipal Code Title 13.32. Staff will bring the draft language to the Planning Commission once complete.

June 14: The meeting on June 14th will be to review the highlights of the Draft Stormwater Management Plan Chapter 1 -4. Staff and the consultant are still working on formatting, Chapters 5 – 6, figures and tables.

Recommendation: No action is required of the Planning Commission at this time. Staff seeks questions and feedback in preparation of the upcoming public hearings.

Next Steps:

? Meeting – to go over remaining Chapters prior to Hearing and the Drainage Way draft language or go over it at the Hearing

June 28, 2018 Stormwater Management Plan Concurrency review - Public Hearing

Attachments

Draft Stormwater Management Plan Chapters 1 -4 with Appendix A and B

PORT TOWNSEND PLANNING COMMISSION REGULAR SESSION AGENDA
CITY HALL COUNCIL CHAMBERS, 540 WATER STREET

Business Meeting **06:29 p.m.** **June 14, 2018**

I. Call to Order

II. Roll Call

III. Acceptance of Agenda

IV. Approval of Minutes - April 26, 2018

042618

V. General Public Comment - None

VI. Old Business

A. Stormwater Management Plan

Action: None. Discussion only.

Staff Memo on Stormwater Management Plan 061418

DRAFT Stormwater Management Plan Chapter 1-4 with Appendices A and B June 2018

Meeting Handout - Kah Tai Lagoon Nature Park Wetland Development

B. Draft Rainier Street and Upper Sims Way Subarea Plan

Action: None. Discussion only.

PortTownsend-Subarea Plan-Draft 060418

Presentation on Draft Subarea Plan

C. Planning Commission Work Plan

Action: None. Discussion only.

Recommendations from Ad Hoc Committee on Housing 021318

Recommendations from Ad Hoc Committee on Housing 032618

Recommendation for Future Work Plans Revised

VII. New Business

A. Letter to City Council Regarding Rainier Street Roundabout Signage

Action: Approve letter and direct staff to forward to City Council.

Draft Letter to Council - Rainier Street Promotion

VIII. Other Business - None

IX. Upcoming Meetings

Planning Commission Meetings Schedule

X. Communications - None

XI. Adjournment

Americans with Disabilities Act
In compliance with the Americans with Disabilities Act, those requiring accommodation for this meeting should notify the City Clerks Office at least 24 hours prior to the meeting at (360) 379-5083.

Hearing Assistance Available

CITY OF PORT TOWNSEND
MINUTES OF THE PLANNING COMMISSION REGULAR SESSION OF JUNE 14, 2018

CALL TO ORDER

The Port Townsend Planning Commission met in regular session on June 14, 2018, in the City Council Chambers at 540 Water Street. Chair Paul Rice called the meeting to order at 6:30 p.m.

ROLL CALL

Commissioners present at roll call were Bob Doyle, Rick Jahnke, James Lagergren, Monica MickHager, Aislinn Palmer, Paul Rice, and Lois Stanford.

Staff members present were Development Services Director Lance Bailey, Assistant City Engineer Samantha Harper, Special Projects Temporary Employee Belinda Graham, and Legal Assistant/Deputy Clerk Amber Long.

ACCEPTANCE OF AGENDA

Motion: Rick Jahnke moved to accept the agenda. Bob Doyle seconded.
Vote: motion carried unanimously, 7-0 by voice vote.

APPROVAL OF MINUTES - APRIL 26, 2018

Motion: James Lagergren moved to approve the minutes of April 26, 2018. Lois Stanford seconded.
Vote: motion carried unanimously, 7-0 by voice vote.

GENERAL PUBLIC COMMENT - NONE

OLD BUSINESS

Stormwater Management Plan

Assistant City Engineer Samantha Harper informed the Commission that staff will postpone the public hearing on the Stormwater Management Plan and will return in September or October with a full draft of the Plan for discussion. She gave an overview of the first four chapters of the draft Plan and discussed the work that still needs to be done.

Public comment: Debbie Jahnke read a definition for "sensitivity analysis." She distributed the Admiralty Audubon Society's proposed plan for wetland development at Kah Tai Lagoon and requested that the Commission recommend including the wetland in the Stormwater Management Plan.

Draft Rainier Street and Upper Sims Way Subarea Plan

Special Projects Temporary Employee Belinda Graham presented on the background, vision, guiding principles, and next steps for the subarea plan. By agreement, the Commissioners discussed the first half of the plan page by page, asking questions of staff and providing suggested revisions to text and photographs. Staff plans to have the Executive Summary available by the next meeting.

Planning Commission Work Plan

Development Services Director Lance Bailey discussed the DSD/Planning Commission work plan document from December 2016 and the housing-related items that have been tasked to Planning Commission by City Council. After discussion, the Commission generally agreed to start with a review of the following:
1. SEPA categorical exemptions;
2. ADU regulations;
3. Daylight plane requirements; and
4. Cottage housing.

NEW BUSINESS

Letter to City Council Regarding Rainier Street Roundabout Signage

Chair Rice noted that he will change "Rainier Street sub-area" in the letter to "Rainier Street and Upper Sims Way sub-area" to match the name of the Plan.

Motion: Aislinn Palmer moved to approve sending the letter with the change noted. James Lagergren seconded.
Vote: motion carried unanimously, 7-0 by voice vote.

OTHER BUSINESS - NONE

UPCOMING MEETINGS

The next meeting is scheduled for June 28th, when the Planning Commission will continue its review of the Rainier Street and Upper Sims Way Subarea Plan.

COMMUNICATIONS - NONE

ADJOURNMENT

There being no further business, the meeting was adjourned at 9:40 p.m.

Attest:

____
Planning Commission Chair

____
City Clerk's Office

Appendix C

FEMA Flood Mapping

PRELIMINARY

BASIN HYDROLOGY REPORT

City of Port Townsend
BASIN 4-A & 4B

100-Year Flood Plain Analysis
49th Street Corridor Southwesterly to Winona Wetlands

Prepared by

Polaris Engineering & Surveying, Inc.
206 S. Lincoln, Suite 201
Port Angeles, Washington 98362
(206) 452-5393

February 15, 1994

Michael S. Szatlocky, PE

MICHAEL STEPHEN SZATLOCKY
STATE OF WASHINGTON
0028309
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 9/27/94

SCOPE

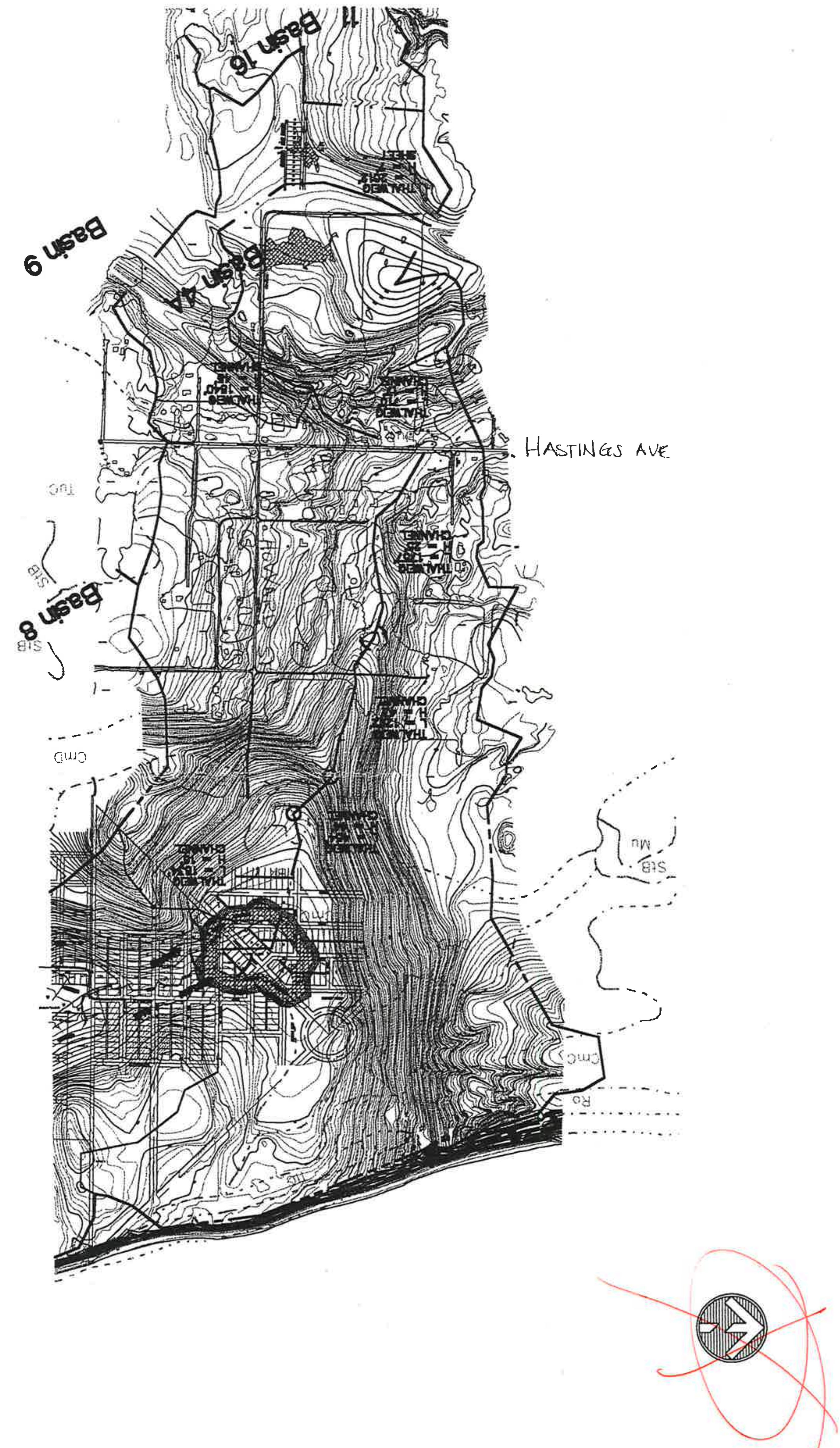
This report will examine the relationships between the level of development and the peak runoff rate and its effects on the 100-year flood plain. The data produces will be used along with other data as the basis for determining a stormwater policy for the City of Port Townsend. There are many other complex issues such as erosion control, the quality of runoff water, and protection of wetlands and wetland corridors which will not be in other studies.

BACKGROUND

Basin 4 drains to the Chinese Gardens and thence to the Strait of Juan de Fuca. It is comprised of three sub-basins. Sub-basin 4A (Figure 1) is comprised of two smaller sub-basins designated as A1 which begins in the vicinity of the City water tank near Rainier Street (EES Basin 17) and drains into two in-series natural depressions and thence to Hastings Street; and sub-basin A2 which continues at Hastings Street and drains to the Winona Wetlands. Sub-basin 4B (Figure 2) is comprised of three sub-basins which encompass drainage from the Winona Wetlands to Cook street (sub-basin B1) to the Chinese Gardens through the 49th Street drainage corridor (sub-basin B3) and drainage from the County Fairgrounds to the 49th Street Corridor (sub-basin B2). Sub-basin 4C (Figure 3) drains from the hills around Fort Worden to the Chinese Gardens. The subject of this report is the development of the 100-year flood plain from the Winona Wetlands through the 49th Street corridor to the Chinese Gardens. Only sub-basins 4A and 4B will be analyzed in this report.

ISSUES

Sub-basins 4A and 4B are comprised of hilly terrain of moderate to steep slopes, heavy tree and brush cover, soils with relatively high runoff potential (Soil Conservation Service runoff curve numbers 75-90), and valleys of low slope which contain bodies of standing water. At present, the majority of sub-basins 4A and 4B are not developed. Most of the sub-basins have been subdivided into approximately 5,000 square foot lots in plats characterized by average size blocks connected by long straight rights-of-way which cut across contour lines. The street patterns act to convey runoff for developed streets directly from the hill top locations directly



TITLE: BASIN 4A

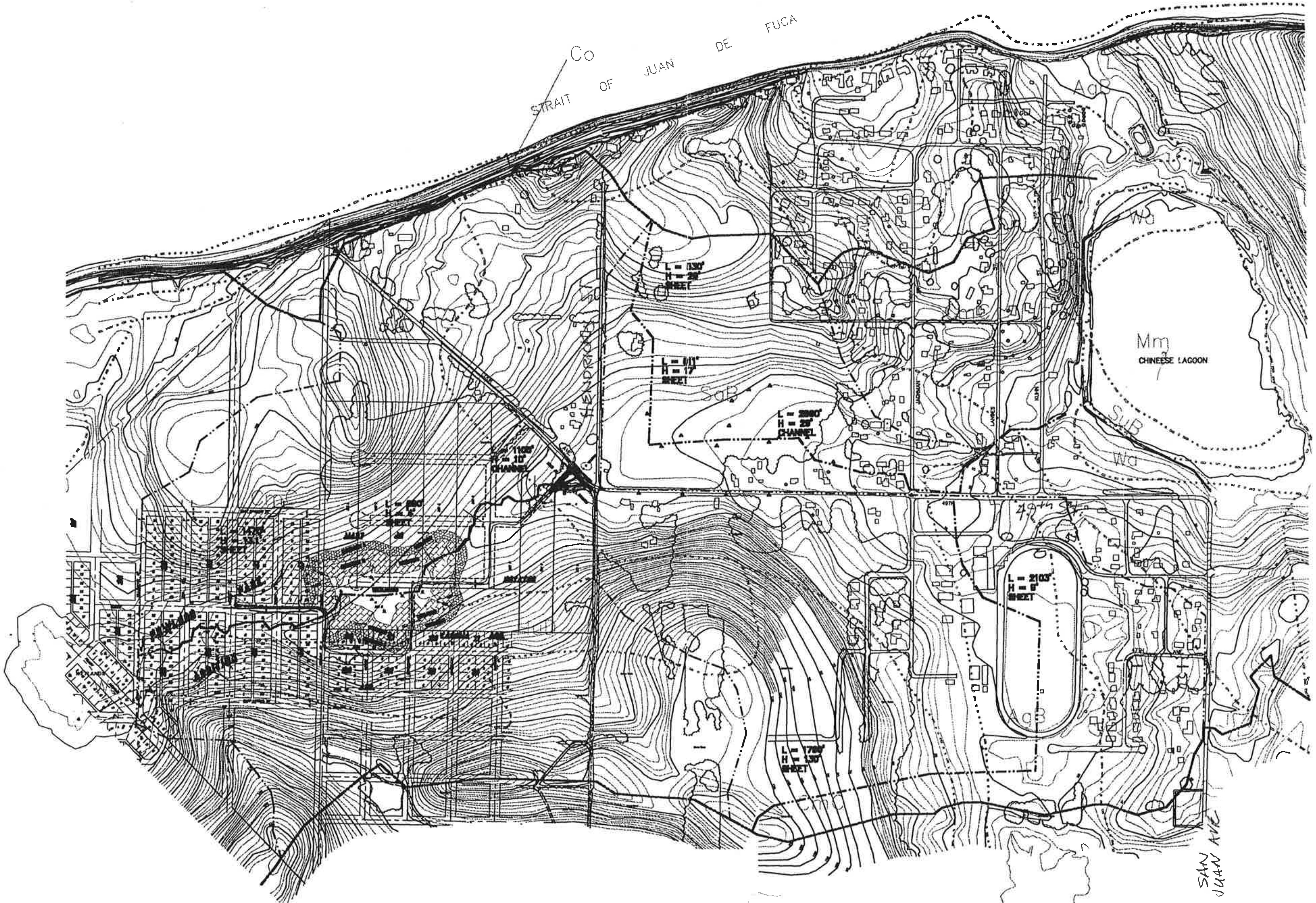
CLIENT: City of Port Towend
Jefferson County, Washington

Polaris
Polaris Engineering & Surveying, Inc.
206 S. Lincoln St. ☆Suite 201 ☆Port Angeles ☆Washington 98362 ☆(206) 452-5393

SCALE 1" = 1000'

JOB # 93088

SHEET 1 OF 1



TITLE: BASIN 4B

CLIENT: City of Port Townsend
Jefferson County, Washington

Polaris
Polaris Engineering & Surveying, Inc.
206 S. Lincoln St. ☆ Suite 201 ☆ Port Angeles ☆ Washington 98362 ☆ (206) 452-5393

SCALE 1" = 600'

JOB # 93088

SHEET 1 OF 1

TITLE: BASIN 4C

CLIENT: City of Port Townsend
Jefferson County, Washington

Polaris
Polaris Engineering & Surveying, Inc.
206 S. Lincoln St. Suite 201 Port Angeles Washington 98362 (206) 452-5393

SCALE 1" = 600'

JOB # 93088

SHEET 1 OF 1

to the valley floor. This pattern will decrease the time required for runoff to reach the sub-basin terminus and thence increase the peak runoff rate. The existing lot density, if fully developed, will increase the percentage of impervious surface which will again increase the peak runoff rate.

The degree of interconnection by roads can markedly change the time of concentration of the basins. Policies ranging from complete onsite detention of runoff or controlled release based on parcel size through no controlled release and no runoff control must be evaluated to determine the degree of sensitivity. The results of the analysis should be used to influence policy decisions.

There are many negative impacts to water quality associated with increased development. The City of Port Townsend ~~has adopted~~ is preparing to adopt the Department of Ecology Stormwater Management Manual for the Puget Sound Basin (The Technical Manual) as its standard for the control of stormwater. The Technical Manual outlines both procedures and methods for controlling the quality of runoff water, limiting erosion, and protection of wetlands. The application of these measures is not within the scope of this report.

Among the measures that can be taken to control the rate of runoff are establishing maximum zoning density, use of alternate paving materials, modifications of subdivision design and/or drainage patterns, implementation of a storm water detention program, use of biofiltration ponds and swales, source control measures, and a host of others. To some degree all of these measures will have an impact on the quantity and quality of runoff. All of these issues will be addressed in the future in a proposed Drainage Basin Plan to be prepared by the City of Port Townsend.

METHODOLOGY

Palazzi

Drainage basin boundaries were from City base maps prepared by Polaris Engineering & Surveying, Inc. The base maps are a combination of data supplied by Economic Engineering Services, drainage surveys made by CH2M-Hill, wetland flagging provided by Lisa Polazi, and physical surveys including flood plain cross sections and wetlands surveys made by Polaris Engineering. A field reconnaissance was made to determine drainage patterns and drainage structure locations. Soils information from the Jefferson County Soil Investigation was also used. The combined information was edited and platted. The plats were evaluated for hydrologic parameters and the mapping was completed.

Hydrologic data was analyzed on the program Water Works, Release 2.6, dated 1993, prepared by Egenious Systems, Inc. Water Works utilizes a number of hydrologic routines which allow for three methods of hydrograph generation (Soil Conservation Service method, Santa Barbara Unit Hydrograph method, and the Triangular Method). The program also allows the routing of programs through detention facilities, combination of hydrographs, and time shifting of hydrographs. The program also has a built-in time of concentration calculator which allows the time of concentration for up to five channel conditions to be evaluated for each hydrograph. The program uses widely adopted procedures for preparing hydrographs in urbanized areas such as those presented in SCS Technical Release No. 55.

The 100-year flood plain was evaluated using the U.S. Army Corps of Engineers program HEC-2, Version 4.6.2 dated May, 1991. The program utilizes a steady state analysis for flat sloping channels to establish 100-year flood elevations and channel velocities for input cross sections. The program generally uses a back step analysis from an initial section backwater elevation and proceeds in an upstream (up station) direction. Input data was prepared from the composite maps. Cross sections were taken at all major changes in channel alignment, near roads or culverts, major changes in grade, and in areas of encroachment. Channel stationing began at the Chinese Garden at section 0.00 (channel Sta 0+00) and ended at Willamett Street at section 66.67 (channel Sta 66+67). Calculations were run for the 1991 basis (baseline condition) as well as for conditions of 4 units/acre, 6 units/acre, and 8 units/acre for minimum Tc's (maximum runoff). The resulting 100-year flood plain elevations for the 8 unit/acre calculations (worst case flood) were overlaid on 100-year flood drawings.

HYDROLOGY

The existing sub-basins are mostly undeveloped. They are characterized by tree and brush covered slopes and flat lands which contain brush and wetlands or wetlands type soils. There are no outstanding drainage courses in the hill areas. Flows tend to be either sheet flow or shallow overland flows. The flat land generally ~~have~~ has minor channels with poorly defined banks. The flat land channel slope for the 6600 foot section from the Chinese Gardens to the Winona Wetlands is a generally uniform 1.00% with only minor local variations.

Soils in the sub-basins are typically SCS hydrologic group "C" which produce higher runoffs than average. Runoff curves used in hydrologic calculations are a function of hydrologic group and land use. Composite curve numbers were computed for the 1991 existing condition using an estimate of existing impervious area and hydrologic soil groups and cover complexes and the table "Runoff Curve Numbers - Type IA Storm Distribution Area" prepared by the U. S. Department of Agriculture, Soil Conservation Service in September, 1993 in lieu of Table III-1.3 of the Technical Manual - the SCS method being preferable since it is more conservative in the percentage of impervious area. Additional composite curves numbers were calculated for the conditions of 4 units/acre, 6 units/acre and 8 units/acre. pervious and impervious curve numbers and areas of coverage were entered as input into the hydrologic basin model.

Time of concentration has a significant effect on peak runoff. The pattern of runoff in the existing condition in characterized by sheet flow and shallow channel flow which tends to retard the time of concentration (Tc) and reduce peak flows. Allowed to develop in the existing plat pattern, the sub-basins will be hydraulically connected with long strait streets having lower friction values and steeper slopes than currently exists. This will decrease the Tc and increase the peak flow. Modifications in street design, the use of biofiltration swales and/or broad gravel swales, the use of site or area detention ponds, the use of gravel paving versus asphalt paving, and other measures can provide a mid-range Tc that will reduce the peak runoff rate somewhere between the existing state and that of maximum connection at buildout. The only way to achieve no increase in Tc in the buildout condition is to have individual site detention coupled with other area wide structural measures such as area or regional detention structures and alternative street design. Time of concentration is calculated by methods specified in Chapter III of the Technical Manual using conveyance constants listed in Table III.1.4. This method is utilized in the Water Works program and was used in the model formulation.

MODEL OPERATION

Hydrology: The five sub-basins are linked as shown in Figure 4. Sub-basin A1 has two in-line natural depressions that act as retention basins. Runoff from storms of low intensity (6-month and 2-year storms) do not generate sufficient runoff to fill

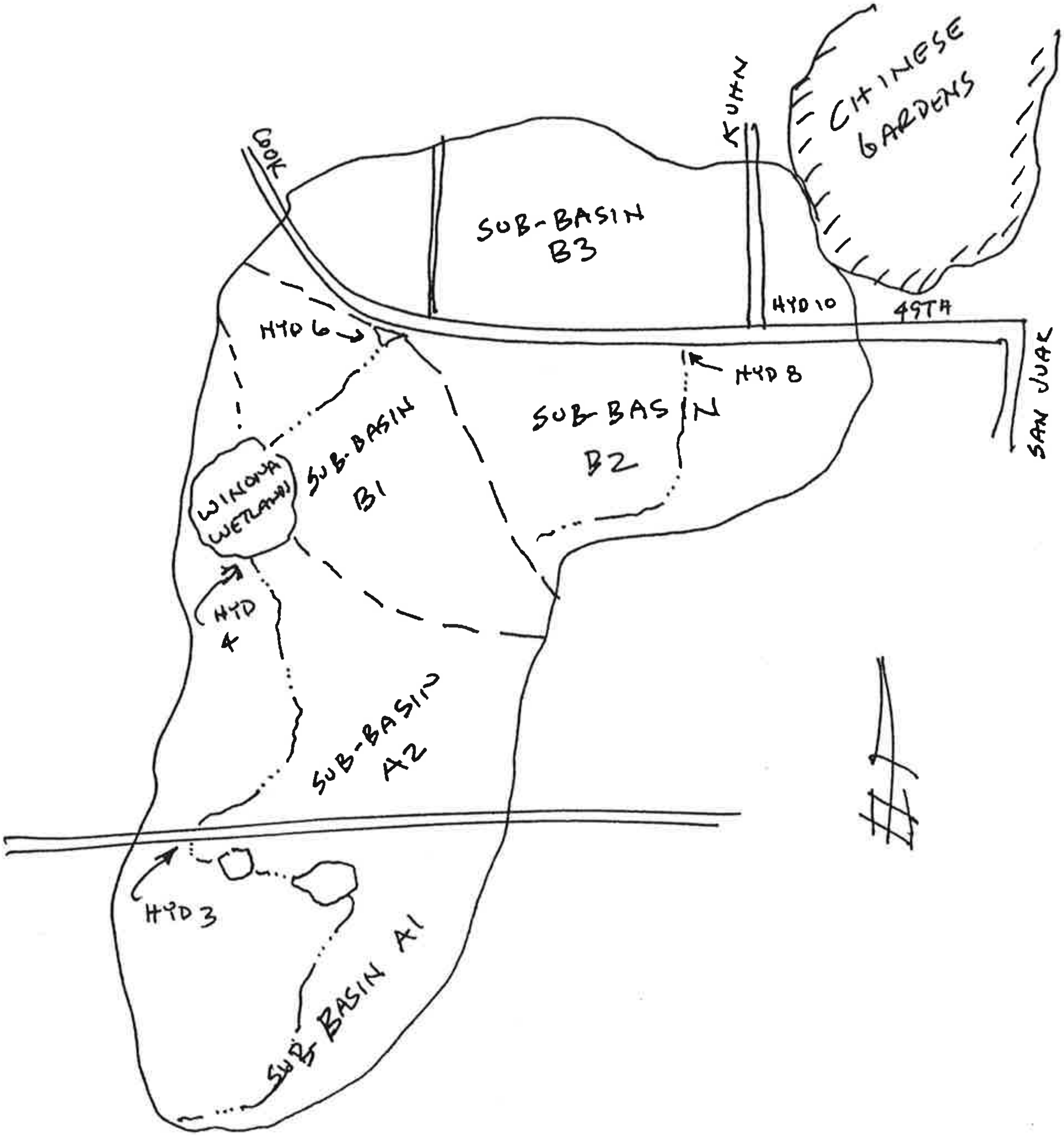
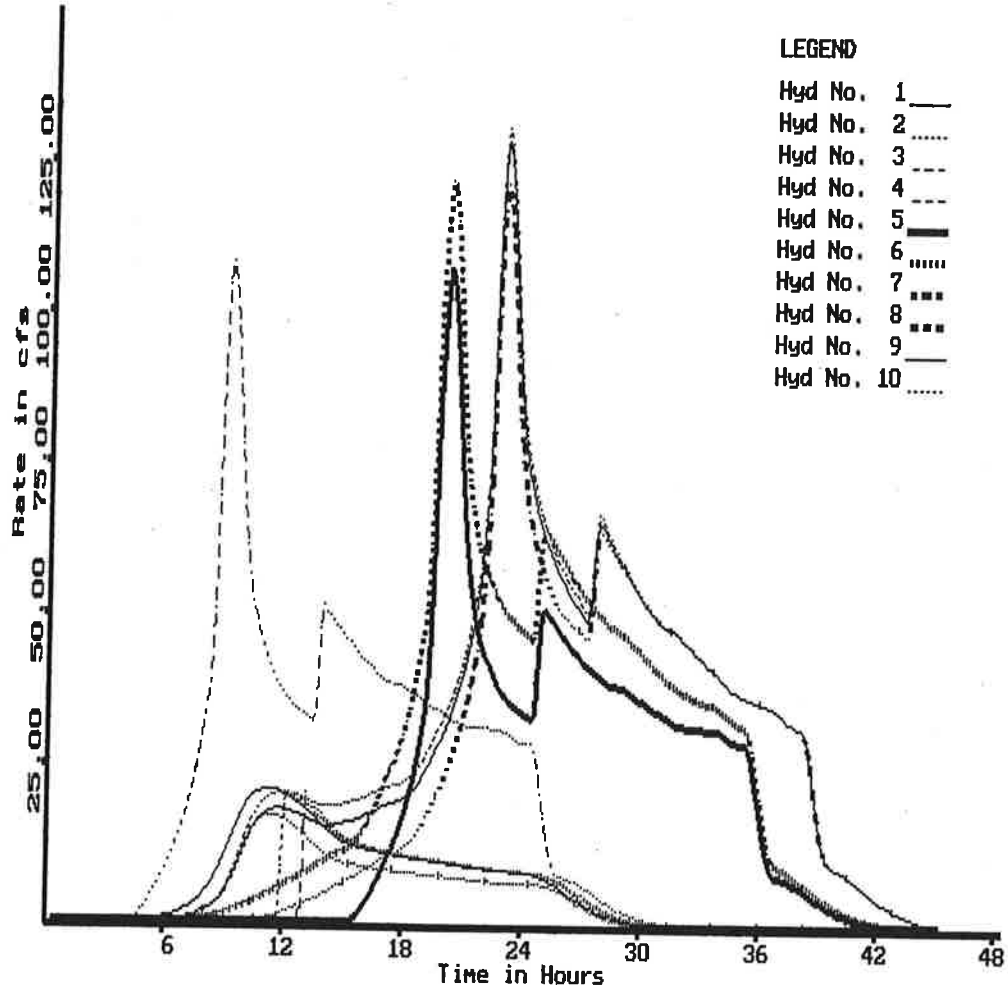


FIGURE 4: BASIN PLAN
H.T.S.

the basins. As a result, no runoff from this sub-basin is generated by low intensity storms. Sub-basin A2 flows accumulate at the Winona Wetlands. The wetlands has only minor storage capacity due to its shallow depth which is controlled by the level of Willamette Street. After allowing for a time shift, flows from sub-basin A1 are added to those of sub-basin A2. Sub-basin B1 which encompasses the area between the Winona Wetlands and Cook Avenue has a channel area largely composed of hydric soils with standing water. It was assumed that the actual channel area will not be developed since 62% is on City owned property and the remainder is in a 100-year flood plain. A time shift was applied to the flows from sub-basins A1 and A2 before they were added to the flow from sub-basin B1 at Cook Avenue. Sub-basin B3 reaches from the Chinese Gardens to Hendricks Street. Over half of the channel has developments in the flood fringe or within the flood plain. These encroachments have a significant effect on the 100-year flood plain. Sub-basin 4B encompasses the Jefferson County Fairgrounds and the hills to the west. After applying a time shift, the flow from sub-basin B2 and sub basins A1, A2 and B1 were added to the B3 flow. A representative hydrograph showing the combining and shifting of the individual hydrographs is shown on Figure 5. Note that the effect of the detention storage on the flow from sub-basin A1 (hydrographs 1 and 2) is clearly shown. No flow is seen from hydrograph 1 and 2 until the natural depressions are filled at around 12 to 14 hours into the storm event. One effect of the storage is to cause a second runoff peak in hydrograph 5 (flow from Hendricks to the Winona Wetlands) due to the delay caused by filling the natural depressions. This second peak is reflected in all subsequent hydrographs.

100-Year Flood Analysis: The flood plain analysis for the 8-unit/acre, Minimum Tc condition (worst case flood) was modeled on the U. S. Army Corps of Engineers program, HEC-2 - a nationally recognized flood plain routing program. Representative sections were input for the reach between the Chinese Garden and the Winona Wetlands. Sections are identified by channel station. Cross sections were prepared from data obtained by a ground survey. Typically, sections are defined by station (distance from the section end) and elevation at each station. Each cross section description defines the main channel and over bank areas as well as roughness coefficients for each segment of the channel. Channel interruptions such as weirs, culverts, buildings, etc., are treated by special subroutines input to the model. Roughness coefficients were selected from standard tables and visual aids presented in Open Channel Hydraulics by Dr. Ven Te Chow (McGraw Hill, 1959), Chapter 5 after a through site inspection. The model varies from the existing condition in that it includes future culverts at Hendricks and Landis Streets. The



2

Hyd No.: 1
Rate: 22.07 cfs Time: 11.00 hr
Vol : 19.59 Ac-ft Int: 10.00 min

Hyd No.: 2
Rate: 21.36 cfs Time: 12.00 hr
Vol : 14.51 Ac-ft Int: 10.00 min

Hyd No.: 3
Rate: 21.36 cfs Time: 12.83 hr
Vol : 13.11 Ac-ft Int: 10.00 min

Hyd No.: 4
Rate: 109.40 cfs Time: 8.83 hr
Vol : 65.95 Ac-ft Int: 10.00 min

Hyd No.: 5
Rate: 108.12 cfs Time: 19.67 hr
Vol : 65.95 Ac-ft Int: 10.00 min

Hyd No.: 6
Rate: 122.75 cfs Time: 19.67 hr
Vol : 87.75 Ac-ft Int: 10.00 min

Hyd No.: 7
Rate: 122.46 cfs Time: 22.50 hr
Vol : 87.75 Ac-ft Int: 10.00 min

Hyd No.: 8
Rate: 17.62 cfs Time: 11.17 hr
Vol : 14.32 Ac-ft Int: 10.00 min

Hyd No.: 9
Rate: 129.17 cfs Time: 22.50 hr
Vol : 102.07 Ac-ft Int: 10.00 min

Hyd No.: 10
Rate: 131.45 cfs Time: 22.50 hr
Vol : 105.85 Ac-ft Int: 10.00 min

FIGURE 5

culverts are designed to convey minor flows and have no significant impact on the 100-year flood level.

STUDY RESULTS

As anticipated, there were differences in runoff due to both the change in impervious coverage and the inter-connection due to street construction. The following table shows the effect of interconnection on the time of concentration (Tc) for the five sub-basins given the 1991 base condition, a maximum inter-connection, and a mid-range inter-connection.

TABLE 1: Interconnection vs. Tc

Sub-Basin Description	Composite Channel Length	Elevation Change	Time of Concentration		
			1991 Base	Average	Minimum
A1 - South of Hastings	4562	69	932	547	214
A2 - Hastings to Winona	5137	128	188	60	47
B1 - Winona to Cook Ave.	3465	27	896	896	656
B2 - County Fairgrounds	3863	139	274	163	163
B3 - Cook Ave. to Chinese L.	4201	75	346	246	298

Four hydrographic models were prepared (1991 basis, 4-units/acre, 6-units/acre, and 8-units/acre) which evaluated for three conditions (1991 Tc, Minimum Tc and Average Tc) for a 100-year event. Additional hydrographs were run on the four models for 6-month, 2-year, 10-year and 25-year storms for the Minimum Tc condition. The following tables show the results for the 100-year storm models at selected points of concentration in the watershed.

TABLE 2: 1991 Base Flows, Minimum Tc

Hydrograph No.	Hydrograph Description	Peak Runoff (cfs)
		1991 Base Condition
3	Sub-basin A1	8.3
4	Combined Flow @ Winona Wetlands	40.1
6	Combined Flow @ Cook Avenue	48.1
8	Fairgrounds @ 49th Street	11.4
10	Combined Flow @ Kuhn Street	55.4

Hydrograph 3 shows the peak release rate for Sub-basin A1 at Hastings Avenue after runoff has been routed through two in-line natural depressions. Figure 5 shows that the peak flow somewhat coincides with the first overflow from the depression basins. Hydrograph 8 shows the runoff from Sub-Basin B2 at the fairgrounds. The remaining hydrographs show combined routing at Winona Wetlands, Cook Avenue and Kuhn Street.

TABLE 3: 100-Year, Existing Tc

Hydro-graph No.	Hydrograph Description	Developed Peak Runoff (cfs)		
		4 Units	6 Units	8 Units
3	Sub-basin A1	11.3	12.0	14.6
4	Combined Flow @ Winona Wetlands	62.9	68.1	87.5
6	Combined Flow @ Cook Avenue	75.6	81.6	104.3
8	Fairgrounds @ 49th Street	13.9	15.4	16.7
10	Combined Flow @ Kuhn Street	77.7	84.0	104.3

TABLE 4: 100-Year, Average Tc

Hydro-graph No.	Hydrograph Description	Peak Runoff (cfs)		
		4 Units	6 Units	8 Units
3	Sub-basin A1	14.3	15.3	19.2
4	Combined Flow @ Winona Wetlands	99.6	108.0	137.8
6	Combined Flow @ Cook Avenue	111.6	121.1	153.4
8	Fairgrounds @ 49th Street	17.6	19.5	21.2
10	Combined Flow @ Kuhn Street	115.5	125.1	153.4

TABLE 5: 100-Year, Minimum Tc

Hydro-graph No.	Hydrograph Description	Peak Runoff (cfs)		
		4 Units	6 Units	8 Units
3	Sub-basin A1	20.5	22.6	30.7
4	Combined Flow @ Winona Wetlands	109.4	118.6	151.6
6	Combined Flow @ Cook Avenue	122.8	133.2	171.4
8	Fairgrounds @ 49th Street	17.6	19.5	21.2
10	Combined Flow @ Kuhn Street	131.4	142.3	174.4

All of the development hydrographs show increases in runoff between the 1991 base condition. The respective percentage increase at Kuhn Street for the 4-Unit, 6-Unit and 8-Unit developments at the 1991 Tc are 40%, 52% and 88%. The maximum runoff peak occurs at the Minimum Tc where the respective increases are 137%, 157% and 215%. The respective increases for the Average Tc are 108%, 126% and 177%.

The results of the 100-Year flood plain analysis are platted on the following 2-page Figure. Again, the flood plain shows the 8-Unit/acre, Minimum Tc condition which is considered the worst case scenario.

DISCUSSION

The 100-year flood plain shown on the adjacent plats, with the exception of the addition of two culverts, does not allow for channel encroachments or improvements. Encroachments in areas of higher channel velocity will cause the flood level to increase. Encroachments in areas of minimal channel velocity can be tolerated where there is no calculated decrease in channel conveyance. The determination of non-

Computed Water Surface Elevation
Basin 4 A & B – 100 Year Flood Plain Data

Section Station	8 Unit/Acre Min. Tc
0.00	3.00
0.50	3.08
0.80	3.33
1.60	8.44
1.80	8.48
3.00	8.61
3.75	8.02
3.95	9.02
4.55	11.73
5.35	11.72
5.63	11.67
8.63	11.65
11.13	12.80
11.75	14.51
12.15	16.84
12.60	16.84
13.10	16.84
14.65	18.80
15.85	19.41
17.00	19.51
17.80	20.64
18.65	22.10
20.70	23.03
21.70	23.36
24.10	26.91
24.85	28.43
27.30	29.20
31.80	29.55
34.20	32.70
34.85	32.88
36.25	32.89
35.65	36.01
36.10	35.01
38.32	35.29
34.82	42.84
44.02	44.80
47.37	45.70
48.07	45.95
50.97	46.02
54.47	47.27
57.27	50.11
61.77	55.18
66.67	60.43

SCALE: 1" = 100'
0 50 100 150 200 250

LEGEND

BLOCK BOUNDARY
LOT LINE
CONTOUR LINE
ROAD
TREE LINE
EXIST. BUILDING
CULVERT
HEC-2 X-SECTION
100-YEAR FLOOD PLAIN

ENGINEER'S NOTE

THIS MAP WAS PREPARED UTILIZING FLOWS GENERATED BY THE PROGRAM "WATER WORKS" AND IS BASED UPON THE FOLLOWING ASSUMPTIONS:

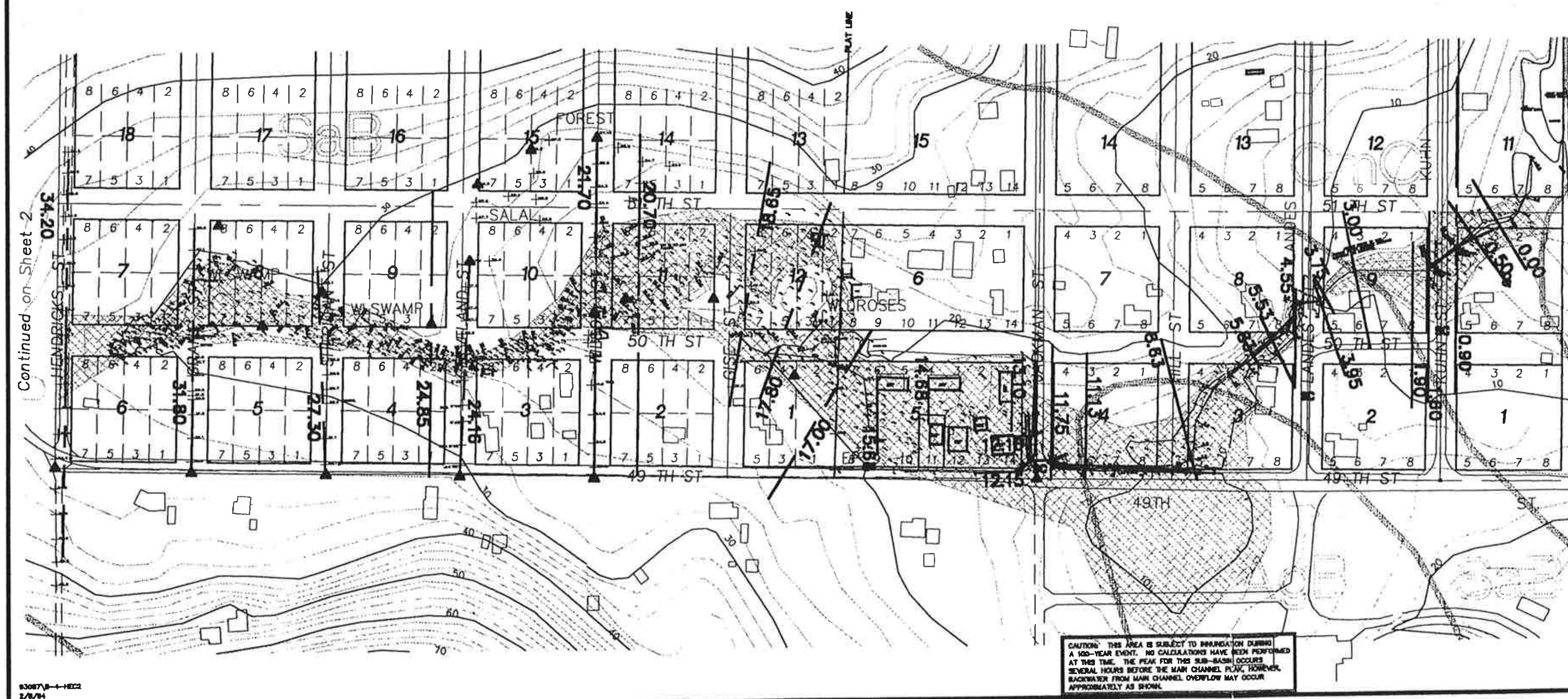
1. BUILD-OUT DENSITIES OF 4, 6 & 8 UNITS PER ACRE. THIS ASSUMES THAT EXISTING 5,000 S.F. LOTS MAY BE COMBINED INTO 10,000 S.F. OR 7,200 S.F. PARCELS.
2. NO ALLOWANCE WAS MADE FOR EXISTING OR PROPOSED ON-LINE OR OFF-LINE DETENTION FACILITIES.
3. ALLOWANCE WAS MADE FOR FUTURE CULVERTS AT LANDIS STREET AND HENDRICKS STREET. NO OTHER CULVERT ALLOWANCE WAS MADE.
4. STUDY AREA WAS BROKEN DOWN INTO FIVE SUB-BASINS. THIS INCLUDES THE 180 ACRE AREA SOUTH OF HASTINGS WHICH IS SHOWN AS BASIN 17 ON THE CITY OF PORT TOWNSEND DRAINAGE MAP PREPARED BY E.E.S.
5. TIME OF CONCENTRATION FOR THREE CONDITIONS WAS ANALYZED: A) EXISTING FLOW CONDITIONS (MAXIMUM Tc); B) MAXIMUM INTERCONNECTEDNESS WITH STREETS (MIN. Tc); AND C) AVERAGE CONNECTEDNESS WITH BIOFILTRATION SWALES, GRAVEL ROADS, ROUGHENED BROAD SWALES, AND LIMITED PROPERTY DETENTION (AVERAGE Tc).
6. RUNOFF PREDICTED BY MINIMUM Tc (MAXIMUM INTERCONNECTEDNESS) IS PLATTED AS THIS IS WORST CASE FOR DEVELOPMENT.

WATER WAS ROUTED UTILIZING THE U.S. ARMY CORPS OF ENGINEERS PROGRAM "HEC-2". CROSS SECTION LOCATIONS ARE SHOWN ON THE MAP BELOW. CALCULATED 100-YEAR FLOOD ELEVATIONS ARE SHOWN ON THE TABLE TO THE LEFT. CALCULATED 100-YEAR FLOOD LIMITS ARE SHOWN ON THE MAP BELOW. CALCULATED 100-YEAR FLOOD LIMITS ARE LIMITS ARE SUBJECT TO THE FOLLOWING INACCURACIES:

1. AVAILABLE TOPOGRAPHY INCLUDED 2-FOOT CONTOUR MAP MADE AVAILABLE BY THE CITY OF PORT TOWNSEND. MAP WAS ORIGINALLY PREPARED IN 1975. SUPPLEMENTARY 1 FOOT CONTOUR INTERVALS OF WETLANDS AND PORTIONS OF THE DRAINAGE CORRIDOR ALONG 49TH STREET WERE PREPARED BY POLARIS ENGINEERING & SURVEYING IN 1993. CROSS SECTION DATA SUPPLIED WAS NOT SUFFICIENT FOR THE PREPARATION OF EXACT CALCULATIONS. CROSS SECTIONS USED REPRESENT THE BEST EXTRAPOLATION FROM AVAILABLE DATA. PREPARED CROSS SECTIONS SHOULD NOT BE ASSUMED TO BE DEFINITIVE.
2. MINOR INACCURACIES WERE NOTED DURING THE HEC-2 CALCULATIONS. THE POST-CALCULATION DATA SET HAS NOT BEEN ANALYZED TO DETERMINE THE SIGNIFICANCE OF THE ERROR NOTICES. CHANGES IN FLOOD ELEVATIONS MAY OCCUR BASED ON THE POST-CALCULATION EVALUATION.
3. THE FLOOD PLAIN TO THE SOUTH OF 49TH STREET WAS NOT INCLUDED IN THE INITIAL EVALUATION. MODIFICATIONS TO THE FLOOD PLAIN WILL OCCUR ONCE THE SUB-BASIN IS INCLUDED IN THE ANALYSIS.

THE INTENT OF THIS MAP IS TO SHOW GENERALIZED 100-YEAR FLOOD PATTERNS IN THE 49TH STREET CORRIDOR BASED ON FULL UPSTREAM DEVELOPMENT. THE MAP SHOULD BE TREATED AS "PRELIMINARY" AND ONLY UTILIZED AS A QUALITATIVE MODEL. FURTHER REFINEMENT IN THE CALCULATION PROCEDURE COUPLED WITH ADDITIONAL TOPOGRAPHY AND A MORE DEFINITIVE BUILD-OUT SCENARIO WILL PRODUCE A MODEL WHICH CAN BE USED FOR FLOOD CONTROL AND LAND DEVELOPMENT ACTIVITIES. POLARIS ENGINEERING & SURVEYING, INC., MAKES NO WARRANTEE, EITHER STATED OR IMPLIED, REGARDING THE ACCURACY OF THE INFORMATION CONTAINED ON THIS MAP WHEN USED FOR FOR THE PURPOSES OF ENGINEERING OR LAND PLANNING. FOR QUESTIONS REGARDING THE APPLICABILITY OF THE CONTAINED DATA, PLEASE CONTACT POLARIS ENGINEERING AND SURVEYING, INC.

EXPIRES: 6/29/94



CAUTION: THIS AREA IS SUBJECT TO INUNDATION DURING A 100-YEAR EVENT. NO CALCULATIONS HAVE BEEN PERFORMED AT THIS TIME. THE PEAK FOR THIS SUB-BASIN OCCURS SEVERAL HOURS BEFORE THE MAIN CHANNEL PLAN, HOWEVER, BACKWATER FROM MAIN CHANNEL OVERFLOW MAY OCCUR APPROXIMATELY AS SHOWN.

93087\B-4-HEC2
2/8/94

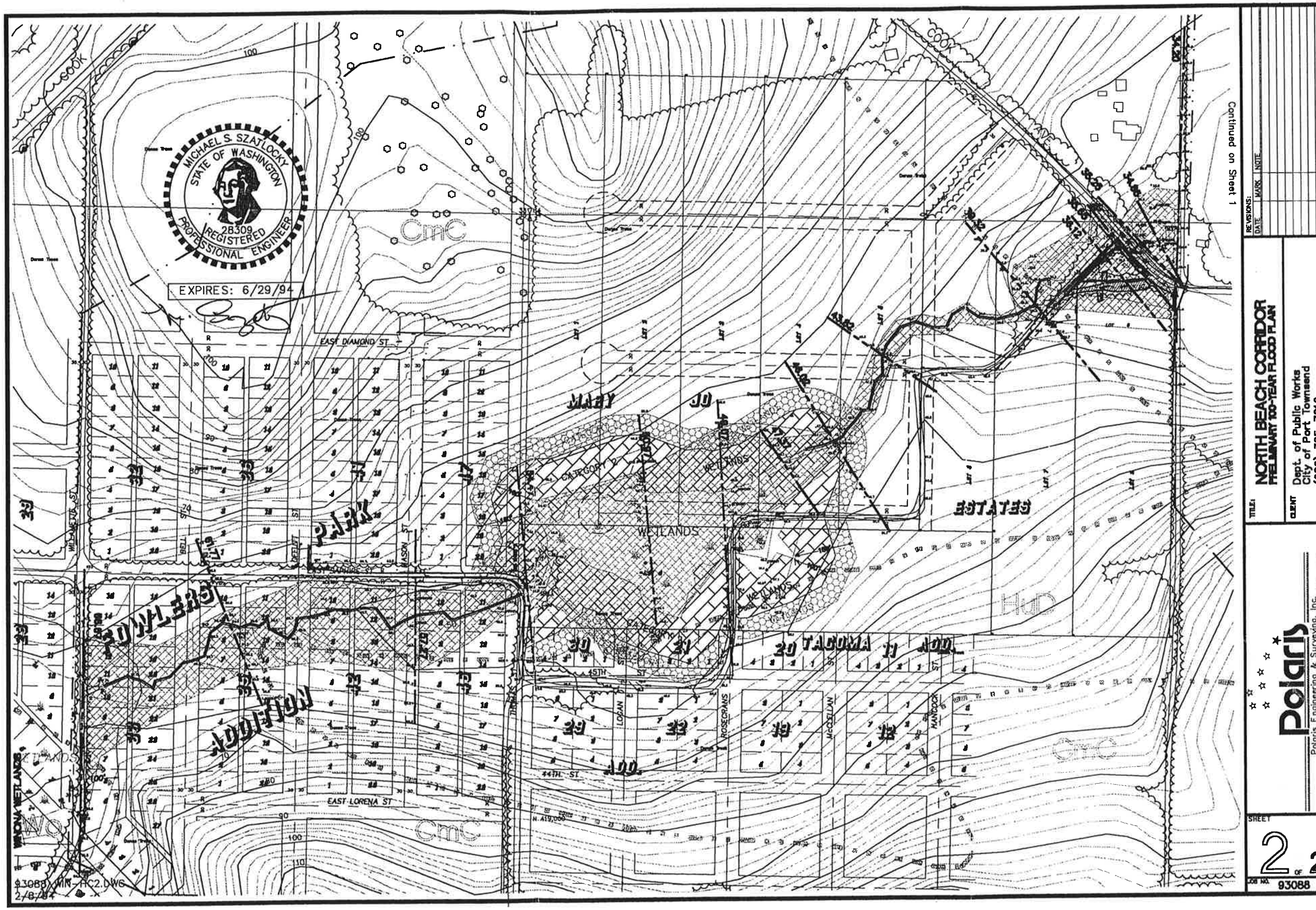
REVISIONS: DATE	MARK	NOTE
12/2/93		100 YR FLOOD PLAIN REVISED TO INCLUDE CONDITIONS OF 4 & 6 UNITS PER ACRE IN DEVELOPED CONDITION & 1991 BASIS
2/8/94		REVISED FOR 8 UNIT, MINIMUM Tc FLOOD

TITLE: NORTH BEACH CORRIDOR
PRELIMINARY 100-YEAR FLOOD PLAIN INFORMATION

CLIENT: CITY OF PORT TOWNSEND
DEPARTMENT OF PUBLIC WORKS
8210 KUHN STREET
PORT TOWNSEND WA 98368

Polaris
Polaris Engineering & Surveying, Inc.
206 S. Lincoln St. ☆Suite 201 ☆Port Angeles ☆Washington 98362 ☆(206) 452-5393

SHEET 1 OF 2
JOB NO. 93088



MICHAEL S. SZATLOCKY
STATE OF WASHINGTON
28309
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES: 6/29/94
EAST DIAMOND ST.
MARY JO
ESTATES
FOWLERS PARK
ADDITION
CATEGORY 2
WETLANDS
TACOMA ADD.
45TH ST
44TH ST.
EAST LORENA ST.
LOGAN
ROSECRANS
McCLELLAN
HANCOCK
CmC
HuD
Continued on Sheet 1
REVISIONS:
DATE MARK NOTE
TITLE: NORTH BEACH CORRIDOR
PRELIMINARY 100-YEAR FLOOD PLAN
CLIENT: Dept. of Public Works
City of Port Townsend
(206) 385-7212
Polaris
Polaris Engineering & Surveying, Inc.
SHEET 2 OF 2
JOB NO. 93088
93088\MN-FC2.DWG

significance for encroachments should be made only by the City Engineer. Improvements causing a significant increase in channel velocity should not be allowed so that erosion can be held to a minimum.

The above tables show significant increases in peak runoff even though there are no decreases in time of concentration for the developed condition. They also show a marked increase in runoff in all cases where the density is increased to 8 units per acre. Decreasing the Tc due to inter-connecting streets and paving also significantly increases peak runoff for the 100-year storms.

No attempt was made during the analysis to identify potential mitigation measures (Technical Manual Best Management Practices) required for water quality treatment, sedimentation/erosion control and wetlands protection. The Technical Manual does not contain requirements for mitigation of 100-year storms. The Technical Manual gives the City considerable latitude in the decision of BMP application for lesser frequency events in cases where a Basin Plan prepared by the City is on file with the Department of Ecology. The acceptability of the BMP's specified in each Basin Plan is based upon a careful analysis of the potential for environmental damage in the specific basin, the probability of effectiveness of each proposed BMP and to some extent, the economic impacts associated with the application of the BMP's.

Appendix D

Modeling Analysis

APPENDIX D MODELING ANALYSIS

The detailed modeling analysis is available at the Port Townsend City offices for review upon request.

Appendix E

Roadway Inventory

Road	From	To	Length	Roadway Width	Sidewalk Width	Gravel Path	Gravel Shoulder	Total	ROW Width	Curb		Curb Length	Swale		Swale Length	Grass		Concrete Ditch	
										Left	Right		Left	Right		Left	Right	Left	Right
Cook Ave.	Elmira St.	Peary Ave.	3,074	21				21	80										
Cook Ave.	Peary Ave.	Emerald St.	550	21				21	80					X	225				
Cook Ave.	Emerald St.	53rd St.	1,236	21				21	80										
53rd St.	Cook Ave.	49th St.	1,265	24				24	60										
49th St.	53rd St.	Hendricks St.	1,270	21				21	60										
49th St.	Hendricks St.	Wilson St.	1,115	21				21	30										
49th St.	Wilson St.	Erin St.	300	21				21	40										
49th St.	Erin St.	Jackman St.	480	22				22	60										
49th St.	Jackman St.	Pettygrove St.	1,000	28				28	60										
49th St.	Pettygrove St.	San Juan Ave.	800	23				23	50										
San Juan Ave.	49th St.	47th St.	455	25				25	50					X	227				
San Juan Ave.	47th St.	St. Mary Cemetery North	1,106	30	6			36	60					X	553				
San Juan Ave.	St. Mary Cemetery North	St. Mary Cemetery South	465	32	6			38	60		X	233							
San Juan Ave.	St. Mary Cemetery South	Center St.	700	44	10			54	85	X	X	700							
San Juan Ave.	Center St.	Cedar St.	162	32	10			44	85	X		81		X	81				
San Juan Ave.	Cedar St.	37th St.	335	33	5			38	100				X	X	335				
San Juan Ave.	37th St.	Tremont St.	208	43	5			48	100		X	104	X		104				
San Juan Ave.	Tremont St.	35th St.	247	32	5			37	100				X	X	247				
San Juan Ave.	35th St.	32nd St.	520	33	10			43	60	X	X	520							
San Juan Ave.	32nd St.	F St.	720	33	5			38	80		X	360	X		360				
San Juan Ave.	F St.	716' South of F St.	716	32	6			38					X	X	716				
San Juan Ave.	716' South of F St.	24th St.	890	32	6			38			X	445	X		445				
San Juan Ave.	24th St.	22nd St.	533	32	6			38					X	X	533				
San Juan Ave.	22nd St.	19th St.	820	32	6			38			X	410	X		410				
19th St.	Sheridan St.	Discovery Rd.	440	50	6			56	66	X	X	440							
19th St.	Discovery Rd.	San Juan Ave.	2,765	50				50	66	X	X	2765							
Blaine St.	San Juan Ave.	Walker St.	1,535	52	6			58	73	X	X	1535							
Discovery Rd.	City Limits	Spring St.	1,340	21				21	60										
Discovery Rd.	Spring St.	6th St.	675	21				21	80										
Discovery Rd.	6th St.	Howard St.	2,006	22		5		26	60										
Discovery Rd.	Howard St.	Rosecrans St.	2,330	23				23	60										
Discovery Rd.	Rosecrans St.	McClellan St.	300	23	6			29	60										
Discovery Rd.	McClellan St.	Grant St.	1,157	23	6			29	80				X		579				
Discovery Rd.	Grant St.	Sheridan St.	265	28	11			39	66	X		133							
Discovery Rd.	19th St.	20th St.	455	26	6			32	60				X		227				
Discovery Rd.	20th St.	166' SW of 22nd St.	665	26	6			32	60										
Discovery Rd.	166' SW of 22nd St.	24th St.	838	26	6			32	60				X		419				
Discovery Rd.	24th St.	Hastings Ave.	998	26	6			32	60				X	X	998				
Discovery Rd.	Hastings Ave.	San Juan Ave.	1,160	31	6			37	60	X	X	1160							
F St.	San Juan Ave.	Blaine St.	3,885	31	10			41	60	X	X	3385							
Walker St.	Lawrence St.	Garfield St.	507	35	5			40	73	X	X	507							
Walker St.	Garfield St.	Blaine St.	381	35	5			40	73	X		190		X	190				
Cherry St.	Blaine St.	A St.	794	26	8			34	73					X	397				
Cherry St.	A St.	E St.	1,031	25				25	60										
Cherry St.	E St.	F St.	268	29	6			35	60										
Cherry St.	F St.	W St. / Redwood St.	4,242	26				26	60										
W St.	Spruce St.	Redwood St.	775	22				22	60					X	388	X			
Walnut St.	W St.	Jackson St.	2,000	20				20	60										
Jackson St.	Bryan St.	Reed St.	332	22				22	60										
Jackson St.	Reed St.	Root St.	265	30				30	60		X	133	X		133				
Jackson St.	Root St.	Foster St.	253	30				30	60	X		126							X
Jackson St.	Foster St.	McKinley St.	256	30				30	60									X	X
Jackson St.	McKinley St.	Monroe St.	941	30				30	60	X		470							X
Monroe St.	Roosevelt St.	Blaine St.	395	31				31	73	X	X	395							
Monroe St.	Blaine St.	Lawrence St.	881	36	5			41	73	X	X	881							
Monroe St.	Lawrence St.	Clay St.	278	36	10			46	73	X	X	278							
Monroe St.	Clay St.	Jefferson St.	596	36	5			41	73	X	X	596							
Monroe St.	Jefferson St.	Washington St.	303	41	11			52	73	X	X	303							
Monroe St.	Washington St.	Water St.	282	47	20			67	73	X	X	282							
Blaine St.	Tyler St.	Taylor St.	284	29	6			35	73	X		142							
Blaine St.	Taylor St.	Adams St.	294	21	5			25	73							X		X	
Blaine St.	Adams St.	Monroe St.	879	22				22	73							X		X	
Hastings Ave.	City Limits	Ivy St.	685	21				21	60				X		343				
Hastings Ave.	Ivy St.	Howard St.	2,000	21				21	100										
Hastings Ave.	Howard St.	Eddy St.	255	22				22	108					X	128				
Hastings Ave.	Eddy St.	Cliff St.	261	21			7	28	108										
Hastings Ave.	Cliff St.	Thomas St.	800	21			5	26	108										
Hastings Ave.	Thomas St.	Sheridan St.	2,178	21			5	26	100				X		1089				
Hastings Ave.	Sheridan St.	Discovery Rd.	2,274	23	6			29	100				X		1137				
Umatilla Ave.	Sherman St.	31st St.	1,963	20				20	60										
Umatilla Ave.	31st St.	Holcomb St	430	20				20	60					X	215				
Umatilla Ave.	Holcomb St.	San Juan Ave.	1,947	20				20	60										
Rainier St.	SR 20	Discovery Rd.	1,960	41	19			60	60	X	X	1960							
McPherson St.	SR 20	6th St.	342	35	6			41	66		X	171							
McPherson St.	6th St.	7th St.	250	21	6			27	66										
McPherson St.	7th St.	Discovery Rd.	2,366	21				21	66										
Sheridan St.	SR 20	7th St.	775	40	6			46	66	X		387							
Sheridan St.	7th St.	8th St.	265	42	12			54	66	X	X	265							
Sheridan St.	8th St.	10th St.	536	49	12			61	66	X	X	536							
Sheridan St.	10th St.	136' North of 10th St.	136	48	6			54	66		X	68	X		68				
Sheridan St.	136' North of 10th St.	14th St.	934	44				44	66				X		197				
Sheridan St.	14th St.	15th St.	262	46				46	66	X	X	262							
Sheridan St.	15th St.	19th St.	1,064	47	12			59	66	X	X	1064							
Sheridan St.	19th St.	Hastings Ave.	2,340	22	5			27	66	X	X	265	X		1,520				
Kearney St.	Blaine St.	Lawrence St.	889	29	6			35	73	X	X	889							
Kearney St.	Lawrence St.	Franklin St.	614	29	6			35	73	X		307		X	307				
Kearney St.	Franklin St.	Jefferson St.	253	48	12			60	73	X	X	253							
Kearney St.	Jefferson St.	SR 20	136	36	12			48	73	X		68		X	68				
Lawrence St.	Kearney St.	Scott St.	576	48				48	73	X	X	576							
Lawrence St.	Scott St.	Walker St.	300	48	10			58	73	X	X	300							
Lawrence St.	Walker St.	Benton St.	875	36	5			41	73									X	
Lawrence St.	Benton St.	VanBuren St.	581	42	10			52	73									X	
Lawrence St.	VanBuren St.	Polk St.	884	50	19			69	73	X	X	884							
Lawrence St.	Polk St.	Taylor St.	585	55	18			73	73	X	X	585							
Lawrence St.	Taylor St.	Monroe St.	1,176	48	10			58	73	X	X	1176							
14th Street	McPherson Street		4,290	19				19	66										
SR 20	City Limits	Spring St.	910	38				38	77										
SR 20	Spring St.	Winery Driveway	937	38				38	100	X	X	937							
SR 20	Winery Driveway	Rainier St.	536	48	6			54	100	X	X	536							
SR 20	Rainier St.	Thomas St.	1,512	44	12			56	100	X	X	1512							
SR 20	Thomas St.	Logan St.	250	39	12			51	100	X	X	250							
SR 20	Logan St.	Ravine	493	38				38	100				X	X	493				
SR 20	Ravine	Hancock St.	336	50				50	100	X	X	336							
SR 20	Hancock St.	Sherman St.	281	50				50	100	X	X	281							
SR 20	Sherman St.	Grant St.	554	55	12			67	100	X	X	554							
SR 20	Grant St.	Wilson St.	776	50				50	100	X	X	776							
SR 20	Wilson St.	10th St.	1,942	42				42	100	X		971							
SR 20	10th St.	Safeway Entrance	280	45				45	100		X	140							
SR 20	Safeway Entrance	Haines Place	381	73	6			79	100	X		190							
SR 20	Haines Place	12th St.	704	62				62	100										
SR 20	12th St.	Thayer St.	1,265	50	8			58	100										
SR 20	Thayer St.	Decatur St.	321	42	14			56	100										
SR 20	Decatur St.	Kearney St.	307	52	6			58	100		X	153							
SR 20	Kearney St.	Gaines St.	319	62	5			67	100	X	X	319							
SR 20	Gaines St.	Water/Walker	596	53	6			59	100	X	X	593							
SR 20	Water/Walker	VanBuren St.	1,362	39	6			45	73	X	X	1362							
SR 20	VanBuren St.	Ferry Terminal	345	51	12			63	73	X	X	345							
SR 20	Ferry Terminal	Polk St.	655	55	18			73	73	X	X	655							
SR 20	Polk St.	Monroe St.	1,760	49	24			73	73	X	X	1760							
Fir St.	B St.	F St.	1,040	31	5			36	60		X	520							
			109,062									**38,780**			**13,132**				
TOTALS		miles of road	20.656																
	feet of road with curbs on both sides and sidewalks		31,457																
		percent of total	28.8%																
bioretention or swale and conveyance	feet of road with <25' road and >60'rw and no sidewalks or curbs		38,986																
			35.7%																
bioretention	about 40' or less of pavement, at least 30 feet of unpaved rw, can have sidewalk, no curb		6,580																
			6.0%																
some treatment possible	about 50' or less pavement, at least 20 feet of unpaved rw, no curb		12,381																
			11.4%																
filter boxes	curb on both sides, at least 20 feet of extra rw		2277																
			2.09%																

Appendix F

Small-Site Stormwater Management Guide

- If the soil is smooth but not sticky, then it is likely a silty soil and moderate to poor-draining.
- If the soil is dry, add water a few drops at a time, break down the chunks to work the water into soil, and then perform the soil texture test.

Record your observations. These observations will help determine how the rain garden is constructed in the next section, 2-BUILD.

3. DETERMINE PONDING DEPTH
Next, decide on the maximum depth that water will pond in your rain garden (6 or 12 inches is recommended). Typically, a rain garden designed with a ponding depth of 12 inches will hold and manage more water from your drainage areas, particularly on poor soils. However, just as important is your preference for how the rain garden looks in your landscape. For example, you may wish to have a 12-inch depth, even if 6 inches is all you need for stormwater storage.

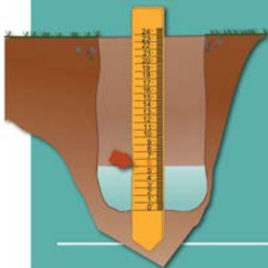
4. FILL THE HOLE WITH WATER AND OBSERVE DRAINAGE RATE
Finally, fill the hole with 6 or 12 inches of water, depending on the maximum depth of ponding decided in Step 3. Secure a yard stick or a self-made gauge in the hole for measuring the drainage rate. The self-made gauge can be a board or pipe with markings every half inch from the bottom.

Time how long it takes for the water to drain out completely. By the way, this can take awhile, so start in the morning. If there is still water in the hole after a day, it's OK to record how many inches have gone down since you started the test. Divide total inches by total hours to calculate the soil drainage rate.

How to Determine the Soil Drainage Rate

Divide Total Inches by Total Hours

Calculate the soil drainage rate by observing how long it takes water to drain in your test hole, then divide the total inches by the total hours.



EXAMPLE #1

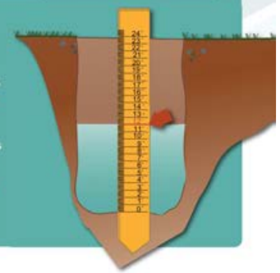
Fill the hole with 6 inches of water.

- If the water drains from the hole in 12 hours, the drainage or infiltration rate is:
  - 6 inches divided by 12 hours = 0.5 inches per hour.
  - Record the drainage rate for later comparison to the rates shown in the Rain Garden Sizing Chart (see page 21).

EXAMPLE #2

Fill the hole with 12 inches of water.

- If the water drains from the hole in 40 hours, the drainage or infiltration rate is:
  - 12 inches divided by 40 hours = 0.3 inches per hour.
  - Record the drainage rate for later comparison to the rates shown in the Rain Garden Sizing Chart (see page 21).



City of Port Townsend

A Guide to Residential Rainwater Management

How to Get Started

Tools and Materials Checklist

- ☐ DRAWING PAPER *(Grid Paper Suggested)*
- ☐ PEN OR PENCIL
- ☐ CALCULATOR
- ☐ MAP *(of Yard/Site Where Rain Garden Will Be Placed with Existing Utilities and Other Features to Avoid; Can Be Your Own Quick Map of the Area)*
- ☐ MEASURING TAPE
- ☐ WATER SOURCE *(for Soil Drainage Test)*
- ☐ YARDSTICK OR SELF-MADE GAUGE *(2" x 4" Board or Pipe with Half Inch Marks)*
- ☐ SHOVELS *(for Soil Drainage Test)*
- ☐ DIGGING BAR
- ☐ POST HOLE DIGGER

To start planning your rain garden, gather the tools and materials listed on this page and follow the guidance in this section of the handbook.

CONSIDER LOCAL AND STATE REQUIREMENTS

Port Townsend local requirements to be inserted here

Port Townsend local requirements to be inserted here

Local and State Requirements Alert

This box reminds you to check local and state requirements, including Department of Ecology Stormwater Minimum Requirements, that may apply to your project.

Adapted from the Rain Garden Handbook for Western Washington, A Guide for Design, Maintenance, and Installation (Washington State Department of Ecology and Washington State University Extension, June 2013)

Local and State Requirements Alert

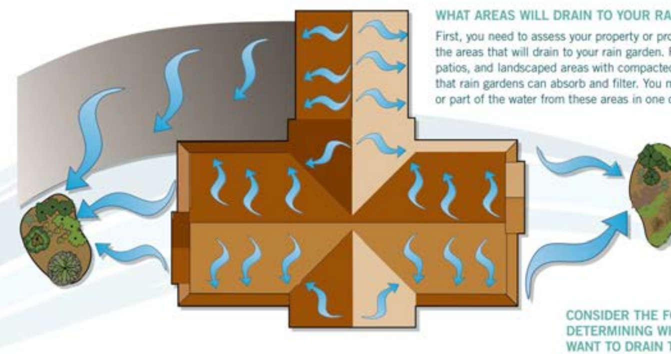
The Washington State Department of Ecology calls for more stringent soil testing for new development and redevelopment projects required to meet Minimum Requirements 1-5. Ecology's soil testing procedure is discussed in Appendix C with full details in the 2012 Stormwater Management Manual for Western Washington. Consult with your local municipality for specific soil drainage testing procedures they may require.

REPEAT TEST THREE TIMES DURING THE DRY SEASON
If it's the wet season (December through April), do this soil drainage test once. If you must test during the dry season, do the test three times (with each test performed immediately after completion of the last). Use the third test as your drainage rate (measured in inches per hour). Testing three times during the dry season provides a better estimate of wetter conditions present in the winter when the rain garden is doing the most work. Testing in the dry season is not recommended, but sometimes may be unavoidable.

The soil drainage test is important for determining the size of the rain garden, but the test also helps you make the following important decisions:

- If the drainage rate is less than 0.25 inches per hour, but more than 0.1 inches per hour, the location may be OK for the rain garden. However, keep in mind that standing water may be present for extended periods during the wettest months (December through April).
- If the drainage rate is less than 0.1 inches per hour, consider a different location for your rain garden.

Check Site Drainage



WHAT AREAS WILL DRAIN TO YOUR RAIN GARDEN?
First, you need to assess your property or project site to determine the areas that will drain to your rain garden. Roof tops, driveways, patios, and landscaped areas with compacted soils produce runoff that rain gardens can absorb and filter. You may want to capture all or part of the water from these areas in one or more rain gardens.

CONSIDER THE FOLLOWING WHEN DETERMINING WHAT AREAS YOU WANT TO DRAIN TO THE RAIN GARDEN

- Water can be delivered to the rain garden across a landscaped area, through an open swale lined with plants and decorative rock, or through an underground pipe (such as from a roof downspout).
- Rain gardens can be placed in more than one location. For example, you can direct water from one part of the roof to a rain garden in the back yard and water from another part of the roof to a rain garden in the front yard.

Check for Seeps and Springs

In the winter, observe the areas that will be draining to your rain garden and check for seeps and springs and other sources of water that may be coming from around your site and adjacent properties. Be sure to include all areas draining to your rain garden in your calculations.

Where to Locate a Rain Garden

DO LOCATE YOUR RAIN GARDEN WHERE:

- It improves the appearance of your home. Rain gardens can provide attractive visual buffers from roads or neighboring homes.
- You have enough space (see guidance for sizing your rain garden on page 18) and in a place that will not be used for other purposes in the future (such as a reserve drainfield area).
- The overflow can direct water safely away from the home and neighboring property.
- Water flows to the garden by gravity.

Be sure to check local city or county requirements that may apply to your rain garden project, including the need for any permits or approvals.

GUIDANCE FOR LOCATING RAIN GARDENS NEAR OR ON SLOPES

If you want to place your rain garden near or on a slope greater than 10%, have a qualified geotechnical engineer evaluate the site for potential problems. Collecting and allowing water to soak into steep slopes can cause instability and possibly landslides.

CALCULATING SLOPE

Slope is typically described in degrees or percent. When using percent, calculate the rise (vertical distance) divided by the run (horizontal distance) and multiply by 100.

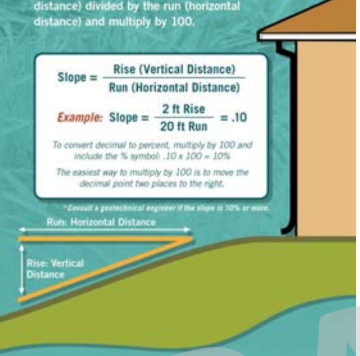
$$\text{Slope} = \frac{\text{Rise (Vertical Distance)}}{\text{Run (Horizontal Distance)}}$$

Example: $$\text{Slope} = \frac{\text{2 ft Rise}}{\text{20 ft Run}} = .10$$

To convert decimal to percent, multiply by 100 and include the % symbol: .10 x 100 = 10%

The easiest way to multiply by 100 is to move the decimal point two places to the right.

**Consult a geotechnical engineer if the slope is 10% or more.*



Where NOT to Locate a Rain Garden

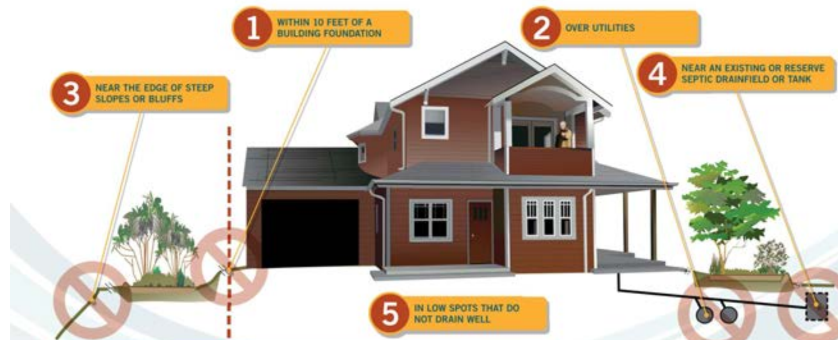
DON'T LOCATE YOUR RAIN GARDEN:

1. Within 10 feet of a building foundation—to avoid water getting into basements and crawl spaces.
2. Over utilities—to prevent extra expense and hazardous conditions, make sure to have all utilities located and marked before digging. Utility companies typically locate and mark power, gas, phone, water, and other lines and facilities. Contact utility locate services by calling 811.
3. Near the edge of steep slopes or bluffs—the additional water soaking into the ground on steep slopes can cause landslides or unwanted settling. In general, slopes should be less than 10% for a conventional rain garden. If the rain garden is within 50 feet of a slope that is more than 10%, consult with a geotechnical engineer.
4. Near a septic tank, septic drainfield, or reserve drainfield area—generally, if uphill of a septic system, provide at least 50 feet and if downhill provide at least 10 feet between the rain garden and the existing or planned septic system. Consult your local health department for specific setback requirements.
5. In low spots that do not drain well—these areas may be helpful for naturally slowing and storing stormwater on your property, but poorly draining depressions will not support rain garden plants very well.
6. In areas that would require disturbing healthy native soils, trees, and other vegetation—these areas already do a good job of filtering and storing stormwater.
7. Where there is high groundwater during the winter—if groundwater rises to within one foot of the bottom (excavated soil surface) of your rain garden during the winter (highest level), you should consider another location. In areas of high groundwater, a rain garden will not drain or function properly.
8. Near wells—your rain garden must be set back a minimum of 100 feet from drinking water wells.

DIAL 811— Call Before You Dig!

Be sure to have all your utilities (gas, power, water, communications, etc.) located and marked as you plan where to build your rain garden and before digging to test for soil and groundwater conditions. In addition to the 811 service that primarily locates utilities in public rights-of-way, utility locate businesses can be retained to locate and mark public and private utilities. You also can contact the utility providers directly for more information. *Note: Utility locates expire after 45 days, and the property owner is responsible for calling 811 to have utilities re-marked after that.*

Where NOT to Locate a Rain Garden



Local and State Requirements Alert

If your rain garden project is used to control stormwater flow under Minimum Requirements 1-5 of the Washington State Department of Ecology Stormwater Management Manual for Western Washington, refer to Appendix C for location restrictions, discussed in part in the "infeasibility" criteria. These requirements apply to projects that create 2,000 to 5,000 square feet of new or replaced hard surfaces or that disturb between 7,000 and 33,000 or more square feet of land. Also, be sure to check with your local municipality to see if they have specific location and feasibility requirements.

6 IN AREAS THAT WOULD REQUIRE DISTURBING HEALTHY NATIVE SOILS AND VEGETATION

7 WHERE THERE IS HIGH GROUNDWATER DURING THE WINTER

8 NEAR WELLS—STAY BACK 100 FEET FROM DRINKING WATER WELLS

Test Your Soil

After finding a location for your rain garden, the next step is to test the soil in that location. You will be evaluating the texture (size of soil particles) and the soil drainage rate (the amount of time it takes water to soak into the ground). Understanding these characteristics will help you properly size your rain garden.

Be Sure to Check for High Groundwater

Avoid locating your rain garden in an area with high groundwater. Test the groundwater level during the rainy winter months, December through April. Late winter through March is the ideal time. To check for high groundwater, dig down 36 inches in a separate hole from where you plan to do your soil drainage test, but within 3 to 5 feet of that location. You can use a post hole digger for the groundwater test. Look into the hole. If you see water seeping in from the bottom or sides, find another location for your rain garden. If you don't see groundwater, go ahead and conduct your soil drainage test at a nearby spot.

***Left Photo:** Clay soil—feels sticky, smooth, and can be molded like modeling clay.*

***Right Photo:** Sandy soil—feels gritty and crumbles easy.*

Soil Texture

Soil texture is determined by the amount of sand, silt, and clay in the soil. The mix of these components affects how well the soil drains and how well it holds water and nutrients for plants to use.

THERE ARE FOUR STEPS TO COMPLETE THE SOIL DRAINAGE TEST

1. Dig Test Hole	3. Determine Desired Ponding Depth
2. Evaluate Soil Texture	4. Fill the Hole with Water and Observe Drainage Rate

1. DIG TEST HOLE

Dig a small hole about 2 feet deep and 1 to 2 feet in diameter. A bigger hole is OK if you have a backhoe or mini-excavator.

2. EVALUATE SOIL TEXTURE

As you dig, and before adding water to the hole to test drainage, evaluate the texture of the soil.

- If the soil is moist, put some in the palm of your hand and try to squeeze it into a ball.
- If the soil falls apart or can be broken up easily and is gritty feeling, this suggests a sandier, well-draining soil. If the soil is sticky, smooth, and forms a ball that can be worked like modeling clay, this suggests poor-draining soil with higher clay content.

Development Services Department
250 Madison Street, Suite 3
Port Townsend WA 98368
Phone: 360-379-5095
Fax: 360-344-4619
www.cityofpt.us

[DRAFT] Street & Utility Development Permit Application

MIP No.	SDP No.	BLD No.

Applicant:	**Phone:**
Mailing Address:	Fax:
City, State, Zip:	E-mail:
Property Owner's Name(s):	**Phone:**
Mailing Address:	
City, State, Zip:	E-mail:
Authorized Representative:	**Phone:**
Address:	E-mail:

Property Site Street (and address if assigned):

Zoning District: Parcel #:

Legal Description: Addition: Block: Lot(s):

Water/Sewer/Street Contractor			
Mailing Address:			
Phone:	Fax:	Cell Phone:	
State License #:	Expiration:	City Business Lic.#:	Expiration:
Estimated value of utility and/or street construction: $			

Describe work to be conducted under this permit and purpose:	
Describe earth work such as landscaping, clearing, grading:	
How many acre(s) will be disturbed?	~~Where will the overflow discharge?~~
Is Latecomer Proposed?	For what Utility?

Will trees or vegetation be removed in the right-of-way? o Yes o No If yes, Describe & show on site plan.

What is the amount of impervious surface on the property? ___________sq. ft. & _______% of the property.

I hereby certify that the information provided is correct, that I am either the owner or authorized to act on behalf of the owner and that all the activities associated with this permit will be in accordance with State Laws and the Port Townsend Municipal Code.

Signature of Owner or Authorized Representative ______________________ Date ______________________

Print Name:

Street & Utility Development Permit Application
Infrastructure

The application is not complete without all the items on this checklist complete.
(If not applicable, mark "N/A")

* All boxes filled in on the front of this application
* City of Port Townsend "Lot Coverage and Impervious Surfaces Worksheet for Applicants"
* Soil percolation test results, based on Port Townsend "Guide to Residential Rainwater Management"
* Vicinity Map
* Two sets of 8 ½ X 11 drawings showing work proposed under this permit. All dimensions must be shown - width, length, depth, etc. Include the following drawings:
  * Site Plan:
    * All lot lines, block number, and lot numbers
    * Lot dimensions
    * Slopes/Contours (existing and proposed)
    * Area (acres or square feet) and volume (cubic yards) of cut and fill
    * Outside dimensions of all buildings, including eaves
    * Dimensions of impervious (hard) surfaces (existing and proposed[1])
    * Edge of street travel way
    * Driveway from edge of travel way (dimensions & type of surface material)
    * Adjoining street names
    * All trees/vegetation proposed for removal in the right-of-way
    * Existing or proposed easements
    * Existing or proposed water and sewer mains
    * Proposed connections to existing utilities (sewer, water, power[2])
    * Profile of lots

1 If creating new impervious surfaces, provide square footage of total impervious and percentage of the property using the City of Port Townsend "Lot Coverage and Impervious Surfaces Worksheet for Applicants"

2 The Public Utility District #1 (PUD #1) provides Port Townsend electrical power; be sure to contact PUD #1 (385-5800) to develop plans for the electrical service connections for your property. Provide a site plan that clearly shows the power route to your project.

* Drainage Plan:

  * Have any known wetlands or their buffers been identified on the property?
    ¨ No o Yes (If yes, you may be required to include a wetland report)

  * Are there any steep slopes (greater than 15%) on the property?
    ¨ No o Yes (If yes, you may be required to include a geotechnical report)

  * North Arrow

  * Slopes/Contours (existing and proposed) and flow direction arrows

  * Dimensions of impervious (hard) surfaces (existing and proposed[1])

  * Location(s) where rainwater flows off of the property (existing and proposed)

  * Location(s) where rainwater discharges to the City street-side drainage system (catch basin inlet, swale, ditch, culvert/pipe, etc.)

  * Direction of flow of City street-side drainage system

  * Dimensions of the on-site stormwater facility (rain garden, dry-well, curtain drain, etc.)

  * Location where site flow will enter proposed on-site stormwater facility

  * Location where water will overflow from on-site stormwater facility and flow to City street-side drainage system in case of heavy rains

* Temporary Erosion and Sediment Control Plan:

  * North Arrow

  * Slopes/Contours (existing and proposed) and flow direction arrows

  * Location(s) where rainwater flows off of the property (existing and proposed)

  * Location(s) where rainwater discharges to the City street-side drainage system (catch basin inlet, swale, ditch, culvert/pipe, etc.)

  * Direction of flow of City street-side drainage system

  * Location(s) of temporary erosion and sediment control management features, based on the Port Townsend Engineering Design Standards Chapter 5.

* If extending water or sewer mains or constructing a new street, 3 sets of plans prepared by a licensed civil engineer must be submitted with this application.

* Did the applicant complete the process of a Technical Conference in the prior 12 months? If yes, a credit may be available for a portion of the SDP/MIP permit fee.

Development Services Department
250 Madison Street, Suite 3
Port Townsend WA 98368
Phone: 360-379-5095
Fax: 360-344-4619
www.cityofpt.us

Lot Coverage and Impervious Surfaces - Worksheets for Applicants

Lot Coverage and Impervious Surface Calculations are similar, but not the same. This worksheet is designed to help you clarify the difference and help you determine the correct numbers to use on our applications.

LOT COVERAGE = STRUCTURAL FOOTPRINTS

Lot coverage is defined as "the total ground coverage of all buildings or structures on a site measured from the outside of exterior walls or supporting members, including accessory buildings or structures, but **not** to include at-grade off-street parking lots, deck areas, terraces, swimming pools, pool deck areas, walkways, roadways or driveways" (Port Townsend Municipal Code 17.08.040).

Calculate the Total Lot Coverage of the Proposed Structures:

All building *footprints* (in square feet) including:

	Existing	Proposed	TOTAL
House			
Garage			
Covered Porch			
Accessory Dwelling Unit			
Deck over 30" Above Ground			
Shed			
Exterior Stairs			
Other:			

TOTAL Lot Coverage of structures: ______________________ square feet

Calculate the Lot Coverage Percentage:

Divide the Total Lot Coverage (above) ___________square feet
by the Square Footage of the Property:____________ square feet
And divide by 100 to equal the

TOTAL percentage of lot coverage: ________%.

IMPERVIOUS SURFACES = STRUCTURAL FOOTPRINTS PLUS IMPERVIOUS SURFACES.

Calculate the Total Impervious Surface of the Proposed Project:

House Roof area: _________________________ square feet

Garage Roof area: ________________________ square feet

Covered Porch Roof area: _______________________ square feet

Other Structure Roof area:_______________________ square feet

Decks and patios and other structures over 30” in Height that ***do not allow rainwater between the slats/surface*****:** _______________________ square feet

Driveway, Sidewalk & gravel/compacted areas: _________________ square feet

TOTAL Impervious Surface Area: _____________________ square feet

Calculate the Impervious Surface Percentage:

Divide the Total Impervious Surface Area (above) __________ square feet

By the Square Footage of the Property __________________ square feet

And divide by 100 to equal the

TOTAL percentage of impervious surface ________%.

“Impervious surfaces” means areas or surfaces that cannot be easily penetrated by rain or surface water runoff. These areas include structures and roof projections, impervious decks, roads, driveways, and surfaces which substantially reduce and alter the natural filtration characteristics of the soil.” *(Port Townsend Municipal Code 19.05.020)*

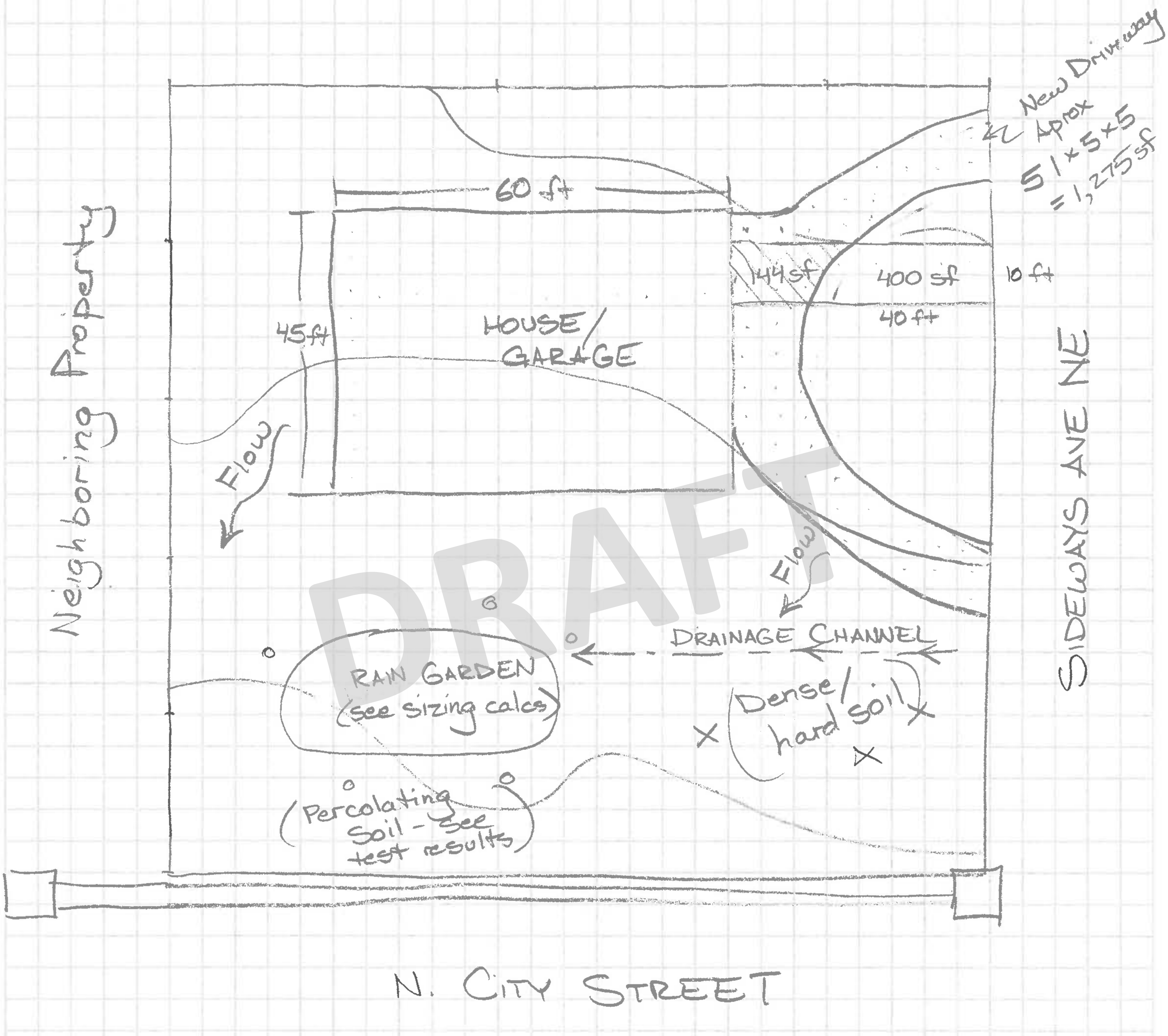
If your building proposal increases the area of impervious surfaces, it may result in stormwater impacts. Refer to the City’s Engineering Design Standards: www.cityofpt.us under “City Plans”. Stormwater methods can include infiltration trenches, dry wells, and rain gardens. Downspouts that flow into splash blocks can only be used for properties where there is a minimum of 50 feet of a vegetated path between the splash blocks and the edge of the property.

If the impervious surface is over 40%, an engineered stormwater drainage plan is required. You will need to retain a Civil Engineer to prepare and stamp drawings to be submitted with the public works permit. Drawings must include specifications of on-site stormwater methods.

If the impervious surface is under 40%, you may conduct your own perc test and submit an on-site stormwater drainage plan with your application for review and approval by city staff. Ask staff for the handout for guidance on conducting a perc test, or go online to www.cityofpt.us to the City’s Engineering Design Standards, Chapter 4 Section 5 *Drainage Plan, Contents and Standard Procedures for Medium Impact Projects*.

(EXAMPLE) **DRAINAGE SKETCH**

- ☐ Topography (steep slopes, flow direction)
- ☐ Vegetation (mature plants/trees, invasives)
- ☐ Sensitive Areas (wetlands, setbacks, tree roots)
- ☐ Soil (shovel test, hand texture, perc test)
- ☐ Water (direction over hard surfaces, standing water, natural springs)
- ☐ Off-site connections (flow to City street drain, neighbor's property)



50 FEET

Scale: 1 square = 5 ft x 5 ft

DRAINAGE SKETCH

- Topography (steep slopes, flow direction)
- Vegetation (mature plants/trees, invasives)
- Sensitive Areas (wetlands, setbacks, tree roots)
- Soil (shovel test, hand texture, perc test)
- Water (direction over hard surfaces, standing water, natural springs)
- Off-site connections (flow to City street drain, neighbor's property)

50 FEET

Scale: 1 square = 5 ft x 5 ft

Best Management Practices (BMPs) for small sites: *Manage future stormwater*

Save the Soil! Preserve and/or rebuild the top soil to a depth of 8 to 12 inches around your site . This will naturally retain and clean stormwater in addition to keeping your landscaping healthy and green. You can reduce your watering and won't need to add fertilizers. Consider using native plants as landscape. They are drought-resistant and provide food and shelter for local wildlife, particularly the birds.

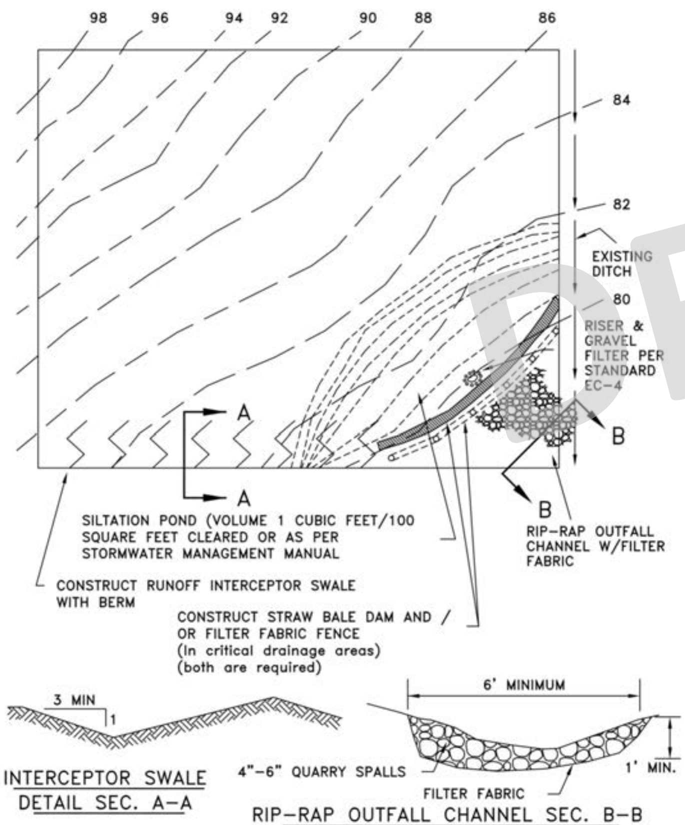


Figure 3 - Typical Temporary Erosion Control

City of Port Townsend

Pollution Prevention Plan for Small Parcel Development

What is it?

This is ***your plan*** to prevent pollution from leaving your construction site, no matter how small it is. It addresses:

- Specific conditions on your site
- Ways to prevent pollution during construction
- Drainage after construction

Why is it needed?

Construction activity and debris can cause problems when it rains. Small amounts of ***dirt and pollution*** from many sources add up to problems in sensitive areas. Muddy roads are a safety hazard to vehicles. Run-off from construction sites can cause erosion resulting in property damage.

Every place is different in its types of soils, slopes, vegetation and nearby senisitive areas. Each Pollution Prevention Plan should address the specific conditions of the proposed construction site.

Note that this document is a general guide. Legal requirements for stormwater pollution prevention and erosion control measures are set by the **Port Townsend Municipal Code Section 13.32.010** and described in the **Port Townsend Engineering Design Standards Chapter 5.**

How does it work?

- Stop slopes from eroding using straw, plastic or matting
- Keep stormwater on the site by infiltrating into the ground
- If not, slow down water moving off-site and filter it to remove dirt and pollutants using a silt fence or straw bales.

Best management practices, BMPs, are proven methods for stopping pollution. Non structural BMPs are as simple as ***leaving existing vegetation, picking up trash*** and other construction debris at the end of the day, ***sweeping streets,*** and maintaining equipment to ***prevent fluid leaks.***

Structural BMPs, such as ***silt fences, straw bales, and construction entrances***, are used to stop mud and muddy water from leaving the construction site. See the other side for more details...

Where are BMPs put?

Structural BMPs are placed ***down slope of the construction site and border sensitive areas.*** Even ditches should be protected from muddy run-off, especially on county and tribal maintained roads. Storm drains, on site or down slope of the site, must be protected from sediment and other debris.

Prepare your Plan to Prevent Pollution before you turn any dirt on your small construction site!

Tool box for Preventing Pollution

Preserve, pick-up and protect (Non Structural BMPs)

(1) Preserving existing trees , shrubs and grasses is a simple and low cost way

(2) Keep topsoil and re-vegetate bare areas (especially slopes) as soon as possible. Adding compost, mulch and topsoil (as thick as 8 inches) to your site before landscaping will keep your landscape plants and lawn healthy throughout the dry summer.

(3) Locate soil piles away from roads and watercourses (wetlands, ditches, streams, and bays). Cover your soil piles, with a tarp or plastic, if you don't plan on using them for 24 – 48 hours.

(4) Keep the site clean; pick up trash and debris often. When cleaning up sediment or mud, do not hose into ditches or storm drains.

Keep the dirt on site (Structural BMPs)

(1) Make a <u>construction entrance</u> for vehicles to prevent tracking mud on <u>paved streets</u>. The entrance must be at least 20 feet long by15 feet wide, lined with a geotextile fabric and have 6 inches of quarry spall or hog fuel placed on top.

(2) <u>Protect bare slopes from erosion using plastic or matting.</u>

Although slight slopes can be protected with straw or mulch (approx. 3 inches thick), use matting for steeper bare slopes to avoid erosion.

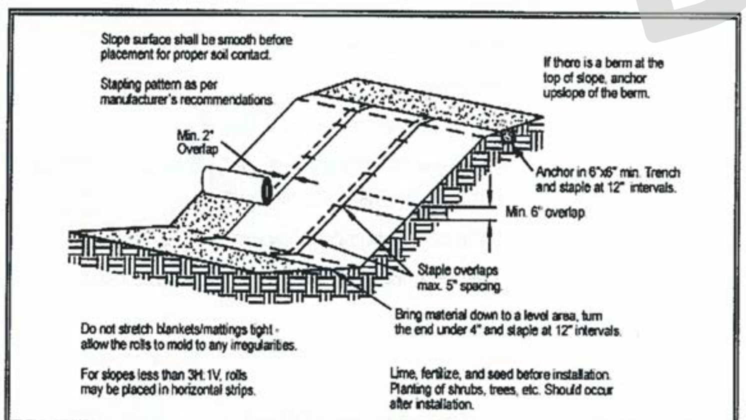


Figure 1 – Slope Installation

Plastic covering is the least expensive way to cover slopes, but it needs to be removed before replanting the slope.

Biodegradable matting doesn't need to be removed. Made from natural materials, it will gradually degrade over time as plants grow over it.

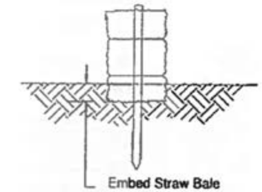
Best Management Practices (BMPs) for small sites

Keep the dirt on site (Structural BMPs) continued

(3) <u>Silt fencing or straw bales</u> will filter sediment if placed on the downslope side of the lot.

This is particularly important for protecting wetlands, streams and even roads. Muddy roads can cause accidents.

It is important to install silt fences and straw bale bariers correctly. Most people forget to bury the silt fence fabric in the ground or forget to stake the straw bales, See illustrations for the details.



Straw bales must be staked into the ground in order to be effective.

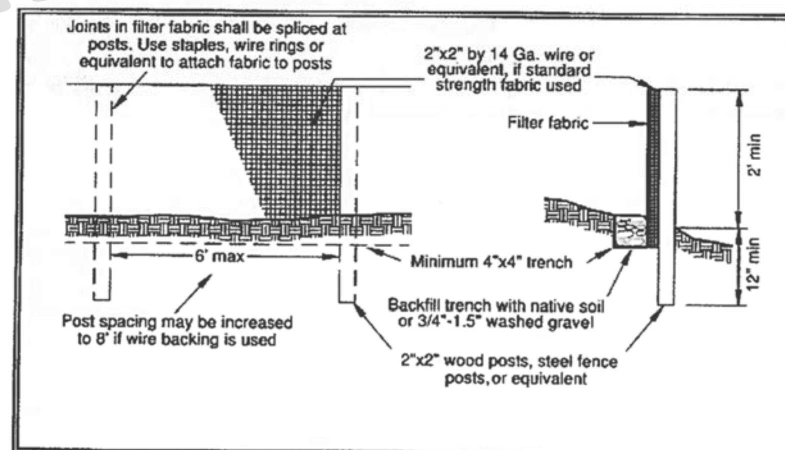


Figure 2 – Silt Fence

13.32 STORMWATER MANAGEMENT REQUIREMENTS

13.32.010 Minimum requirements for drainage improvements.

A. All developments shall comply with the Department of Ecology's February 2005 Stormwater Management Manual for Western Washington ("2005 SWMM-WW")~~, except f or the following: Section 2.6 – Optional guidance relating to financial liability and off-site analysis and mitigation, city engineering design standards, city stormwater master plan, and adopted drainage basin plans~~ for all clearing and grading activities, for erosion control during construction, and for permanent drainage system improvements~~.~~; except developments shall comply with the following City requirements, which supersede the 2005 SWMMWW:

1. Section 2.6 – Optional guidance relating to financial liability and off-site analysis and mitigation

2. Engineering Design Standards

3. Stormwater Master Plan, and

~~1.~~4. Adopted drainage basin plans

~~A.~~B. Surface water entering the subject property shall be received at the naturally occurring locations and surface water exiting the subject property shall be discharged at the natural locations with adequate energy dissipaters within the subject property to minimize downstream damage and with no diversion at any of these points.

~~B.~~C. All developments shall ~~do the necessary~~conduct analysis and install ~~the necessary~~ mitigations to ensure that stormwater exiting their property is discharged at a safe location which will not impact other property owners.

~~C.~~D. All structures shall be built such that finished floor elevations are in conformance with the International Building Code as adopted or hereafter amended.

~~D.~~E. ~~Building~~ Drainage plans shall clearly show locations of drainage system and stormwater controls within property limits and any off-site drainage improvements.

~~E.~~F. Considerations for the discharge of water off-site include but are not limited to the following:

1. Sufficient capacity of downstream facilities under design conditions;

2. Maintenance of the integrity of the receiving waters;

3. Possibility of adverse effects of retention/detention;

4. Utility of regional retention/detention facilities;

5. Capability of maintenance of the system; and 6. Structural integrity of abutting foundations and structures.

~~F.~~G. All developers not providing permanent stormwater control facilities will be required to sign a no-protest agreement for future participation in a stormwater-related LID. (Ord. 2915 § 1, 2006; Ord. 2867 § 2, 2004; Ord. 2579 § 1, 1997).

13.32.020 Drainage plan – Submission.

A. All developers applying for any of the following permits and/or approvals may be required to submit for approval a drainage plan with their application and/or request:

1. Grading permit;
2. Street development permit;
3. Substantial development permit required under Chapter 90.58 RCW (Shoreline Management Act);
4. Subdivision approval;
5. Short subdivision approval;
6. Commercial, industrial or multifamily site plan approval;
7. Rezones;
8. Conditional use permits;
9. Planned unit developments;
10. Building permits, where the permit either (a) authorizes or is for new construction totaling 40 percent or more of developmental coverage within the subject property; or (b) authorizes or is for new construction which, together with pre-existing developmental coverage, would result in 40 percent or more developmental coverage within the property or (c) is for development in an environmentally sensitive area or which has the potential to impact an environmentally sensitive area;
11. Building permits, where the new development does not involve a change in impervious coverage of a site but where one of the following conditions exist:

    a. The stormwater from the existing development is connected to the sanitary sewer system.

    b. The drainage system serving the existing development is inadequate to prevent impacts to neighboring properties.

    c. Water quality issues are a concern either from the existing development or from the proposed development.

B. In addition, a drainage plan may be required for creation of impervious area, not covered by a permit, which exceeds either:

   1. Five thousand square feet; or

   2. Forty percent developmental coverage within the subject property.

C. Construction work done under any of the above permits or applications shall not begin until such time as final approval of the drainage plan is obtained in accordance with PTMC 13.32.050.

D. The same plan submitted during one permit/approval process may be subsequently submitted with further required applications. The plan shall be supplemented with such additional information that is requested by the public works department or required by the provisions of the engineering design standards manual and/or DOE Stormwater Management Manual for the Puget Sound Basin.

E. Temporary erosion and sediment control measures may be required under Chapter 5 of the engineering design standards at the discretion of the director for:

   1. Site preparation and/or construction of any development; or

   2. Creation of impervious area which exceeds either:

      a. Five thousand square feet; or

      b. Forty percent of the subject property. (Ord. 2687 § 1, 1999; Ord. 2579 § 1, 1997; Ord. 2126 § 1, 1988; Ord. 1957 § 3, 1983).

13.32.030 Drainage plan – Contents.

All persons applying for any of the permits and/or approvals contained in PTMC 13.32.020 shall provide a drainage plan for surface and pertinent subsurface water flows entering, flowing within, and leaving the subject property both during and after construction. The detailed form and contents of the drainage plan shall be described in procedures established by the public works department, or in the engineering design standards manual and/or DOE Stormwater Management Manual for the Puget Sound Basin. The engineering design standards manual, and the DOE Manual, will set forth the manner of presenting the required information which may include but is not limited to the following:

A. Background computations for sizing drainage facilities:

   1. Depiction of the drainage area on a topographical map of approved scale and contour interval, with acreage of the site, development, and developmental coverage indicated;

   2. Indications of the peak discharge and volume of surface water currently entering and leaving the subject property due to the design storm;

3. Indication of the peak discharge and volume of runoff which will be generated due to the design storm within the subject property if the development or proposed activity is allowed to proceed; and

4. Determination of the peak discharge and volume of water that will be generated by the design storm at various points on the subject property;

B. Proposed measures for handling the computed runoff at the detail level specified in the engineering design standards manual and/or DOE Stormwater Management Manual for the Puget Sound Basin:

1. The design storm peak discharge from the subject property may not be increased by the proposed development; and

2. Retention/detention facilities must be provided in order to maintain surface water discharge rates at or below the existing design storm peak discharge; and

C. Proposed Measures for Controlling Runoff During Construction. The requirements of this section may be modified at the discretion of the city public works department in special cases requiring more information. (Ord. 2579 § 1, 1997; Ord. 2444 § 2, 1995; Ord. 1957 § 4, 1983).

13.32.040 Development in environmentally sensitive areas or impacting ESAs.

Development in environmentally sensitive areas (ESAs) or development which has the potential to impact ESAs must meet the requirements of Chapter 19.05 PTMC or other requirements as determined necessary for the protection of the ESAs as determined by the public works director. (Ord. 2579 § 1, 1997; Ord. 1957 § 6, 1983).

13.32.050 Review and approval of the plan.

All storm drainage plans prepared in connection with any of the permits and/or approvals listed in PTMC 13.32.020 shall be submitted for review by and approval of the public works department in accordance with the procedures established in the engineering design standards manual and/or DOE Stormwater Management Manual for the Puget Sound Basin. (Ord. 2579 § 1, 1997; Ord. 2444 § 3, 1995; Ord. 1957 § 7, 1983).

13.32.060 Establishment of regional facilities.

In the event that public benefits would accrue due to modification of the drainage plan for the subject property to better implement the recommendations of the comprehensive drainage plan, the public works department may recommend that the city should assume responsibility for the further design, construction, operation and maintenance of drainage facilities on the subject property. Such decision shall be made concurrently with review and approval of the plan as specified in PTMC 13.32.050. In the event that the city decides to assume responsibility for design, construction, operation, and maintenance of the facilities, the developer will be required to contribute a pro rata share to the construction cost of the facilities. The developer may be required to supply additional information at the request of the public works department to aid in the determination by the city. Guidelines for implementing this section will be defined in the engineering design standards manual and/or DOE Stormwater Management Manual for the Puget Sound Basin. (Ord. 2579 § 1, 1997; Ord. 1957 § 8, 1983).

13.32.070 Applicability to government entities.

A. All municipal corporations and governmental entities shall be required to submit a drainage plan and comply with the terms of this chapter when developing and/or improving land including, but not limited to, road building and widening within the areas of the city.

B. It is recognized that many other city, county, state and federal permit conditions may apply to the proposed action and that compliance with the provisions of this chapter does not constitute compliance with such other requirements. (Ord. 2579 § 1, 1997; Ord. 1957 § 12, 1983).

13.32.080 Protection of public/private rights.

Implementation of any provision of this chapter shall not cause nor be construed as an infringement of the rights of individuals, municipalities, or corporations other than the developer seeking a permit or approval as described in PTMC 13.32.030. (Ord. 2579 § 1, 1997; Ord. 1957 § 14, 1983).

19.05 - CRITICAL AREAS

19.05.060 Performance standards for development – Mitigation, on-site and off-site, density, minimum lot size, subdivisions, preferred construction practices, impervious surface standards, stormwater plans, mitigation plans.

D. The performance standards below apply to any development and to all short plats, subdivisions and lot line revisions proposed for sites wholly or partially within confirmed critical areas or their buffers in Port Townsend. These standards are general development practices to minimize problems related to water quality, stormwater and erosion control, and the placement and construction of development in the city's critical areas. In addition to the following general performance standards, if a site contains a critical area or its buffer, such as a steep slope or a wetland, the applicable set(s) of regulations outlined in the following sections of this chapter shall also apply.

   5. Stormwater and Erosion Control.

      a. Stormwater Management Plan.

         All development subject to the provisions of this chapter shall comply with the 2005 Department of Ecology Stormwater Management Manual for Western Washington (SWMM-WW (2005)), city engineering design standards manual, city stormwater master plan, and adopted drainage basin plans.

         i. Stormwater management plans shall be consistent with the standards contained in the city's EDS manual and the SWMM-WW (2005), and must be developed on a site-specific basis and must contain a technical report that identifies existing or predicted problems and sets forth solutions to each. Off-site measures may be required to correct existing on-site problems or to prevent new problems from occurring. Surface water discharge from the site shall not be greater than historic or predevelopment rates.

ii. If the development does not meet water quality standards established by law or administrative rules, the city may suspend further development work on the site until such standards are met.

b. Erosion control practices must be detailed using best management practices for situation/filtration devices to control surface runoff during construction, and the 2005 Department of Ecology Stormwater Management Manual for Western Washington (SWMM-WW (2005)).

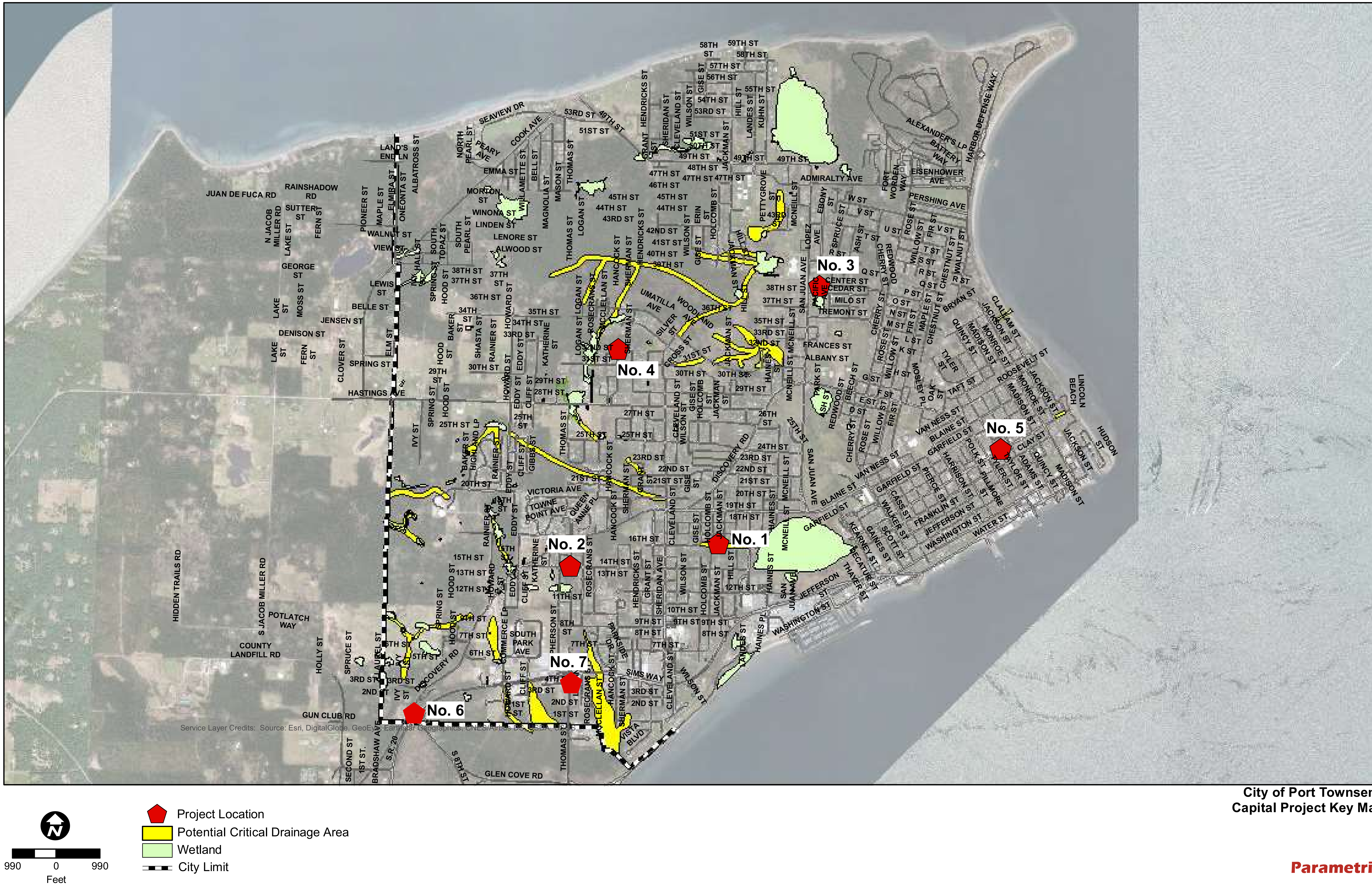
i. Applicants shall indicate erosion control measures on the site construction plan or stormwater control management plan, as appropriate for the project.

ii. These requirements shall be in place following the preconstruction meeting outlined in PTMC 19.05.040(D)(1)(i) and shall be reviewed and approved prior to clearing and grading.

c. Applicants are also encouraged to consult the recommendations set forth in Chapter 5 of the Low Impact Development Technical Guidance Manual for the Puget Sound (2004) for guidance concerning the protection of native soils and vegetation, and retention of hydrologic function, during clearing and grading for development proposals.

Appendix G

Capital Projects Worksheets

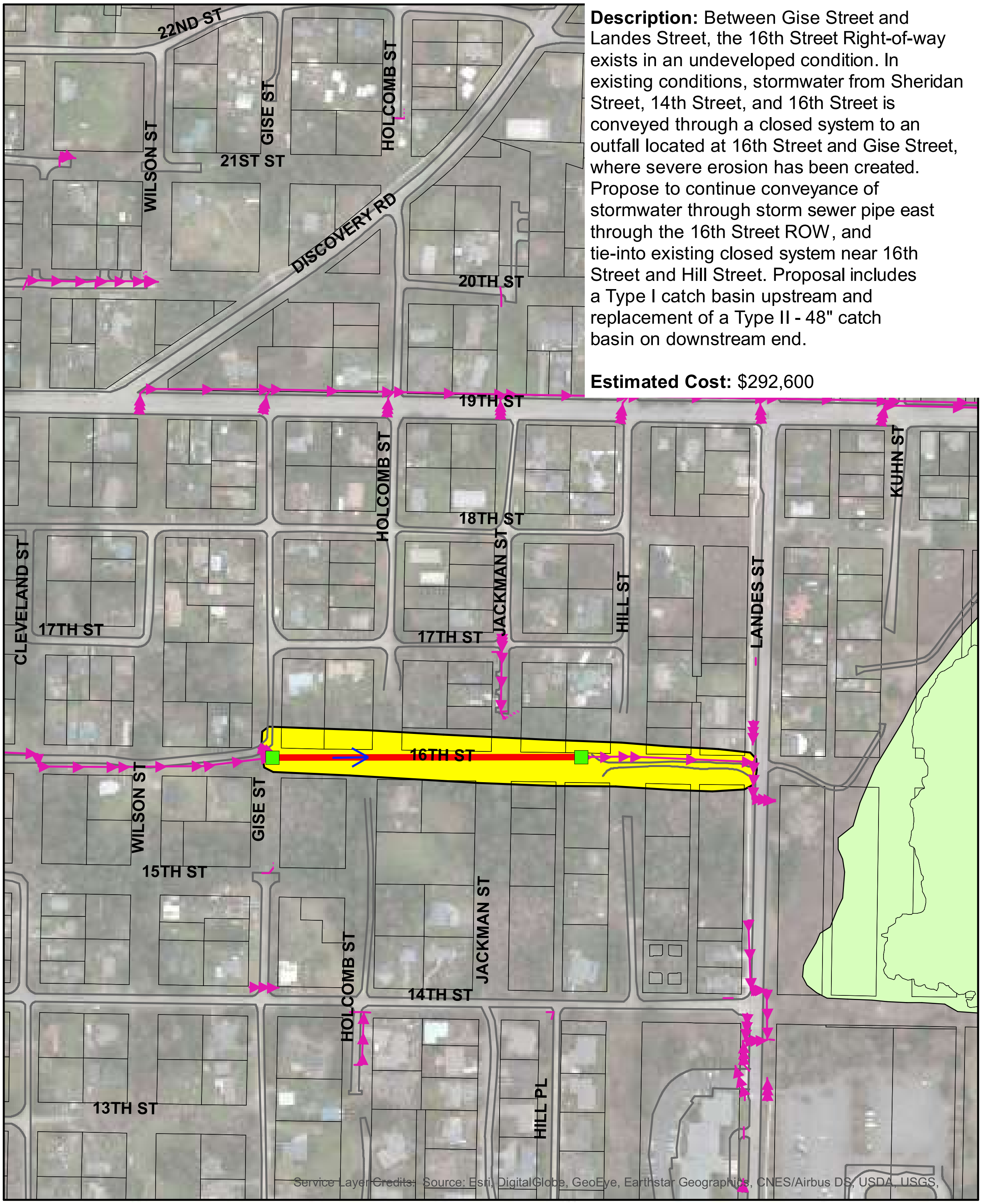


City of Port Townsend
Capital Project Key Map

Parametrix

Description: Between Gise Street and Landes Street, the 16th Street Right-of-way exists in an undeveloped condition. In existing conditions, stormwater from Sheridan Street, 14th Street, and 16th Street is conveyed through a closed system to an outfall located at 16th Street and Gise Street, where severe erosion has been created. Propose to continue conveyance of stormwater through storm sewer pipe east through the 16th Street ROW, and tie-into existing closed system near 16th Street and Hill Street. Proposal includes a Type I catch basin upstream and replacement of a Type II - 48" catch basin on downstream end.

Estimated Cost: $292,600

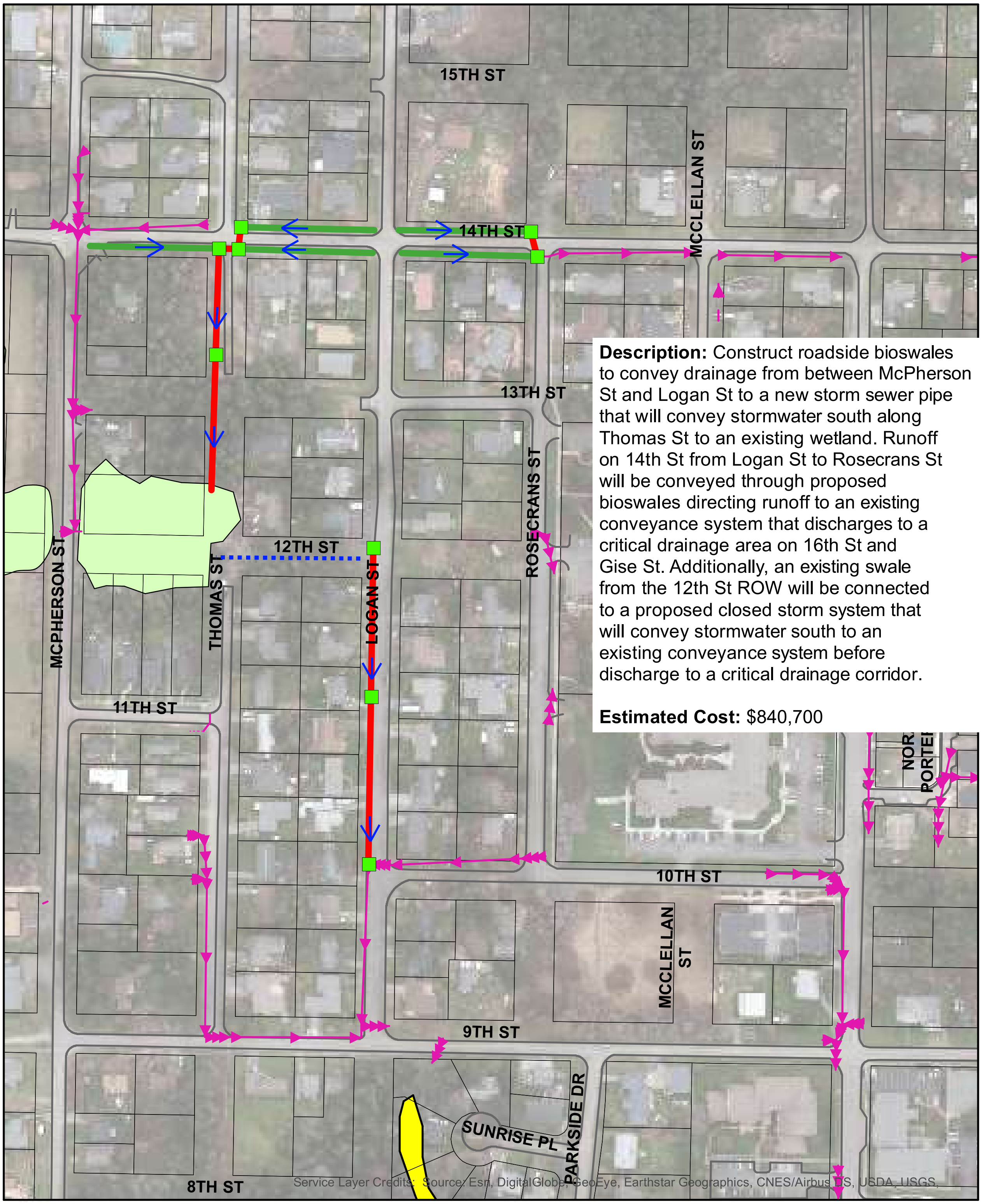


Potential Critical Drainage Area
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Proposed Catchbasin

150 0 150
Feet

City of Port Townsend
Capital Project 1
16th Street - Sheridan Street to Landes Street

Parametrix



Description: Construct roadside bioswales to convey drainage from between McPherson St and Logan St to a new storm sewer pipe that will convey stormwater south along Thomas St to an existing wetland. Runoff on 14th St from Logan St to Rosecrans St will be conveyed through proposed bioswales directing runoff to an existing conveyance system that discharges to a critical drainage area on 16th St and Gise St. Additionally, an existing swale from the 12th St ROW will be connected to a proposed closed storm system that will convey stormwater south to an existing conveyance system before discharge to a critical drainage corridor.

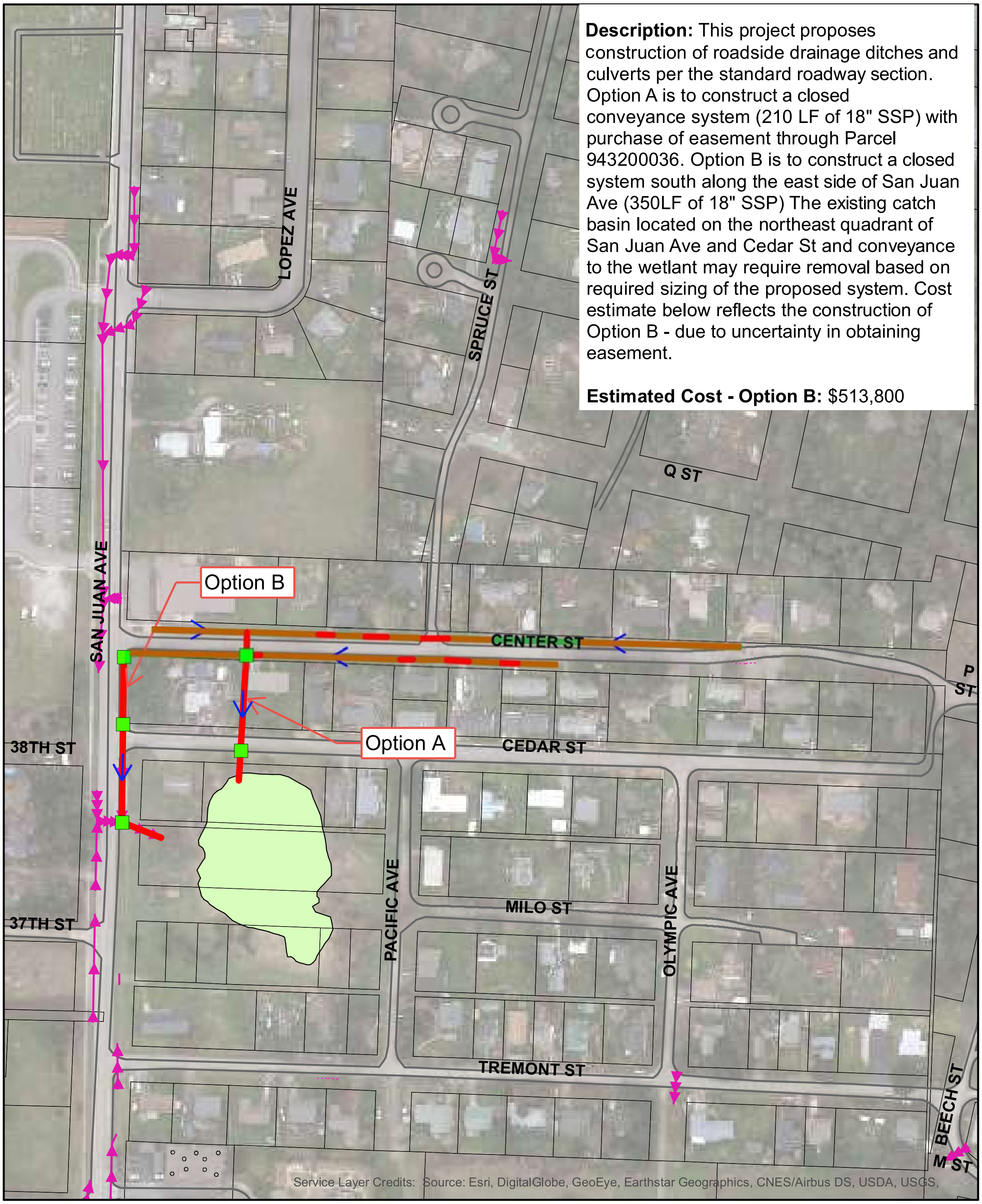
Estimated Cost: $840,700

Potential Critical Drainage Area
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Proposed Catchbasin
Existing Swale

110 0 110
Feet

City of Port Townsend
Capital Project 2
12th St ROW - McPherson to Logan
Logan - 10th to 12th St
14th St - McPherson to Rosecrans

Parametrix



Description: This project proposes construction of roadside drainage ditches and culverts per the standard roadway section. Option A is to construct a closed conveyance system (210 LF of 18" SSP) with purchase of easement through Parcel 943200036. Option B is to construct a closed system south along the east side of San Juan Ave (350LF of 18" SSP) The existing catch basin located on the northeast quadrant of San Juan Ave and Cedar St and conveyance to the wetlant may require removal based on required sizing of the proposed system. Cost estimate below reflects the construction of Option B - due to uncertainty in obtaining easement.

Estimated Cost - Option B: $513,800

Potential Critical Drainage Area
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Proposed Catchbasin

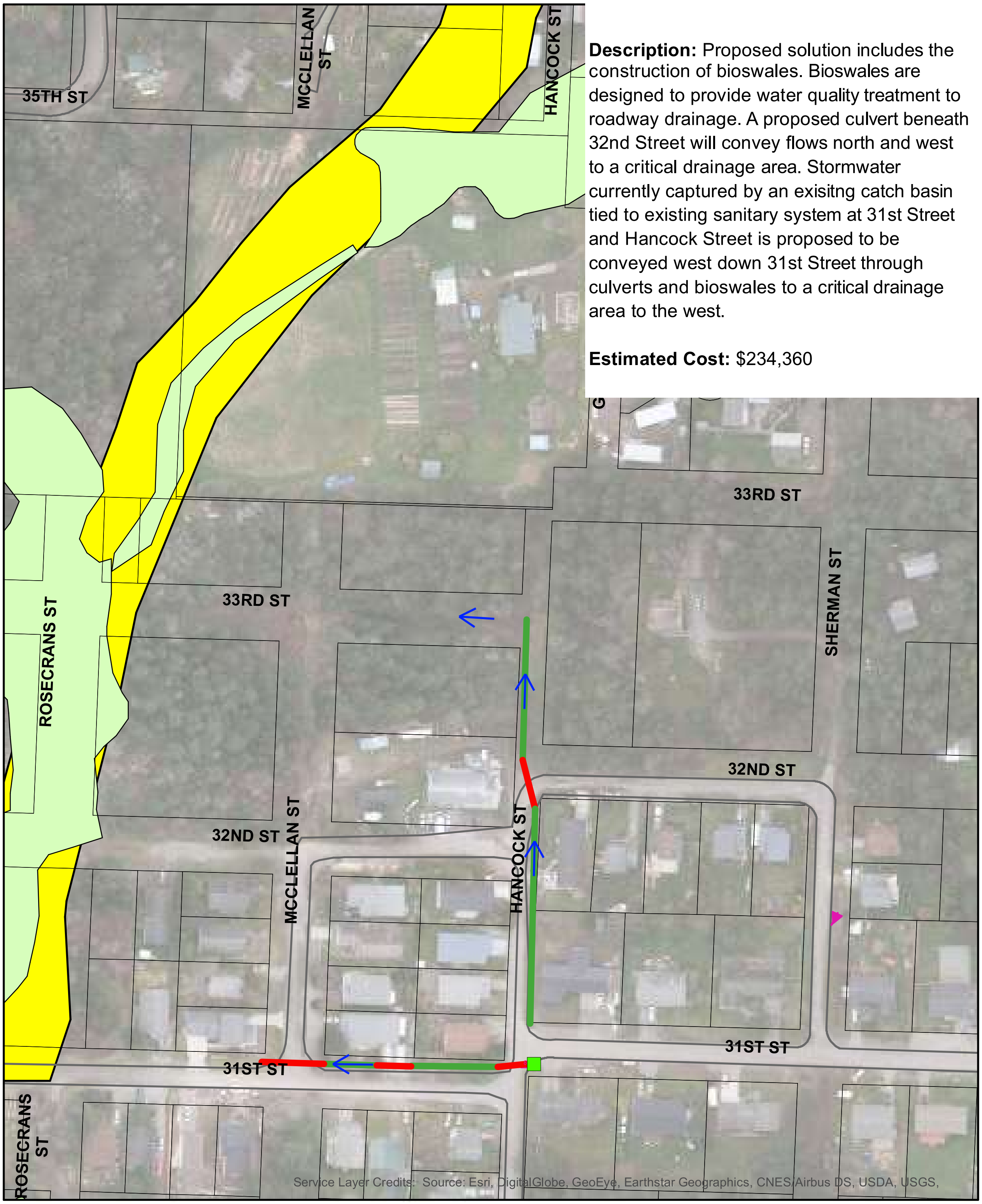
110 0 110
Feet

City of Port Townsend
Capital Project 3
Center Street - San Juan Avenue to Olympic Avenue

Parametrix

Description: Proposed solution includes the construction of bioswales. Bioswales are designed to provide water quality treatment to roadway drainage. A proposed culvert beneath 32nd Street will convey flows north and west to a critical drainage area. Stormwater currently captured by an exisitng catch basin tied to existing sanitary system at 31st Street and Hancock Street is proposed to be conveyed west down 31st Street through culverts and bioswales to a critical drainage area to the west.

Estimated Cost: $234,360



Potential Critical Drainage
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Proposed Catchbasin

80 0 80
Feet

City of Port Townsend
Capital Project 4
Hancock Street and 32nd Street

Parametrix

Description: Storm sewer catch basins located on Lawrence St at the intersections of Polk St, Taylor St, and Tyler St are currently directly connected the sanitary sewer system. This project proposes the construction of new stormwater conveyance system with a 12" trunkline running north along Lawrence St with lateral pipes and catch basins to collect stormwater on both sides of Lawrence St. This trunkline would connect to the existing 30" conveyance system located along Monroe St, where capacity should be adequate to introduce this stormwater.

Estimated Cost: $1,409,940

Potential Critical Drainage
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Proposed Catchbasin

City of Port Townsend
Capital Project 5
Lawrence Street at Intersections of Polk St., Taylor St., and Tyler St.

N

190 0 190
Feet

Parametrix

Description: Regional Stormwater Facility will provide stormwater detention for approximately 33 acres of commercial properties and public rights-of- way along the Rainier Street corridor from Discovery Road to the south side of Sims Way (SR 20). The facility will be a constructed pond, located just outside the city limits and adjacent to Mill Road, that will be connected by pipes from the overflow of an existing stormwater pond on Rainier Street, south of SR 20.

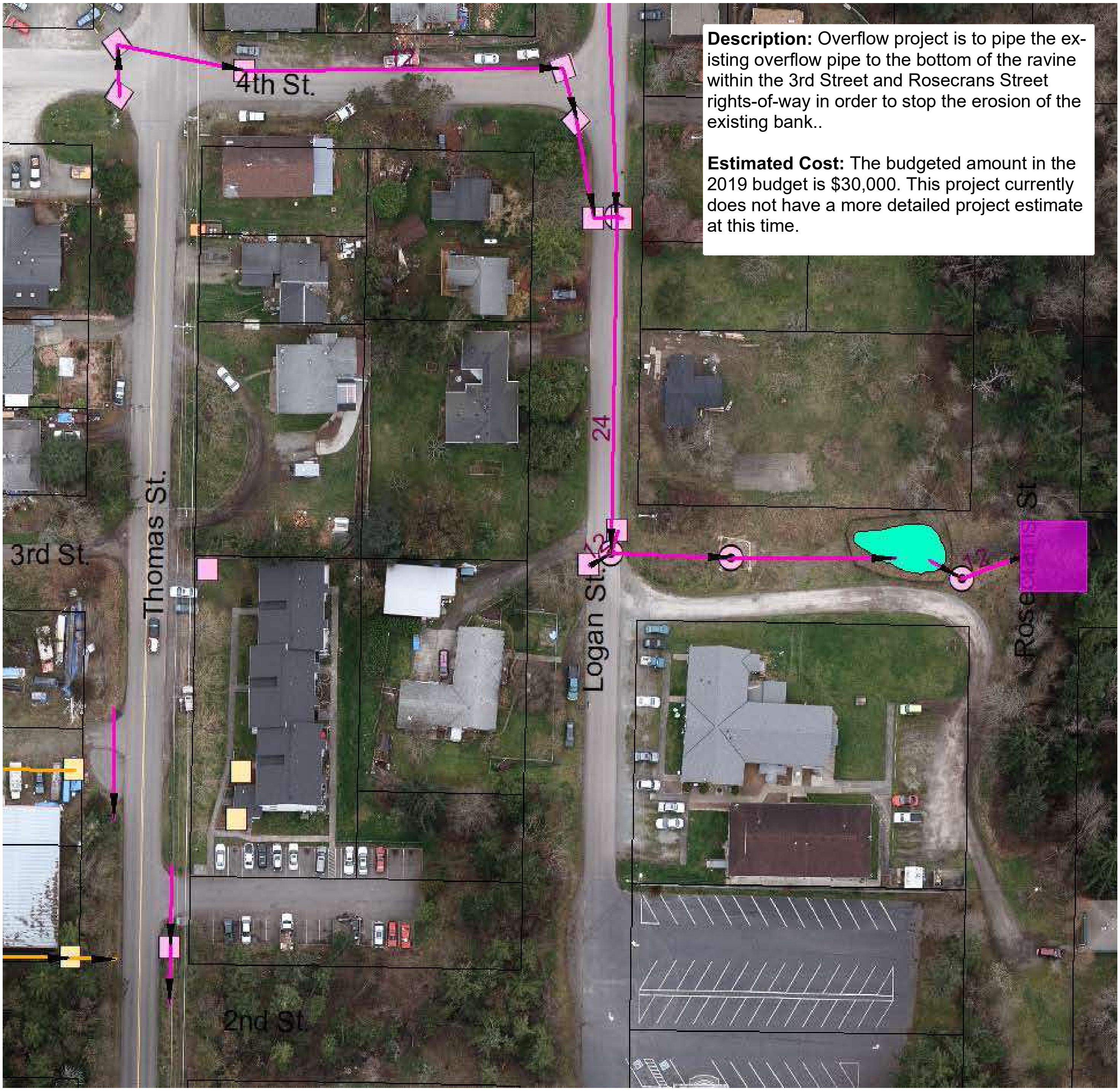
Estimated Cost: $573,198.30

Potential Critical Drainage Area
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Regional Stormwater Facility Area

110 0 110
Feet

City of Port Townsend
Capital Project 6
Regional Stormwater Facility
Rainier Street Commercial Corridor

Parametrix



Potential Critical Drainage Area
Wetland
Existing Storm Pipe
Existing Infiltration Pipe
Proposed Bioswale
Proposed Ditch
Proposed Pipe
Proposed Catchbasin
Pond Area

110 0 110
Feet

City of Port Townsend
Capital Project 7
Logan St Pond Overflow

Parametrix

Port Townsend CIP Area Summary

Project No.	Project Title	Estimated Cost	Description
No. 1	16th Street - Sheridan Street to Landes Street	$292,600	Closed conveyance system
No. 2	12th Street ROW, Logan Street, and 14th street	$840,700	Bioswales and closed conveyance system
No. 3	Center Street - San Juan Avenue to Olympic Avenue	$513,800	Closed conveyance system
No. 4	Hancock Street and 32nd Street	$234,360	Ditch and culvert
No. 5	Lawrence Street at Intersections of Polk Street, Taylor Street, and Tyler Street	$1,409,940	Closed conveyance system
No. 6	Regional Stormwater Facility for Rainier Street Commercial Corridor	$573,198	Regional Stormwater Facility
No. 7	Logan Street Pond Overflow	-	Closed conveyance system
	Total Cost	**$3,864,598**	

Citywide

Project No.	Project Title	Estimated Cost

TOTAL CIP COST: **$3,864,598**

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 1
Project Name: 16th Street - Sheridan Street to Landes Street
Prepared By: Tyler Nabours **Checked By:** C. Buitrago
Project Description:

Between Gise Street and Landes Street, the 16th Street Right-of-way exists in an undeveloped condition. In existing conditions, stormwater from Sheridan Street, 14th Street, and 16th Street is conveyed through a closed system to an outfall located at 16th Street and Gise Street, where severe erosion has been created. Propose to continue conveyance of stormwater through storm sewer pipe east through the 16th Street ROW, and tie-into existing closed system near 16th Street and Hill Street. Proposal includes a Type I catch basin upstream and replacement of a Type II - 48" catch basin on downstream end.

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount
1	1	LS	Mobilization	$19,200	$19,200
2	1	LS	Traffic Control	$2,500	$2,500
3	1	LS	Erosion/Sedimentation Control	$2,500	$2,500
4	690	LF	Storm Sewer Pipe - 12 Inch	$160	$110,400
5	40	LF	Pavement Repair	$50	$2,000
6	1	EA	Catch Basin Type I	$3,960	$3,960
7	1	EA	Catch Basin Type II, 48" Diam.	$6,690	$6,690
8					
9					
10					

Construction Subtotal (2018 Dollars) =		$147,250
Inflation from 2018 to 2019	2.10%	$3,092
Construction Subtotal (2018 Dollars) =		**$150,342**
Contingency	30.0%	$45,103
Sales Tax	9.0%	$13,531
Planning Level Construction Cost =		**$209,000**
Environmental Permitting and Documentation	5.0%	$10,450
Administration	5.0%	$10,450
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$62,700
2018 TOTAL =		**$292,600**

ASSUMPTIONS:

Mobilization equals approximately 15-percent of Subtotal.
Traffic Control equals approximately 2-percent of Subtotal.
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($1,000 min).
Pavement Restoration includes the cost of HMA (4-inch), CSTC (2-inch), and CSBC (6-inch).
Cost of pipe installation includes structure excavation and shoring.
Cost of catch basin installation includes structure excavation and shoring.

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 2
Project Name: 12th Street ROW, Logan Street, and 14th street
Prepared By: Tyler Nabours **Checked By:** C. Buitrago
Project Description:

Several flooding issues occur in the vicinity of the wetland located at McPherson St and the 12th St ROW. This project proposes to construct roadside bioswales to convey drainage from between McPherson St and Logan St to a new storm sewer pipe that will convey stormwater south along Thomas St to an existing wetland. Runoff on 14th St from Logan St to Rosecrans St will be conveyed through proposed bioswales directing runoff to an existing conveyance system that discharges to a critical drainage area on 16th St and Gise St. Additionally, an existing swale from the 12th St ROW will be connected to a proposed closed storm system that will convey stormwater south to an existing conveyance system before discharge to a critical drainage corridor.

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount
1	1	LS	Mobilization	$55,200	$55,200
2	1	LS	Traffic Control	$17,200	$17,200
3	1	LS	Erosion/Sedimentation Control	$6,900	$6,900
4	1067	LF	Storm Sewer Pipe - 12 Inch	$160	$170,720
5	1116	LF	Bioswale Grading	$90	$100,440
6	10	EA	Catch Basin Type I	$3,960	$39,600
7	661	LF	Pavement Repair	$50	$33,050
8					
9					
10					

Construction Subtotal (2018 Dollars) =		$423,110
Inflation from 2018 to 2019	2.10%	$8,885
Construction Subtotal (2019 Dollars) =		**$431,995**
Contingency	30.0%	$129,599
Sales Tax	9.0%	$38,880
Planning Level Construction Cost =		**$600,500**
Environmental Permitting and Documentation	5.0%	$30,025
Administration	5.0%	$30,025
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$180,150
2018 TOTAL =		**$840,700**

ASSUMPTIONS:

Mobilization equals approximately 15-percent of Subtotal.
Traffic Control equals approximately 5-percent of Subtotal.
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($1,000 min).
Pavement Restoration includes the cost of HMA (4-inch), CSTC (2-inch), and CSBC (6-inch).
Cost of pipe installation includes structure excavation and shoring.
Cost of catch basin installation includes structure excavation and shoring.

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 3
Project Name: Center Street - San Juan Avenue to Olympic Avenue
Prepared By: Tyler Nabours **Checked By:** C. Buitrago
Project Description:

There exists a low point (sump) condition along Center St between San Juan Ave and Spruce St, along with a lack of well developed roadside drainage infrastructure. This project proposes construction of roadside drainage ditches and culverts per the standard roadway section. There are two proposed options of layout for closed conveyance of discharge from Center St to a wetland located south of Cedar St. Option A is to construct a closed conveyance system (210 LF of 18" SSP) with purchase of easement through Parcel 943200036. Option B is to construct a closed system south along the east side of San Juan Ave (350LF of 18" SSP). The existing catch basin located on the northeast quadrant of San Juan Ave and Cedar St and conveyance to the wetlant may require removal based on required sizing of the proposed system. Cost estimate below reflects the construction of Option B due to uncertainity in acquiring easement.

Item No.	Estimated Quantity	Unit	Description		Unit Cost	Amount
1	1	LS	Mobilization		$33,700	$33,700
2	1	LS	Traffic Control		$11,500	$11,500
3	1	LS	Erosion/Sedimentation Control		$3,300	$3,300
4	283	LF	Storm Sewer Pipe - 12 Inch		$160	$45,280
5	350	LF	Storm Sewer Pipe - 18 Inch		$190	$53,770
6	1740	LF	Ditch Grading		$50	$87,000
7	1	EA	Catch Basin Type I		$3,960	$3,960
8	3	EA	Catch Basin Type II		$6,690	$20,070
9						
10						
			Construction Subtotal (2018 Dollars) =			$258,580
			Inflation from 2018 to 2019		2.10%	$5,430
			Construction Subtotal (2019 Dollars) =			**$264,010**
			Contingency		30.0%	$79,203
			Sales Tax		9.0%	$23,761
			Planning Level Construction Cost =			**$367,000**
			Environmental Permitting and Documentation		5.0%	$18,350
			Administration		5.0%	$18,350
			Preliminary Engineering, PS&E Engineering and Construction Management		30.0%	$110,100
			2018 TOTAL =			**$513,800**

ASSUMPTIONS:

Mobilization equals approximately 15-percent of Subtotal.
Traffic Control equals approximately 7-percent of Subtotal.
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($1,000 min).
Pavement Restoration includes the cost of HMA (4-inch), CSTC (2-inch), and CSBC (6-inch).
Cost of pipe installation includes structure excavation and shoring.
Cost of catch basin installation includes structure excavation and shoring.

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 4
Project Name: Hancock Street and 32nd Street
Prepared By: Tyler Nabours **Checked By:** C. Buitrago
Project Description:

Poor drainage exists along Hancock St and in the intersection of Hancock St and 32nd St. Proposed solution includes the construction of bioswales per Port Townsend standard proposed in this watershed plan. Bioswales are designed with 2 foot bottom widths and depth of 1.33 feet minimum with 3 to 1 side slopes to provide water quality treatment to roadway drainage. A proposed culvert beneath 32nd Street will convey flows north and west to a critical drainage area. Stormwater currently captured by an existing catch basin tied to existing sanitary system at 31st Street and Hancock Street is proposed to be conveyed west down 31st Street through culverts and bioswales to a critical drainage area to the west.

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount
1	1	LS	Mobilization	$15,400	$15,400
2	1	LS	Traffic Control	$4,800	$4,800
3	1	LS	Erosion/Sedimentation Control	$1,900	$1,900
4	560	LF	Bioswale Grading	$90	$50,400
5	200	LF	Storm Sewer Pipe - 12 Inch	$160	$32,000
6	190	LF	Pavement Repair	$50	$9,500
7	1	EA	Catch Basin Type 1	$3,960	$3,960
8					
9					
10					

Construction Subtotal (2018 Dollars) =		$117,960
Inflation from 2018 to 2019	2.10%	$2,477
Construction Subtotal (2019 Dollars) =		**$120,437**
Contingency	30.0%	$36,131
Sales Tax	9.0%	$10,839
Planning Level Construction Cost =		**$167,400**
Environmental Permitting and Documentation	5.0%	$8,370
Administration	5.0%	$8,370
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$50,220
2018 TOTAL =		**$234,360**

ASSUMPTIONS:
Mobilization equals approximately 15-percent of Subtotal.
Traffic Control equals approximately 5-percent of Subtotal.
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($1,000 min).
Pavement Restoration includes the cost of HMA (4-inch), CSTC (2-inch), and CSBC (6-inch).
Cost of pipe installation includes structure excavation and shoring.
Cost of catch basin installation includes structure excavation and shoring.

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 5
Project Name: Lawrence Street at Intersections of Polk Street, Taylor Street, and Tyler Street
Prepared By: Tyler Nabours **Checked By:** C. Buitrago
Project Description:
Storm sewer catch basins located on Lawrence St at the intersections of Polk St, Taylor St, and Tyler St are currently directly connected the sanitary sewer system. This project proposes the construction of new stormwater conveyance system with a 12" trunkline running north along Lawrence St with lateral pipes and catch basins to collect stormwater on both sides of Lawrence St. This trunkline would connect to the existing 30" conveyance system located along Monroe St, where capacity should be adequate to introduce this stormwater.

Item No.	Estimated Quantity	Unit	Description		Unit Cost	Amount
1	1	LS	Mobilization		$92,600	$92,600
2	1	LS	Traffic Control		$39,600	$39,600
3	1	LS	Erosion/Sedimentation Control		$11,300	$11,300
4	2400	LF	Storm Sewer Pipe - 12 Inch		$160	$384,000
5	2400	LF	Pavement Repair		$50	$120,000
6	14	EA	Catch Basin Type I		$3,960	$55,440
7	1	EA	Catch Basin Type II		$6,690	$6,690
8						
9						
10						
			Construction Subtotal (2018 Dollars) =			$709,630
			Inflation from 2018 to 2019		2.10%	$14,902
			Construction Subtotal (2019 Dollars) =			**$724,532**
			Contingency		30.0%	$217,360
			Sales Tax		9.0%	$65,208
			Planning Level Construction Cost =			**$1,007,100**
			Environmental Permitting and Documentation		5.0%	$50,355
			Administration		5.0%	$50,355
			Preliminary Engineering, PS&E Engineering and Construction Management		30.0%	$302,130
			2018 TOTAL =			**$1,409,940**

ASSUMPTIONS:
Mobilization equals approximately 15-percent of Subtotal.
Traffic Control equals approximately 7-percent of Subtotal.
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($1,000 min).
Pavement Restoration includes the cost of HMA (4-inch), CSTC (2-inch), and CSBC (6-inch).
Cost of pipe installation includes structure excavation and shoring.
Cost of catch basin installation includes structure excavation and shoring.

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 6
Project Name: Regional Stormwater Facility for Rainier Street Commercial Corridor
Prepared By: Tyler Nabours **Checked By:** C. Buitrago
Project Description:

The Regional Stormwater Facility will provide stormwater detention for approximately 33 acres of commercial properties and public rights-of-way along the Rainier Street corridor from Discovery Road to the south side of Sims Way (SR 20). The facility will be a constructed pond, located just outside the city limits and adjacent to Mill Road, that will be connected by pipes from the overflow of an existing stormwater pond on Rainier Street, south of SR 20.

Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount
1	2	AC	Clearing and Grubbing	$11,000	$22,000
2	4500	CY	Roadway Excavation Incl. Haul	$15	$67,500
3	2000	CY	Embankment Compaction	$12	$24,000
4	1000	CY	Common Borrow Incl. Haul	$27	$27,000
5	2.5	AC	Seeding, Fertilizing, and Mulching	$3,250	$8,125
6	250	SY	Stabilized Construction Entrance	$15	$3,750
7	2000	LF	Silt Fence	$4	$8,000
8	1	LS	Erosion Control and Watter Pollution Pl	$15,000	$15,000
9	7	EA	Inlet Protection	$150	$1,050
10	50	DAY	ESC Lead	$150	$7,500
11	30	TON	Quarry Spalls	$40	$1,200
12	1450	LF	Schedule a Storm Sewer Pipe 24 in. diam.	$100	$145,000
13	6	EA	Catch Basit Type 2 48 in. diam.	$3,200	$19,200
14	1	EA	Catch Basit Type 2 54 in. diam.	$6,000	$6,000
15	1000	LF	Chain Link Fence Type 3	$30	$30,000
16	1	EA	Double 14 ft. Chain Link Gate	$5,500	$5,500
17	50	TON	Crushed Surfacing Top Course	$40.00	$2,000
18	150	TON	Crushed Surfacing Base Course	$36.00	$5,400
19	1	LS	Mobilization (@10%)	$40,000.00	$40,000

Construction Subtotal (2018 Dollars) =		$438,225
Inflation from 2018 to 2019	2.10%	-
Construction Subtotal (2019 Dollars) =		-
Contingency	20.0%	$87,645
Sales Tax	9.0%	$47,328
Planning Level Construction Cost =		**$573,198**
Environmental Permitting and Documentation	5.0%	-
Administration	5.0%	-
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	-
2018 TOTAL =		**$573,198**

ASSUMPTIONS:
Cost provided by City of Port Townsend

CITY OF PORT TOWNSEND
Port Townsend Stormwater Management Plan
Preliminary Opinion of Probable Cost

Capital Project No. 7
Project Name: Logan Street Pond Overflow
Prepared By: Tyler Nabours **Checked By:**
Project Description:

The Logan Street Overflow project is to pipe the existing overflow pipe to the bottom of the ravine within the 3rd Street and Rosecrans Street rights-of-way in order to stop the erosion of the existing bank. The budgeted amount in the 2019 budget is $30,000. This project currently does not have a more detailed project estimate at this time.

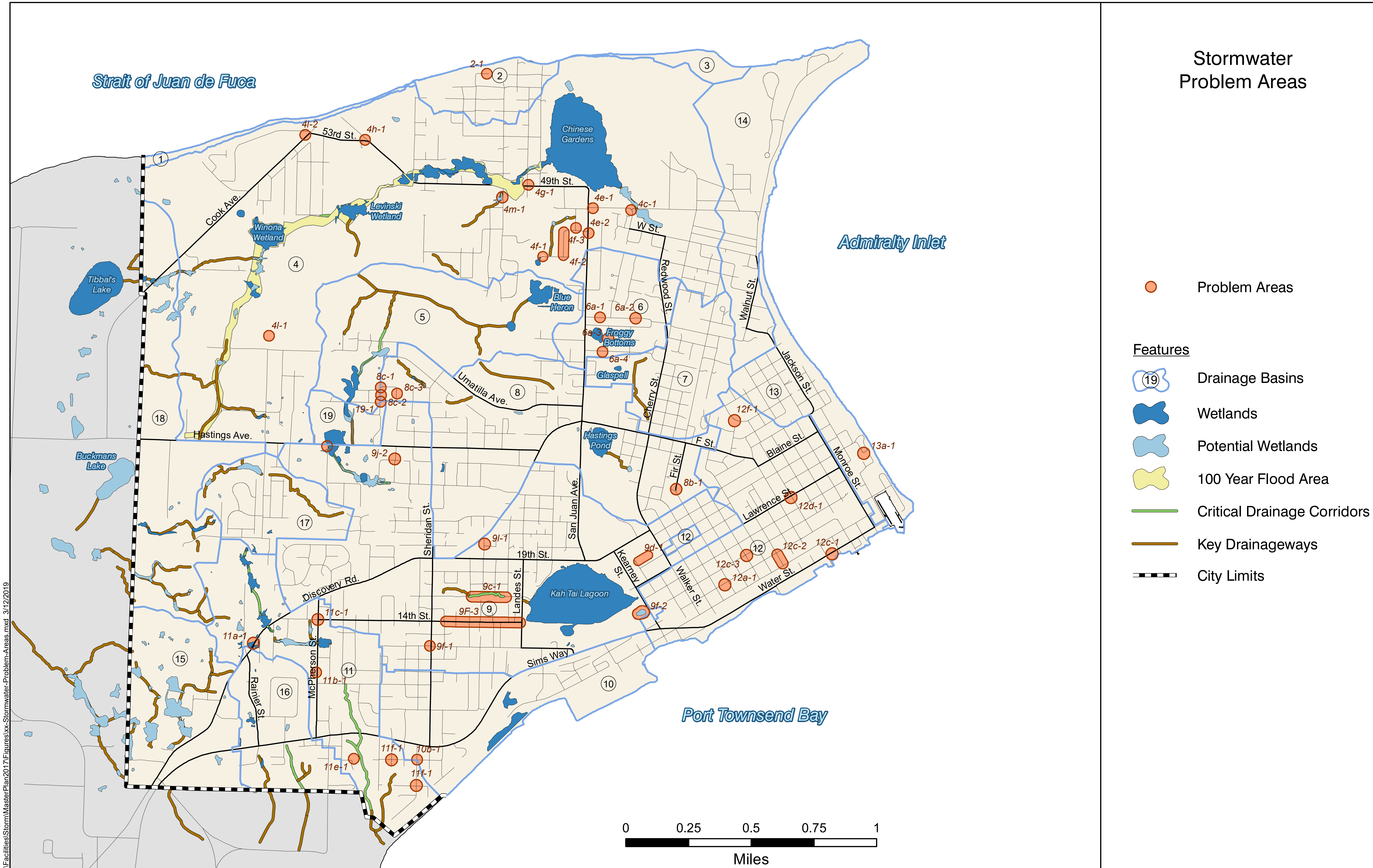
Item No.	Estimated Quantity	Unit	Description	Unit Cost	Amount
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Construction Subtotal (2018 Dollars) =		$0
Inflation from 2018 to 2019	2.10%	$0
Construction Subtotal (2019 Dollars) =		**$0**
Contingency	30.0%	$0
Sales Tax	9.0%	$0
Planning Level Construction Cost =		**$0**
Environmental Permitting and Documentation	5.0%	$0
Administration	5.0%	$0
Preliminary Engineering, PS&E Engineering and Construction Management	30.0%	$0
2018 TOTAL =		**$0**

ASSUMPTIONS:
Mobilization equals approximately 15-percent of Subtotal.
Traffic Control equals approximately 2-percent of Subtotal.
Erosion/Sedimentation Control equals approximately 2-percent of Subtotal ($1,000 min).
Pavement Restoration includes the cost of HMA (4-inch), CSTC (2-inch), and CSBC (6-inch).
Cost of pipe installation includes structure excavation and shoring.
Cost of catch basin installation includes structure excavation and shoring.

Drainage Problem Areas

ID	Location	Description
2-1	58th St. East of Gise St.	Street Flooding
4c-1	Admiralty Ave. and Spruce St.	Street Flooding
4e-1	Admiralty Ave. East of San Juan Ave.	Stormwater Drains to Sewer Manhole Lid
4e-2	San Juan Ave. at 45th St., East Side	Water Over Roadway
4f-1	Happy Valley Pond (43rd St.)	Water Over Roadway
4f-2	Haines St.; 43rd St. to 45th St.	No Conveyance
4f-3	McNeill St. North of 45th St.	No Conveyance
4g-1	Landes St. & 49th St.; Northeast Corner	Street Flooding
4h-1	53rd St. & 49th St.; Northwest Corner	No Conveyance
4l-1	Howard St. Trail North of 35th St.	Stormwater Eroding Trail
4l-2	Cook Ave. West of Seaview Dr.	Stormwater Directed to Private Property
4m-1	Jackman St.; 47th St. to 49th St., West Side	Local Flooding
6a-1	Center St.; San Juan Ave. to Spruce St.	Water Ponding at Edge of Roadway
6a-2	Center St.; Spruce St. to P St.	No Conveyance
6a-3	Pacific Ave. and Milo St. Intersection	Water Over Roadway
6a-4	Tremont St. West of Pacific Ave.	Infiltration System Insufficient
8b-1	Fir St. and Benton St.	Lack of Conveyance
8c-1	Hancock St. & 32nd St. Intersection	Ponding in Intersection
8c-2	1550 31st St.	Lack of Conveyance, Property Damage
8c-3	Sherman St.; 31st St. to 32nd St.	Catch Basin Tied to Sewer System
9c-1	16th St.; Gise St. to Hill St.	Ravine Erosion
9d-1	Mountain View Police Road	Lack of Conveyance
9f-1	Sheridan St. and 12th St.	Lack of Conveyance
9f-2	Kearney St. and Franklin St.	Flooding on Kearney Street
9f-3	14th St.; Cleveland St. to Landes St.	Erosion at Edge of Roadway
9j-1	Thomas St. and Hastings Ave., SW Corner	Flooding over Thomas Street
9j-2	Sherman St. & 27th St., NW Corner	Inadequate Conveyance
9l-1	2010 Holcomb St.	Street Runoff Flooding Driveway
10b-1	3rd St. and Grant St.	Catch Basin Tied to Sewer System
11a-1	Discovery Rd. Northeast of Roundabout	Flooding at Edge of Roadway
11b-1	McPherson St.; 9th St. to 11th St.	Catch Basin Tied to Sewer System
11c-1	McPherson St. and 14th St.	Water Ponding at Edge of Intersection
11e-1	3rd St. and Rosecrans St.	Storm Pond Outfall Eroding Bluff
11f-1	3rd St. and Sherman St.	Inadequate Conveyance
12a-1	1623 Jefferson St.	Street Run-off Flooding Garage
12c-1	Water St.; Taylor St. to Adams St., (South)	Ponding Over Sidewalk
12c-2	Fillmore St.; Jefferson St. to Washington St.	Erosion at Edge of Roadway
12c-3	VanBuren St. and Franklin St.	Catch Basin Has No Outlet
12d-1	Lawrence St. and Taylor St.	Ponding on Southwest Corner
12f-1	Tyler St. and Oak St.	Trail Erosion From Roadway Runoff
13a-1	Lincoln Beach	Water Over Roadway
19-1	Hancock St. & 31st St.	Catch Basin Tied to Sewer System


Stormwater
Problem Areas
Problem Areas
Features
Drainage Basins
Wetlands
Potential Wetlands
100 Year Flood Area
Critical Drainage Corridors
Key Drainageways
City Limits
Strait of Juan de Fuca
Admiralty Inlet
Port Townsend Bay
Chinese Gardens
Levinski Wetland
Winona Wetland
Tibbal's Lake
Buckmans Lake
Blue Heron
Froggy Bottoms
Glaspell
Hastings Pond
Kah Tai Lagoon
53rd St.
49th St.
Cook Ave.
W St.
Redwood St.
Walnut St.
Jackson St.
Cherry St.
Umatilla Ave.
Hastings Ave.
F St.
Blaine St.
Monroe St.
Fir St.
Lawrence St.
San Juan Ave.
Sheridan St.
19th St.
Discovery Rd.
Kearney St.
Walker St.
Water St.
Landes St.
14th St.
McPherson St.
Rainier St.
Sims Way
0 0.25 0.5 0.75 1
Miles
Q:\Facilities\Storm\MasterPlan2017\Figures\xx-Stormwater-Problem-Areas.mxd 3/12/2019

Appendix H

Stormwater Manual Comparison

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

719 2ND AVENUE, SUITE 200 | SEATTLE, WA 98104 | P 206.394.3700

TECHNICAL MEMORANDUM

DATE:	December 7, 2017
TO:	Samantha Harper, P.E.
FROM:	Julie Brandt, P.E.
SUBJECT:	Stormwater Manual Comparison
CC:	Paul Fendt, P.E.
PROJECT NUMBER:	553-2836-004 (01/04)
PROJECT NAME:	Stormwater Management Plan

1. INTRODUCTION

Port Townsend is developing a comprehensive stormwater management plan to improve the operation of the city's existing system and anticipate future needs. Part of the stormwater management plan development includes review and evaluation of the City's current stormwater standards and manuals. This technical memorandum compares the City's current adopted stormwater guidance manual against subsequent revisions implemented by the Washington State Department of Ecology (Ecology).

2. CURRENT CITY GUIDANCE MANUAL

The City adopted Ecology's 2005 Stormwater Management Manual for Western Washington (2005 SWMMWW) under Section 13.32.010.A of the Port Townsend Municipal Code (Stormwater Code). The Stormwater Code directs developers to use the 2005 SWMMWW for all clearing and grading activities, for erosion control during construction, and for permanent drainage system improvements; except that developments must comply with the following City requirements, which supersede the 2005 SWMMWW:

1. Section 2.6 – Optional guidance relating to financial liability and off-site analysis and mitigation
2. Engineering Design Standards
3. Stormwater Master Plan, and
4. Adopted drainage basin plans

The major elements included in the 2005 SWMMWW (and year the change was made) are:

1. Flow Control and Water Quality Treatment (2001):

   The thresholds for selection of Best Management Practices (BMPs) were expanded to require nearly all projects to apply appropriate flow control and runoff treatment BMPs, including on-site stormwater management techniques.

2. Duration Standard and Continuous Modeling (2001):

   The flow control requirements were increased to address both peak flows and duration of high flows, and calling for the use of continuous runoff models when available.

3. Enhanced Treatment (2001):

   Requirements were increased to result in higher levels of water quality treatment (enhanced treatment) for discharges from most industrial, commercial, and multifamily sites and arterials and highways.

4. Western Washington (2005):

   The geographic scope of the SWMMWW was expanded to apply previous requirements to all of Western Washington rather than Puget Sound only.

3. ECOLOGY REVISIONS

Subsequent to the City adoption of the 2005 SWMMWW, Ecology has published updates to the manual in 2012 and 2104. The major elements included in those updates (and year the change was made) are listed below in order of their relevance to Port Townsend. Summary tables published by Ecology that discuss all of the SWMMWW changes from 2012 and 2014 are included in Attachment 1.

1. Minimum Requirement 8 – Wetland Protection (2012):

   Most of Appendix I-D was rewritten to remove outdated information, clarify concepts, and update the requirements for protecting wetlands through controlling stormwater runoff discharges. Requirements were added dictating that total discharges to wetlands must not deviate by more than 20 percent on a single event basis and must not deviate by more than 15 percent on a monthly basis.

2. Puget Sound Action Agenda Terminology (2012):

   Outdated references and guidance related to the Puget Sound Water Quality Management Plan were removed and replaced with guidance on the Puget Sound Action Agenda.

3. Additional Basin Planning Guidance

   Appendix I-A was updated to clarify the guidance for altering the minimum requirements through basin planning, and language was added to address retrofit needs and alternative flow control strategies.

4. LID Requirements:

   - LID Performance Standard for Stream Protection (2012) – The new LID performance standard and BMP list options were added. The LID standard is based on project size, location, and BMP feasibility for projects that discharge to fresh waterbodies.

     Direct discharges to marine waterbodies through man-made conveyance systems are exempt from the LID standard as long as erosion and flooding are prevented.

   - LID Definition Consistency (2012) – Definitions were revised for terms relevant to the new low impact development (LID) guidance (hard surfaces, LID, converted vegetation) and requirements in the Municipal Stormwater Permits.

   - Hard Surface Threshold Changes (2012) – Thresholds and terminology were updated to determine which minimum requirements apply to new development and redevelopment, such as the replacement of “impervious” surfaces with “hard” surfaces, the application of minimum requirements #6 -#9 to replaced hard surfaces at new development sites, the deletion of the word "native" from the land conversion threshold.

- Updated Stormwater Site Plan Contents (2012) - Additional guidance was added regarding LID site design.
- Construction Stormwater Pollution Prevention (2012) – Construction stormwater management requirements were updated to protect LID BMPs
- Universal LID Language Clarification (2014) – Typos, spelling corrections, and terminology inconsistencies that resulted from the incorporation of the LID standard were address throughout the manual.
- Updated WWHM Software Guidance (2014) – Wording was revised to reflect recent upgrades to the Western Washington Hydrology Model (WWHM2012) to include LID simulation capabilities.

5. Historical Development Map (2012):

   To show which basins potentially qualify for use of existing land cover as the target for flow control purposes, a map was added depicting basins that have had 40 percent or more total impervious area since 1985. These basins are mainly comprised of areas between Everett and Tacoma east of Puget Sound and in the vicinity of Bremerton and Bainbridge Island.

6. NPDES Permit References (2012):

   - Guidance was added to refer Phase I and Phase II Municipal Stormwater Permittees to Appendix 1 of their respective general permits for more information on the requirements for their stormwater program requirements.
   - An overview was added regarding the requirements of the Industrial Stormwater General Permit and their relationship to the BMPs in the manual.
   - An overview was added regarding the requirements of the Construction Stormwater General Permit and their relationship to the BMPs in the manual.

4. RECOMMENDATION

The Ecology Manual was written to be reasonably applicable to a majority of landscapes and development scenarios found in western Washington. With the exception of the new wetland protection standard, the key recent SWMMWW revisions published by Ecology are not well-applied to Port Townsend development types, landscape, receiving water bodies, and precipitation regimes. The City is not now precluded from using the LID techniques described in the 2012 Manual and it could be expected that they would be used *when applicable and feasible* because they are often a preferred choice for circumstances where they would function in the landscape (e.g. good soils that infiltrate at high rates). Therefore, it is recommended that the City consider adoption of the updated wetland protection standard through the Municipal Code and continue use of the 2005 SWMMWW.

Attachment 1a
2012-2005 SWMMWW Chart of Changes

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
General				
Inside cover page	ES-i and ES-ii		Added an Executive Summary	Summarized the reasons for the update, the uses of the manual and provided information on the public involvement process.
All Volumes			Renumbered Tables and Figures	Renumbered all tables and figures in all Volumes. The new numbers coordinate tables and figures to the section of the Volume where they are located. (Eg. Figure 2.4.2 is the second figure in Section 2.4, Table 4.1.3 is the third table in Section 4.1).
Volume I Minimum Technical Requirements and Site Planning				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-26		Update incorrect or outdated code references.	Revised incorrect or outdated code references, such as the RCW and WAC.
Chapter 1 - Introduction	1-1 through 1-26		Minor language changes.	Revised for clarity and removed outdate language in Sections 1.2, 1.4, 1.5.1, 1.6.10.
Section 1.5.4 Flow Control BMPs	1-5		Minor language changes.	Revised language for changes made in *Appendix I-D Guidelines for Wetlands when Managing Stormwater.*
Section 1.5.5 On-site Stormwater Management BMPs	1-6		Additional guidance provided.	Language added to categorize On-site Stormwater Management BMPs, including LID BMPs.
Section 1.6.4 The Puget Sound Action Agenda	1-11 through 1-13		Significant revisions to remove outdated guidance and to add new guidance. Section renamed.	Removed references and guidance related to the Puget Sound Water Quality Management Plan and replaced with guidance on the Puget Sound Action Agenda.
Section 1.6.5 Phase I - NPDES and State Waste Discharge Stormwater Permits for Municipalities	1-13 through 1-14	Yes	Additional guidance provided and outdated guidance removed.	Added guidance referring Phase I Municipal Stormwater Permittees to Appendix 1 of the permit for more information on the requirements for their stormwater program requirements.
Section 1.6.6 Phase II - NPDES and State Waste Discharge Stormwater Permits for Municipalities	1-14	Yes	Additional guidance provided and outdated guidance removed.	Added guidance referring Phase II Municipal Stormwater Permittees to Appendix 1 of the permit for more information on the requirements for their stormwater program requirements.
Section 1.6.7 Municipalities Not Subject to the NPDES Stormwater Municipal Permits	1-14		Guidance removed.	Removed outdated references to the Puget Sound Water Quality Management Plan. Section renamed.
Section 1.6.8 Industrial Stormwater General Permit	1-14 through 1-15	Yes	Revised to coordinate with the current Industrial Stormwater General Permit	Revised to provide an overview of the requirements of the current Industrial Stormwater General Permit and their relationship to the BMPs in the manual.
Section 1.6.9 Construction Stormwater General Permit	1-15 through 1-16	Yes	Revised to coordinate with the current Construction Stormwater General Permit	Revised to provide an overview of the requirements of the current Construction Stormwater General Permit and their relationship to the BMPs in the manual.
Section 1.6.15 Underground Injection Control Authorizations	1-18 through 1-19		Significant revisions to add guidance.	Added language to refer to Ecology's website and to define UIC well.
Chapter 2 - Minimum Requirements for New Development and Redevelopment				
Chapter 2 - Minimum Requirements for New Development and Redevelopment	2-1 through 2-46		Minor language changes.	Revised for clarity and removed outdated language in the introduction and in Sections 2.1, 2.2, 2.5.3, and 2.5.10.
Chapter 2 - Minimum Requirements for New Development and Redevelopment	2-1 through 2-46	Yes	Revised language.	Revised definitions, requirements, supplemental guidance, etc. to correspond to the changes in the Municipal Stormwater Permits and for new LID requirements.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 2.1 Relationship to the Puget Sound Action Agenda	2-2		Added guidance. Section renamed.	Removed outdated references to the Puget Sound Water Quality Management Plan. Section renamed and focuses on relationship of the manual to the municipal stormwater permits.
Section 2.3 Definitions Related to Minimum Requirements	2-5 through 2-9	Yes	Added and revised definitions.	Added definitions for a few terms used previously but not previously defined. Other terms have a revised definition or a new definition (hard surfaces, LID, converted vegetation) because of the new low impact development (LID) guidance and requirements in the Municipal Stormwater Permits.
Section 2.4 Applicability of the Minimum Requirements	2-9 through 2-16	Yes	Revised the thresholds for determining which minimum requirements apply to new development and redevelopment. Revised supplemental guidelines.	Changes include: the replacement of “impervious” surfaces with “hard” surfaces, the application of minimum requirements #6 - #9 to replaced hard surfaces at new development sites, the deletion of the word "native" from the land conversion threshold.
Section 2.5.1 Minimum Requirement #1: Preparation of Stormwater Site Plans	2-16	Yes	Revised requirements and objective.	Added a new statement for the site plan to use site-appropriate development principles to retain native vegetation and minimize impervious surfaces to the extent feasible.
Section 2.5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)	2-17 through 2-26	Yes	Reorganized and revisions to: thresholds, general requirements, construction SWPPP elements, objective, and supplemental guidelines.	Changes include: revisions to the construction SWPPP elements to correspond with the Construction Stormwater General Permit, the addition of element #13 that requires the protection of LID Best Management Practices, and revision of element #12 to include responsibilities for an inspector or CESCL depending on the size of the project.
Section 2.5.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls	2-27 through 2-28	Yes	Minor additions.	Added clarification for peak discharges using 15 minute time steps.
Section 2.5.5 Minimum Requirement #5: On-site Stormwater Management	2-28 through 2-32	Yes	Multiple revisions for new low impact development (LID) requirements.	Changes include: the new LID performance standard and list options based on project size and location. The lists are divided into three land use types: lawn and landscaped areas; roofs, and other hard surfaces. Projects implementing the list option must select the first feasible BMP for each land use type. Some of the BMPs included in the lists are: rain gardens, permeable pavements, bioretention, soil quality and depth, full and partial dispersion methods, full downspout infiltration and perforated stub-outs.
Section 2.5.6 Minimum Requirement #6: Runoff Treatment	2-33 through 2-35	Yes	Revisions to the thresholds, Water Quality Design Flow Rate, and supplemental guidelines.	Revisions made to acknowledge the use of permeable pavements and the related new definitions. The intent is to continue to capture the same size and types of projects as previously. More accurate definitions for water quality design storm volume and flow rate.
Section 2.5.7 Minimum Requirement #7: Runoff Flow Control	2-35 through 2-40	Yes	Revisions to the thresholds and supplemental guidelines.	Revisions to acknowledge the use of permeable pavements and the related new definitions. Clarifications about the surfaces that the requirement applies to, and the use of the 0.10 /0.15 cfs threshold. The intent is to capture the same size and types of projects as previously.
Section 2.5.8 Minimum Requirement #8: Wetlands Protection	2-40 through 2-41	Yes	Revisions to the applicability, thresholds, standard requirement, additional requirements, and supplemental guidelines.	Revisions correspond to the significantly revised *Appendix I-D Guidelines for Wetlands when Managing Stormwater* .

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 2.8 Exceptions/Variances	2-45 through 2-46	Yes	Additional guidance provided.	Changed and added language to be consistent with the requirements in Appendix 1 of the 2007 municipal stormwater permits.
Chapter 3 - Preparation of Stormwater Site Plans				
Chapter 3 - Preparation of Stormwater Site Plans	3-1 through 3-17	Yes	Significant changes to incorporate procedures necessary for LID implementation.	Revised for clarity and removed outdate language in the introduction and in section 3.1.7.
Section 3.1.1 Step 1 - Collect and Analyze Information on Existing Conditions	3-2 through 3-7	Yes	Additional guidance provided and outdated guidance removed.	Additional guidance details the information necessary for site analysis, and in particular for LID site design. Split into subsections based on whether Min. Requirements 1 - 5 apply, or Min. Requirements 1 - 9 apply.
Sections 3.1.2 to 3.1.4	3-7 through 3-8	Yes	Guidance added.	References to on-site BMPs added and preliminary determination of applicable minimum requirements.
Section 3.1.5 Step 5 - Prepare a Permanent Stormwater Control Plan	3-8 through 3-12	Yes	Revisions to all subsections of Developed Site Hydrology of the Permanent Stormwater Control Plan.	Significant changes to describe how to prepare the Permanent Stormwater Control Plan that incorporates LID features. Separate guidance for projects subject to Min. Requirements 1 - 5 and projects subject to Min. Requirements 1 - 9.
Section 3.1.6 Step 6 - Prepare a Construction Stormwater Pollution Prevention Plan	3-13 through 3-14	Yes	Minor language changes.	Changes for clarification and to remove repetitive language.
Section 3.1.7 Step 7 - Complete Stormwater Site Plan	3-14 through 3-16	Yes	Reference to needed soils report and addition of Declaration of Covenants and Grants of Easement.	Soils reports are necessary part of LID decisions. Declarations of Covenants and Grants of Easement are necessary mechanisms to identify LID features, establish maintenance requirements and government access for inspections of privately maintained stormwater BMPs and facilities.
Section 3.2.2 Final Corrected Plan Submittal	3-17		Guidance added.	Added several LID BMPs that require the submission of as-builts.
Chapter 4 - BMP and Facility Selection Process for Permanent Stormwater Control Plans				
Section 4.2 BMP and Facility Selection Process	4-1 through 4-4		Revised language, proposed replacing the language in *Step V: Select Treatment Facilities* with a reference to Chapter 2 of Volume V.	Revisions and new language especially in Step III for guidance on modeling threshold discharge areas. Minor revisions to correspond with the changes in the Municipal Stormwater Permits and for new LID requirements. Ecology replaced the language in *Step V: Select Treatment Facilities* with a reference to Chapter 2 of Volume V.
Appendix I-A Guidance for Altering the Minimum Requirements Through Basin Planning				
Appendix I-A Guidance for Altering the Minimum Requirements Through Basin Planning	A-1 through A-3		Additional guidance provided.	Added language for clarity on use of Basin Planning for addressing retrofit needs and for developing an alternative flow control strategy.
Appendix I-B Rainfall Amounts and Statistics				
Appendix I-B Rainfall Amounts and Statistics	B-1 through B-5		Removed introductory language and background information on the Water Quality Design Storm and Water Quality Design Flow Rate.	Removed background and outdated information for brevity. Renamed the appendix and retained the rainfall tables.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Appendix I-D Guidelines for Wetlands when Managing Stormwater				
Appendix I-D Guidelines for Wetlands when Managing Stormwater	D-1 through D-18	Yes	Multiple revisions for the use and/or the protection of Wetlands when managing stormwater.	Rewritten to remove outdated information, clarify concepts, and approach the protection and use of wetlands through controlling discharges to wetlands. Total discharges to wetlands must not deviate by more than 20% on a single event basis, and must not deviate by more than 15% on a monthly basis.
Appendix I-E Flow Control-Exempt Surface Waters				
Appendix I-E Flow Control-Exempt Surface Waters	E-1 through E-4	Yes	Added and deleted Exempt Surface Waters.	List edited to add additional waters based on specific requests and analyses, and to remove reference to a creek in Eastern WA.
Appendix I-F Feasibility Criteria for Selected Low Impact Development Best Management Practices				
Appendix I-F Basins with 40% or more total impervious area since 1985	F-1	Yes	Added Map	Map shows basins which potentially qualify for use of existing land cover as the pre-developed land cover for flow control purposes. See reference in Min. Requirement #7.
Glossary and Notations				
Glossary and Notations	Glossary-1 through Glossary-47		Added and revised definitions.	There are a few terms, used previously but not defined, for which a definition has been added. A handful of other terms have a revised definition, and there are new terms, because of the new low impact development (LID) guidance and requirements in the Municipal Stormwater Permits.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume II Construction Stormwater Pollution Prevention				
Chapter 1 - Introduction Construction Stormwater Pollution Prevention				
Chapter 1 - Introduction Construction Stormwater Pollution Prevention	1-1 through 1-9		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Section 1.3 How to Use This Volume	N/A		This section was removed. The information in this section is now included in Sections 1.2.	Removed this section by combining it with Section 1.2 to eliminate duplicate language.
Section 1.3 Thirteen Elements of Construction Stormwater Pollution Prevention	1-3	Yes	Renamed.	Revised to incorporate a new element, Protect Low Impact Development BMPs.
Figure 1.5.1	1-6		Replaced.	Replaced older figure with an updated one.
Chapter 2 - Regulatory Requirements				
Chapter 2 - Regulatory Requirements	2-1 through 2-6		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Information covered in Volume I, Section 1.6 Relationship of the Manual to Federal, State, and Local Regulatory Requirements was removed.
Chapter 2 - Regulatory Requirements	2-1 through 2-6	Yes	Multiple revisions to coordinate the manual to the Washington State General Stormwater Permits.	Revised this chapter to update this information for revisions to the Stormwater General Permits (including the Municipal, Construction, and Industrial Permits).
Section 2.1 and Section 2.2	2-2 through 2-4	Yes	Section 2.1 The Construction Stormwater General Permit and Section 2.2 Construction Stormwater Pollution Prevention Plans now replace the previous Sections 2.1 and 2.2.	Replaced these sections to remove invalid information or duplicate information. Sections 2.1 and 2.2 now go into detail about the relationship of Volume II to the Construction Stormwater General Permit and the requirements for a Stormwater Site Pollution Prevention Plan.
Chapter 3 - Planning				
Chapter 3 - Planning	3-1 through 3-32		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Information covered in Volume I, Section 1.6 Relationship of the Manual to Federal, State, and Local Regulatory Requirements was removed.
Section 3.2 and Section 3.3	3-4 through 3-32		Previous Sections 3.2 and 3.3 have been reversed.	Moved The Construction SWPPP Requirements, previously in Section 3.3 to Section 3.2 for clarity. The Step-By-Step Procedure now follows in Section 3.3. Please note that the Construction Stormwater Pollution Prevention Plan Checklist is still located in Section 3.3.
Section 3.3.3 (Previously Section 3.2.3) Step 3 - Construction SWPPP Development and Implementation	3-8 through 3-32	Yes	Multiple revisions to the Construction SWPPP Elements.	Revised The Construction SWPPP Elements, described in Section 3.3.3 to coordinate with the Construction Stormwater General Permit, Municipal Stormwater Permits, and the Construction BMPs in Chapter 4. Each element now contains an Additional Guidance section that has information not required by the permits. Added Element #13 Protect Low Impact Development BMPs.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Chapter 4 - Best Management Practices Standards and Specifications				
Chapter 4 - Best Management Practices Standards and Specifications	4-1 through 4-128		Added approved equivalent BMPs Sections.	Refers to Ecology's website for BMPs that have been approved as equivalent.
Section 4.1 Source Control BMPs	4-1 through 4-2	Yes	Added Table 4.1 Source Control BMPs by SWPPP Element	Ecology added Table 4.1 Source Control BMPs by SWPPP Element to show how the BMPs listed in Section 4.1 relate to the SWPPP Elements.
BMP C103: High Visibility Fence	4-6		This BMP now includes high visibility silt fence. Multiple revisions for plain language, clarity, and brevity.	Added high visibility silt fence because it meets the intent of BMP C103. Ecology revised this chapter to use simpler and clearer language.
BMP C104: Stake and Wire Fence	N/A		This BMP was removed.	Removed this BMP because BMP C103: High Visibility Fence meets the intent of this BMP in a safer and more commonly used manner.
BMP C105: Stabilized Construction Entrance / Exit	4-7 through 4-9		Additional guidance provided and outdated guidance removed.	Added and removed guidance for this BMP based on comments received and field experience.
BMP C106: Wheel Wash	4-9 through 4-11		Additional guidance provided and outdated guidance removed.	Added guidance to clarify that wheel wash wastewater shall not discharge to surface or ground water.
Figure 4.1.2 - Wheel Wash	4-11		Figure was updated	Updated figure to provide more details of a typical Wheel Wash.
BMP C120: Temporary and Permanent Seeding	4-13 through 4-19		Multiple revisions for plain language, clarity, and brevity. Additional guidance provided and removed.	Revised and reorganized this BMP to use simpler and clearer language. Moved some guidance to BMP C121: Mulching or BMP C125: Top soiling. Ecology added and removed additional guidance for this BMP based on comments received and field experience.
BMP C121: Mulching	4-19 through 4-21		Additional guidance provided.	Added minimum mulch thickness based on field experience and comments. Ecology added guidance previously found in BMP C120: Temporary and Permanent Seeding to this BMP.
Table 4.1.8	4-21		Additional guidance provided.	Added Wood Straw and Wood Straw Mulch to the table.
BMP C122: Nets and Blankets	4-22 through 4-25		Multiple revisions for plain language, clarity, and brevity.	Revised this BMP to use simpler and clearer language.
BMP C123: Plastic Covering	4-25 through 4-27		Additional guidance provided and outdated guidance removed.	Removed the use of plastic sheeting over seeded areas because other coverings (such as compost and straw) are preferable. Ecology added and removed guidance for this BMP based on comments received and field experience.
BMP C124: Sodding	4-27 through 4-28		Additional guidance provided and outdated guidance removed.	Provided a link to composting guidance and removed old reference to compost specification.
BMP C125: Top soiling / Composting	4-29 through 4-32		Additional guidance provided and outdated guidance removed.	Added guidance previously found in BMP C120: Temporary and Permanent Seeding to this BMP. Ecology added and removed guidance for this BMP based on comments received and field experience.
BMP C150: Materials on Hand	4-42 through 4-43		Suggested measures and quantities removed.	Removed measures and quantities because measures and quantities should be based on the size of the construction site.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
BMP C151: Concrete Handling and BMP C152: Sawcutting and Surface Pollution Prevention	4-43 through 4-45	Yes	Additional guidance provided.	Added guidance to coordinate this BMP with the requirements of the Construction Stormwater General Permit and to make it clear that Concrete spillage or concrete discard to surface waters of the State is prohibited.
BMP C154: Concrete Washout Area	4-48 through 4-53		Added this BMP.	Added this BMP to provide additional guidance for concrete washout areas.
BMP C160: Certified Erosion and Sediment Control Lead	4-54 through 4-55		Additional guidance provided and outdated guidance removed.	Minimum Requirements for ESC Training and Certification Courses has been removed. Ecology plans on issuing separate, updated guidance in the near future.
BMP C161: Payment of Erosion Control Work	N/A		This BMP was removed.	Removed this BMP because it is not applicable to the full range of projects needing to perform Erosion and Sediment Control Work.
BMP C180: Small Project Construction Stormwater Pollution Prevention	N/A	Yes	This BMP was removed.	Removed this BMP because of changes in threshold requirements in both the Municipal Stormwater General Permits and Construction Stormwater General Permit.
Section 4.2 Runoff Conveyance and Treatment BMPs	4-57	Yes	Added Table 4.2 Runoff Conveyance Treatment BMPs by SWPPP Element	Added Table 4.2 Runoff Conveyance Treatment BMPs by SWPPP Element to show how the BMPs listed in Section 4.2 relate to the SWPPP Elements.
BMP C207: Check Dams	4-74 through 4-77		Additional guidance provided.	Added guidance for this BMP based on comments received and field experience.
BMP C220: Storm Drain Inlet Protection	4-78 through 4-79		Additional guidance provided.	Added guidance for inlet protection of lawn and yard drains and based on comment received and field experience.
BMP C230: Straw Bale Barrier	N/A		This BMP was removed.	Removed this BMP because this BMP has been proven to be ineffective.
BMP C233: Silt Fence	4-90 through 4-95		Multiple revisions for plain language, clarity, and brevity.	Revised and reorganized this BMP to use simpler and clearer language.
BMP C235: Wattles	4-96 through 4-99		Renamed from Straw Wattles.	Renamed this BMP to include wattles made from compost or other materials.
BMP C236: Vegetated Spray Fields	4-100 through 4-102		Added this BMP.	Added this new BMP for dewatering, Construction SWPPP Element #10.
BMP C250: Construction Stormwater Chemical Treatment	4-112 through 4-120		Additional guidance provided.	Added guidance for this BMP, previously available online, to coordinate with the Chemical Technology Assessment Protocol (CTAPE) program.
BMP C251: Construction Stormwater Filtration	4-120 through 4-124		Additional guidance provided.	Added sizing criteria for this BMP, previously available online.
BMP C252: High pH Neutralization Using CO_2	4-125 through 4-127		Added this BMP.	Added this BMP, previously available online, to provide guidance on neutralizing high pH through the use of CO_2.
BMP C253: pH Control for High pH Water	4-128 through 4-129		Added this BMP.	Added this BMP, previously available online, to provide additional guidance for neutralizing high pH.
Appendix II-B Background Information on Chemical Treatment	B-1 through B-3		Multiple revisions to coordinate with BMP C252 and BMP C53.	Revised this appendix to coordinate with the new information provided in BMP C252 and in BMP C253.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume III Hydrologic Analysis and Flow Control Design / BMPs				
Chapter 2 - Hydrologic Analysis				
Chapter 2 - Hydrologic Analysis	2-1 through 2-17		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language. Outdated guidance was replaced.
Section 2.2 Western Washington Hydrology Model	2-4 through 2-9		Section 2.2 split into multiple subsections.	Section 2.2 split into multiple subsections for clarity and for referencing purposes.
Section 2.2 Western Washington Hydrology Model	2-4 through 2-9		Additional guidance provided.	Added guidance on upcoming Western Washington Hydrology Model (WWHM) changes.
Section 2.2.2 Assumptions made in creating the WWHM	2-5 through 2-8		Additional guidance provided.	Added guidance on precipitation data and upcoming WWHM changes.
Section 2.2.3 Guidance for flow-related standards	2-8 through 2-9	Yes	Additional guidance provided and outdated guidance removed for Minimum Requirements (MR).	Added guidance for MR #5 which now includes an LID Performance Standard. Revised the guidance for MR#8 to reflect the changes made in Volume I, Appendix 1-D.
Chapter 3 - Flow Control Design				
Chapter 3 - Flow Control Design	3-1 through 3-109		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Chapter 3 - Flow Control Design	3-1	Yes	Update text for consistency with revised Min Req'mt #5 and LID	Added references to Minimum Requirement #5, bioretention and permeable pavements in introductory section.
Section 3.1 Roof Downspout Controls	3-1 through 3-18	Yes	Update text & figure for consistency with revised Min Req'mt #5	Text and figures updated to indicate priorities for handling roof runoff.
Section 3.1 Roof Downspout Controls	3-1 through 3-3	Yes	Update text for consistency with revised Min Req'mt #5	Updated references to revised roof downspout BMPs and Rain Gardens in the introductory section.
Section 3.1.1 Roof Downspout Full Infiltration (BMP T5.10A)	3-4 through 3-10	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min.Req'ment #5 and feasibility criteria. Needed better clarity in design guidance
Section 3.1.2 Downspout Dispersion Systems	3-11 through 3-16	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min. Req'ment #5 and feasibility criteria. Improved clarify in design guidance and computer modeling. Added guidance for design criteria for dispersion trenches and splashblocks.
Section 3.1.3 Perforated Stub-out Connections	3-17 through 3-18	Yes	Update text for consistency with revised Min Req'mt #5	Text changes for consistency with new priority lists in Min. Req'ment #5 and feasibility criteria. Updated design guidance.
Section 3.2 Detention Facilities	3-19 through 3-64		Multiple revisions for plain language, clarity, and brevity.	Revised this chapter to use simpler and clearer language.
Section 3.2 Detention Facilities	3-35		Updated references.	Updated Maintenance narrative to refer to Appendix IV-G Management of Street Wastes in Volume IV.
Section 3.3 Infiltration Facilities for Flow Control and Treatment	3-65 through 3-102		Section significantly rewritten.	Made significant changes to all sub-sections. Section pertains primarily to design of centralized infiltration facilities. Certain sections also apply to distributed bioretention facilities as indicated in text.
Section 3.3.1 Purpose	3-65	Yes	Revised guidance and reference LID.	Expanded purpose statement and clarified in regard to the types of facilities covered in Section 3.3. Added references to Bioretention and Permeable Pavement sections.
Section 3.3.2 Description	3-65	Yes	Additional guidance provided including Min Req'mt #5.	Made clarifications and added language for complying with MR#5. Added guidance for oil control and pre-treatment facilities.
Section 3.3.3 Applications	3-66		Additional guidance provided.	Minor text change
Section 3.3.4 Steps for Design of Infiltration Facilities	3-68 through 3-71	Yes	Revised several steps for new infiltration rate guidance and the new LID performance standard.	Revised Step 2 to include guidance for meeting MR#5. Significantly revised Step 5 for the new guidance provided in section 3.3.6. Revised Step 6 for clarity and for meeting MR#5. Revised Step 7 for clarity.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 3.3.5 Site Characterization Criteria	3-72 through 3-75		Revised guidance on subsurface characterization, soil testing, and infiltration receptor. Removed guidance for hydrogeologic investigation and figure 3.27, USDA Textural Triangle.	Multiple changes to subsurface characterization include added guidance on groundwater monitoring wells and the use of grain size analysis method for estimating infiltration rates. Deleted infiltration rate determination sub-section due to redundancy with next section.
Section 3.3.6 Design Saturated Hydraulic Conductivity - Guidelines and Criteria	3-75 through 3-83		Revisions for determining the saturated hydraulic conductivity (infiltration rate). Section renamed.	Replaced "Infiltration Rate" with "Saturated Hydraulic Conductivity" throughout section. Updated the guidelines and criteria for determining saturated hydraulic conductivity. Added guidance on pilot infiltration testing (PIT), and soil grain size analysis. Revised correction factors for PIT results and soil grain size method. Removed options based on USDA Soil Texture Classification and D10 grain size.
Section 3.3.7 Site Suitability Criteria (SSC)	3-83 through 3-86		Additional guidance provided and outdated guidance removed.	Updated references, removed unneeded guidance, revised limits on infiltration rates, added a minimum organic content for treatment, amended drawdown guidance, and verification testing.
Section 3.3.8 Steps for Designing Infiltration Facilities - Detailed Approach	3-86 through 3-90		Multiple revisions. Previous steps 1-4 removed. Multiple steps revised. Added groundwater mounding analysis step.	Removed steps to select location, estimate volume of stormwater, develop a trial infiltration facility geometry, conduct a geotechnical investigation, and determine the saturated hydraulic conductivity; instead refers to steps 1-5 in section 3.3.4. Revised Figure 3.27 for updated guidance. Revised guidance for adjusting the preliminary design infiltration rate. Added a step for groundwater mounding analysis. Added guidance for conducting performance testing.
Section 3.3.9 General Design, Maintenance, and Construction Criteria for Infiltration Facilities	3-90 through 3-94		Additional guidance provided and outdated guidance removed.	Added guidance for sizing for flow control, pretreatment design criteria, and maintenance. Made wording clarifications to guidance.
Section 3.4 Site Procedures for Bioretention and Permeable Pavement Use	3-103 through 3-109	Yes	Added this section for bioretention and permeable pavement.	Added guidance re field tests, computer modeling, and implementation for bioretention / rain gardens and permeable pavement.
Appendix III-A Isopluvial Maps for Design Storms				
Appendix III-A Isopluvial Maps for Design Storms	A-1		Added link to website.	Added a link to a website where isopluvial maps are available.
Appendix III-B Western Washington Hydrology Model - Information, Assumptions, and Computation Steps				
Appendix III-B Western Washington Hydrology Model - Information, Assumptions, and Computation Steps	B-1 through B-13	Yes	Additional guidance provided and outdated guidance removed.	Added guidance on current and upcoming versions of WWHM. Added guidance for the modeling on LID elements and wetlands. Removed outdated computation steps.
Appendix III-C Washington State Department of Ecology Low Impact Development Design and Flow Modeling Guidance				
Appendix III-C Washington State Department of Ecology Low Impact Development Flow Modeling Guidance	C-1 through C-13	Yes	Additional guidance provided and outdated guidance removed.	Text in regard to design guidance removed. All design guidance moved to Volume V. Two sets of modeling guidance provided. One for WWHM 3, and one for upcoming WWHM 2012.
Appendix III-D Procedure for Conducting a Pilot Infiltration Test				
Appendix III-D Procedure for Conducting a Pilot Infiltration Test	N/A		Appendix removed.	Procedures for conducting the PIT have been included within the proposed text on “Design Infiltration Rate Determination” in sections 3.3.6.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume IV Source Control BMPs				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-5		Minor language changes.	Revised for clarity and removed outdated language.
Section 1.3 How to Use this Volume	1-2		Additional guidance provided and outdated guidance removed.	Added new guidance regarding the Industrial Stormwater General Permit (ISWGP), Boatyard General Permit (BGP), and Sand and Gravel General Permit (S&GP) and the inclusion of "applicable" BMPs from this volume in Industrial Stormwater Pollution Prevention Plans (Industrial SWPPPs).
Section 1.5 Treatment BMPs for Specific Pollutant Sources	1-3	Yes	Additional guidance provided and outdated guidance removed.	Added new guidance clarifying the requirements regarding treatment BMPs for facilities covered under the ISWGP (or other General Stormwater Permits).
Section 1.6.1 Applicable (Mandatory) BMPs	1-3 through 1-4		Additional guidance provided and outdated guidance removed.	Added new guidance describing the use of applicable (mandatory) BMPs in regards to the ISGP, BGP, and S&GP. Section renamed to make it clearer that applicable BMPs are Mandatory for permittees under the ISWGP and BGP.
Section 1.6.2 Recommended BMPs	1-4	Yes	Additional guidance provided.	Added guidance regarding facilities covered under the ISWGP that trigger a corrective action.
Chapter 2 - Selection of Operational and Structural Source Control BMPs				
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-66		Numbered BMPs.	Added numbers in the "S400" series to BMPs in Volume IV.
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-66		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language, and removed outdated references.
Chapter 2 - Selection of Operational and Structural Source Control BMPs	2-1 through 2-2		Additional guidance provided and outdated guidance removed.	Added new guidance describing the use of applicable (mandatory) BMPs in regards to the ISGP, BGP, and S&GP. Added guidance regarding facilities covered under the ISWGP that trigger a Level 1 or 2 corrective action.
Section 2.1 Applicable (Mandatory) Operational Source Control BMPs	2-2 through 2-6		Additional guidance provided and outdated guidance removed.	Revised wording to clarify where this Section applies. Revised several BMPs for clarity and to coordinate with the ISWGP. Significant changes include the addition of vacuum sweeping and pressure washing, spill prevention and cleanup, visual inspections and record keeping.
Section 2.2 Pollutant Source Specific BMPs	2-7 through 2-66		Additional guidance provided and outdated guidance removed. Minor formatting revisions.	Revised wording to clarify where this Section applies. Added new text on ISWGP requirements. Added guidance regarding facilities covered under the ISWGP that trigger a Level 1 or 2 corrective action. Changed the title format for the BMPs to match the other volumes and added a numbering system to the BMPs.
S401 BMPs for the Building, Repair, and Maintenance of Boats and Ships	2-7 through 2-9		Additional guidance provided and several BMPs clarified.	Clarified guidance describing the requirements under the BGP and ISGP regarding boatyard activities. Revised BMPs to use simpler and clearer language.
S402 BMPs for Commercial Animal Handling Areas	2-10		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language.
S403 BMPs for Commercial Composting	2-10 through 2-12		Additional guidance provided and outdated guidance removed.	Revised language because solid waste regulations prohibit discharge of compost leachate. Revised BMPs to use simpler and clearer language, and removed outdated references.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
S405 BMPs for Deicing and Anti-Icing Operations - Airports and Streets	2-13 through 2-14		Additional guidance provided and outdated guidance removed.	Revised language to coordinate with the ISGP. Removed outdated references.
S414 BMPs for Maintenance and Repair of Vehicles and Equipment	2-32 through 2-34	Yes	Revision for consistency with the ISGP	Updated "applicable BMP" guidance for handling of liquids in scrap vehicles to align with ISGP.
S416 BMPs for Maintenance of Roadside Ditches	2-35 through 2-37		Additional guidance provided and updated references.	Additional guidance provided for the handling of ditch cleanings.
S423 BMPs for Recyclers and Scrap Yards	2-45 through 2-46		Updated reference to guidance.	Updated the reference to guidance for Vehicle Recyclers.
S424 BMPs for Roof/Building Drains at Manufacturing and Commercial Buildings	2-46 through 2-47		Added reference to guidance.	Added a references to Volume V and Ecology publications for BMPs.
S426 BMPs for Spills of Oil and Hazardous Substances	2-48 through 2-49		Additional guidance provided and outdated guidance removed.	Revised several BMPs for clarity and to coordinate with the ISWGP.
S430 BMPs for Urban Streets	2-58 through 2-59		Additional guidance provided.	Clarified that facilities not under the ISWGP may consider some water use in street cleaning.
S431 BMPs for Washing and Steam Cleaning Vehicles / Equipment / Building Structures	2-60 through 2-62	Yes	Additional guidance provided and outdated guidance removed.	Added guidance to clarify that the ISWGP prohibits the discharge of process wastewater to ground water or surface water. Removed outdated guidance.
Figure 2.15 - Uncovered Wash Area	N/A		Figure Deleted	Figure was unclear and the existing text provided a better description of the required controls.
S432 BMPs for Wood Treatment Areas	2-63 through 2-64		Additional guidance provided and several BMPs clarified.	Clarified guidance describing which NPDES permit(s) regulate wood treatment areas. Revised BMPs to use simpler and clearer language.
S433 BMPs for Pools, Spas, Hot Tubs and Fountains	2-64 through 2-66		Additional guidance provided.	Added this BMP to provide further guidance consistent with BMPs within this volume.
Appendix IV-A Urban Land Uses and Pollutant Generating Sources				
Appendix IV-A Urban Land Uses and Pollutant Generating Sources	A-1 through A-24		Minor language changes.	Edits for clarity and to replace and revise guidance documents and WAC references.
Commercial Composting - SIC 2875	A-14		Additional guidance provided	Added "Potential Pollutant Generating Sources"
Appendix IV-B Stormwater Pollutants and Their Adverse Impact				
Appendix IV-B Stormwater Pollutants and Their Adverse Impact	B-1 through B-2		Minor language changes. Removed Table.	Minor language changes for clarity. Removed the outdated Table in Appendix IV-B.
Appendix IV-C Recycling/Disposal of Vehicle Fluids/Other Wastes				
Appendix IV-C Recycling/Disposal of Vehicle Fluids/Other Wastes	C-1		Minor language changes.	Minor language changes for clarity.
Appendix IV-D Regulatory Requirements That Impact Stormwater Programs				
Appendix IV-D Regulatory Requirements That Impact Stormwater Programs	D-1 through D-9		Minor language changes.	Edits for clarity and to replace and revise guidance documents and WAC references.
Appendix IV-E NPDES Stormwater Discharge Permits				
Appendix IV-E NPDES Stormwater Discharge Permits	E-1 through E-7	Yes	Additional guidance provided and outdated guidance removed.	Edits to make guidance consistent with the most recent industrial and municipal stormwater permits.
Appendix IV-G Recommendations for Management of Street Wastes				
Appendix IV-G Recommendations for Management of Street Wastes	G-1 through G-15		Multiple revisions for plain language, clarity, and brevity. Additional guidance provided and outdated guidance removed.	Removed outdated guidance and added new guidance in the contamination in Street Waste Solids subsection. Reorganized the disposal of street waste liquids subsection, no major content changes. Minor revisions to the Site Evaluation subsection.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Volume V Runoff Treatment BMPs				
Chapter 1 - Introduction				
Chapter 1 - Introduction	1-1 through 1-4		Minor revisions for plain language, clarity, and brevity.	Revised BMPs to use simpler and clearer language, and removed outdated references.
Section 1.4.3 Treatment Methods	1-2 through 1-4		Additional guidance provided and outdated guidance removed.	Revised guidance for oil/water separation, pretreatment, infiltration, filtration, emerging technologies, and on-line systems. Added Bioretention as a treatment method.
Chapter 2 - Treatment Facility Selection Process				
Chapter 2 - Treatment Facility Selection Process	2-1		Additional guidance provided.	Added paragraph on emerging technology options.
Section 2.1 Step-by-Step Selection Process for Treatment Facilities	2-1 through 2-9		Minor revisions to the steps. Revised description of surface waters triggering enhanced treatment.	Revised selection process steps for clarity and to remove outdated information. Revised the Treatment Facility Selection Flow Chart for revised guidance throughout Volume V. Revised description of surface waters triggering enhanced treatment for accuracy.
Figure 2.1.1	2-3		Revised list of options.	Some treatment BMP options removed, emerging technologies added, one BMP renamed. Added a note for Phosphorous facilities that require Enhanced Treatment.
Section 2.2 Other Treatment Facility Selection Factors	2-9 through 2-11		Removed the subsection on Pollutants of Concern, the Suggested Treatment Options Table, and Ability of Treatment Facilities Table.	Removed the Suggested Treatment Options Table and Ability of Treatment Facilities Table because they provided limited usefulness and removed the associated subsection, Pollutants of Concern.
Chapter 3 - Treatment Facility Menus				
Chapter Introduction Paragraph	3-1		Additional guidance provided.	Added paragraph on emerging technology options.
Section 3.2 Oil Control Menu	3-2 through 3-3		Revised list of options.	Removed catch basin inserts and added emerging stormwater treatment technologies. To date, no catch basin inserts have been approved though the TAPE process but Ecology has approved one emerging technology. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.3 Phosphorous Treatment Menu	3-3 through 3-4		Revised list of options.	Removed amended sand filter (no design criteria have been developed for this treatment), and media filter, added emerging stormwater treatment technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.4 Enhanced Treatment Menu	3-5 through 3-7		Multiple revisions to remove outdated guidance and to provide new guidance. Revised list of options. Revised waters triggering enhanced treatment consistent with Chapter 2.	Revised the performance goal for dissolved metals. Removed Amended Sand Filter. Added "vegetated" to "Compost Amended "Vegetated" Filter Strip. Removed "rain garden" for consistency with proposal to distinguish between "bioretention" and "rain gardens." Replaced "Ecology Embankment" with "Media Filter Drain." Added emerging technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Section 3.5 Basic Treatment Menu	3-7 through 3-9		Minor language changes for clarity. Revised list of options.	Removed "rain garden" for consistency with proposal to distinguish between "bioretention" and "rain gardens." Replaced "Ecology Embankment" with "Media Filter Drain". Added Compost-amended Vegetated Filter Strip. Removed Bio-infiltration Swale. Added emerging technologies. Deleted the "Where Applied" section since it was duplicated from Chapter 2.
Chapter 4 - General Requirements for Stormwater Facilities				
Section 4.1.1 Water Quality Design Storm Volume	4-1	Yes	Inserted updated modeling guidance.	New guidance more accurately describes how volume is determined by computer models.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 4.1.2 Water Quality Design Flow Rate	4-1 through 4-2		Minor language changes for clarity.	Revised language for clarity.
Section 4.1.3 flows Requiring Treatment	4-2 through 4-4		Minor language changes for clarity. Changes to incorporate new terms.	Replaced "impervious" surfaces with "hard" surfaces in coordination with general changes in terminology. Added guidance regarding pollution-generating hard surfaces, pollution-generating impervious surfaces, and pollution-generating pervious surfaces.
Section 4.6 Maintenance Standards for Drainage Facilities	4-31 through 4-53	Yes	Added new tables within overall set of operation and maintenance standards	Changed "StormFilter" to "Manufactured Media Filters", added information from WSDOT on Media Filter Drains and Compost Amended Vegetated Filter Strips. Minor additions to the recommended maintenance tables added. Added placeholders for Bioretention and permeable pavement pending completion of the development of LID maintenance standards grant.
Chapter 5 - On-Site Stormwater Management				
Section 5.1 Purpose	5-1		Additional guidance provided.	Add reference to expanded BMP options and LID Manual to acknowledge the expansion of Chapter 5 and source of additional design details (LID Manual).
Section 5.2 Application	5-1	Yes	Additional guidance provided.	Revised application to refer specifically to Minimum Requirements #5, #6, and #7.
Section 5.3 Best Management Practices for On-Site Stormwater Management	5-1 through 5-2		Additional clarifying guidance provided. Full list of BMPs provided.	Expanded the list of BMPs in sections 5.3.1 and 5.3.2. Revised language and references for clarity.
Section 5.3.1 On-site Stormwater Management BMPs	5-3 to 5-39	Yes	Amend existing BMP's add new BMP's	Downspout infiltration moved to Volume III. Revised BMP T5.11 Concentrated Flow Dispersion and BMP T5.12 Sheet Flow Dispersion. Updated figures. Added BMP T5.14A Rain Gardens and BMP T5.14B Bioretention but details are in Volume V of Chapter 7. Added BMP T5.15 Permeable Pavements, BMP T5.16 Tree Retention and Tree Planting, BMP T5.16 Vegetated Roofs, BMP T5.18 Reverse Slope Sidewalks, BMP T5.19 Minimal Excavation Foundations, BMP T5.20 Rainwater Harvesting. Revised BMP T5.30 Full Dispersion by incorporating details from previous Appendix III-C.
Section 5.3.2 Site Design BMPs	5-39 through 5-42		Deleted Full Dispersion and section *5.3.3 Other Practices*	Moved Full Dispersion into Section 5.3.1 because the Municipal Stormwater Permits make it a necessary option in MR #5. Clarifying statement added in BMP T5.40.
Chapter 6 - Pretreatment				
Section 6.1 Purpose	6-1		Minor language changes.	Removed "and media filtration" in first bullet for clarity.
Section 6.2 Application	6-1		Additional guidance provided.	Added discussion that there are emerging technologies approved for pretreatment.
Section 6.3 Best Management Practices (BMPs) for Pretreatment	6-1		Additional guidance provided.	Added reference to Chapter 12.
Chapter 7 - Infiltration and Bioretention Treatment Facilities				
Section 7.1 Purpose	7-1		Changed bioinfilltration to bioretention.	Updated listed BMPs and made minor revisions to text.
Sections 7.2 General Considerations	7-1		Additional guidance provided.	Renamed this Section and added information regarding Bioretention and Rain Gardens.
Sections 7.3 Applications	7-1 through 7-2		Additional guidance provided.	Renamed this Section and added information for the BMPs discussed in this chapter.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 7.4 and BMPs 7.10 & 7.20	7-2		Updated references to Volume III	Design details for these BMPs remain in Volume III.
BMP T 7.30 Bioretention Cells, Swales, and Planter Boxes	7-3 through 7-25		Replaced Bio-infiltration Swale with Bioretention Cells, Swales, and Planter Boxes.	Added detailed guidance, design criteria, infeasibilty criteria and figures for Bioretention Cells, Swales, and Planter Boxes.
BMP T7.40 Compost-amended Vegetated Filter Strips (CAVFS)	7-25 through 7-29		Transferred this BMP from Chapter 9.	Added guidance and design criteria for Compost-Amended Vegetated Filter Strips. Treatment via infiltration through amended soils.
Chapter 8 - Sand Filtration Treatment Facilities				
Chapter 8 - Filtration Treatment Facilities	8-1 through 8-39		Changed title and introduced minor language changes for clarity.	Revised name from Sand Filtration to just Filtration.
8.1 Purpose	8-1		Revised guidance.	Revised the purpose to apply to both sand and media filtration facilities.
8.2 Description	8-1		Additional guidance provided.	Added reference to Media Filter Drain to description.
Section 8.3 Performance Objectives	8-2		Included new technologies	Added Media Filter Drain to list of approved technologies. Clarified objective for sand filters.
Section 8.4 Applications and Limitations	8-2		Revised guidance.	Revised to include media filter drains.
Section 8.5 Best Management Practices (BMPs) for Sand Filtration / BMP T8.10 Sand Filter Basin	8-2 to 8-15		Renamed and reorganized section. Additional guidance provided.	Added design criteria for sand filter basins. reorganized section so that previous sections 8.5, 8.6, 8.7, & 8.8 become subsections under BMP T8.10.
BMP T8.11 Large Sand Filter Basin	8-16 through 8-17		Separated out BMP previously reference within BMP T8.10	BMP T8.11 Large Sand Filter Basin was described in the prior manual under BMP T8.10 Sand Filter Basin. The Large Sand Filter was given a separate BMP for clarity.
BMP T8.20 Sand Filter Vault	8-17 through 8-23		Additional guidance provided.	Added design criteria, construction criteria, and maintenance criteria for sand filter vault.
BMP T8.40 Media Filter Drain	8-24 through 8-38		Added this BMP.	Added design criteria for new Media Filter Drain (MFD) option (previously referred to as Ecology Embankment). Text matches WSDOT Highway Runoff Manual.
Chapter 9 - Biofiltration Treatment Facilities				
Chapter 9 - Biofiltration Treatment Facilities	9-1 through 9-26		Minor language changes for clarity.	Minor language changes for clarity throughout the chapter.
Section 9.4 Best Management Practices	9-1 through 9-26		Additional guidance provided and outdated guidance removed.	Revised list of BMPs. Revised Sizing Criteria table for clarity.
BMP T9.50 Narrow Area Filter Strip	N/A		Removed this BMP.	No design criteria exists for this BMP to validate basic treatment. Designers should refer to Basic Filter Strip.
Chapter 10- Wetpool Facilities				
BMP T10.10 Wet Pond	10-1 through 10-17		Minor language changes for clarity.	First cell must be lined to be consistent with liner requirements in Chapter 4. Added cell requirements for consistency with design criteria for 2-cell ponds. Definition of WQ Design Storm Volume amended.
Chapter 11 - Oil and Water Separators				
BMP T11.10 API (Baffle type) Separator Bay	11-8 through 11-9		Corrected formula.	Corrected Stokes Law equation for rise rate.
BMP T11.11 Coalescing Plate (CP) Separator Bay	11-10 through 11-11		Corrected formula.	Corrected the equation to calculated the projected (horizontal) surface area of plates.
Chapter 12 - Emerging Technologies				
Chapter 12 - Emerging Technologies	12-1 through 12-6		Replaced sections 12.1 through 12.5 with new guidance.	Replaced sections 12.1 through 12.5 to provide new guidance on the Technology Assessment Protocol (TAPE) review and approval process.

Location	Approximate Page Numbers	Change Tied to Permit Language	Change	Reasoning or Comments
Section 12.6 Examples of Emerging Technologies for Stormwater Treatment and Control	N/A		Removed examples of emerging technologies.	Removed examples of emerging technologies. Added some examples previously listed throughout this volume.
Appendix V-B Recommended Procedures for ASTM D 2434				
Appendix V-B Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes.	B-1 through B-2		Additional guidance provided.	Added Recommended Modifications to ASTM D 2434. The results of this test for saturated hydraulic conductivity can be influenced by how the general procedures in the ASTM method are implemented. This appendix lays out more specific procedures to help with consistency in evaluating soils used for bioretention.
Appendix V-C Geotextile Specifications				
Appendix V-C Geotextile Specifications	C-1 through C-3		Revised Guidance.	Corrected several test procedures and geotextile property requirements.
Appendix V-E Recommended Bioretention Plant Species				
Appendix V-E Recommended Newly Planted Tree Species	E-1 through E-5		New appendix pertinent to BMP T5.16	Lists of species from City of Seattle guidance.

Attachment 1b
2012-2014 SWMMWW Chart of Changes

See the 2012 to 2014 SWMMWW Redlines for full change details.

Location	Change	Reasoning or Comments
All Volumes	Updated date in footer	Date updated to reflect the manual's revision date
	Updated page numbers and Figure numbers as appropriate	Page and Figure numbers may have changed due to content insertion or deletion
	Updated Table of Contents as appropriate	Some page numbers may have changed due to content insertion or deletion
	Minor spelling corrections	examples include: groundwater changed to ground water; under-drain changed to underdrain
	Minor text clarifications	examples include: changing "the Department of Ecology" to "the Washington State Department of Ecology"; inserting and/or clarifying acronyms where appropriate
	Minor typographical errors	examples include changing "text" to test" and "lopers" to "loppers"
	Updates per previous errata	Updates per previously published errata to the 2012 SWMMWW have been incorporated
Volume I - Minimum Technical Requirements and Site Planning		
Volume I Acknowledgements	Minor language changes	Inserted text indicating the shorthand for "The Washington State Department of Ecology" is "Ecology", added Craig Doberstein to the acknowledgement list, reformated the acknowledgement list
Chapter 1 - Introduction		
Section 1.1 - Objective	corrected "Ground Waters" to "Groundwaters"	Although the rest of the manual uses the spelling "ground water" (two separate words), the spelling here was updated to be consistent with the WAC title referenced
Section 1.6.4 - The Puget Sound Action Agenda	Revised this section	Revision of this section reflects changes from the Puget Sound Partnership's 2008 Action Agenda to the Puget Sound Partnership's 2014/2015 Action Agenda
Chapter 2 - Minimum Requirements for New Development and Redevelopment		
Section 2.2 - Exemptions	Deleted sentence: "They are considered redevelopment."	These practices are not restricted to redevelopment projects. The bullets that follow this sentence properly indicate that how the surfaces are considered within new or redevelopment projects.
	Restored formatting for second bullet regarding extending the pavement edge.	Formatting error correction
Section 2.3 - Definitions	definitions have been moved from seciton 2.3 to the Glossary	definitions have been moved in an effort to consolidate and organize the SWMMWW
Section 2.5.2 - Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
	revised "with outfall to" to "that discharges to"	revision made per settlement agreement PCHB No. 12-097c
Section 2.5.5 - Minimum Requirement #5: On-Site Stormwater Management	Added Figure 2.5.1: MR5 Flow Chart	A flow chart to help determine MR5 requirements
Chapter 3 - Preparation of Stormwater Site Plans		
Section 3.1.1 - Step 1 - Site Analysis: Collect and Analyze Information on Existing Conditions	Added text: "Testing should occur between December 1 and April 1."	Clarification
	Under Projects required to meet MR 1-9: 2.c., revised cited clearances	Revised to be consistent throughout the manual
Section 3.1.2 - Step 2 - Prepare Preliminary Development Layout	Added text referring to LID manual for additional information	clarification
Appendix I-G - Glossary and Notations		
Glossary	Added a definition for "Biosolids"	Clarification
	Deleted the definition for "Commercial Agriculture"	The entry deleted was a duplicate entry and out of aphabetical order

Location	Change	Reasoning or Comments
Glossary	Deleted the definition for "Converted Vegetation (areas)"	The entry deleted was a duplicate entry and out of aphabetical order
	Commercial Agriculture definition - replaced the word "wholesale" with "commercial" within the definition	Clarification
	Amended definition for compost. Deleted composted mulch and composting.	Updated to correct WAC reference.
	Added a definition for "Discharge Point"	Added for consistency with proposed permit modification as part of a settlement under PCHB No. 12-093c and - 097c
	Updated freeboard definition	Reworded for clarification
	revised "Low Permeable Liner" definition	revised to be consistent with other text within the manual
	Added a definition for "Mulch"	Clarification
	Added definition for "outfall"	Added for consistency with proposed permit modification as part of a settlement under PCHB No. 12-093c and - 097c
	Deleted reference to Rain Garden Handbook in "Rain Garden" definition.	Ecology prefers users to first refer to the guidance within the SWMMWW
	Updated "receiving waters" definition	Revised for consistency with proosed permit modification as part of a settlement under PCHB No. 12-093c and - 097c
Volume II - Construction Stormwater Pollution Prevention		
Chapter 3 - Planning		
Section 3.3.3 - Step 3 - Construction SWPPP Development and Implementation	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
	revised "sites larger than 1 acre" to "applies only to sites that have coverage under the Construction Stormwater General Permit"	revised to clarify the intent of the original wording
	added wording to clarify that the LID Technical Guidance Manual is for additional informational purposes only	Clarification that the SWMMWW guidance overrules the LID Technical Guidance Manual if discrepancies are found
Chapter 4 - Best Management Practices Standards and Specifications		
Section 4.1 - Source Control BMPs	Table 4.1.1 updated to match Errata, and reformatted as a word table for ease in future revisions	See 10/14/2013 Errata
BMP C121: Mulching	Added a specification for coarse compost for use when the option of Composted Material is selected	Clarification
BMP C121, Table 4.1.8	Replaced the terms "composted mulch and compost" with terms consistent with WAC 173-350	Clarification
BMP C125: Topsoiling/Composting	Updated for consistency with BMP T5.13	Clarification
BMP C151: Concrete Handling	Updated sentence to clarify that concrete washout cannot be discharged to ground	Clarification
BMP C154: Concrete Washout Area	Updated sentence to clarify that concrete washout cannot be discharged to ground	Correction
	Removed wording telling volume of wash water typically used	Clarification

Location	Change	Reasoning or Comments
Section 4.2 - Runoff Conveyance and Treatment BMPs	Table 4.2.1 updated to match Errata, and reformatted as a word table for ease in future revisions	Clarification
BMP C200: Interceptor Dike and Swale	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
BMP C201: Grass-Lined Channels	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
BMP C204: Pipe Slope Drains	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
Volume III - Hydrologic Analysis and Flow Control BMPs		
Chapter 2 - Hydrologic Analysis		
Section 2.2 - Western Washington Hydrology Model	updated sentence to state that low impact development modeling capabilities have been added to WWHM2012	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
Section 2.2.1 - Limitation to the WWHM	Clarified that routing limitations in the earlier versions of WWHM (WWHM1 and WWHM2) have changed considerably. WWHM3 and WWHM2012 have much greater routing capability that allow them to model multiple facilities and wetlands	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
Section 2.2.2 - Assumptions Made in Creating the WWHM	Clarified that WWHM2012 now uses over 50 years of precipitation time series from more than 17 stations. Precipitation time series are in 15-minute time steps.	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
	Clarified that WWHM2012 now uses 15-minute precipitation time series in its computations to generate hydrographs and to calculate water quality design flows	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
	Clarified that the advanced user may change coefficient **Precipitation multiplication factor** where justified and approved by reviewing jurisdiction	Clarification
	Clarified that the advanced user may change coefficient **Pan evaporation coefficient** justified and approved by reviewing jurisdiction	Clarification
Section 2.2.3 - Guidance for Flow-Related Standards	Noted the updated capability to model flows to wetlands and analyze the daily and monthly flow deviations per MR 8 in WWHM2012	wording was revised to reflect updates to WWHM since the last publishing of the SWMMWW
Section 2.3.2 - Runoff Parameters	Added footnote to Table 2.3.1 allowing modeling soils with a measured infiltration rate of less than 0.3 in/hr as Class C	Clarification

Location	Change	Reasoning or Comments
Chapter 3 - Flow Control Design		
Section 3.1 - Roof Downspout Controls	Updated wording that directs user to BMP design guidance within the SWMMWW instead of the Rain Garden handbook	Clarification
Section 3.1.1 - Downspout Full Infiltration Systems (BMP T5.10A)	Revised subsection title from "Flow Credit for Roof Downspout Full Infiltration" to "Runoff Modeling for Roof Downspout Full Infiltration"	Clarification
	revised sentence to clarify that clearance is measured to the seasonal high ground water table	Clarification
Section 3.1.2 - Downspout Dispersion Systems (BMP T5.10B)	Revised subsection title from "Flow Credit for Roof Downspout Dispersion" to "Runoff Modeling for Roof Downspout Dispersion"	Clarification
	Added modeling guidance where a dispersion trench is used with a vegetated flowpath of 25 to 50 feet.	Clarification
	removed footnote defining "Vegetative Flow Path"	
Section 3.2.1 - Detention Ponds	Added text to Emergency Overflow Spillway section to ensure a min 1 foot of freeboard in detention pond design	Clarification
	Updated Landscaping section to refer to BMP T5.13.	Clarification
	Added a reference to the Maintenance Tables in Volume V, removed the Maintenance Tables from this section	tables have been moved in an effort to consolidate and organize the SWMMWW
	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
Section 3.2.2 - Detention Tanks	Added a reference to the Maintenance Tables in Volume V, removed the Maintenance Tables from this section	tables have been moved in an effort to consolidate and organize the SWMMWW
Section 3.2.4 - Control Structures	Added a reference to the Maintenance Tables in Volume V, removed the Maintenance Tables from this section	tables have been moved in an effort to consolidate and organize the SWMMWW
Section 3.3.4 - Steps for the Design of Infiltration Facilities - Simplified Approach	Sentence added "Testing should occur between December 1 and April 1"	Clarification
Section 3.3.7 - Site Suitability Criteria (SSC)	Updated SSC-2 Ground Water Protection Areas per Errata	See 10/14/2013 Errata
	Corrected reference cited in SSC-6	Correction
Section 3.4.2 - Description	Removed reference to the LID Technical Guidance Manual for Puget Sound	Ecology wants users to first consider the design guidance within the SWMMWW.
	Revised wording to state design criteria "per BMP T5.14A" instead of the Rain Garden Handbook	Ecology wants users to first consider the design guidance within the SWMMWW.

Location	Change	Reasoning or Comments
Section 3.4.2 - Description	Added statement allowing infiltration through the side slopes to be modeled for facilities with side slopes 3H:1V or flatter	Clarification
Appendix III-B - Western Washington Hydrology Model - Information, Assumptions, and Computation Steps		
WWHM Information and Assumptions - Precipitation Data	Revised text to state that WWHM2012 uses 15-minutes precipitation time series	Clarification
WWHM Information and Assumptions - Soil Data	Added statement that soils tested at less than 0.3 in/hr may be modeled as Class C soil.	Clarification
	Clarified that type D soil is generally modeled as till and saturated soil category in WWHM is to be used for wetlands	Clarification
WWHM Information and Assumptions - Development Land Use Data	Updated text that conflicted with information elsewhere in the manual	Clarification
	Updated text that the Appendix C guidance was developed before WWHM2012 became available. WWHM2012 can model permeable pavements directly.	Clarification
WWHM Information and Assumptions - PERLND and IMPLND Parameter Values	Added statements concerning adjustment of LSUR, SLSUR, and NSUR by the model user	Clarification
	Added a paragraph explaining WWHM2012and WWHM3 provides 2 additional land slopes, flat and steep, to the existing moderate land slope for modeling purposes	Clarification
Appendix III-C - Washington State Department of Ecology Low Impact Development Flow Modeling Guidance		
Appendix III-C	Added a "Note" that the guidance in Appendix C was developed for use with WWHM3 before WWHM2012 became available.	Clarification
Part 1 C.2.3 - Partial Dispersion on Residential Lots and Commercial Buildings	Clarified guidance for consistency with text regarding modeling of partial dispersion options.	Clarification
Part 1 C.10.1 - Runoff Model Representation	Added guidance regarding modeling bioretention that has an underdrain	Clarification
Part 1 C.11.1 - Instructions for Roads on Zero to 2% Grade	Added guidance regarding modeling permeable pavement that has underdrains at the bottom of base course	Clarification
Part 1 C.11.2 - Instructions for Roads on Grades above 2%	Added guidance regarding modeling permeable pavement that has underdrains at the bottom of base course	Clarification
Part 2 Downspout Dispersion - BMP T5.10B	Inserted guidance for downspout dispersion modeling	Clarification
Part 2 Bioretention - BMP T7.30	Added modeling guidance on Bioretention with underlying perforated drain pipes	Clarification

Location	Change	Reasoning or Comments
Volume IV - Source Control BMPs		
Chapter 2 - Selection of Operational and Structural Source Control BMPs		
S403 BMPs for Commercial Composting	revised text to reflect updated regulations and guidance	Clarification
S411 BMPs for Landscaping and Lawn/Vegetation Management	Revised S411 BMP bullet point to clarify use of pesticides in Landscaping	Clarification
S430 BMPs for Urban Streets	deleted reference to Vol. V, Ch. 12 which no longer has information on sweepers	Clarification
S431 BMPs for Washing and Steam Cleaning Vehicles/Equipment/Building Structures	Revised text to reference updated guidance	Clarification
Appendix IV-G - Recommendations for Management of Street Wastes		
Contamination in Street Waste Solids	Total Copper added to Table G.4	Copper overlooked in previous editions
	Added note that the Interim Compost Guidelines are no longer effective. Retained for background info.	Clarification
Volume V - Runoff Treatment BMPs		
Chapter 2 - Treatment Facility Selection Process		
Section 2.1 - Step-by-Step Selection Process for Treatment Facilities	Step 5: revised "urban growth management area" to "urban growth area"	Clarification
Chapter 3 - Treatment Facility Menus		
Section 3.4 - Enhanced Treatment Menu	Revised "urban growth management area" to "urban growth area"	Clarification
	Bioretention: removed text directing reader to LID Manual for bioretention guidance. Text now directs reader to Chapter 7 only. (Text within Chapter 7 refers to the LID manual for additional guidance)	Clarification
Section 3.5 - Basic Treatment Menu	Deleted: “The goal also applies on an average annual basis to the entire annual discharge volume (treated plus bypassed).”	Clarification - See 10/14/2013 Errata
	Bioretention: removed text directing reader to LID Manual for bioretention guidance. Text now directs reader to Chapter 7 only. (Text within Chapter 7 refers to the LID manual for additional guidance)	Clarification
Chapter 4 - General Requirements for Stormwater Facilities		
Section 4.1.2 - Water Quality Design Flow Rate	(last sentence of section) Deleted reference to an average annual performance goal	Indefinite determination.
Section 4.1.4 - Minimum Treatment Facility Size	New section re minimum treatment facility size	Additional guidance provided on the minimum treatment facility size.

Location	Change	Reasoning or Comments
Section 4.6 - Maintenance Standards for Drainage Facilities	Updated Tables 21&22 with information from LID O&M Guidance document, with note that inspection and routine maintenance frequencies are recommended only.	Guidance added per PCHB No. 12-093c and - 097c
Chapter 5 - On-Site Stormwater Management		
Section 5.1 - Purpose	Added text clarifying that LID manual is for additional guidance only.	Clarification
Section 5.3.1 - On-Site Stormwater Management BMPs	Added bullet under Competing Needs on local codes	Clarification
BMP T5.11: Concentrated Flow Dispersion	Added modeling guidance for use of dispersion trench with flowpath of 25-50 feet	Additional guidance for runoff modeling
BMP T5.12: Sheet Flow Dispersion	Added modeling guidance for use of dispersion trench with flowpath of 25-50 feet	Additional guidance for runoff modeling
BMP T5.13: Post-Construction Soil Quality and Depth	Updated the compost specification requirement to be consistent with the Bioretention compost specification but allowing use of biosolids	Corrected WAC reference, made clarifications
BMP T5.14A: Rain Gardens	Revised Rain Garden Handbook reference to specify 2013 version	Clarification per PCHB No. 12-093c and - 097c
	Added a design guideline concerning use of composts	Additional Guidance for rain gardens
	Provided guidance for sizing rain gardens serving lawn/landscape areas in addition to impervious surfaces	Additional Guidance for rain gardens
	Provided guidance for underdrains in rain gardens	Additional Guidance for rain gardens
	updated the maintenance section to refer to both the Rain Garden Handbook and the Western Washington LID O&M Guidance Document	Additional Guidance for rain gardens
BMP T5.14B: Bioretention	Provided guidance for sizing bioretention facilities serving lawn/landscape areas in addition to impervious surfaces	Additional Guidance for bioretention facilities
BMP T5.15: Permeable Pavements	Revised guideline regarding the amount of impervious area draining to a pervious area	Clarification
	Revised infeasibility criterion for permeable pavement and roads re PCHB decision	Revised to implement PCHB No. 12-093c and -097c
	Deleted the second sentence of the infeasibility criterion addressing road sanding for snow and ice, Per PCHB ruling	Deleted per PCHB No. 12-093c and - 097c
	New text in regard to municipalities designating areas as infeasible and the data required	Clarification and additional guidance as directed by PCHB No. 12-093c and - 097c

Location	Change	Reasoning or Comments
BMP T5.15: Permeable Pavements	Revised 1st paragraph of "Design Guidelines" section to clarify that LID Manual is for additional guidance only, and that alternatives adopted by municipalities must not conflict with Ecology design criteria.	Clarification
	Removed reference to the LID manual in the "Base Material" section. The LID manual is already referenced as additional guidance in the opening paragraph.	Clarification
	"Wearing layer": updated infiltration rate in first sentence from 10 in/hr to 20 in/hr. The 10 in/hr rate was a typo and conflicted with information given later in this section.	Clarification
	Removed reference to the LID manual in the "Wearing Layer", "Pervious Concrete", and "Permeable Interlocking Concrete Pavement and Aggregate Pavers" sections. The LID manual is already referenced as additional guidance in the opening paragraph.	Clarification
	"Underdrains": Added a section regarding underdrains affecting the status of permeable pavements as LID BMPs	Additional Guidance for permeable pavements
	added a reference to Table 22 within Table 4.5.2 in Chapter 4 for maintenance guidance	Additional Guidance for permeable pavements
BMP T5.17: Vegetated Roofs	Added text clarifying that LID manual is for additional guidance only.	Clarification
BMP T5.30: Full Dispersion	Corrected section sub header name	Clarification, the guidance is not only for residential projects
	Corrected design requirements for residential projects text for clarity	Clarification
	Revised "urban growth management area" to "urban growth area"	Clarification
Chapter 7 - Infiltration and Bioretention Treatment Facilities		
BMP T7.30: Bioretention Cells, Swales, and Planter Boxes	Replaced Figure 7.4.1	Clarification
	Added Figure 7.4.1b	Clarification
	Added Figure 7.4.1c	Clarification
	New text in regard to municipalities designating areas as infeasible and the data required	Additional guidance to be consistent with directive of PCHB No. 12-093c and - 097c for permeable pavement
	Determining Bioretention soil mix infiltration rate: Updated Ksat Safety Factor language for consistency with WWHM.	Clarification

Location	Change	Reasoning or Comments
BMP T7.30: Bioretention Cells, Swales, and Planter Boxes	Design criteria for bioretention - updated text to clarify that LID manual is additional guidance only; under "curb cuts for roadside, driveway, and parking lot areas" - removed reference to LID manual because it is already referenced in the design criteria opening paragraph.	Clarification
	Added text to "ponding area" section describing surface areas when designing for MR5	For consistency w/Min. Requirement #5 and recommendation for size increase if draining pervious area
	Default Bioretention Soil Media: Multiple changes to the compost specification; and to incorporate a specification for fine compost	Changes needed to be consistent with updated WAC 173-350-220; Incorporated fine compost spec. to delete reference to LID Manual
	Design Criteria for Custom Bio Soil Mixes: Added text clarifing that custom mix does not need to meet gradation specification	Clarification
	Soil Depth: Removed guidance for 24" BSM depth	Additional Guidance for bioretention facilities. Local monitoring indicates phosphorus loss from media.
	Underdrain (optional): Added guidance for modeling bioretention with underdrains	Additional Guidance
	Added text to clarify that LID manual is additional guidance only.	Clarification
	Added statement that compost shall not include biosolids or manures	Clarification
BMP T7.40: Compost-Amended Vegetated Filter Strips	Soil Design Criteria: Emphasized exclusion of biosolids and manure from compost used for CAVFS	Clarification
	Maintenance: deleted bullets per Errata	Clarification - See 10/14/2013 Errata
BMP T8.30: Linear Sand Filter	Additional Design Criteria for Linear Sand Filters: corrected text	Correction
BMP T8.40: Media Filter Drain	Grass Strip: restricted compost to that used for Bioretention soil media	Clarification
Chapter 9 - Biofiltration Treatment Facilities		
BMP T9.10: Basic Biofiltration Swale	revised wording to read "volumetric flow rate calculated using a 10-minute time step"	edit made to accurately describe the design criterion
	Soil Criteria: SC-15: Restricted compost to that used for Bioretention soil media	Clarification
BMP T9.40: Basic Filter Strip	Corrected error in figure 9.4.9	Correction
Chapter 11 - Oil and Water Separators		
Section 11.6 - Design Criteria - General Considerations	Corrected Schueler citation from 1990 to 1992	Correction
BMP T11.11: Coalescing Plate (CP) Separator Bay	Clarification in design flowrate variable	Clarification

Appendix I

Updated Capital Improvements Plan

Stormwater
Capital Improvement Program
2019-2028

Updated CIP with $6 surcharge and development fee

Project Title	Total Project Cost	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029-2039
Stormwater General Projects												
Stormwater General Repairs/Upgrades		$ 120,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00
Capital Projects												
16th Street - Sheridan Street and Landes Street	$ 210,000.00	$ -	$ -	$ -	$ 60,000.00	$ 150,000.00	$ -	$ -	$ -	$ -	$ -	$ -
Hancock Street and 32nd Street	$ 180,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 180,000.00
Center Street - San Juan Avenue to Olympic Avenue	$ 400,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 125,000.00	$ 275,000.00	$ -	$ -	$ -
12th Street Right-of-way, Logan Street and 14th Street	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Inflow/Infiltration Removal - Lawrence Street at the intersections of Polk Street, Taylor Street and Tyler Street	$ 850,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 300,000.00	$ 550,000.00
Rainier Street Regional Stormwater Project	$ 808,000.00	$ 808,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Logan Street Stormwater Pond Overflow	$ 60,000.00	$ 10,000.00	$ 50,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Basin 8 - Wetland Overflow (Hastings Pond)	$ 250,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000.00
Basin 7 - Wetland Overflow (Glasbell Property)	$ 300,000.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 300,000.00
Basin 5 - Wetland Overflow (Behind Blue Heron Middle School)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Basin Planning												
Basin Planning Studies	$ 250,000.00	$ -	$ -	$ -	$ 50,000.00	$ -	$ -	$ -	$ 50,000.00	$ -	$ -	$ 150,000.00
Existing Street Stormwater Improvements												
Major Collectors and Minor Arterials	$ 600,000.00	$ -	$ -	$ 300,000.00	$ -	$ -	$ -	$ -	$ -	$ 300,000.00	$ -	$ -
Local Access Streets	$ 200,000.00	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -	$ 100,000.00	$ -
Stormwater Management Plan Updates												
Stormwater Management Plan	$130,000.00	$30,000.00	$ -	$ -	$ -	$ -	$ 100,000.00	$ -	$ -	$ -	$ -	$ -
	Total Per Year	$ 968,000.00	$ 100,000.00	$ 350,000.00	$ 260,000.00	$ 200,000.00	$ 150,000.00	$ 175,000.00	$ 375,000.00	$ 350,000.00	$ 450,000.00	$ 1,480,000.00
Debt Service Payments												

Appendix B

2012 Mill Road Pump Station and Force Main Predesign Report by CH2M HILL

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Predesign Report

City of Port Townsend – Mill Road Pump Station and Force Main

Prepared for

City of Port Townsend Department of Public Works

September, 2012

CH2MHILL®

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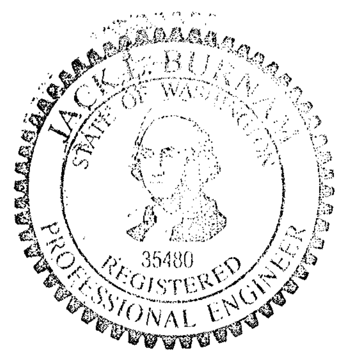
CERTIFICATION PAGE

CITY OF PORT TOWNSEND
MILL ROAD PUMP STATION AND FORCE MAIN

CITY OF PORT TOWNSEND DEPARTMENT OF PUBLIC WORKS

The engineering material and data contained in this Predesign Report were prepared under the supervision and direction of the undersigned, whose seal as registered professional engineer is affixed below.



CH2M HILL

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Contents

Acronyms and Abbreviations v

1. Introduction 1

2. Influent Flow 1

3. Gravity Collection Mains 2

4. Pump Station Design Criteria 4
- 4.1 Pump Station Structure 5
  - 4.1.1 Wet Well Sizing 5
- 4.2 Pump Station Mechanical Components 7
  - 4.2.1 Pumps 7
  - 4.2.2 Station Operation 8
  - 4.2.3 Pump Station Design Criteria 9
- 4.3 Pump Station Electrical Components 10
  - 4.3.1 Electrical Service 10
  - 4.3.2 Configuration 10
  - 4.3.3 Size of Main Electrical Components 10
  - 4.3.4 Pump Motor Starters and Standby Generator 10
  - 4.3.5 Storage versus Standby Generator 11
- 4.4 Pump Station Control System 11

5. Force Main Sizing and Alignment 13
- 5.1 Force Main Sizing 13
- 5.2 Force Main Alignment 14

6. Cost Estimate 14
- 6.1 Methodology 14
  - 6.1.1 Markups 15
  - 6.1.2 Assumptions 15

And I 7. Summary and Recommendations 16
- 7.1 Recommendations 18

Appendixes

A City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review
B Pump Curves for Submersible and Suction Lift Pumps
C Pump Station Force Main Alignment
D Cost Estimate
E Calculations

Tables

1 Calculated Influent Wastewater Loading at Build Out
2 Wet Well Storage Times
3 Advantages and Disadvantages of Submersible and Suction Lift Pumps
4 Pump Station Design Criteria
5 Pumped Flow versus Force Main Velocities
6 Gravity Collection Main Alternatives

Figures

1 Gravity Sewer Alignment
2 Cycle Time (T) Minutes vs. % of Influent Flow
3 Generic Wet Well Layout
4 Preliminary One-Line Power Diagram Mill Road Pump Station

Acronyms and Abbreviations

Cfs	cubic feet per second
Ft	feet
Fps	feet per second
Gpd	gallons per day
Gpm	gallons per minute
Hp	horsepower
Hrs	hours
Mgd	million gallons per day
MH	maintenance hole
Min	minutes
Rpm	revolutions per minute

1. Introduction

The intent of this Predesign Report is to further define the pump station identified as Alternative 7 in the December 2009 *Southwest Sewer Basin Study (Basin Study)*, by Gray & Osborne, Inc. The Basin Study evaluated the City's sewer basins and presented a series of alternatives for future development within and adjacent to the existing City limits. The data presented in the Basin Study was used to develop a peak hourly flow rate to use in development of the predesign of the new Mill Road Pump Station.

It should be noted that the intent of the Mill Road Pump Station is to collect domestic sewage from Basins 1, 2 and 3 (as identified in the Basin Study) through the use of a yet to be constructed gravity collection system consisting of 8 inch through 12 inch gravity mains. The collected sewage would then be lifted (pumped) approximately 200 (vertical) feet using a new force main to the existing gravity system serving the southwest portion of the City. The following material is presented and discussed in this Predesign Report:

1. Evaluation of anticipated influent flow (Section 2).
2. Backbone Gravity Collection System Alignment (Section 3)
3. New Pump Station design criteria (Section 4), including:
    a. The pump station (physical) structure.
    b. Mechanical components
    c. Electrical Components
    d. Control System
4. Force Main Sizing and Alignment (Section 5), including:
    a. Force Main Sizing
    b. Force Main Alignment
5. Cost Estimate(Section 6)
6. Summary and Recommendations (Section 7)

2. Influent Flow

The Basin Study had previously established an anticipated peak hourly influent flow (at build out) of 1,185 gpm. CH2M HILL reviewed the hydraulic modeling data from the City of Port Townsend's (City's) wastewater collection system as presented in the Basin Study. The summary evaluation Technical Memorandum entitled *City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review*, February, 2012 is included herein as Appendix A and summarized in the following.

As shown in Table 1 the anticipated peak hourly loading based on the results of the Basin Study was compared to that developed using the Washington State Department of Ecology *Criteria for Sewage Works Design* (October, 2006, commonly called the Orange Book).

The peak hourly flow will be used for sizing and design of the Mill Road Pump Station. As shown in Table 1 (above) the comparison of the various calculation methods to determine the peak hourly flow for design results in a difference of only plus 6 gpm or minus 126 gpm (from less than 0.5% to roughly 10% on the minus side). Based on these results it was decided to utilize the Basin Study anticipated flow of 1,185 gpm for the predesign of the new pump station and force main.

The peak hourly flow above represents the ultimate flow for the pump station or the peak hourly flow it is expected to experience in year 2046. The near term flows will actually be significantly lower than this until the area becomes more developed and each of the 3 basins are connected to the pump station. Because of this variation, the pump station shall be designed to accommodate a wide range of flows.

TABLE 1
Calculated Influent Wastewater Loading at Build Out

Influent Flow	Row	Basin Study Calculation	Orange Book Calculation
Average Dry Weather Flow (gpd)	(1)	588,400	588,400
Peak Day Flow (gpd)	(2)	1,008,600	1,008,600
Calculated Peak Day to Average Day Peaking Factor	(3) = (2)/(1)	1.71	NA[1]
Peak Hour to Peak Day Factor	(4)	1.70	NA[1]
Calculated Peak Hour to Average Day Factor	(5) = (4) x (3)	2.91	2.59[2]
Peak Hour Flow (gpd)	(6) = (1) x (5)	1,714,620	1,524,935
Calculated Peak Hourly Flow (gpm)	(7) = (6)/1440 min/day	1,191	1,059

[1] Not applicable for this comparison. Only comparing the Peak Hour to Average Day Factor (Row (5))

[2] Calculation of Peak Hour to Average Day Factor from the Orange Book = (18 + √23,000)/4+√23,000), where 23,000 is the population in 2046.

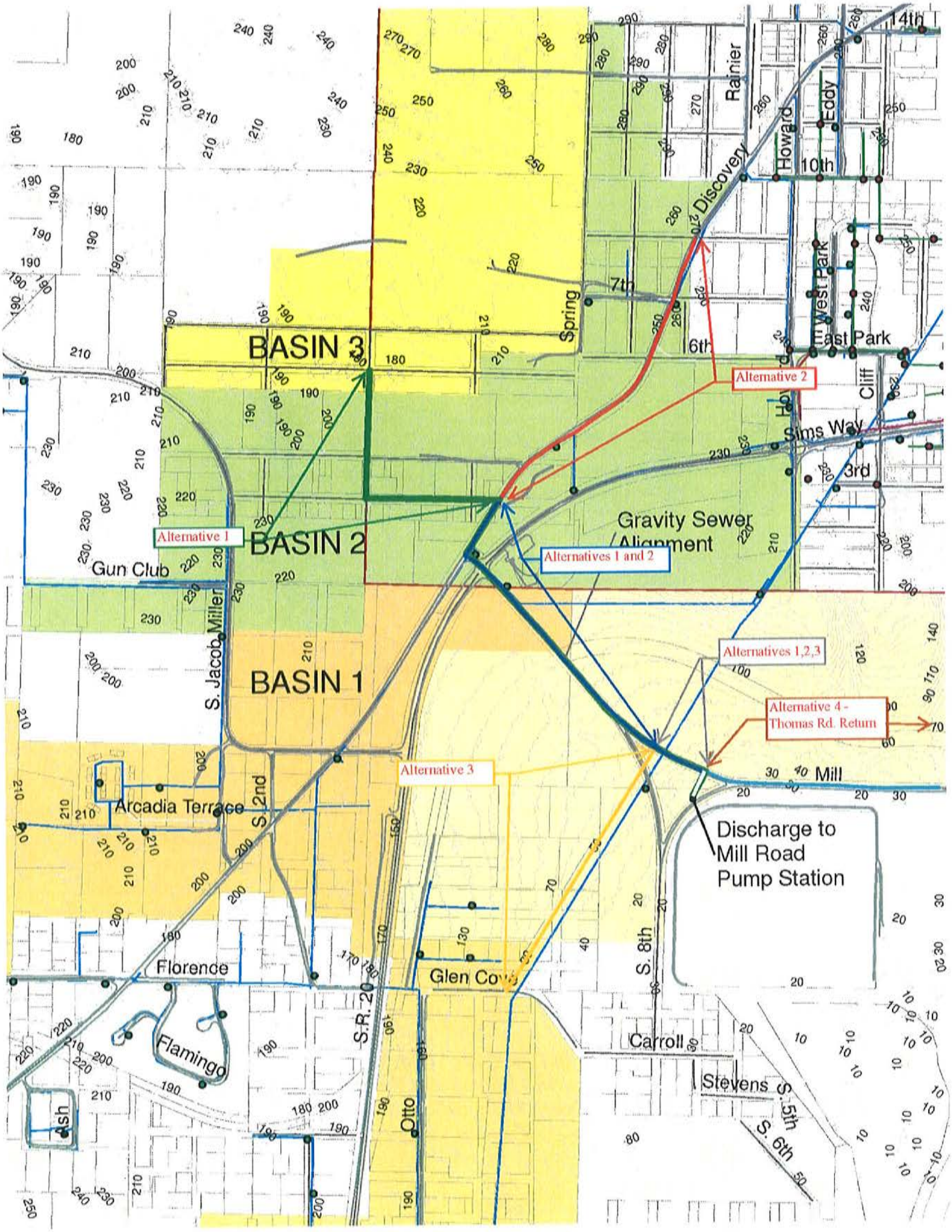
The following section describes the gravity system that will be needed to provide flow to the Mill Road Pump Station. The different alternatives are presented to give the City options when deciding which basin areas to connect first. These gravity lines (or a portion of them) will need to be constructed and individual users connected to this system before the Mill Road Pump Station can become operational.

3. Gravity Collection Mains

Transporting wastewater flows from Basins 1, 2, and 3 to the new Mill Road Pump Station requires the installation of a backbone collection main system. The backbone system described herein will just deliver flow from the individual basin areas to the new pump station. This backbone system **does not** include the required collection system within each basin to connect to the backbone line. The backbone collection system can be divided into four different alternatives, however, it should be realized that several alternatives may have to be installed (combined) to actually reach from the Basin indicated to the new pump station. The alternatives are shown graphically in Figure 1 and described in Table 2 (below).

It is very important to note here that the designation of the new backbone gravity line alignments and diameters are based on a cursory examination of Lidar survey elevations and resultant slopes. It is also important to note that road slopes on both Mill Road and Thomas Street have steep sections approaching 12 percent. In these sections installing the new gravity mains following the street profiles will result in flows running at supercritical velocities. It will be necessary to carefully design these reaches of sewer mains to eliminate (if possible) the supercritical flow reaches. Hydraulic jumps in the flow regime occur when flows transition from supercritical to subcritical velocities (the hydraulic jump dissipates the excess energy created in the supercritical flow). This jump can cause damage to the MHs as well as the immediately adjacent influent and effluent piping. In addition, the turbulence created by the hydraulic jump can release sulfides naturally occurring in sewage that can combine with the water and oxygen to form sulfide gasses (the rotten egg smell) or sulfuric acid which besides resulting in odor complaints could also affect the longevity of the pipe and MH at that location. The installation of new gravity sewers through such reaches is commonly accomplished by "stepping" the new sewer from MH to MH with either inside or outside drops at the downstream MH. This allows the gravity line to be installed at lesser slopes

Figure 1
Gravity Sewer Alignment



(avoiding supercritical flow velocities). By "stepping" the installation a balance between the required depth of the new gravity sewer to eliminate steep slopes and the cost of installation is also achieved.

TABLE 2
Gravity Collection Main Alternatives

Alternative	Description	Diameter (in)	Length (ft)
1	Allows flow collected in Basin 3 to extend south and east to a common collection point on Discovery Road.	8	1,690
2	Extends from the intersection of Discovery Road and 8th Street to the southwest to an intersection with Alternative 1 on Discovery Road.	8	2,200
Common Alternative 1,2	Extends from the common collection point on Discovery Road southwest to a cross over intersection with Mill Road, then southeast down Mill Road to an intersection with Alternative 3 (described below).	10	2,520
3	Extends from an unimproved road easement north from Glen Cove Road to a power line easement; then north and east in the power line easement (paralleling an existing water line) to a connection on Mill Road with Common Alternative 1,2.	8	1,870
Common Alternative 1,2,3	Extends east on Mill Road to the junction with Alternative 4 (below).	12	187
4	Parallels the new force main from the pump station – allows the City to pick up existing lots below (south) of the connection point of the new force main into the City's gravity collection system. This gravity line would begin on the lower reaches of Thomas Street and proceed south to Mill Road and then east on Mill Road to the connection with Common Alternative 1,2,3 and into the new pump station.	8	3,500

Anticipated gravity line diameters are based on assumed flows. The information contained herein is for planning level purposes only. A more detailed design survey would be required to confirm actual slopes, lengths and diameters of this gravity collection backbone system.

4. Pump Station Design Criteria

The design of the new pump station has to take into account the near term and long term uses that it will likely experience. In the near term, influent flows are not expected to be at or near the anticipated build out flows of 1,185 gpm. Accepted life span estimates for structures are commonly in the 50 to 100 year range assuming that standard operation and maintenance practices are performed. Accepted life span estimates for electrical equipment (pumps, controls, power, etc.) are in the 15 to 25 year span again assuming standard operation and maintenance practices.

There are three generic types of pump stations, each based on the type of pumps used to convey the flow from the station to its destination. These are:

1. Wet Pit/Dry Pit pump stations – these have a standalone wet well with a suction pipe extending from the wet well to the dry pit where the pumps are located at the same elevation as the wet well. These pump stations can come as a package however, when this does occur they are very tight quartered. This type of pump station is more expensive to design and construct. It is commonly considered for pump stations that would exceed 3 mgd (2,083 gpm). This is when the installation of the additional structures for separate or contiguous wet wells and dry pump pits can become more cost effective. This type of pump station will not be considered further herein.

2. Submersible pump stations – in this type of station the pumps actually sit down in the wet well. The footprint of the station is much reduced over wet pit/dry pit stations with an associated reduction in cost for design and construction. This is common for pump stations that are to accommodate influent flows of 3 mgd (2,083 gpm) or less.
3. Suction Lift pump stations – similar to the submersible pump station described above, but have the suction lift pumps sitting on top of the wet well out of the actual influent flow. Because of the additional components outside the wet well, this type of station is commonly more expensive than a submersible station due to the need for additional structures to protect the pumps, etc. from the elements but is still less expensive than the wet pit/dry pit pump stations. As above, this is also common for pump stations that are to accommodate influent flows of 3 mgd (2,083 gpm) or less.

4.1 Pump Station Structure

Current best practices for structures are to build the structure that is needed for the long term (up to build out) for the following reasons:

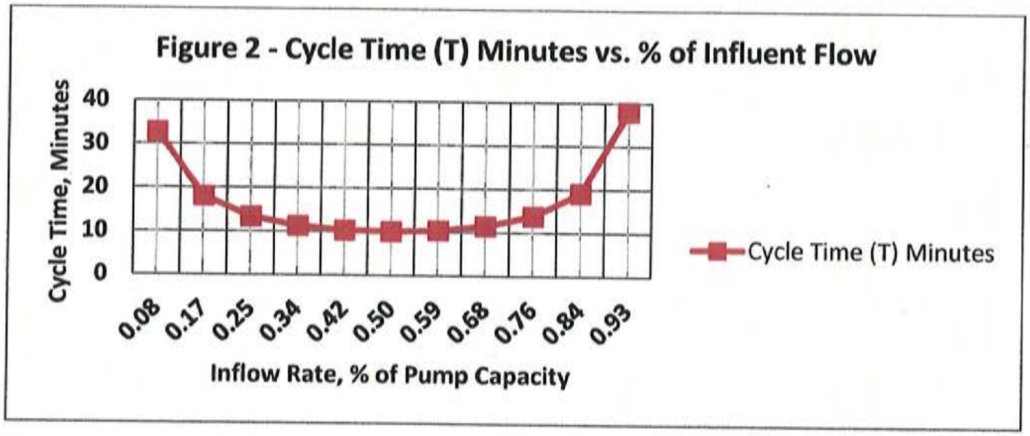
1. A properly constructed and maintained structure will last well past the anticipated planning horizon of 2046 (34 years into the future).
2. The construction of a wet well structure that would have to be expanded in the future is difficult and would require that the (then) existing structure be shut down to allow for the installation of additional storage.
3. This would require the excavation of the wet well which in this case is likely below the existing ground water level.
4. The new pump station is to be constructed on a limited site so the construction of an expansion to the existing wet well would likely also require the removal of much of the above grade equipment to make room for the construction. This would exacerbate the length of the shut down and would likely require additional property outside the station easement to stage and complete construction.
5. It should be recalled that at the time of the potential expansion, influent flows will have built up close to that of ultimate build out. Shutting down the station to accommodate the new construction on the structure would likely require the installation of a significant by-pass pumping operation so that those in the stations service area would not be adversely affected. The cost for a by-passing operation of this magnitude (approximately 1.7 mgd) can be as much as the cost for the excavation and installation of the additional wet well walls.
6. Any by-pass pumping operation increases the risk of a surface spill of raw wastewater. This can result in fines from controlling agencies as well as impact the public and businesses nearby the station.

For these reasons, the predesign is based on the construction of the physical features required to accommodate the ultimate build out influent flows.

4.1.1 Wet Well Sizing

Three criteria were used to determine the size of the required wet well:

1. Maintenance of an active storage volume that will require a single pump to go through one complete cycle from pump on to pump off and back to pump on in no less than 10 minutes (maintaining a maximum number of cycles to six (6) per hour). For a two pump redundant system this would mean that the number of cycles per hour would be twelve (2 X 6) per hour. Note that the worse case cycle time always occurs when influent flow is equal to one half (1/2) the pumping rate. This is shown graphically in Figure 2.



2. Providing a minimum of 60 minutes of storage between the high, high water alarm and the invert of the influent line to the station at anticipated build out influent flows of 1,185 gpm. Meeting this criterion while still allowing for the use of suction lift pumps (maximum lift of 17.5 feet) requires a wet well diameter of 45 feet. This allows for greater storage when the pump station is first brought on line and influent flows have not yet reached the peak hour rate anticipated at build out (1,185 gpm). The available storage times based on varying influent flows are shown in Table 3 (below).

TABLE 3
Wet Well Storage Times

Influent Flow (gpm)	Wet Well Diameter (ft)[1]	Storage Depth (ft)	Storage Time (min)	Storage Time (hrs)
200	45	5.98	355.5	5.93
400	45	5.98	177.8	2.96
600	45	5.98	118.5	1.98
800	45	5.98	88.9	1.48
1,000	45	5.98	71.1	1.19
1,185[2]	45	5.98	60.0	1.00

[1] The wet well diameter can vary while still maintaining the required 60 minutes of retention at peak hour flow by varying the storage depth. It should be noted that the depth of the wet well may be limited by the type of pump selected for use. Suction Lift pumps have a limit to the lift that they can accommodate.

[2] Peak Hour influent flows at build out (planning horizon)

3. For preliminary design purposes, set the wet well depth so that it will work for both submersible and suction lift pumps. Suction lift pumps will limit the depth of the wet well between pump volute and Pump Off elevation to approximately 17.5 feet. The diameter of the new wet well has to be balanced against the depth to insure that the required active storage volume is achieved. The other limit on this is the sensitivity of the controls for pump on and off – for the purposes of this preliminary design it was assumed that the minimum depth between pump on and pump off could be no less than six (6) inches. This allows for variations in instrument sensitivity and wet well diameter while still meeting the requirements for the use of suction lift pumps. A decision to use submersible pumps only would allow for a reduction in wet well diameter and deepening of the active storage volume.

It should be noted that accommodating influent flows that will be significantly less than those anticipated at build out will be accomplished through the control system and set levels on the pump operation. This is discussed further in the following.

4.2 Pump Station Mechanical Components

4.2.1 Pumps

As stated above, the use of a wet pit/dry pit pump station is not recommended for an application that is this far out in the service area and that experiences this type of low flow. Limiting the new pump station to a single wet well limits the types of pumps that may be used to either submersible pumps that are installed in the wet well or suction lift pumps that are installed on top of, or adjacent to, the wet well with suction piping that extends into the wet well. The advantages and disadvantages of submersible and suction lift pumps are presented in Table 4.

TABLE 4
Advantages and Disadvantages of Submersible and Suction Lift Pumps

Pump Type	Advantages	Disadvantages
Submersible Pumps	Smaller footprint than other pump types. Maintains surface construction to a minimum	Pulling pumps for maintenance or repairs is messy. Requires a wash down area at the wet well so that pumps can be cleaned off prior to loading on trucks, etc.
	Can accommodate deeper wet wells, suction lift limitations do not apply.	Requires the maintenance of a "dead" storage volume in the wet well that acts to cool the pump motors during operation
	Can accommodate a wide range of TDH and flow conditions.	Access to motors and impellers requires pulling the pumps from the wet well.
	Less costly because most mechanical equipment is below ground, does not require an above surface structure to house the equipment	Does require the wet well to have 2 to 3 feet of dead storage (depending on the pump) to act as cooling during pump operation.
	Simple Mechanical System	Pulling the pumps to perform maintenance operations will require a cleaning area.
Suction Lift Pumps	Motors, volutes, etc. are at ground surface and more accessible for operation and maintenance activities.	Requires more surface construction or installation of a package pump station on top of or adjacent to the wet well
	Pump wash down area is not required when taking pumps down for maintenance.	Limits depth of the wet well to the depth of maximum suction lift, available lift will vary based on suction pipe diameter, motor Hp and impellers.
	Commonly supplied as a "package" lift station such that all the associated station piping, priming pumps, controls, etc., come in one package contained in a steel container that is set on the new wet well.	More Costly when compared to a submersible system because more equipment is above grade and needs to be housed in a structure to protect it.
	Pulling the pumps for maintenance will not require a cleaning area.	More complex mechanical system including additional equipment (primer pump)
		Once maximum depth is reached the only way to create additional volume is by increasing the diameter.

It should be noted that there are additional expenses associated with the construction/installation of a suction lift package pump station that make it the more expensive option. As stated in Table 3, suction lift pumps are commonly supplied as part of a "package" lift station that includes all the ancillary equipment required to operate the station. This can include priming pumps, discharge piping, check valves and controls connected to an in station control system. This control system can then be connected to a PLC for operating the station and annunciating alarms via either the City's SCADA system or via telephone lines. Whether or not the advantages of the suction lift station outweigh the associated costs are a judgment call that the City will have to make.

The pump station shall include a minimum of two pumps, each capable of accommodating the anticipated peak hour influent flow of 1,185 gpm (providing full redundancy). It is further recommended that a third pump be purchased at the time of construction and provided to the City for storage as a replacement for one of the installed pumps should a failure occur. Supplier lead times for replacement pumps or even parts have been increasing and the relatively remote location of the City would support this recommendation.

4.2.2 Station Operation

Pump station controls will operate the pumps/station in the following manner:

1. Pumps will operate in a lag/lead manner that automatically switches the lead pump to come on after every pumping cycle (one pump cycle is from pump on – to pump off and back to pump on again). This will equal out the hours that each pump operates over time.
2. Controls will include(starting from the bottom of the wet well):
   a. Dead storage – this extends from the bottom of the wet well to the height required to cover the pump motor and provide cooling as recommended by the manufacturer of the submersible pump. NOTE THAT THIS IS ONLY REQUIRED FOR SUBMERSIBLE PUMPS.

   b. Low, low level alarm/redundant pump off – this control elevation is approximately 6" below the Pump Off elevation. In a submersible pump station this level would also represent the top of the dead storage required to cool the pump motors. It actuates an alarm indicating that the pumps are not shutting off at the control point specified and are pumping down the wet well to an elevation where suction could be lost or the pump motor could overheat.

   c. Pump Off elevation – pump off set point for one pump operating or both pumps operating.

   d. Pump On elevation – the difference between this elevation and the pump off elevation represents the "Active Storage" volume of the wet well. At this elevation the lead pump is called into service to pump the "active storage" volume down to Pump Off elevation.

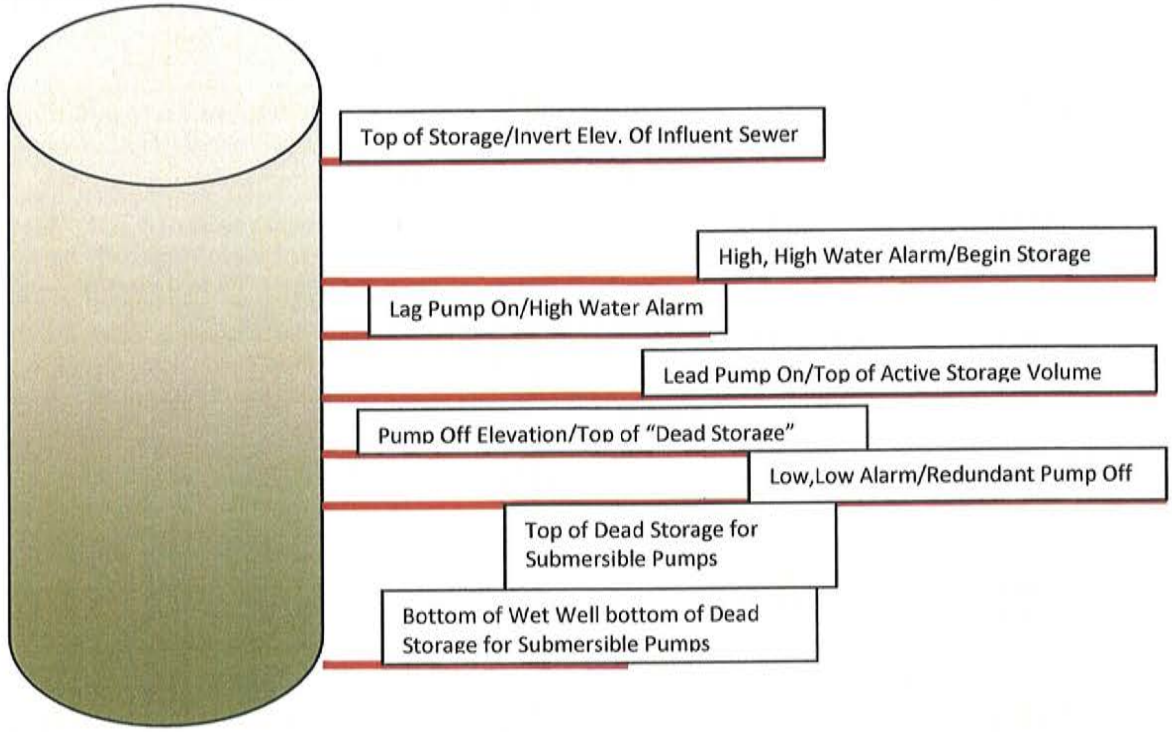
   e. High Water Alarm/Redundant Pump On elevation – this occurs if the lead pump is called to operate and either fails or cannot keep up with the influent flow and the level in the wet well continues to rise. Once it reaches this elevation the second pump (lag pump) is called to operate and an alarm is sent indicating that for whatever reason the lead pump could not keep up with influent flow (potential reasons for lead pump failure could include ragging, motor failure, power failure, impeller wear, etc.).

   f. High, High Water Alarm Elevation – is sent once both pumps have been called to operate and the level in the wet well continues to rise. The high, high water alarm elevation also represents the bottom elevation of storage included in the wet well design for situations such as this.

   g. Influent Sewer Invert Elevation – this is commonly the top of the storage volume included in the wet well design. The intent is to contain all storage within the wet well rather than depending on possible storage within the collection system.

Figure 3 below shows a representation of the wet well and control elevations. In order to size the wet well the operation of the station must be determined. These criteria should be used for design of the wet well in addition to the controls system.

Figure 3
Generic Wet Well Elevation Layout



4.2.3 Pump Station Design Criteria

The design criteria in Table 5 were used to develop the preliminary design for the Mill Road Pump Station.

TABLE 5
Pump Station Design Criteria

Peak Hour Influent Flow	**1,185 gpm**
No. of Pumps	2 (minimum) – each able to accommodate peak hourly influent flow (completely redundant) Whether or not to provide a third pump as a standby for replacement of the two operating pumps should be evaluated during final design. The speed of each operating pump shall be controlled by a adjustable frequency drive (AFD).
Storage Capacity	60 minutes at Build Out without utilizing the influent line for storage.
Standby Generator	Install as part of the initial construction sized to provide the ability to start both pumps (with a lag time in between starts) and run both pumps and the station lighting, controls and SCADA.
Pump Cycle Time	No more than 6 complete cycles per hour (Minimum 10 minute cycle time from pump on to pump on again assuming one pump in operation)
Active Storage Volume	Based on Equation $T = V/i + V/(q-i)$ Where: T = time (min); V = volume (gallons); i = influent flow (gpm); q = pumping rate (gpm) NOTE: Minimum cycle time occurs when influent flow equals one-half of the pumping capacity.
Wet Well Construction	Wet well shall be designed and constructed to accommodate anticipated peak flow at build out (1,185 gpm). Design and construct bottom of wet well to be self cleaning – slope sides to a center channel that will direct solids to the pump suction and create velocities to the suction that will enhance lifting the solids into the pumps.

Peak Hour Influent Flow	1,185 gpm
Wet Well Construction	Predesign is based on the installation of a concrete caisson for the new wet well due to high groundwater concerns. Other installation methods may be possible but will require significant shoring and dewatering efforts.
Submersible Pump	Flygt NP 3315 HT 3˜ 456 – 1760 RPM – 160 Hp (used for comparison purposes in predesign) Pump curves included herein in Appendix B – Pumps should be installed AFD's to limit inrush current during start up.
Suction Lift Pump	Smith & Loveless 8D4V – 1760 RPM – Maximum Suction Lift = 17.5 feet (conservative) – 150 Hp (used for comparison purposes in predesign) Pump curves included herein in Appendix B – Pumps should be installed with AFD's to limit inrush current during start up.
Station Operation	As described above (Section 4.2.2) Alarm modes and actual elevations to be confirmed in final design. Additional alarm sequences to be confirmed with the City if needed.
Required Generator to run Station during extended outage events	Required Standby Generator Power: either 150kW or 350kW. The 150 kW generator will run the station and one pump. The 350 kW generator will run the station and two pumps.

4.3 Pump Station Electrical Components

As previously stated, electrical components for a pump station of this nature commonly are assumed to have an average life span of 20 years. This is less than the planning horizon of 2046 (34 years into the future), however, logic would dictate that savings generated by putting in lower Hp pumps and electrical equipment for today would not exceed the cost required to install the higher Hp pumps and associated electrical equipment 20 years into the future. In addition, there is no way to truly tie down the rate at which flows would increase to the pump station over time. More recent experience would indicate that it would take longer to reach predicted peak influent flows rather than less time. But this cannot be guaranteed. For the purposes of this preliminary design it has been assumed that the electrical components will be designed for complete build out flows.

4.3.1 Electrical Service

Given the size range of the pumps, 160 hp to 150 hp, the electrical service from the local utility will need to be 480 volts, 3-phase. Assume 600 amperes for initial planning purposes.

4.3.2 Configuration

The electrical service will include a utility power meter with current transformer enclosure, main breaker, automatic transfer switch, and an installed standby generator. A preliminary one line diagram of this configuration is shown in Figure 4. Other components will depend upon the type of pumps selected

4.3.3 Size of Main Electrical Components

The above ground electrical equipment will need to be protected from the weather and securable. This can be accomplished using a shelter and lockable enclosures or a single lockable enclosure with components mounted inside. The footprint will vary depending again on the type of pumps selected but assume a shelter will be larger and allow a space 16ft long by 8ft wide. The other main component is the standby generator. Allow a space 7ft wide by 20ft long by 10ft high for a permanently installed generator capable of powering two 160hp pumps at the same time. (This assumes that the two pumps will start in a lead/lag configuration and that they will be controlled by AFD's or have solid state soft starts on them.)

4.3.4 Pump Motor Starters and Standby Generator

The pump motors are large enough to require means to reduce the motor starting current which is often six or more times the motor running current. There are several means to control the starting current, but the two to be considered here are solid-state "softstarters" and adjustable frequency drives (AFDs). While AFDs are not "needed" for the operation of the pump station, they can be used to reduce the size of the mobile generator needed to operate the station during a utility power outage. A single pump operated on an AFD requires only a 150kW standby generator while a pump operated on a softstarter requires a 250kW standby generator. AFDs are generally twice as expensive as softstarters but AFDs have better power factor and reduce the starting current more. If both pumps are required to operate on a standby generator then the size of the generator will be the same for both types of starters, i.e. about 350kW.

4.3.5 Storage versus Standby Generator

The City has stated that they want to have the standby power generator installed at the time of initial construction. However, if desired, the large change anticipated between initial influent flows and those that would occur at build out can be used to delay the installation of a standby generator. By constructing the new structure so that it will have a minimum of 60 minutes of storage capacity following an alarm for a power outage or pump failure at ultimate peak hour conditions (1,185 gpm, build out) will mean that up to several hours of storage are available during the time from initial construction until build out flows are reached. As shown in Table 3 in the near term when influent flows will be less than those anticipated for build out the new system will exhibit larger retention times.

If delaying the installation of the standby mobile generator is chosen the design for the new station would include a connection point for a portable generator to plug in so that during an extended power outage the station could be brought back on line using the generator. The City would monitor flows at the pump station in order to decide when a permanent standby generator would be installed in the future.

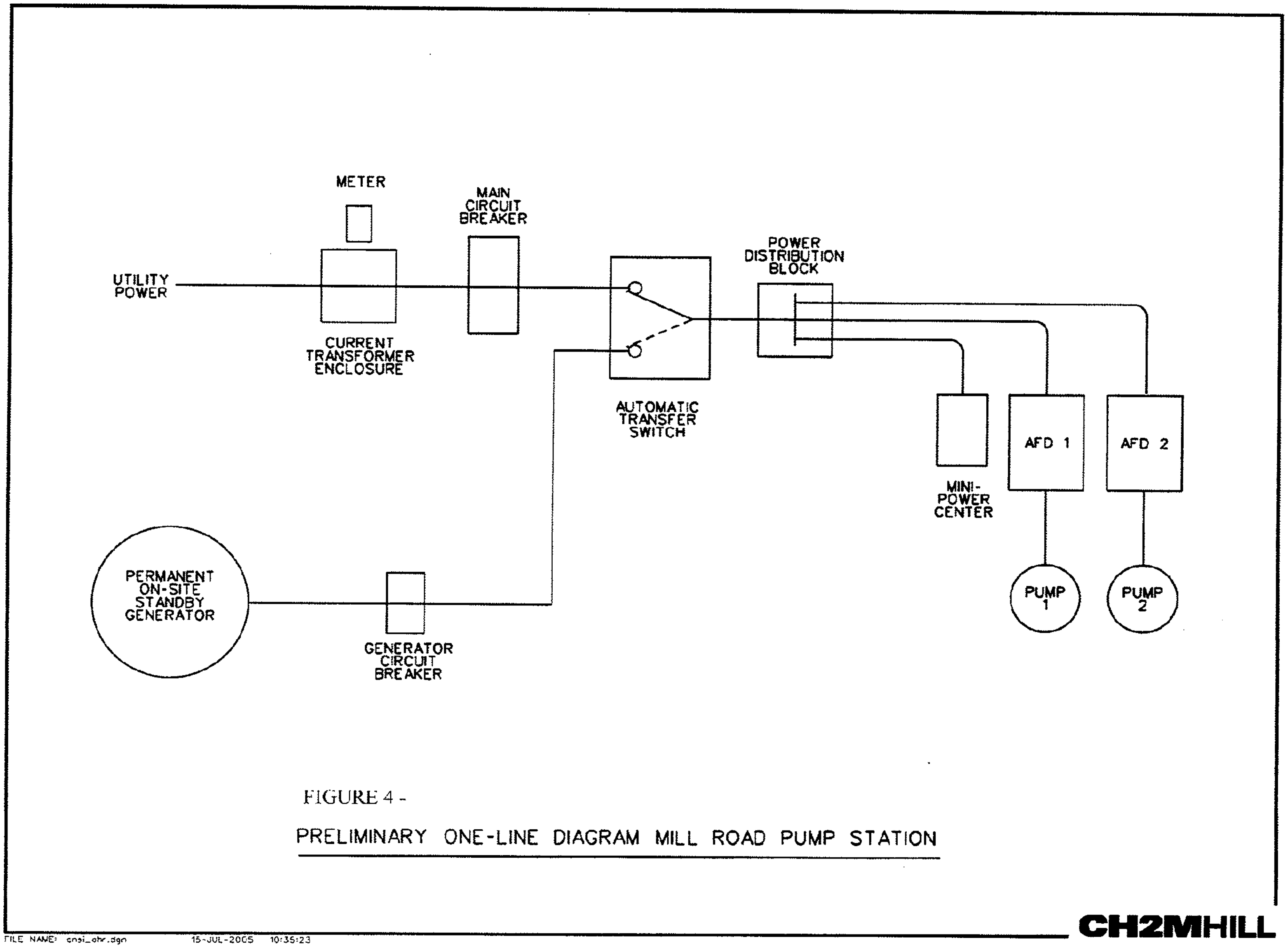
4.4 Pump Station Control System

The control system design for the pump station will be customized to meet current City standards for equipment and functionality. In addition to matching existing City technical standards, the control system will be designed to integrate the features and equipment associated with the selected pump station configuration.

Although specifics of the control system cannot be defined at this point, the following outlines the general elements of the control system that will be incorporated into the pump station design.

1. Programmable Logic Controller (PLC): A PLC will be used as the central controller for the pump station. For the submersible pump option, the PLC will control all functions of the pump station. For the suction lift pump option, the package controls for the pumps will be integrated with the pump station PLC to provide facility control. The PLC manufacturer and model will be selected to match City standards.
2. Local Operator Interface (OI): An operator interface device will be included to allow operations staff to locally monitor equipment operation, control equipment and adjust pump station operations setpoints. The OI manufacturer and model will be selected to match City standards.
3. SCADA System Communications Interface: The pump station PLC system will be integrated into the City's existing SCADA system. The communications interface will allow pump station operation, status and alarm signals to be viewed and controlled remotely. The communications system will be designed to match the communications systems currently in service.
4. Wet Well Level Sensor: A wet well level sensor will be installed to provide continuous measurement of the wet well level. Operator adjustable level setpoints for pumps off, lead pump start and lag pump start will be compared against the level signal for pump control.
5. Wet Well Float Switches: Float switches for low-low and high-high level detection will be installed (if applicable to City standards) for detection of the low-low water level/redundant pump off and high-high water level alarms. These float switches can also be used as a backup control to start and stop the pumps in the event of a wet well level sensor failure.

FIGURE 4
Preliminary One-Line Diagram Mill Road Pump Station



6. Intrusion Detection: Sensing devices will be installed within the pump station to detect intrusion into the facility. The types of devices used will be based upon the selected pump station configuration and City standards.

Support Systems Integration: The control system design will include PLC interfaces to pump station support systems such as the backup power generator and combustible gas monitors.

5. Force Main Sizing and Alignment

5.1 Force Main Sizing

Force mains should be sized to maintain a minimum flow velocity of 2.0 fps to prevent solids from settling in the line between each pumping cycle (in many cases a minimum velocity of 2.5 fps is preferred to insure movement of solids during each pumping cycle). Maximum force main velocities should not exceed 7.0 fps to prevent the creation of significant headlosses that would increase the pump power required, cost of operating the pumps and the required size of the standby generator. A breakdown of pumped flow versus velocity in force main diameters from 6 inches to 10 inches is shown in Table 6.

TABLE 6
Pumped Flow versus Force Main Velocities

		Velocity (fps)[1]		
Pumped Flow (gpm)	**Pumped Flow (cfs)**	**6 inch Force Main**	**8 inch Force Main**	**10 inch Force Main**
200	0.45	2.27	1.28	0.82
400	0.89	4.54	2.55	1.63
500	1.11	5.67	3.19	2.04
600	1.34	6.81	3.83	2.45
800	1.78	9.08	5.11	3.27
1000	2.23	11.35	6.38	4.09
1185	2.64	13.45	7.56	4.84
[1] Flow velocities within the acceptable range of 2.0 fps to 7.0 fps are highlighted				

Based on the peak hourly flow of 1,185 gpm, a 10 inch diameter force main should be installed for this application for the following reasons:

1. It would not be cost effective to install a smaller force main and then replace it with a larger force main in the future. This would also require additional work at the pump station to revise the piping and increase easement widths required for the force main to allow installation of a second line while keeping the first line in service (to limit any required shutdowns of the pump station).
2. The installation of an 8 inch force main or 6 inch force main would result in increasing the TDH for the pump station by 82 feet and 324 feet, respectively, at the build out flow of 1,185 gpm. Both would increase required pump horsepower and electrical system design and installation costs.
3. During final design the City can look at reducing the flow rate from the recommended pumps by installing a trimmed impeller. This would also reduce the motor Hp required. However, if this is considered, it should be realized that the pump impellers and motors could require switching out before the end of their useful life.

The flow from the pumps will need to be at least 500 gpm to provide the needed minimum velocity in the forcemain.

5.2 Force Main Alignment

The alignment of the new force main from the pump station is shown on plan and profile sheets included herein Appendix C. Generally, the new force main will exit the pump station site on Mill Road (north side), then proceed east on Mill Road (remaining on the north side of the road) to the intersection with Thomas Street; north on Thomas Street (remaining on the west side) to a location just above Workman Street. As shown on the included plan and profile sheets the new forcemain would then proceed east again following an undeveloped road easement to an existing MH connected to the City's gravity collection system on the southern end of Logan Street. The force main would discharge into this MH. Alternatively, the new force main could continue north on Thomas Street to 4th Street and discharge into a MH at this location. Some resloping of the existing sewer on 4th Street would likely be required to make this alternative work. For planning purposes, the cost for either alignment would be roughly the same. The approximate length of the new force main is 4, 278 feet.

6. Cost Estimate

Table 7 is a summary of the estimate costs. The base construction cost shown includes mobilization, bonds, contingency and escalation. It does not include project costs such as design, administrative, legal, or services during construction. See Appendix D for a complete breakdown of the costs included in each category.

TABLE 7
Cost Estimate Summary

	Low Range	Estimate Range	High Range
	-20%	**Base Cost**	+30%
Submersible Pump Station & Force Main (yard piping)	$1,633,000	**$2,041,000**	$2,653,000
Suction Lift Pump Station & Force Main (yard piping)	$1,702,000	**$2,127,000**	$2,765,000
Force Main	$882,000	**$1,102,000**	$1,433,000
Gravity Pipe Alt 1	$306,000	**$383,000**	$498,000
Gravity Pipe Alt 2	$394,000	**$492,000**	$640,000
Gravity Pipe Common Alt 1 & 2	$542,000	**$678,000**	$881,000
Gravity Pipe Alt 3	$170,000	**$213,000**	$277,000
Gravity Pipe Common Alt 1, 2 & 3	$43,000	**$54,000**	$70,000
Gravity Pipe Alt 4	$674,000	**$843,000**	$1,096,000

6.1 Methodology

This cost estimate is considered a Schematic Design Estimate (Class 3) construction cost estimate. It is based upon the 15 percent design drawings and specification dated May 2012, and design information provided by the engineer at the time of the estimate.

Where possible, a quantity takeoff was developed for all elements shown in sufficient detail in the design drawings or described in the report. For an item known to exist but not defined in the project drawings, the cost estimator applied an allowance based on estimator experience and consultation with the project engineer.

The final costs of the project will depend on actual labor and material costs at the time of bid, actual site conditions, productivity, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from those presented herein. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

6.1.1 Markups

Table 8 summarizes various markups applied to the cost estimate to develop the overall construction cost. Unit costs include contractor overhead and profit. Mobilization, contingency, sales tax, market factor and escalation are also applied to the bottom line totals.

TABLE 8
Markup Summary

Markup	Percentage
Contractor Overhead & Profit (In unit costs)	18%
General Conditions	7%
Mobilization/Bonds/Insurance	5.16%
Construction Cost Estimate Contingency	40%
Escalation (Aug 2013)	3.58%
Sales Tax (Port Townsend)	9%
Market Conditions	0%

6.1.2 Assumptions

The following assumptions were used to develop the construction cost estimate:

General Assumptions:

1. Labor rates are based on the RS Means National Average Rate and adjusted for local wage rates using the RS Means regional adjustment factor.
2. The estimate currently includes escalation to mid-point of construction to August 2013.
3. Costs assume that the work is done during a regular 40 hour work week and does not include any overtime cost markups.
4. Costs do not include purchase of easements or right-of-way, engineering, administration or owner costs beyond the capital construction costs. The cost estimate is intended to represent the total contractor bid price as shown on the bid price schedule at the time of the bid opening.
5. Site access for the contractor and contractor staging areas are assumed to be adequate for the contractors needs.
6. The estimate is based on aggregates, drain sand, and clay materials being available locally to the contractor.
7. Temporary erosion and sediment control are expected to be minor. No wetland impacts are known at this time.
8. Pipe trenching is based on 5' of cover to the top of the pipe.
9. It is assumed that dewatering for pipe trenching can be controlled with sump pumps in trench.
10. Roadway patching is based on 6" of asphalt over 6" of crushed surface base course.
11. The pump station wet well construction is based on a dropped caisson construction.
12. Due to the pump cooling requirements the submersible pump station wet well is 30" deeper than the suction lift pump station.

13. The pipe alternatives costs with the exception of Alternative 3 are based on the pipeline being placed in the roadway and include ACP demo and patching. Alternative 3 is outside of the roadway and travels cross country.
14. The estimate includes a 350 KW standby generator at the pump station and VFD's controlling the pumps.

7. Summary and Recommendations

The following (Table 9) summarizes the previous discussions and presents recommendations for taking the new Mill Road Pump Station and Force Main into design.

TABLE 9
Summary

Item	Description	Recommendation
Pump Station		
Wet Well	Several methods of construction of the wet well were considered, however, due to the existence of high groundwater it appears that a circular wet well installed as a caisson would work best in this situation. It would limit the need for dewatering and for shoring which would be an advantage.	Install the new wet well as a caisson. This would be a concrete structure and would include a corrosion resistant lining (once completed and the bottom sealed)
Wet Well Diameter	For the purpose of this planning level evaluation, it was decided to make the wet well compatible with the use of either submersible or suction lift pumps. If submersible pumps are chosen for final design it may be possible to reduce the diameter and deepen the wet well creating a somewhat smaller footprint.	Anticipated ID of the wet well is 45 feet to obtain a standby storage capacity of 1 hour at buildout and keeping the wet well shallow enough to use suction lift pumps. Wall thickness is 2 feet. Anticipated OD of the wet well is 49 feet.
Wet Well Depth	Depth in this case is based on the anticipated elevation of the suction pump volute which has been estimated as 18" above the top cap of the wet well. From this point down the depth to the established pump off elevation can be no more than 17.5 feet.	Assuming surface elevation = 23.0 feet Suction Lift Station – depth from surface elevation to pump off elevation = 15.98 feet Submersible Pump Station - depth from surface elevation to bottom of dead storage = 17.98 to 18.98 feet (depending on depth of dead storage required to cool pump motors)
Pumps	System head curves for both the use of submersible pumps and suction lift pumps were developed. These were graphed against pumps curves for both types of pumps to identify pumps that could be used under this scenario. It was also noted that if suction lift pumps were used they would be supplied as a package that included the priming pumps, controls, station piping, etc. within a epoxy coated steel container.	Submersible pump recommendation: Flygt – Model NP 3315 HT3-456; 160 Hp; station piping diameter = 6"; Impeller diameter = 15 7/8" Suction Lift Pump recommendation: S&L – Model 8D4V, 150 Hp, Suction pipe Diameter = 12"; Station piping diameter = 8"; Impeller diameter = 14 5/8" – Included in a package suction lift station. *System head curves vs. pump curves are included in the appendix.*
Station Operation	See Section 4.2.2 and Table 5	See Section 4.2.2 and Table 5
Alarms and Communication	This would have to be in keeping with the City requirements and should be vetted early in the actual design phase.	See Section 4.4
Standby Generator	As discussed in Section 4.3.4 (above) the intent is to	Required Standby Generator Power: either 150kW or

Item	Description	Recommendation
	install the required standby generator during original construction. If this is revised during final design a plug in for the use of a mobile standby generator during the initial years of station operation will be included. This will continue as long as the City believes that the provided storage in the wet well is enough to allow City Maintenance Crews to access the station and provide standby power during any extended outage event. Once influent flows reach a point where either City Crews cannot access the station quickly enough or storage time reaches 60 minutes – then a permanent standby generator will be installed.	350kW.
Force Main		
Alignment	Generally, the new force main will exit the pump station site on Mill Road (north side), then proceed east on Mill Road (remaining on the north side of the road) to the intersection with Thomas Street; north on Thomas Street (remaining on the west side) to a location just above Workman Street; at this point the new force main can proceed either west again following an undeveloped road easement to an existing MH connected to the City's gravity collection system on the southern end of Logan Street or continue north to a connection to the existing collection system on 4th Street.	Plan and Profile Sheets contained in the attached Appendix.
Length		4,278 feet
Diameter		10"
Gravity (Backbone) Collection System		
Alternative		
1	Allows flow collected in Basin 3 to extend south and west to a common collection point on Discovery Road.	Length = 1,690 feet; Diameter = 8"
2	Extends from the intersection of Discovery Road and 8th Street to the southwest to an intersection with Alternative 1 on Discovery Road.	Length = 2,200 feet; Diameter = 8"
Common Alternative 1,2	Extends from the common collection point on Discovery Road southwest to a cross over intersection with Mill Road, then southeast down Mill Road to an intersection with Alternative 3 (described below).	Length = 2,520 feet; Diameter = 10"
3	Extends from an unimproved road easement north from Glen Cove Road to a power line easement; then north and east in the power line easement (paralleling an existing water line) to a connection on Mill Road with Common Alternative 1,2.	Length = 1,870 feet; Diameter = 8"
Common Alternative 1,2,3	Extends east on Mill Road to the new pump station site	Length = 187 feet; Diameter = 12"
4	Parallels the new force main from the pump station – allows the City to pick up existing lots below (south) of the connection point of the new force main into	Length = 3,500 feet; Diameter = 8"

Item	Description	Recommendation
	the City's gravity collection system. This gravity line would begin on the lower reaches of Thomas Street and proceed south to Mill Road and then east on Mill Road to the connection with Common Alternative 1,2,3 and into the new pump station.	
Estimated Cost		
	Based on planning level considerations including a 40% contingency for unknowns at this time. As shown here the estimate has been broken into several categories and a complete copy of the estimate is included in Appendix D:	
	Submersible Pump Station w/Force Main (yard piping)	$2,041,000
	Suction Lift Pump Station w/Force Main (yard piping)	$2,127,000
	Force Main (outside yard piping)	$1,102,000
	Gravity Lines	
	Alternative 1	$383,000
	Alternative 2	$492,000
	Alternative 1 & 2	$678,000
	Alternative 3	$213,000
	Alternative 1, 2 & 3	$54,000
	Alternative 4	$843,000

7.1 Recommendations

The following steps need to be undertaken to initiate and complete final design:

1. A complete survey of the gravity alternatives needs to be completed to better document the existing slopes that will have to be accommodated and what steps (if any) that will be required to eliminate or at least reduce the occurrence of supercritical flow regimes.
2. A survey of the alternative force main route to 4th Street needs to be completed to determine the feasibility of the alternative route and whether the static head requirements change significantly.
3. Soil borings need to be completed for the new pump station site and the alternative pipeline alignments (gravity and force main) to confirm design criteria, trench backfill requirements, etc. Recommend that there be at least two soil borings at the pump station site with one extending at least 25 feet below the invert of the wet well. Borings on the gravity and force main alignment should be spaced at 1,000 foot intervals and be completed to a depth of at least 5 feet below the proposed trench invert. This information will be critical to the final design process.
4. Property acquisition issues will have to be better identified and how they will affect the design addressed.
5. City and Engineer need to work closely together to better clarify the anticipated influent flow to the new pump station site.
6. The City needs to revisit and confirm whether or not the installation of a standby generator should be included in the final design or left as a future project.

7. A more definitive decision needs to be reached regarding the use of submersible or suction lift pumps.
8. The City needs to revisit the Master Plan completed by Gray & Osborn to confirm that there is capacity in the existing collection system downstream of the tie in point for the new force main all the way to the City's Wastewater Treatment Plant.

Appendix A:
City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review

City of Port Townsend Mill Road Pump Station Hydraulic Modeling Review

PREPARED FOR: Mary Heather Ames
City of Port Townsend

COPY TO:

PREPARED BY: Amie Roshak

DATE: February 23, 2012

PROJECT NUMBER: 425179

This technical memorandum summarizes the review of hydraulic modeling data from the City of Port Townsend's (City's) wastewater collection system as presented in the December 2009 *Southwest Sewer Basin Study (Basin Study)*, by Gray & Osborne, Inc. The report evaluated the City's sewer basins and presented a series of alternatives for future development within and adjacent to the existing City limits. The data presented in the Basin Study will be used to develop a peak hourly flow rate to use as design criteria for the design of the new Mill Road Pump Station. The specific alternative in the Basin Study that was reviewed for the Mill Road Pump Station is Alternative 7. The areas that Alterative 7 represents are summarized below along with the review of the loading rates and peaking factors presented in the Basin Study.

Area of Interest for Mill Road Pump Station: Basin Areas for Alternative 7

Alternative 7 in the Basin Study represents the option for a common lift station (Mill Road Pump Station) to serve Basins 1, 2, and 3. In this alternative, Basin 1 also includes the Local Area of More Intense Rural Development (LAMIRD) south of the City. The analysis presented in the Basin Study included a layout of future gravity sewers that would serve the basins and discharge to the Mill Road Pump Station.

The areas summarized for Basins 1, 2, and 3 in the Basin Study were confirmed, and the basins are shown in Figure 1.

Design Flow Development

This section presents information on the calculation of the projected wastewater flow to be pumped by the Mill Road Pump Station. The projected average and peak day flow is presented as well as the determination of the peak hourly flow.

Wastewater Loading Rate Determination

In the *1999 City of Port Townsend Wastewater Comprehensive Plan* (Comprehensive Plan) by CH2M HILL, wastewater loading rates were defined based upon seventeen classes of Land Use. This approach also discounted the land dedicated to Right-of-Ways. Development factors for existing and future development density were also taken into account when determining the total amount of developable lands. During the Basin Study, the ultimate wastewater flows developed for each basin in the Comprehensive Plan were divided by the total number of acres in each basin to develop a basin-wide loading rate. This basin-wide loading rate was then applied to the new basins defined in the Basin Plan. The foundation of this approach in the Basin Plan was to apply the calculated basin-wide loading rate to a basin that was assumed to have a similar development pattern as the basin in the Comprehensive Plan. For the basins involved in this study (Basins 1, 2, and 3), the Southwest Basin in the Comprehensive Plan was identified as the similar basin. Figure 2 shows the overlay of the extent of the Southwest Basin from the Comprehensive Plan and Basins 1, 2, and 3 in the Basin Plan, and Table 1 summarizes the calculation of the basin-wide loading rate for the Southwest Basin and Table 2 summarizes the ultimate flows for Basins 1, 2, and 3 using the calculated Southwest Basin basin-wide loading rates shown in Table 1.

FIGURE 1
Mill Road Pump Station (Alternative 7)
Basin Areas

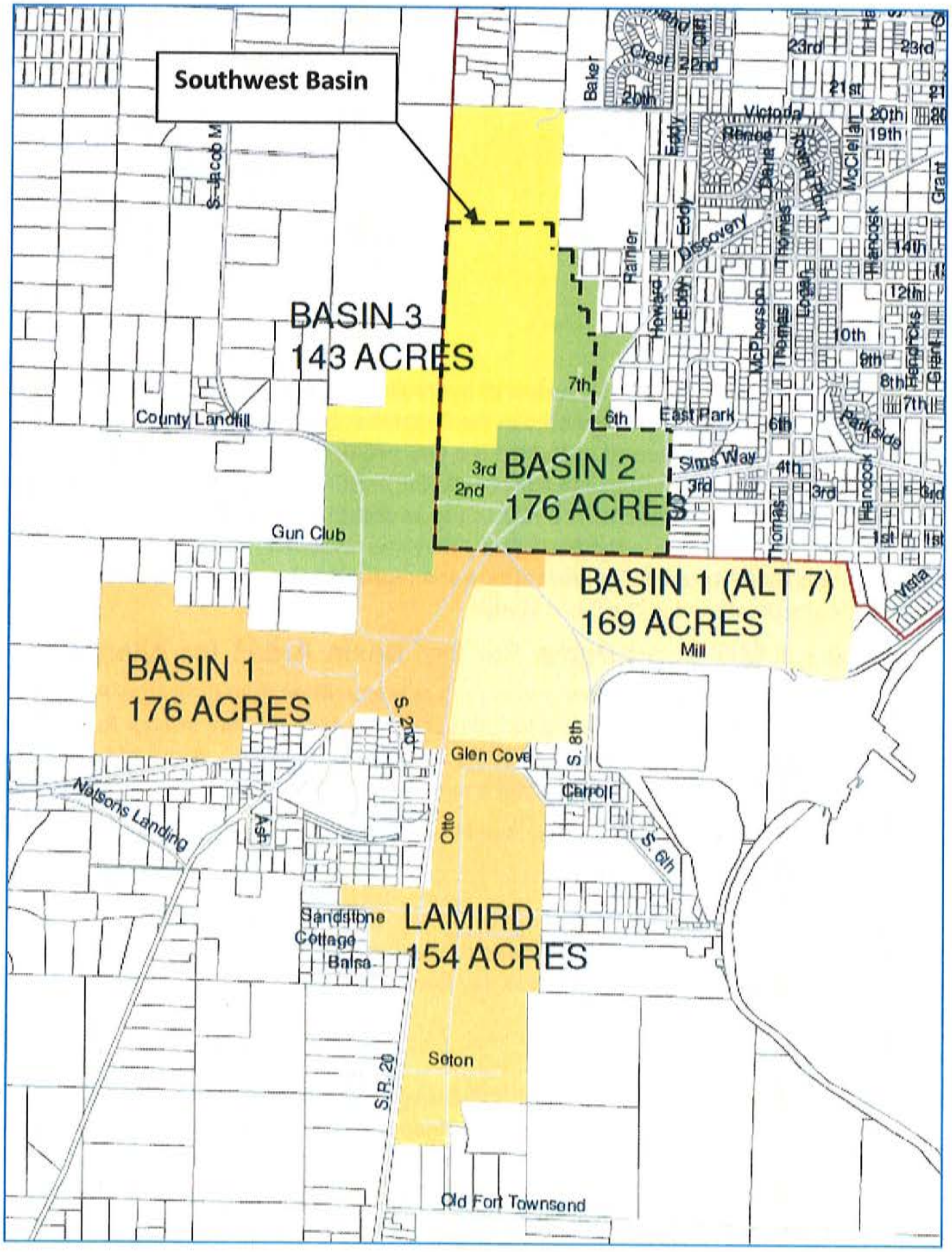


TABLE 1
Basin Flowrate Calculation: Basin-wide Loading Rate and Projection

	Southwest Basin Projected Ultimate Flows (2047)		
	Flow (gpd)	Basin Area (acres)	Calculated Basin-Wide Loading Rate (gpd/acre)
Average Dry Weather Flow	139,988[1]	195[1]	718
Peak Day Flow	240,521[1]	195[1]	1,233

[1]Source: CH2M HILL, Inc., City of Port Townsend Wastewater Comprehensive Plan, 1999.

TABLE 2
Calculated Wastewater Loading by Basin

	Calculated Basin-Wide Loading Rate (gpd/acre)	Basin Area (acres)	Flow (gpd)
Average Dry Weather Flow			
Basin 1 (with LAMIRD)	718	499	358,300
Basin 2	718	176	126,400
Basin 3	718	143	103,700
Total			588,400
Peak Day Flow			
Basin 1	1,233	499	615,300
Basin 2	1,233	176	217,000
Basin 3	1,233	143	176,300
Total			1,008,600

Peaking Factor

In the Basin Study, a peak hour to peak daily flow peaking factor of 1.7 was applied to the Peak Day Flow to determine peak hourly flow for each basin. The Basin Study stated that this factor was adjusted upward from a factor of 1.27 that was applied in the hydraulic modeling for the Comprehensive Plan. In the Comprehensive Plan, a diurnal curve was presented from flow monitoring in a residential area. This curve (Figure 5-2) indicated that the peak flow may be 1.79 times higher at the peak hour than the average. The Comprehensive Plan also notes that this diurnal curve is slightly conservative for non-residential areas.

According to the Department of Ecology, Criteria for Sewage Works Design (Orange Book), the minimum peaking factor that should be used to calculate peak hourly flow is 2.5, and the peak hour factor is based upon population. In addition, for the Orange Book methodology, the peaking factor is to be applied to the average daily flow, not the peak daily flow.

Peak Hourly Flow

A comparison was performed on the two different calculation methods of the peak hourly flow. This is summarized in Table 3. For the Basin Plan flows, the effective peak hour to average day peaking factor was determined to be 2.92. This peaking factor corresponds to a town with a population of approximately 11,000. The Orange Book calculated peaking factor is 2.59, assuming a population of approximately 23,000 for 2046, the year of the projected ultimate flows. See Figure C1.1 from the Orange Book (attached). Cities with smaller populations are assigned a higher peaking factor due to the nature of the variability of flow with smaller populations. According to the City of Port Townsend Comprehensive Plan, the City's population is expected to reach a population of about 14,000 in the year 2024 and may reach 23,000 by 2046

TABLE 3
Calculated Wastewater Loading by Basin (2047)

	Row	Basin Plan Calculation	Orange Book Calculation
Average Dry Weather Flow (gpd)	(1)	588,400	588,400
Peak Day Flow (gpd)	(2)	1,008,600	1,008,600
Calculated Peak Day to Average Day Peaking Factor	(3) = (2)/(1)	1.71	NA[1]
Peak Hour to Peak Day Factor	(4)	1.70	NA[1]
Calculated Peak Hour to Average Day Factor	(5) = (4) x (3)	2.91	2.59[2]
Peak Hour Flow (gpd)	(6) = (1) x (5)	1,714,620	1,524,935
Calculated Peak Hourly Flow (gpm)	(7) = (6) / 1440 min/day	1,191	1,059

[1]Not applicable for this comparison. Only comparing the Peak Hour to Average Day Factor (Row (5))

[2]Calculation of Peak Hour to Average Day Factor from the Orange Book = $(18 + \sqrt{23{,}000})/(4+\sqrt{23{,}000})$, where 23,000 is the population in 2046.

Selection of Peak Hourly (Design) Flow

The peak hourly flow will be used for sizing and design of the Mill Road Pump Station. Based on the comparison of the various calculation methods to determine the peak hourly flow for design of the Mill Road Pump Station, it is recommended that the peak hourly flow of 1,185 gpm be used for the design.

Appendix B:
Pump Curves for Submersible and Suction Lift Pumps

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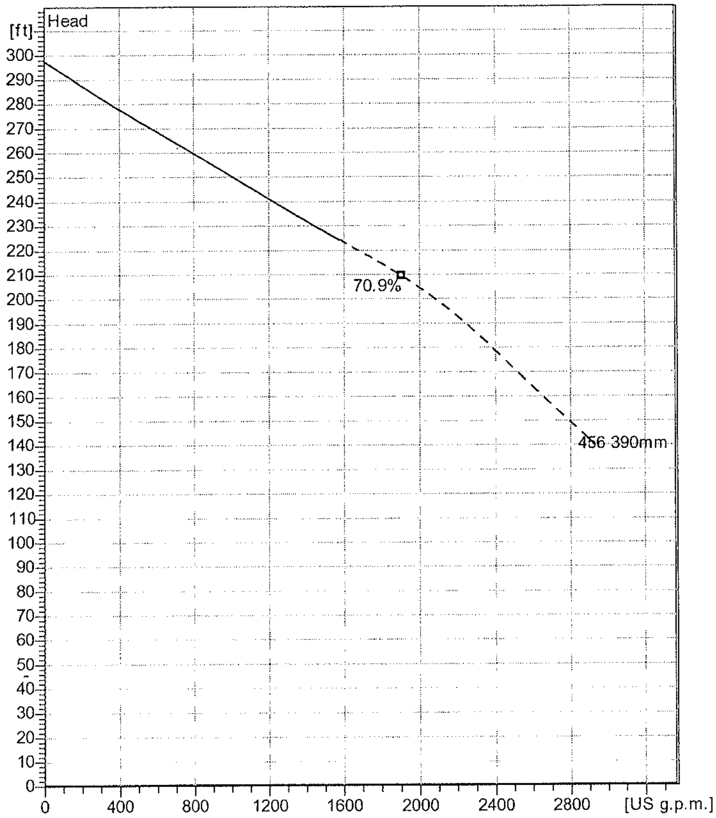
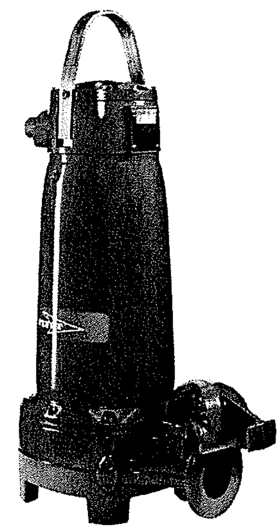
Technical specification

FLYGT



Curve according to: ISO 9906 grade 2 annex 1 or 2



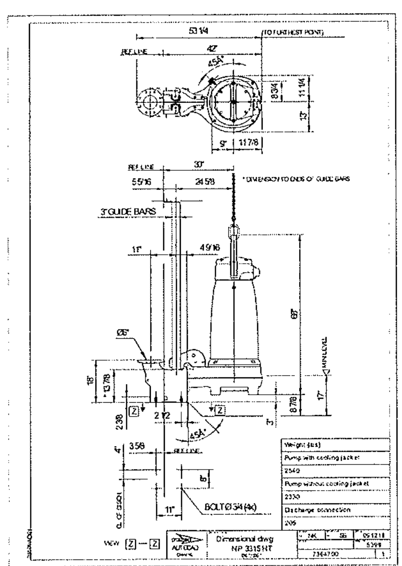
Note: Picture might not correspond to the current configuration.

General
Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Grey cast iron
Outlet width	5 7/8 inch
Inlet diameter	150 mm
Impeller diameter	390 mm
Number of blades	3

Installation: P - Semi permanent, Wet



Motor

Motor #	N3315.180 35-35-4AA-W 130hp
Stator variant	
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	130 hp
Rated current	156 A
Starting current	705 A
Rated speed	1775 1/min
Power factor	
1/1 Load	0.83
3/4 Load	0.80
1/2 Load	0.71
Efficiency	
1/1 Load	93.5 %
3/4 Load	94.0 %
1/2 Load	94.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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NP 3315 HT 3~ 456

FLYGT

Performance curve

Pump

Outlet width	5 7/8 inch
Inlet diameter	150 mm
Impeller diameter	15³/₈"
Number of blades	3

Motor

Motor #	N3315.180 35-35-4AA-W 130hp
Stator variant	
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	130 hp
Rated current	156 A
Starting current	705 A
Rated speed	1775 1/min

Power factor	
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Efficiency	
1/1 Load	93.5 %
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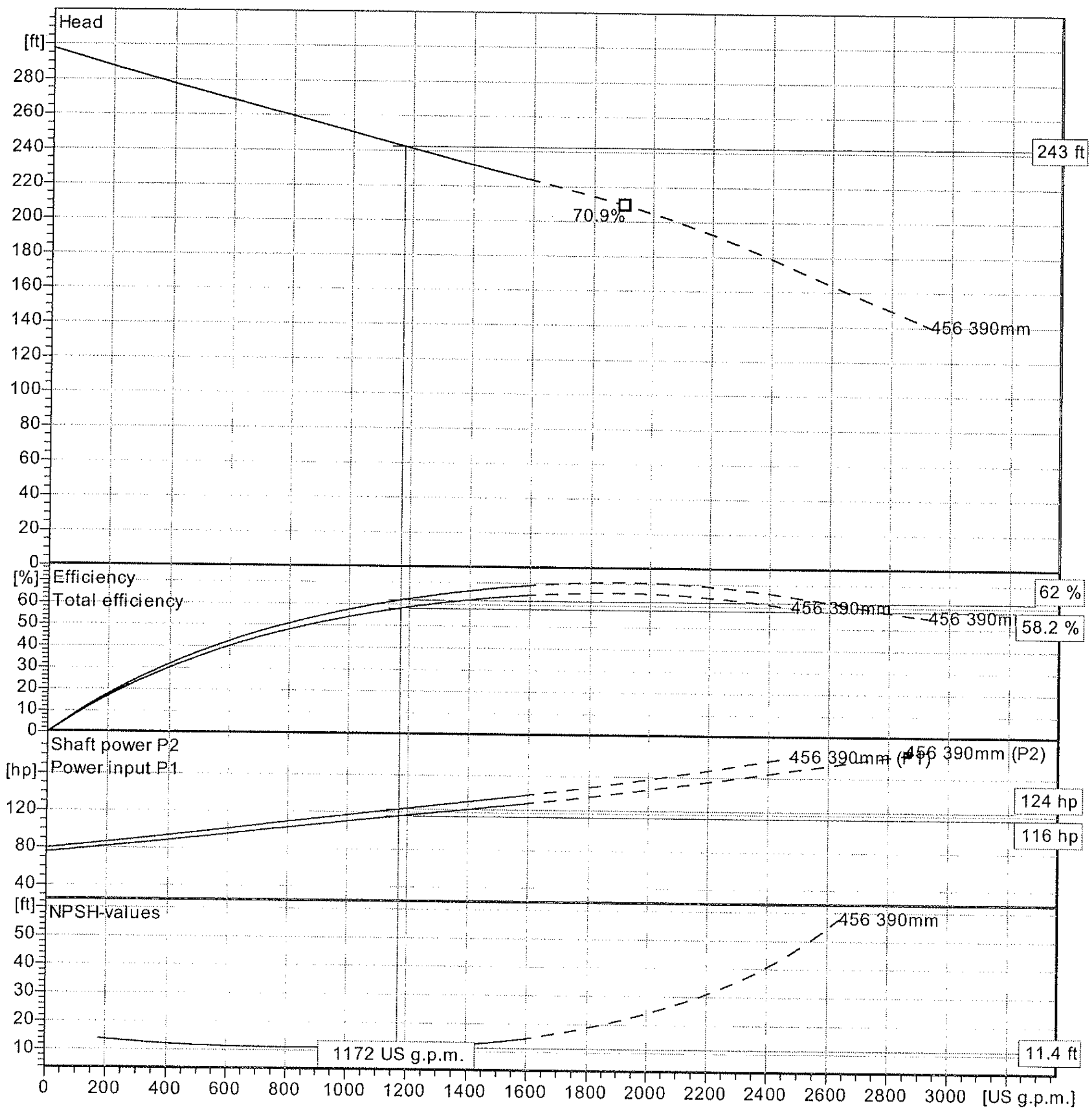
1/2 Load	94.5 %



Curve according to: ISO 9906 grade 2 annex 1 or 2

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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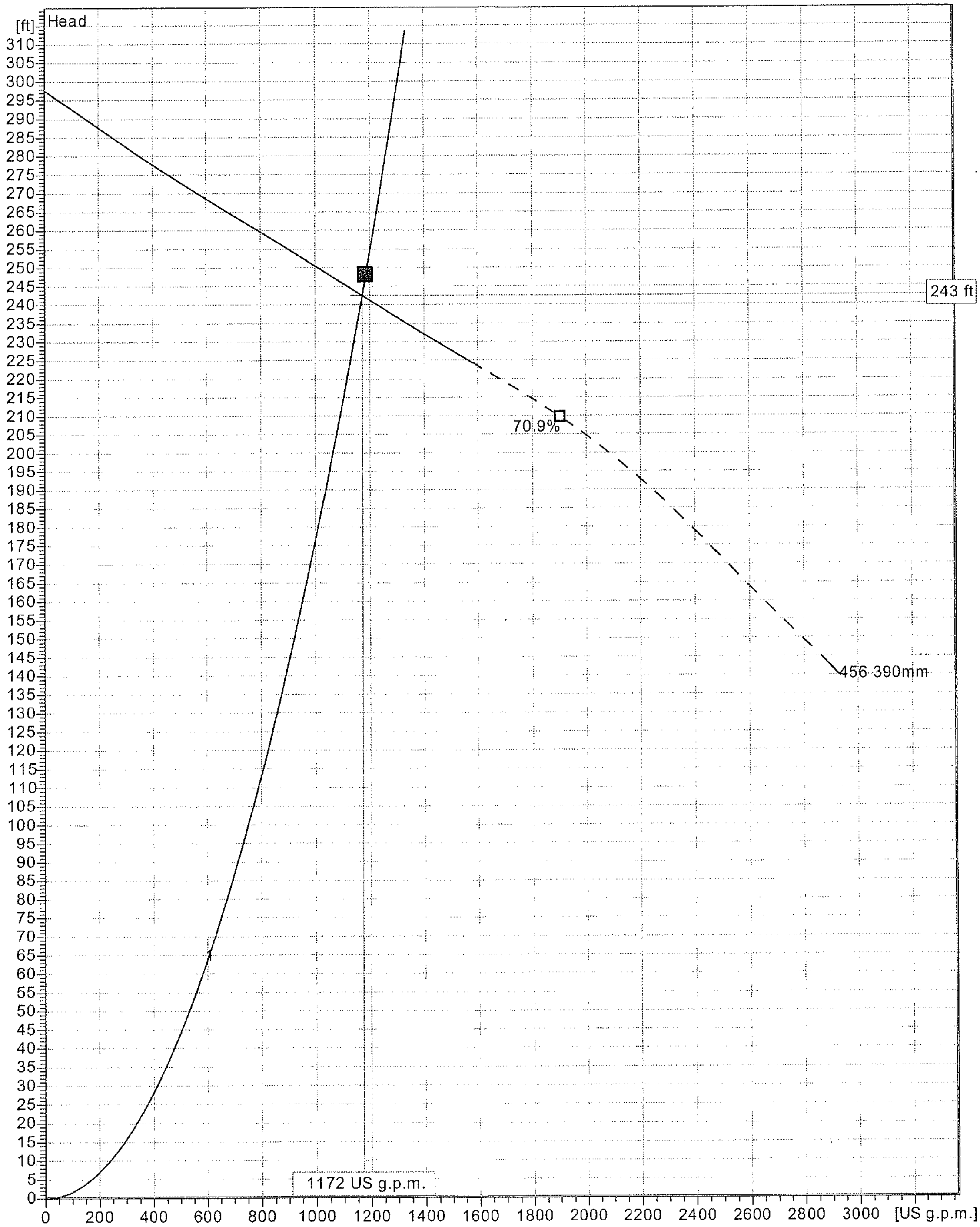
Duty Analysis

FLYGT



Curve according to: ISO 9906 grade 2 annex 1 or 2

Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	1170 US g.p.m.	243 ft	116 hp	1170 US g.p.m.	243 ft	116 hp	62 %	1310 kWh/US MG	11.4 ft

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

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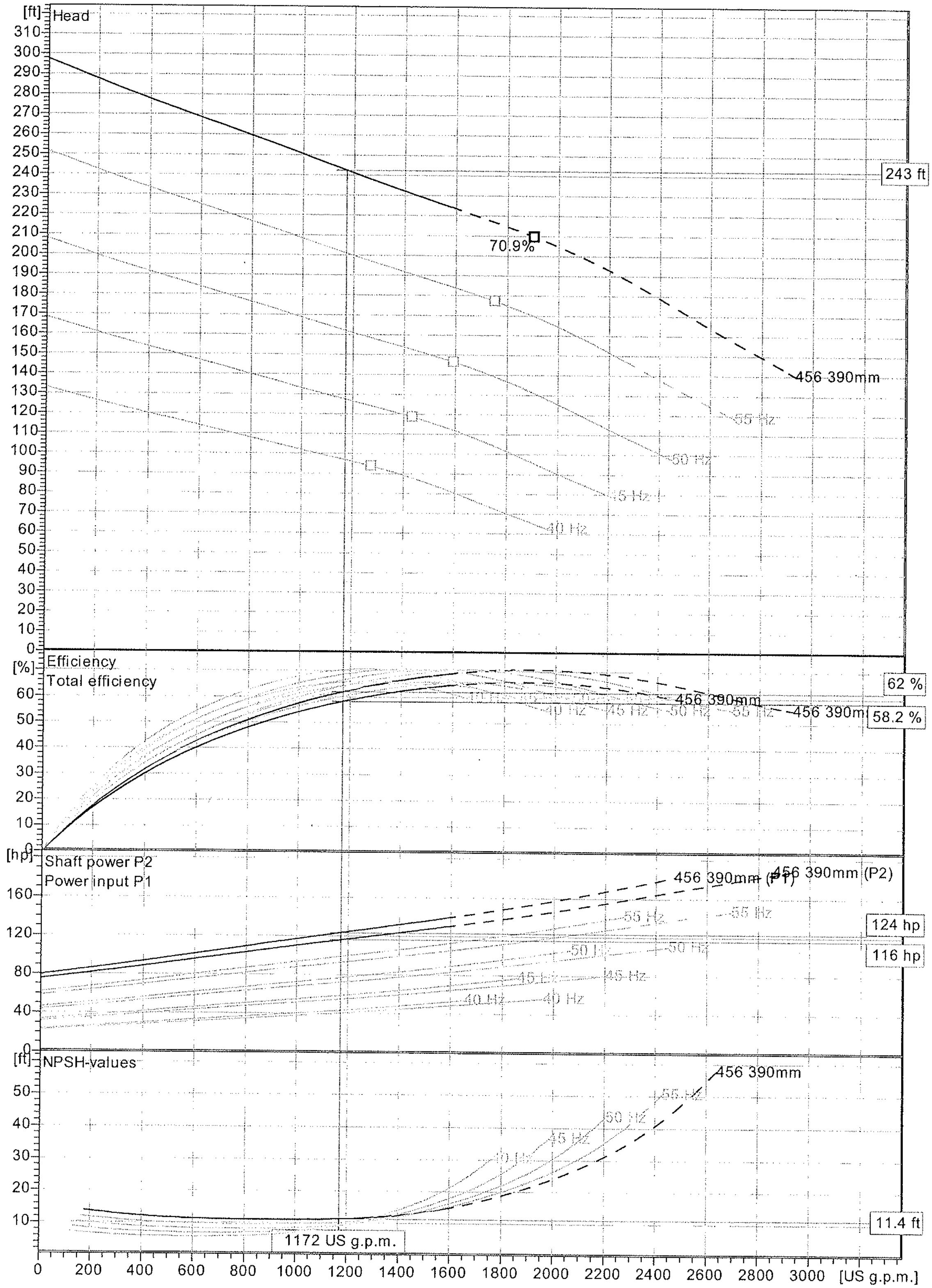
NP 3315 HT 3~ 456
VFD Curve

FLYGT



Curve according to: ISO 9906 grade 2 annex 1 or 2

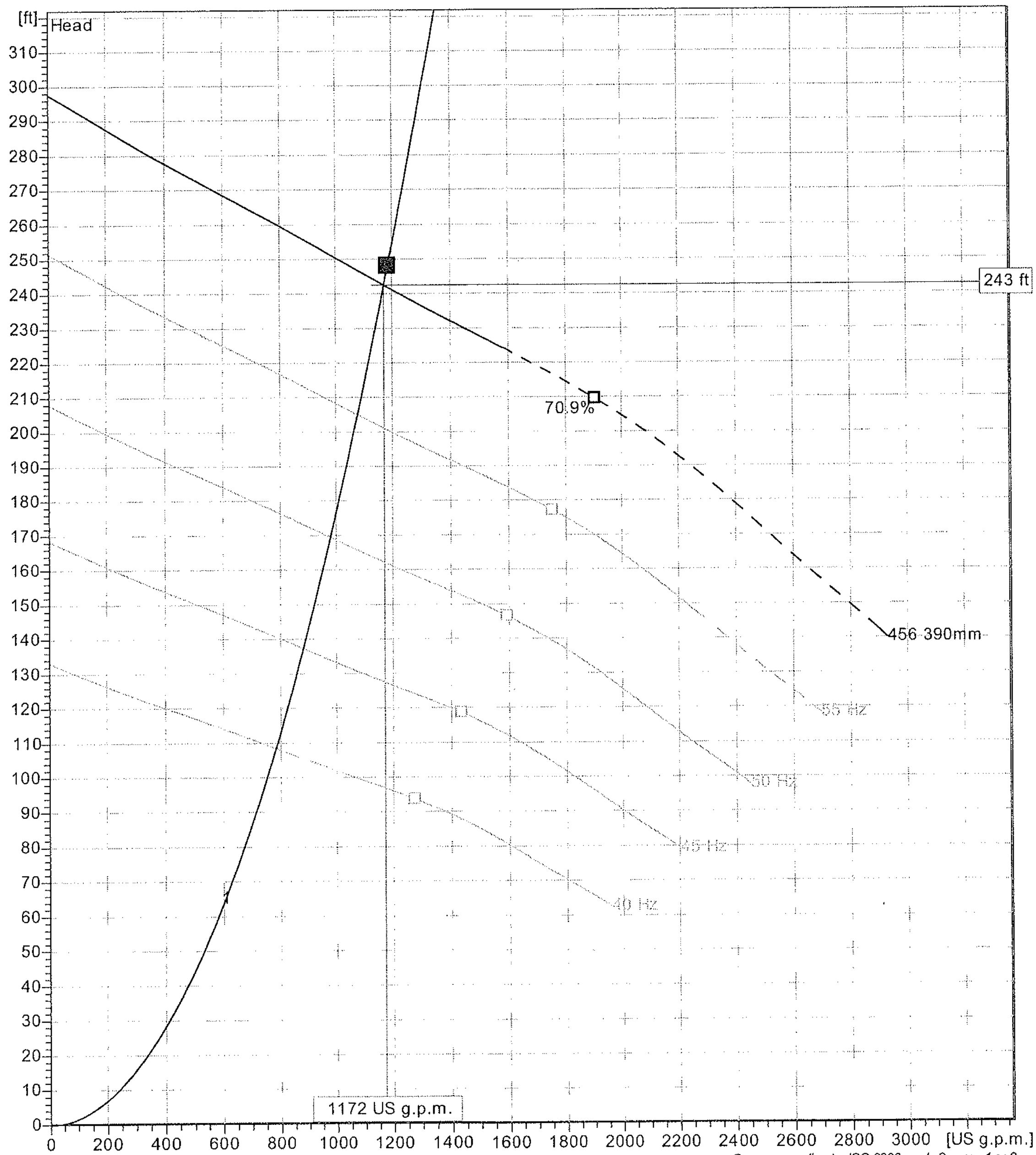
Project	Project ID	Created by	Created on	Last update
			2012-04-13	

xylem
Let's Solve Water

NP 3315 HT 3~ 456

FLYGT

VFD Analysis



Curve according to: ISO 9906 grade 2 annex 1 or 2

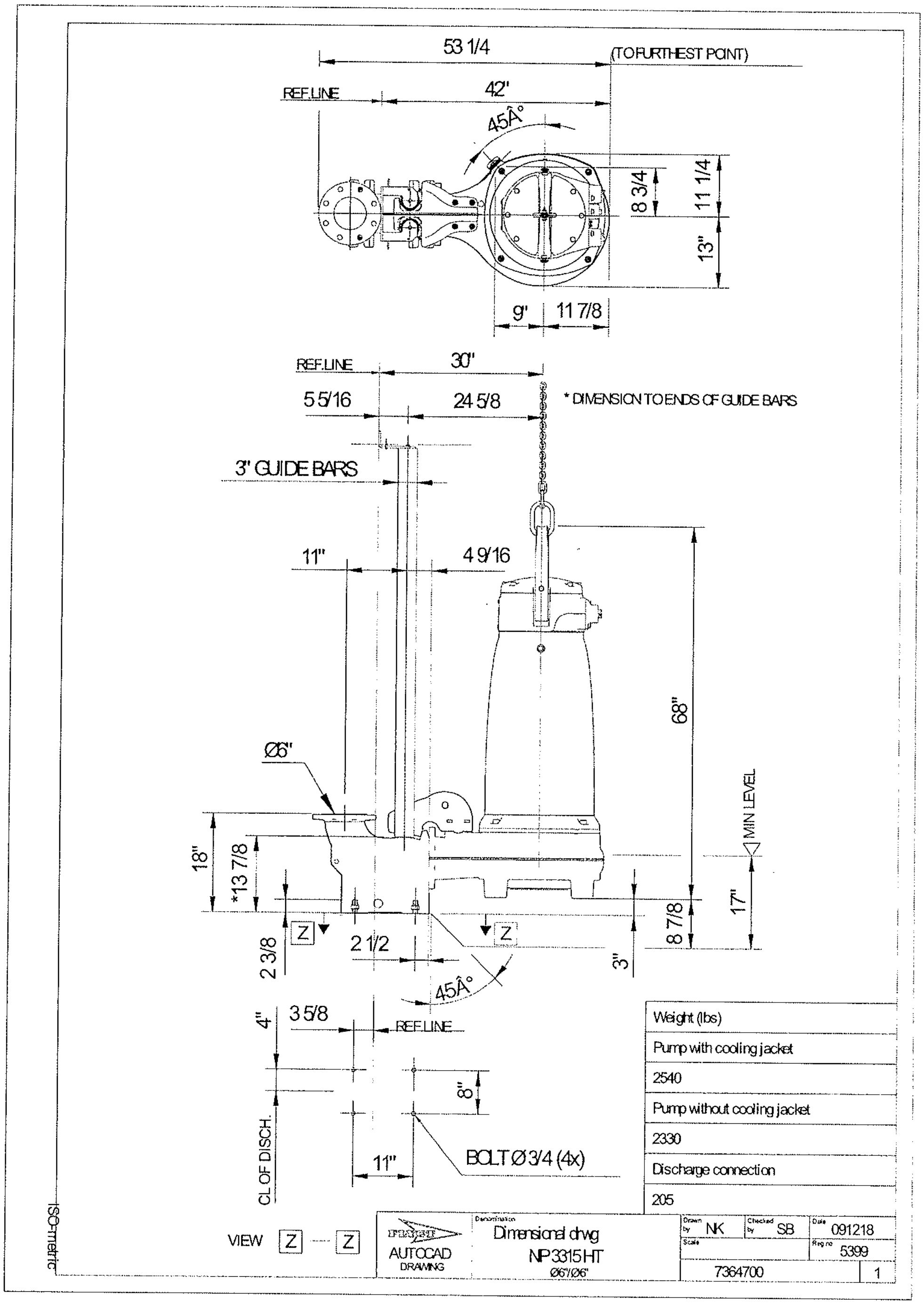
Pumps running /System	Individual pump Frequency	Flow	Head	Shaft power	Total Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	1170 US g.p.m.	243 ft	116 hp	1170 US g.p.m.	243 ft	116 hp	62 %	1310 kWh/US MG	11.4 ft
1	55 Hz	1080 US g.p.m.	205 ft	90.3 hp	1080 US g.p.m.	205 ft	90.3 hp	62 %	1100 kWh/US MG	9.96 ft
1	50 Hz	980 US g.p.m.	169 ft	67.8 hp	980 US g.p.m.	169 ft	67.8 hp	62 %	908 kWh/US MG	8.55 ft
1	45 Hz	882 US g.p.m.	137 ft	49.4 hp	882 US g.p.m.	137 ft	49.4 hp	62 %	738 kWh/US MG	7.22 ft
1	40 Hz	784 US g.p.m.	108 ft	34.7 hp	784 US g.p.m.	108 ft	34.7 hp	62 %	589 kWh/US MG	5.98 ft

Project	Project ID	Created by	Created on	Last update
			2012-04-13	

xylem
Let's Solve Water

NP 3315 HT 3~ 456
Dimensional drawing

FLYGT



Project	Project ID	Created by	Created on	Last update
			2012-04-13	

Pump ESP™

Smith & Loveless' Electronic Selection Program

Smith & Loveless Inc.
14040 Santa Fe Trail Drive • Lenexa, Kansas 66215-1284 • Ph: 913-888-5201 • Fax: 913-888-2173 • answers@smithandloveless.com

Location: Kitsap Co **Project Name:** Future

Customer: Kitsap Co **Engineer:** CH2M-Hill

Inquiry #: **WW Diam:** 12 **Type:** Classic **Pumps:** Duplex

Design Data:
Flow: 1200 GPM
Sta. piping size: 8"
Suction Piping Size: 12"
TDH: 229 FT.

Force Main Data:
Force main length:
Force main Dia.:
Force Main Vel: N/A

System Head (Max) C-Factor: → Static Head Max: → System Head Max: N/A

System Head (Min) C-Factor: → Static Head Min: → System Head Min: N/A

875 RPM Pumps:	IMP. DIA.	BHP	EFF.	Suction Piping		Station Piping		Max Suction Lift
				Recom.	Select	Recom.	Select	
O 4B2B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B2X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 6B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 8D4D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 8D4V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 12D6V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:
1.) Max Suction lift is based on an elevation of 1000' ASL. For each 1000 foot increment, subtract an additional foot.

Max Suction Lift of pump must equal or exceed Required Suction Lift

1170 RPM Pumps:	IMP. DIA.	BHP	EFF.	Suction Piping		Station Piping		Max Suction Lift
				Recom.	Select	Recom.	Select	
O 4B2B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B2D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B2X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 6B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 8D4D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 8D4V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 12D6V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

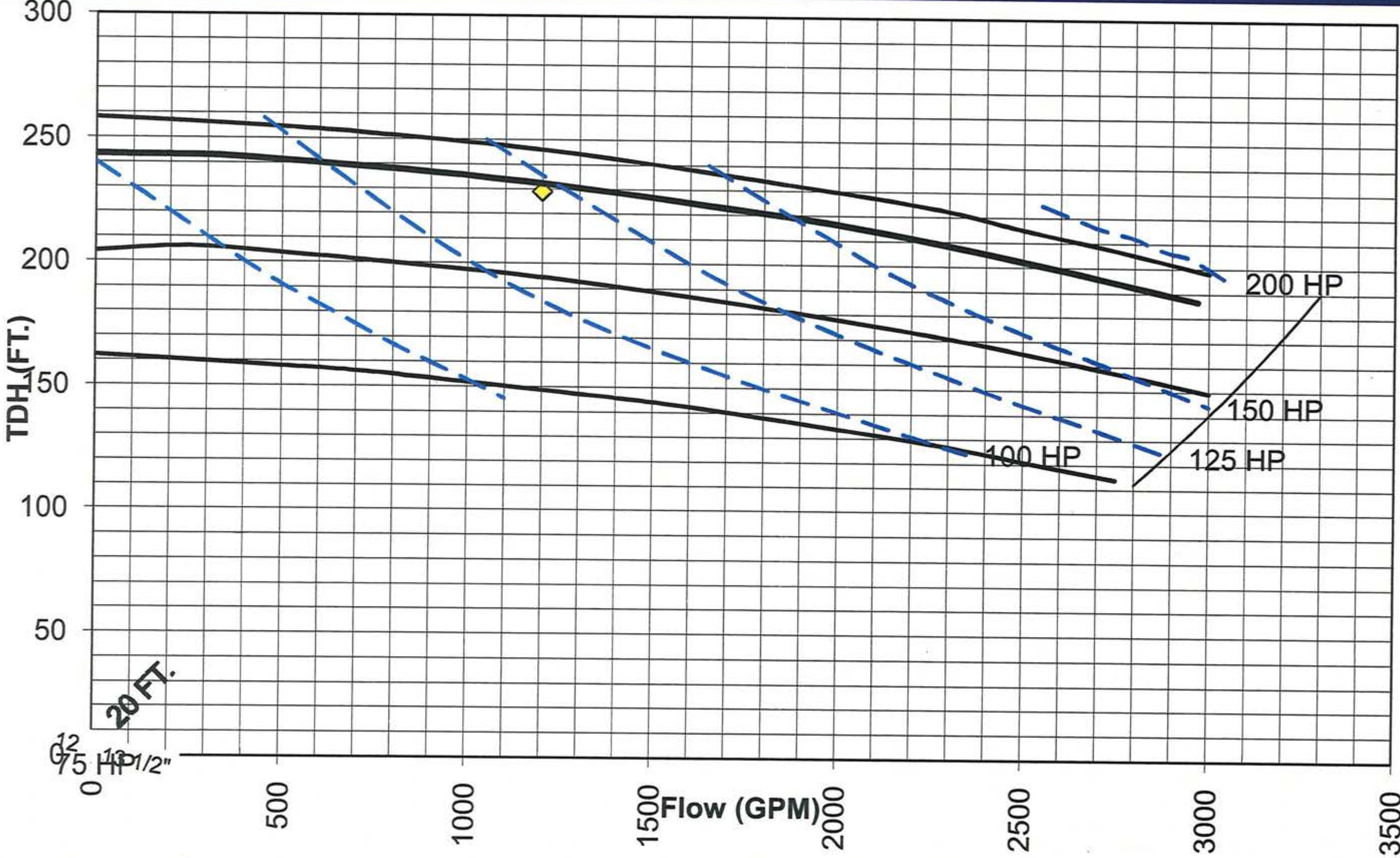
1760 RPM Pumps:	IMP. DIA.	BHP	EFF.	Suction Piping		Station Piping		Max Suction Lift
				Recom.	Select	Recom.	Select	
O 4B2B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B2D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B2X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4B3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 4D4B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
O 6C3B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
● 8D4V	14 5/8"	121.8	57.0%	8"	12"	8"	8"	19.4 FT.
585 RPM Pump:								
O 12D6V	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Only stations with 8" or 12" pumps are available with 8" or larger station and discharge piping.

Representative: ADS Equipment, Inc Prepared By: Steve Azose Date: 4/8/2012

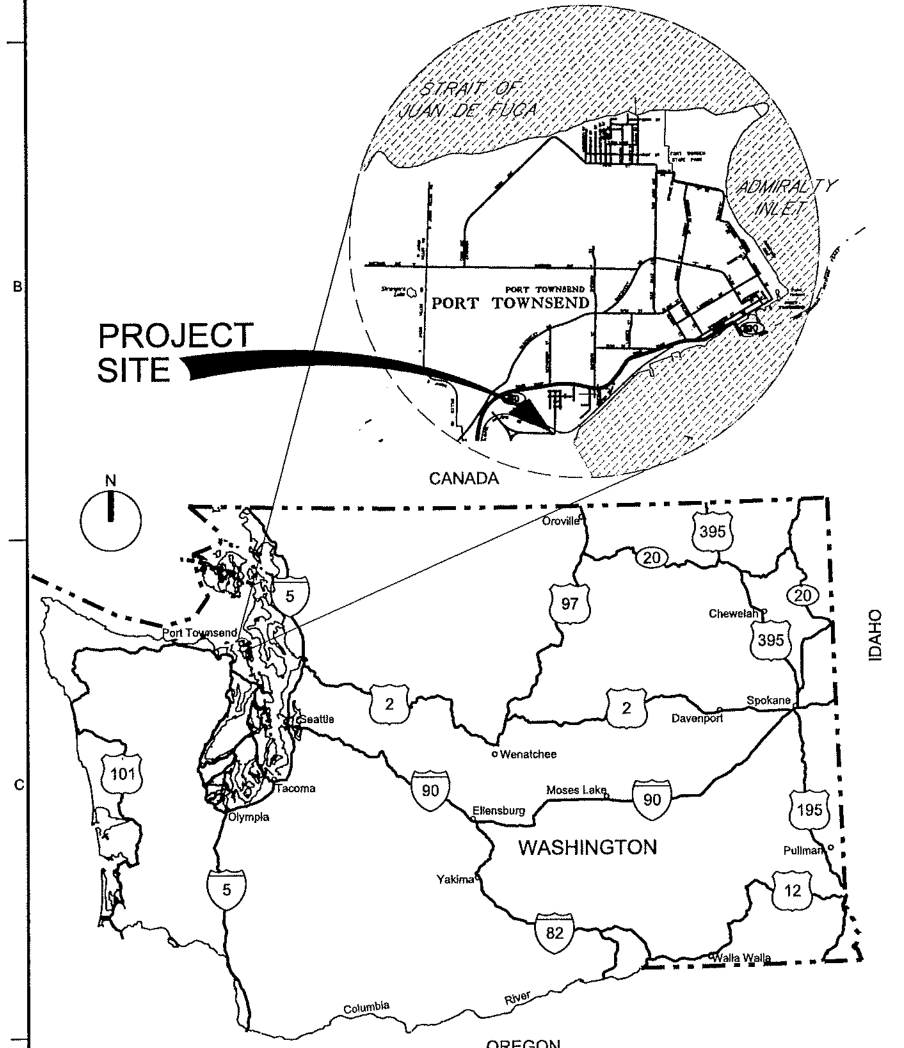
Pump Curve

Smith & Loveless Inc.

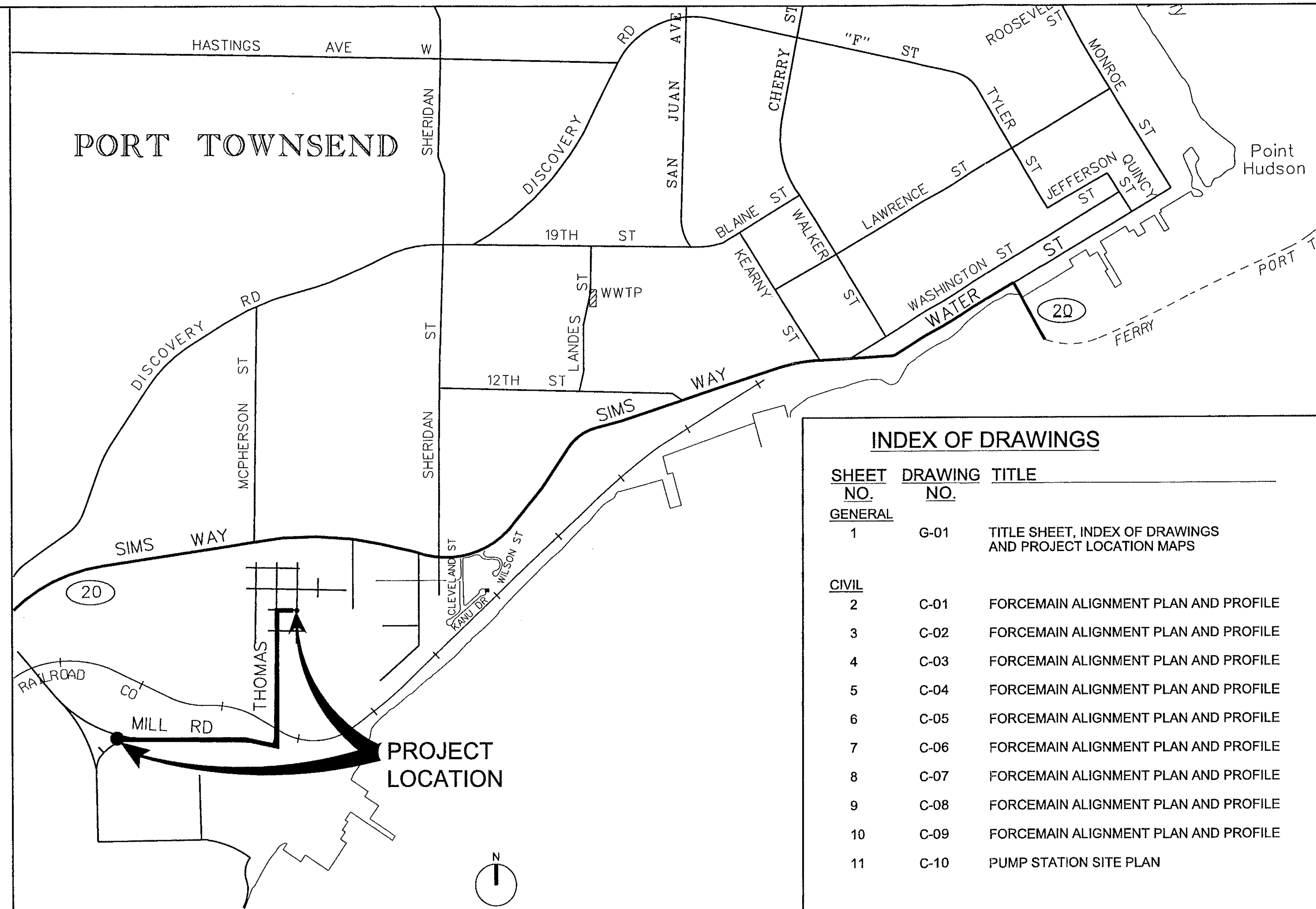


Appendix C:
Pump Station Force Main Alignment

PORT TOWNSEND
MILL ROAD PUMP STATION AND FORCEMAIN
PORT TOWNSEND, WASHINGTON



VICINITY MAP
NTS



LOCATION MAP
NTS

INDEX OF DRAWINGS

SHEET NO.	DRAWING NO.	TITLE
GENERAL		
1	G-01	TITLE SHEET, INDEX OF DRAWINGS AND PROJECT LOCATION MAPS
CIVIL		
2	C-01	FORCEMAIN ALIGNMENT PLAN AND PROFILE
3	C-02	FORCEMAIN ALIGNMENT PLAN AND PROFILE
4	C-03	FORCEMAIN ALIGNMENT PLAN AND PROFILE
5	C-04	FORCEMAIN ALIGNMENT PLAN AND PROFILE
6	C-05	FORCEMAIN ALIGNMENT PLAN AND PROFILE
7	C-06	FORCEMAIN ALIGNMENT PLAN AND PROFILE
8	C-07	FORCEMAIN ALIGNMENT PLAN AND PROFILE
9	C-08	FORCEMAIN ALIGNMENT PLAN AND PROFILE
10	C-09	FORCEMAIN ALIGNMENT PLAN AND PROFILE
11	C-10	PUMP STATION SITE PLAN

30% Design - Not For Construction

NO.	DATE	REVISION	BY	APVD

DSGN A. ROSHAK | DR K. WEIGUM | CHK J. BURNAM | APVD J. BURNAM

PORT TOWNSEND
MILL ROAD PUMP STATION AND FORCEMAIN
PORT TOWNSEND, WA

CH2MHILL

GENERAL
TITLE SHEET, INDEX OF DRAWINGS AND PROJECT LOCATION MAPS

VERIFY SCALE
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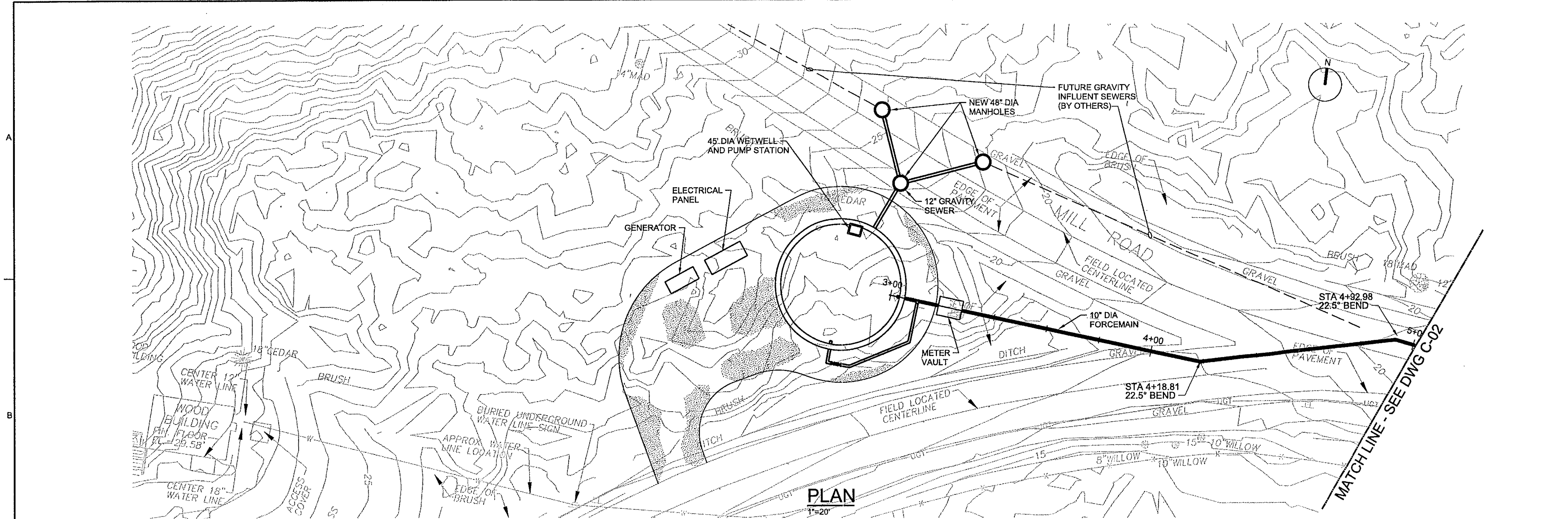
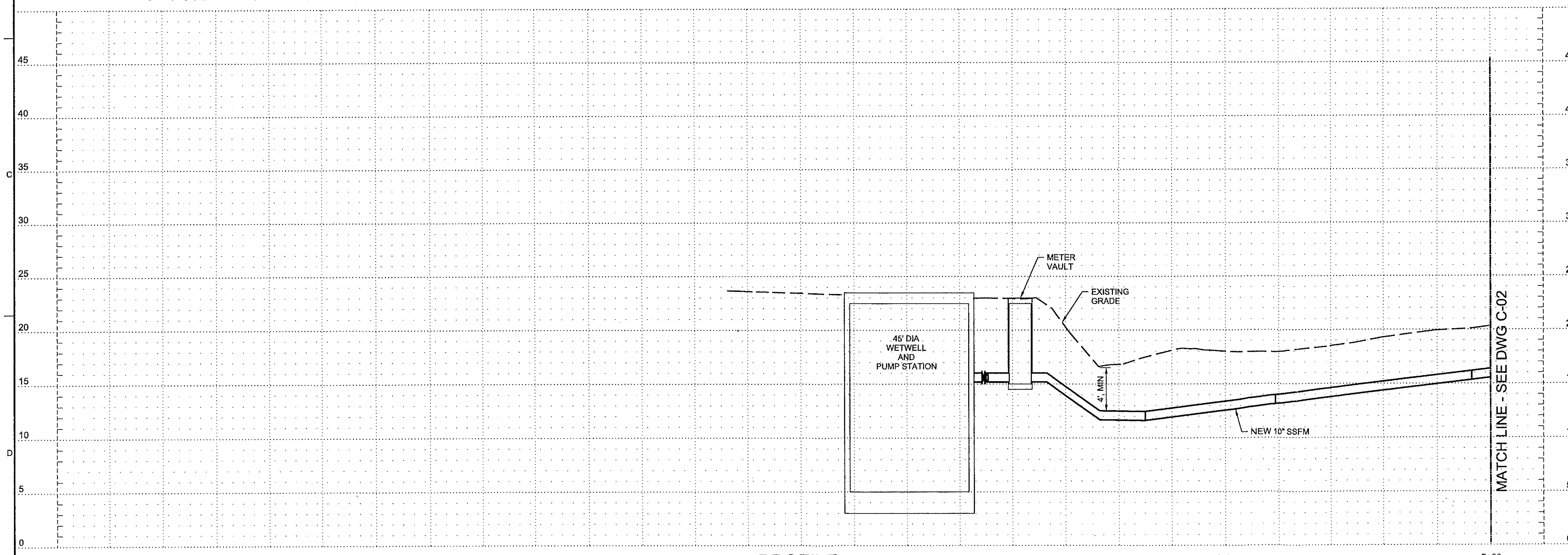
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	G-01
SHEET	1 of 5





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CIVIL

FORCEMAIN ALIGNMENT PLAN AND PROFILE

PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

NO.	DATE	REVISION	BY	APVD

DSGN A. ROSHAK | DR D SUNSERI | CHK J BURNAM | APVD J BURNAM

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-01
SHEET	

PRELIMINARY

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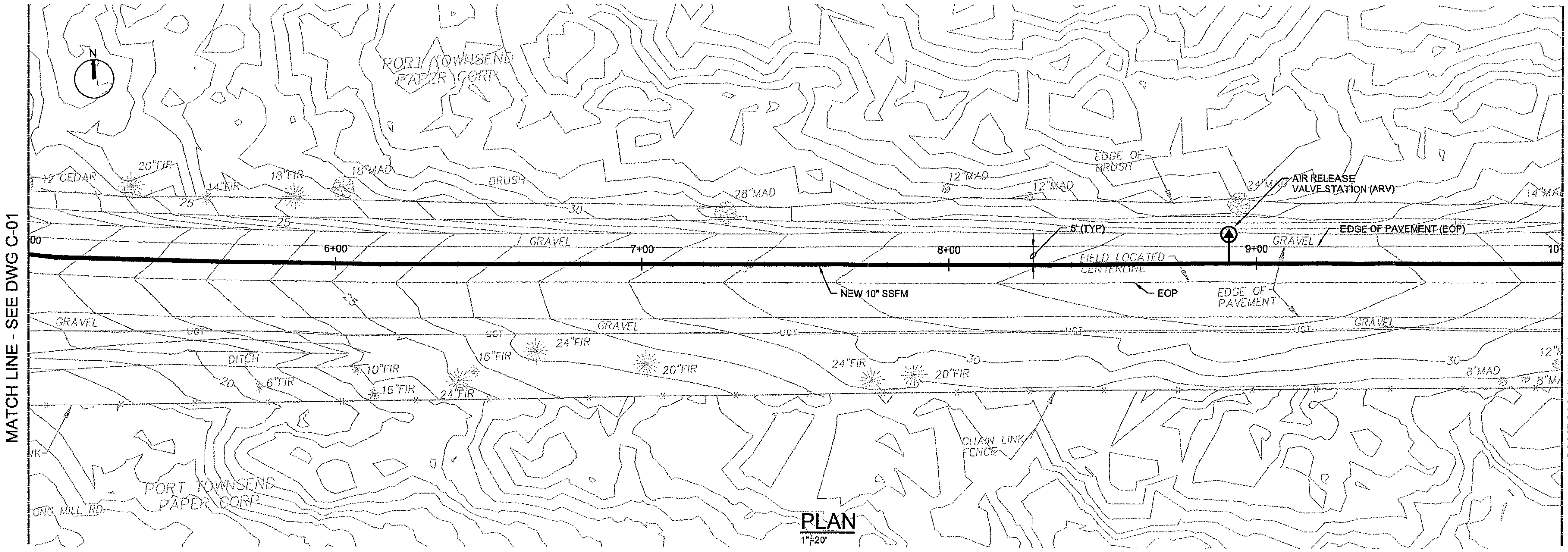

PLAN
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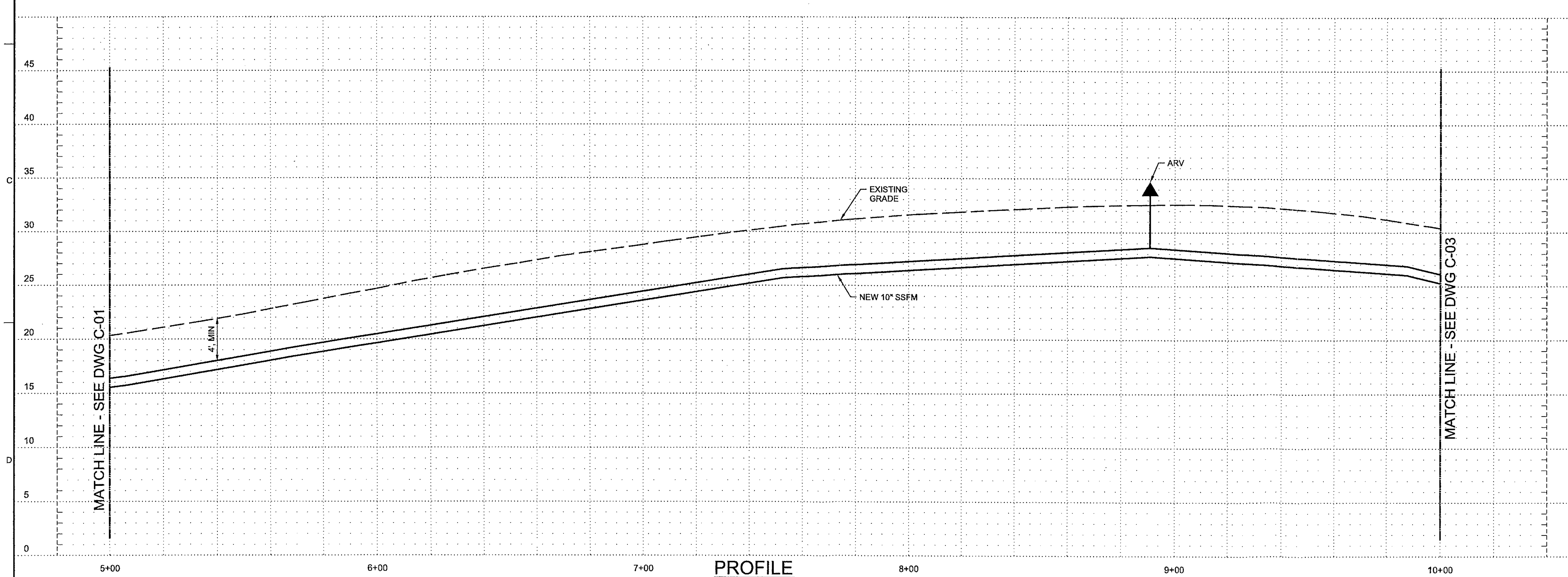

PROFILE
1"=20' HORIZ, 1"=5' VERT

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NO.	DATE	REVISION	BY	APVD

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PORT TOWNSEND
MILL ROAD PUMP STATION AND FORCEMAIN
PORT TOWNSEND, WA

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CIVIL
FORCEMAIN ALIGNMENT PLAN AND PROFILE

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-02
SHEET	

PRELIMINARY

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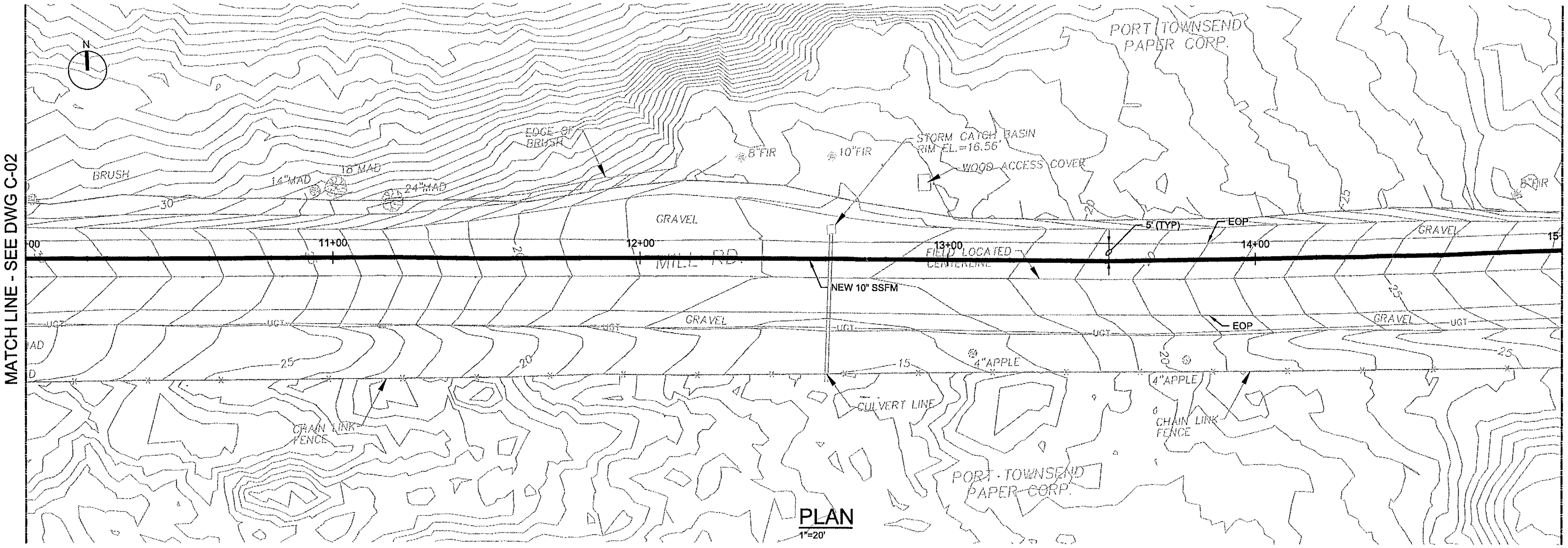

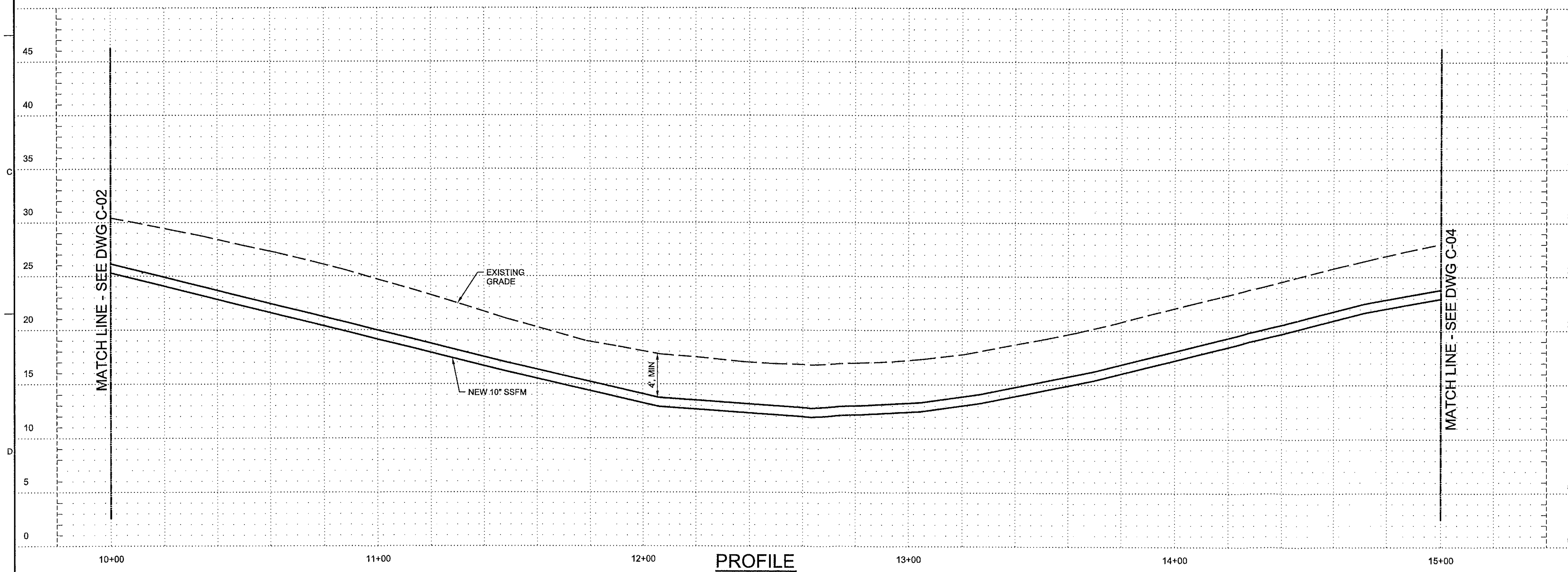

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

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CIVIL
FORCEMAIN ALIGNMENT
PLAN AND PROFILE

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-03
SHEET	

PRELIMINARY

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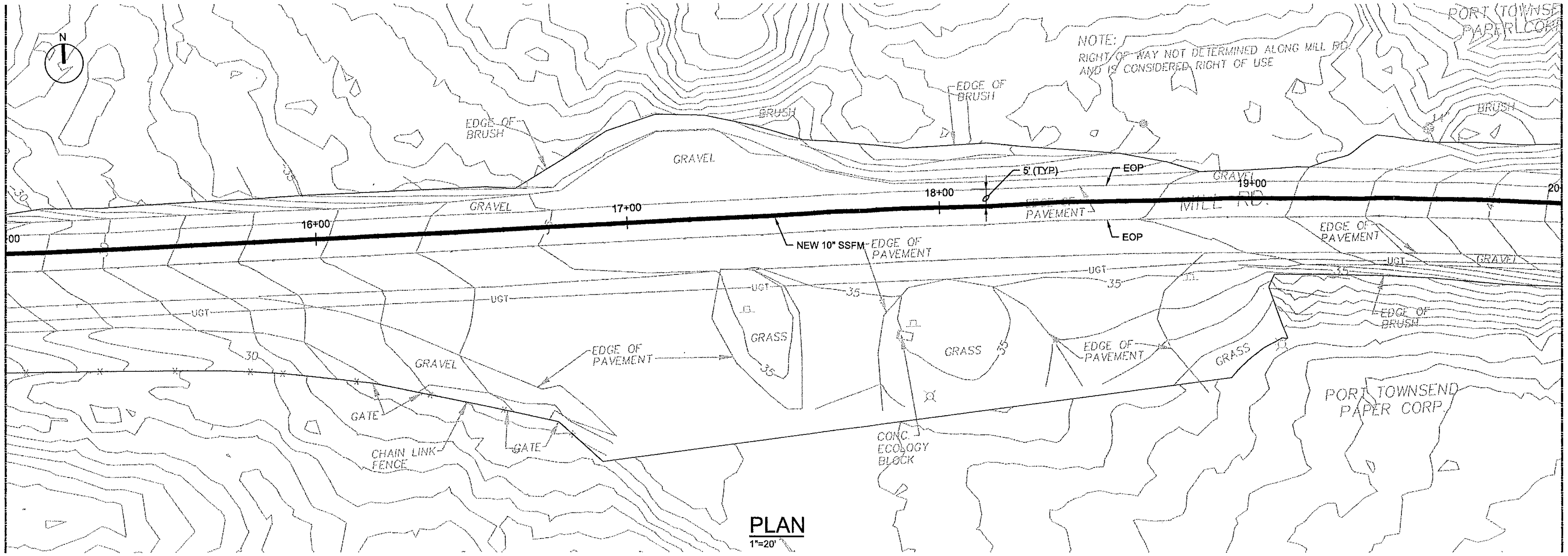

PLAN

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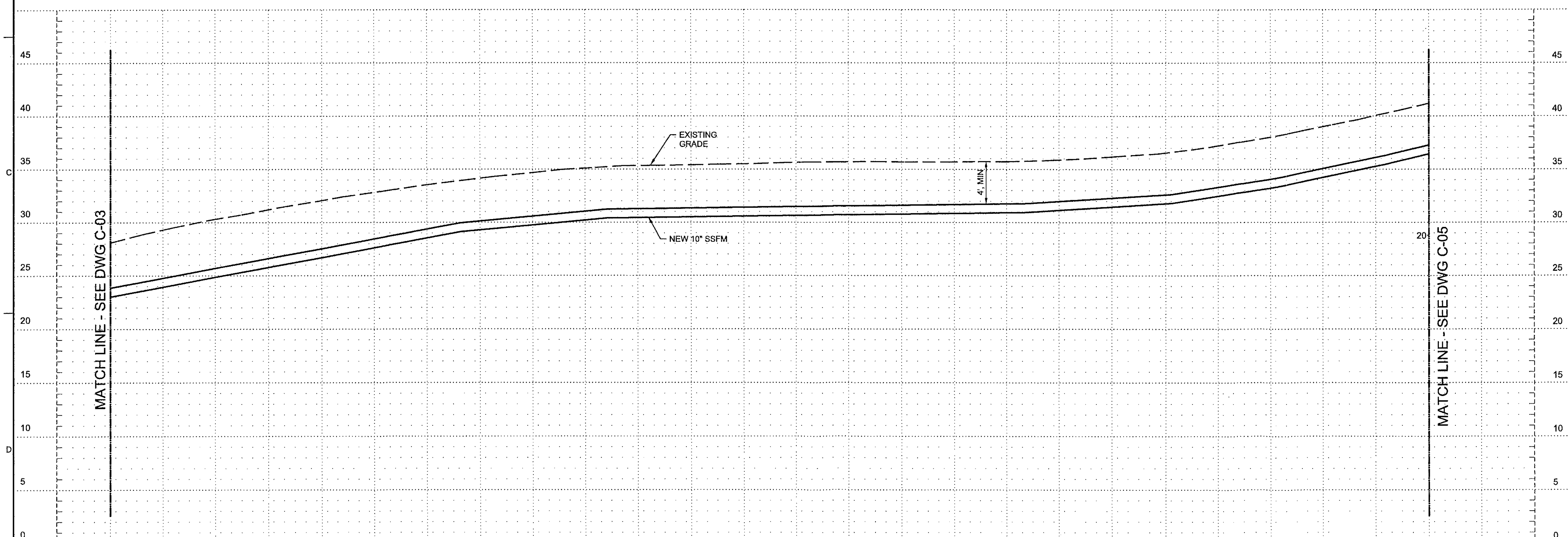

PROFILE

1"=20' HORIZ, 1"=5' VERT

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NO.	DATE	REVISION	BY	APVD

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

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FORCEMAIN ALIGNMENT PLAN AND PROFILE

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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-04
SHEET	

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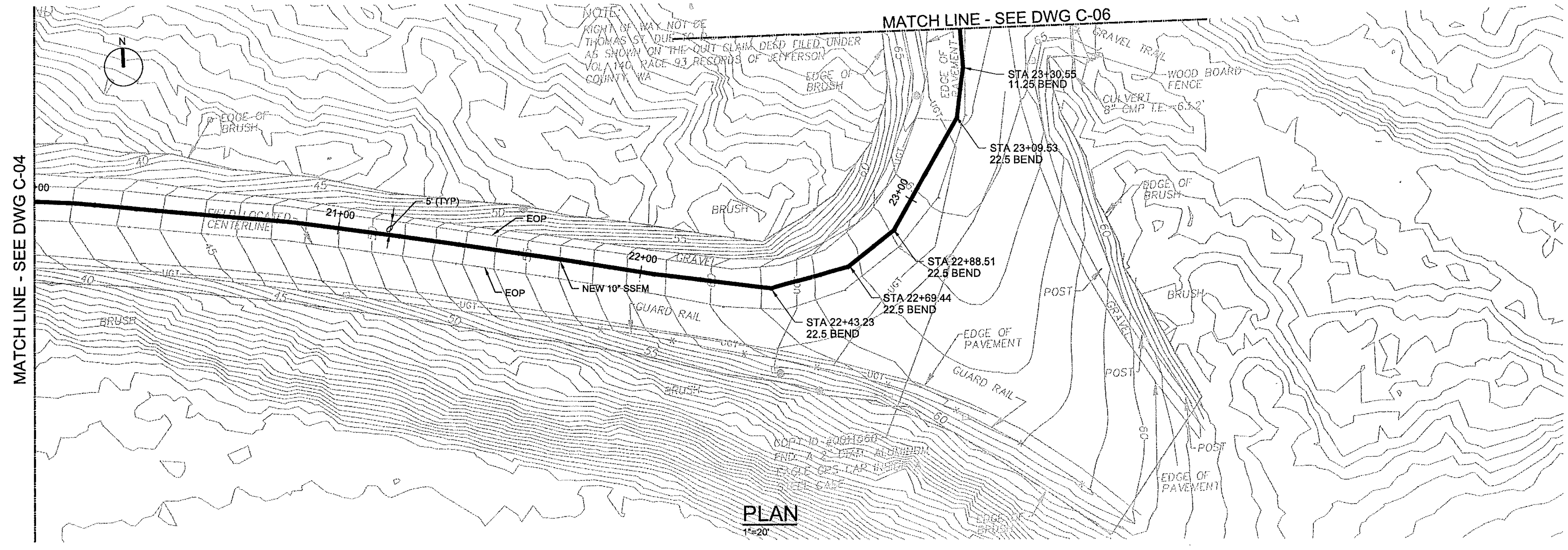

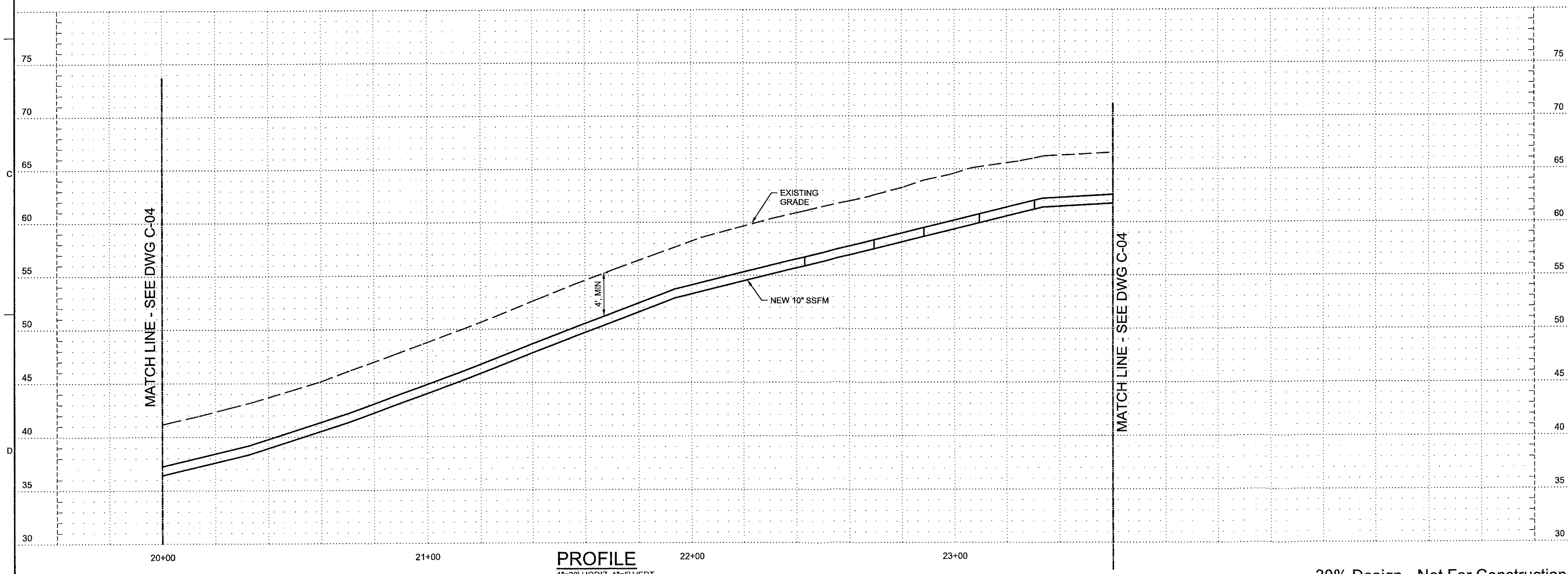

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

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FORCEMAIN ALIGNMENT PLAN AND PROFILE

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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-05
SHEET	

PRELIMINARY

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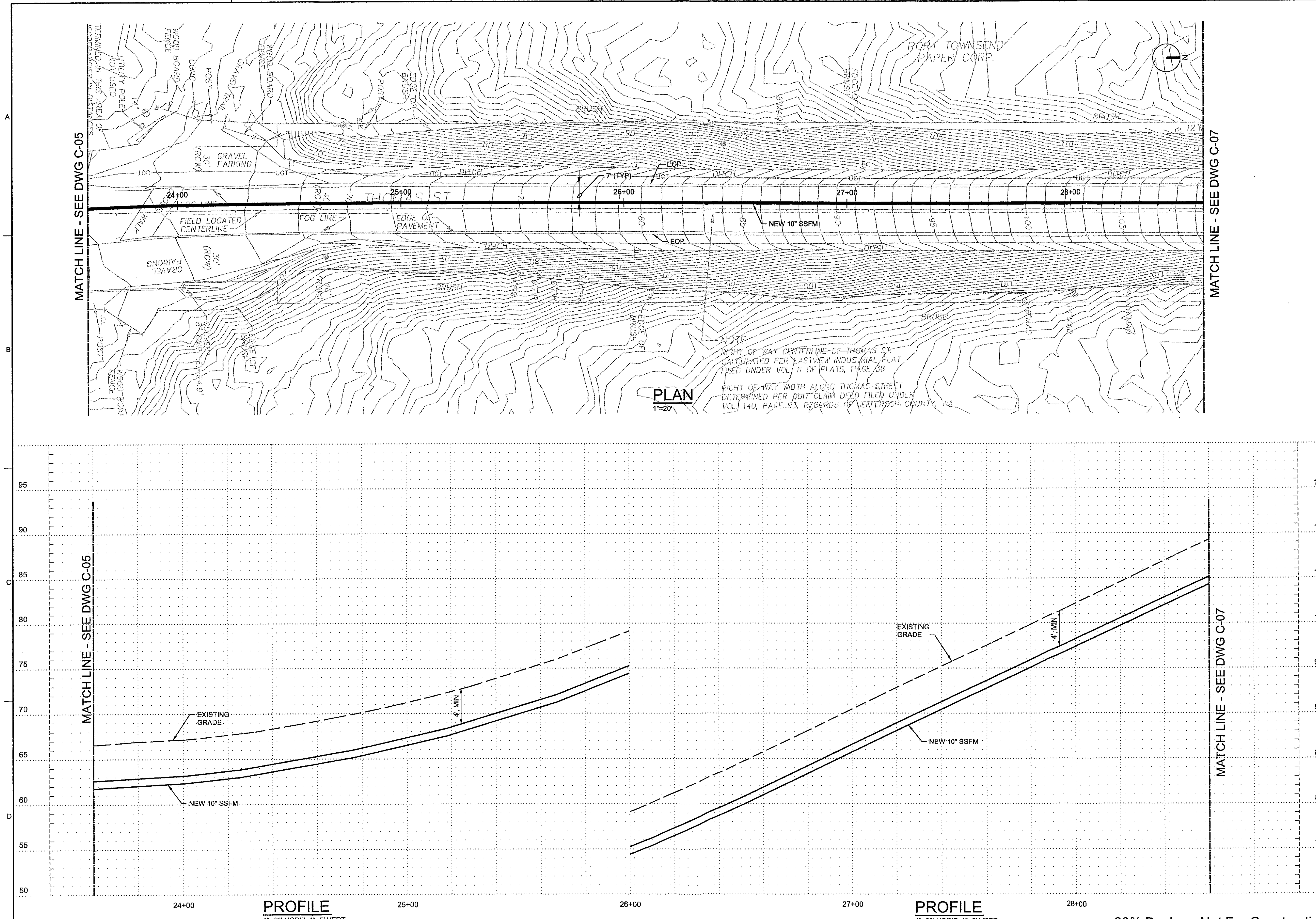

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

CIVIL
FORCEMAIN ALIGNMENT
PLAN AND PROFILE

VERIFY SCALE
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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-06
SHEET	

PRELIMINARY

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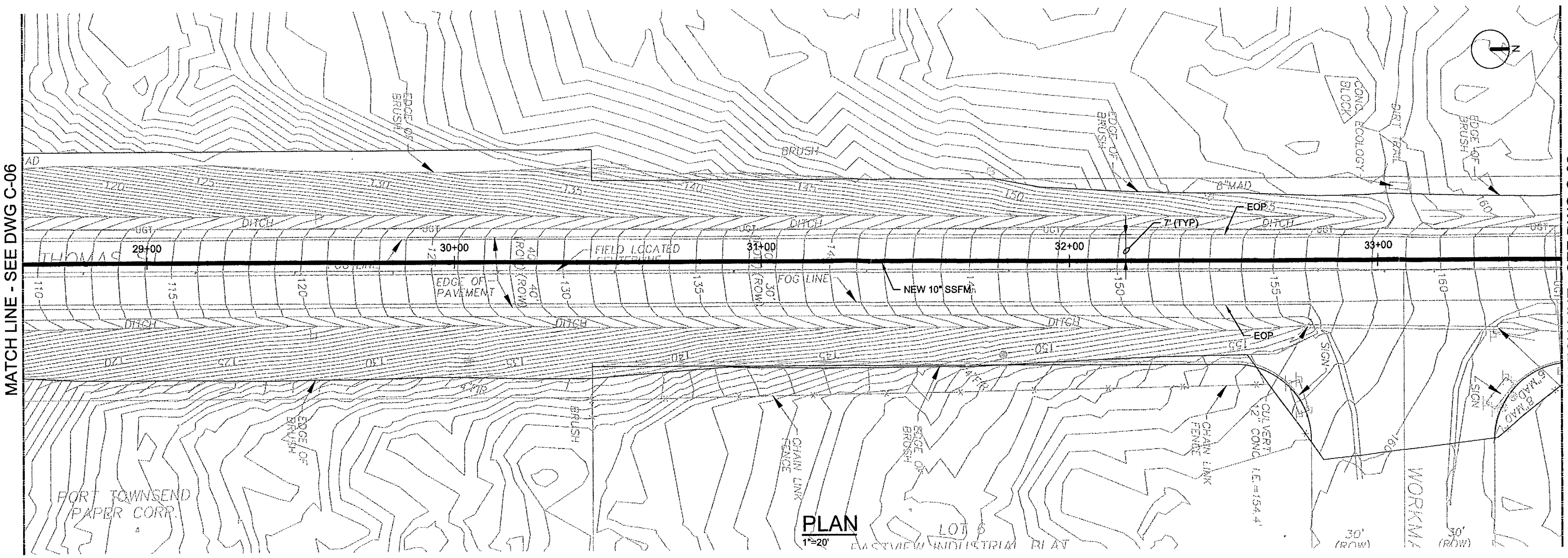

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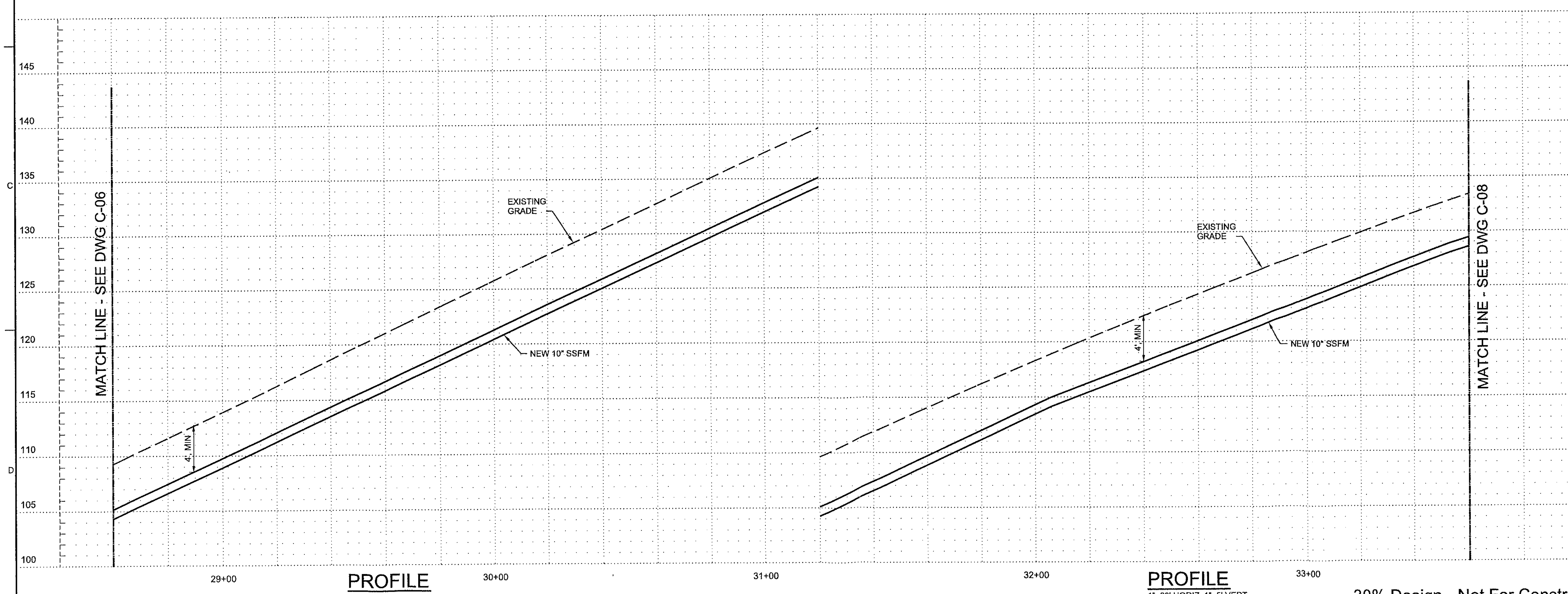

PROFILE
1"=20' HORIZ, 1"=5' VERT

PROFILE
1"=20' HORIZ, 1"=5' VERT

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NO.	DATE	REVISION	BY	APVD

DSGN	DR	CHK	APVD
A. ROSHAK	D SUNSERI	J BURNAM	J BURNAM

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

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PLAN AND PROFILE

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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-07
SHEET	

PRELIMINARY

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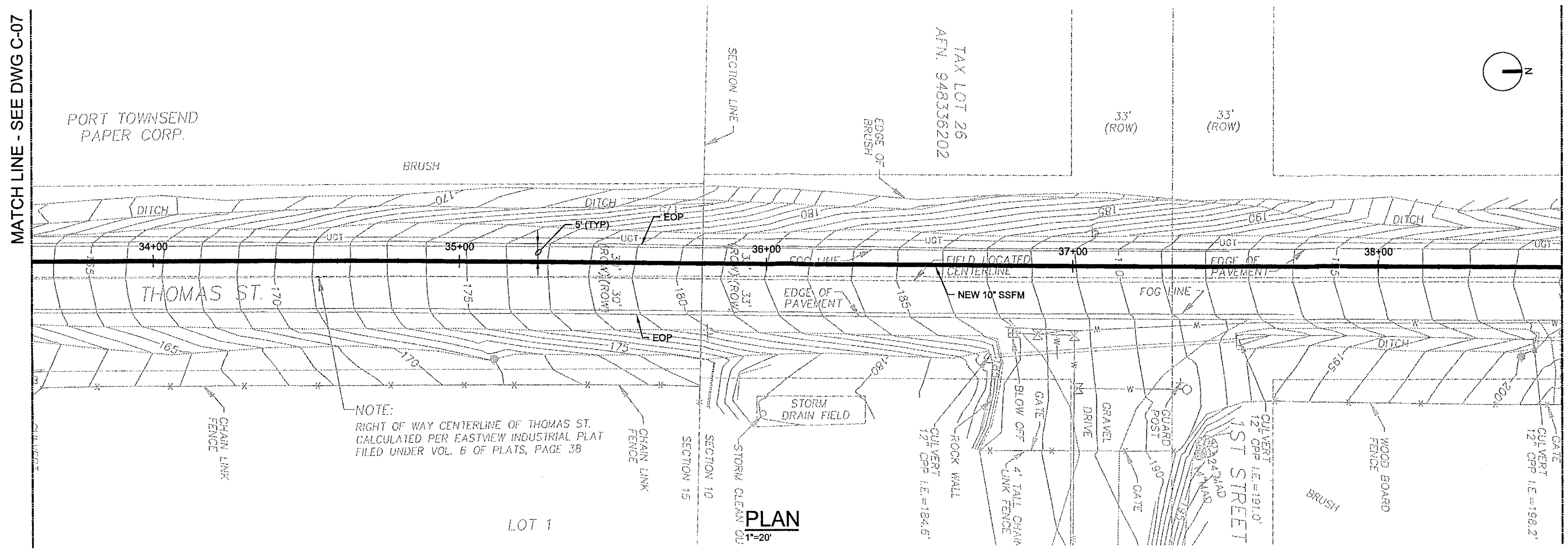

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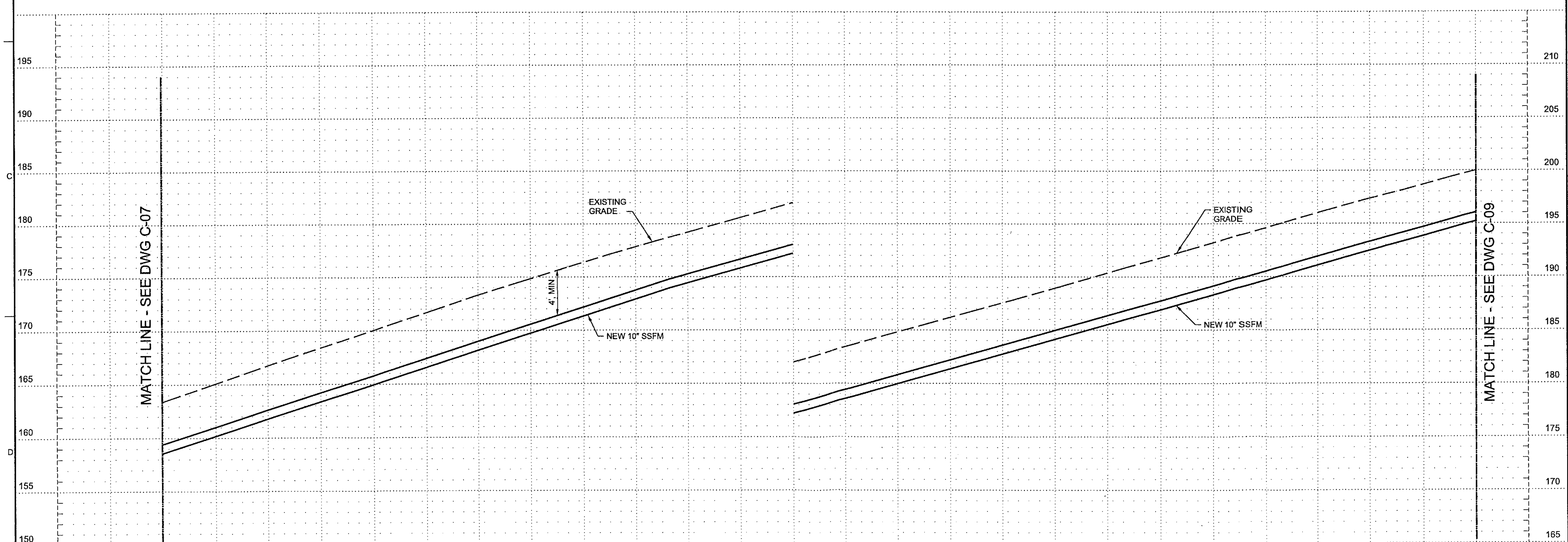

PROFILE
1"=20' HORIZ, 1"=5' VERT

PROFILE
1"=20' HORIZ, 1"=5' VERT

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-08
SHEET	

PRELIMINARY

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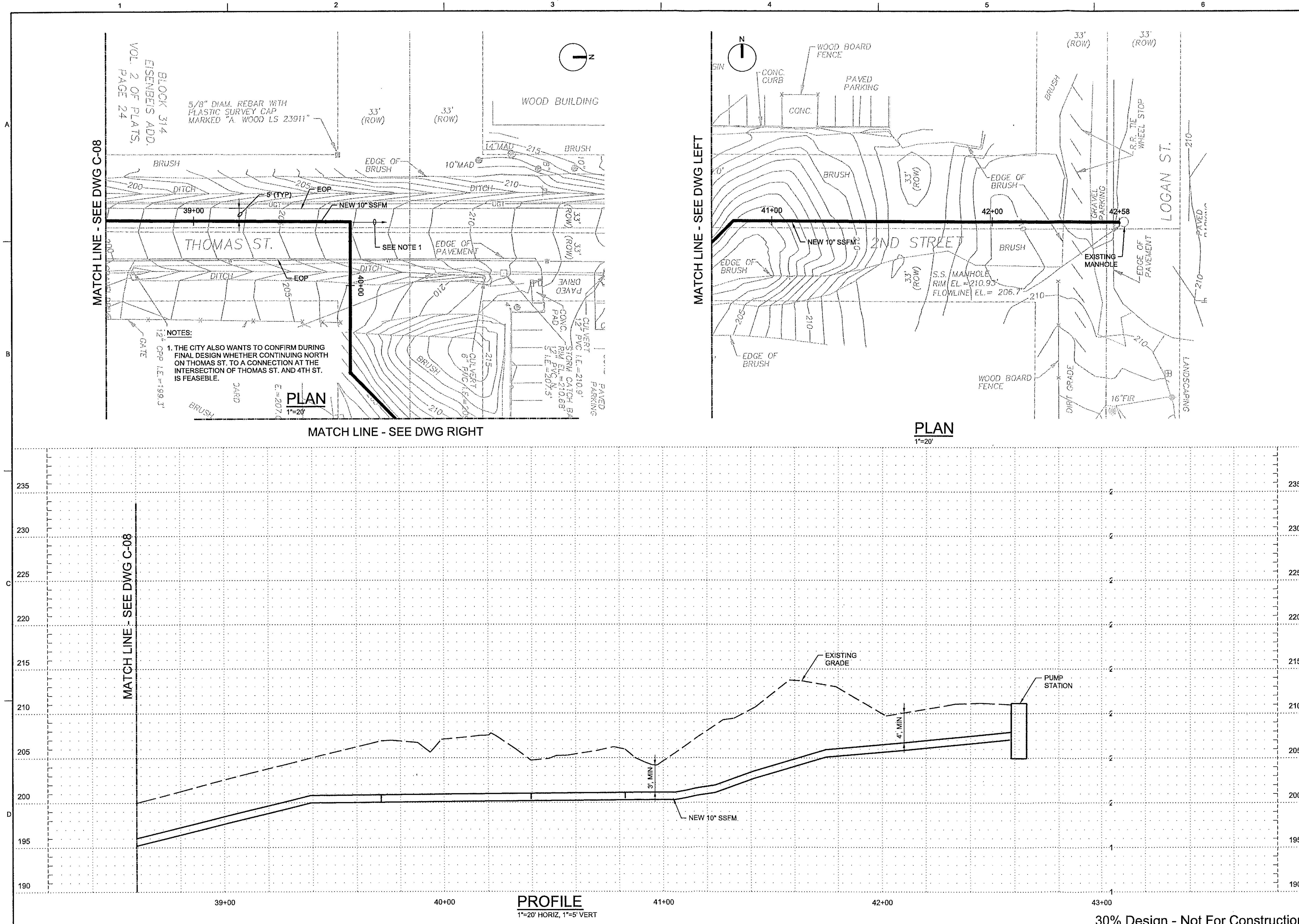

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PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

CIVIL

FORCEMAIN ALIGNMENT
PLAN AND PROFILE

NO.	DATE	REVISION	BY	APVD

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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-09
SHEET	

PRELIMINARY

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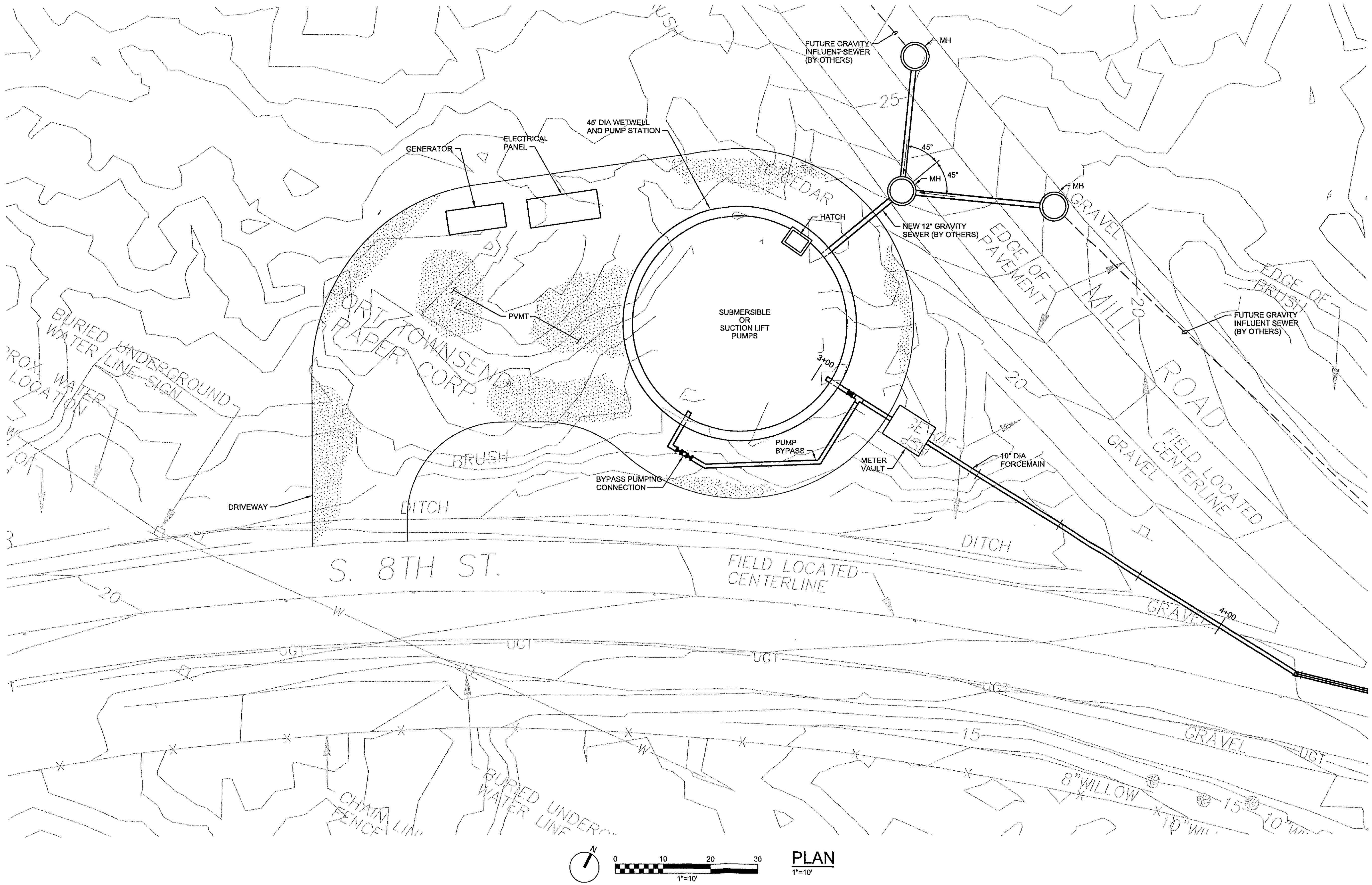

NO.	DATE	REVISION	BY	APVD

DSGN A. ROSHAK | DR | CHK D SUNSERI | APVD J BURNAM

PORT TOWNSEND
MILL ROAD PUMP STATION
AND FORCEMAIN
PORT TOWNSEND, WA

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CIVIL
PUMP STATION SITE PLAN

VERIFY SCALE
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0 1"

DATE	OCTOBER 2012
PROJ	425179
DWG	C-10
SHEET	

30% Design - Not For Construction

PRELIMINARY

Appendix D:
Cost Estimate

MEMORANDUM CH2MHILL

City of Port Townsend

Mill Road Pump Station & Force Main

Construction Cost Estimate

PREPARED FOR:	Jack Burnam/SEA
PREPARED BY:	Craig Moore/SEA
DATE:	July 17, 2012
PROJECT NUMBER:	425179

Purpose

The purpose of this memorandum is to document the cost estimating methodology and assumptions used in preparing the Schematic Design construction cost estimate for the Port Townsend Pump Station and Force Main. The basis of this cost estimate is summarized below:

Original Estimate Date:	May 23, 2012
Revision:	July 17, 2012
Construction Cost Index (CCI) Number:	Seattle ENR CCI (April 2012) 9056
Estimate Type:	15% Estimate (Class 3)
Accuracy Level:	+30% to -20%

The following memorandum provides a description of the cost estimating methodology, overall costs, markups, assumptions, productivity rates, cost basis, and excluded costs.

Summary of Costs

The following is a summary of the estimate costs. The base construction cost shown includes mobilization, bonds, contingency and escalation. It does not include project costs such as design, administrative, legal, or services during construction. See the attached estimate for a breakdown of the costs included in the estimate.

Option Costs

	Low Range	Estimate Range	High Range
	-20%	Base Cost	+30%
Submersible Pump Station & Force Main	$1,633,000	**$2,041,000**	$2,653,000
Suction Lift Pump Station & Force Main	$1,702,000	**$2,127,000**	$2,765,000
Force Main	$882,000	**$1,102,000**	$1,433,000
Gravity Pipe Alt 1	$306,000	**$383,000**	$498,000
Gravity Pipe Alt 2	$394,000	**$492,000**	$640,000
Gravity Pipe Common Alt 1 & 2	$542,000	**$678,000**	$881,000
Gravity Pipe Alt 3	$170,000	**$213,000**	$277,000
Gravity Pipe Common Alt 1, 2 & 3	$43,000	**$54,000**	$70,000
Gravity Pipe Alt 4	$674,000	**$843,000**	$1,096,000

Methodology

This cost estimate is considered a Schematic Design Estimate (Class 3) construction cost estimate. It is based upon the 15 percent design drawings and specification dated May 2012, and design information provided by the engineer at the time of the estimate.

Where possible, a quantity takeoff was developed for all elements shown in sufficient detail in the design drawings or described in the report. For an item known to exist but not defined in the project drawings, the cost estimator applied an allowance based on estimator experience and consultation with the project engineer.

The final costs of the project will depend on actual labor and material costs at the time of bid, actual site conditions, productivity, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from those presented herein. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

Markups

Table 1 summarizes various markups applied to the cost estimate to develop the overall construction cost. Unit costs include contractor overhead and profit. Mobilization, contingency, sales tax, market factor and escalation are also applied to the bottom line totals.

TABLE 1
Markup Summary

Markup	Percentage
Contractor Overhead & Profit (In unit costs)	18%
General Conditions	7%
Mobilization/Bonds/Insurance	5.16%
Construction Cost Estimate Contingency	40%
Escalation (Aug 2013)	3.58%
Sales Tax (Port Townsend)	9%
Market Conditions	0%

Assumptions

The following assumptions were used to develop the construction cost estimate:

General Assumptions:

1. Labor rates are based on the RS Means National Average Rate and adjusted for local wage rates using the RS Means regional adjustment factor.
2. The estimate currently includes escalation to mid-point of construction to August 2013.
3. Costs assume that the work is done during a regular 40 hour work week and does not include any overtime cost markups.
4. Costs do not include purchase of easements or right-of-way, engineering, administration or owner costs beyond the capital construction costs. The cost estimate is intended to represent the total contractor bid price as shown on the bid price schedule at the time of the bid opening.
5. Site access for the contractor and contractor staging areas are assumed to be adequate for the contractors needs.
6. The estimate is based on aggregates, drain sand, and clay materials being available locally to the contractor.
7. Temporary erosion and sediment control are expected to be minor. No wetland impacts are known at this time.
8. Pipe trenching is based on 5′ of cover to the top of the pipe.

9. It is assumed that dewatering for pipe trenching can be controlled with sump pumps in trench.

10. Roadway patching is based on 6" of asphalt over 6" of crushed surface base course.

11. The pump station wet well construction is based on a dropped caisson construction.

12. Due to the pump cooling requirements the submersible pump station wet well is 30" deeper than the suction lift pump station.

13. The pipe alternatives costs with the exception of Alternative 3 are based on the pipeline being placed in the roadway and include ACP demo and patching. Alternative 3 is outside of the roadway and travels cross country.

14. The revision adds a 350 KW emergency generator to the pump station and adds VFDs to the pumps.

Productivity Rates

The following assumptions were used in determining the Productivity Rates:

1. Contractor production rates for installation of standard items are taken from RS Means or are per the RS Means database and are based on 40 work weeks.

2. For equipment installation or non-standard items, production rates are per the cost estimator's best judgment based on experience and consultation with the design engineer.

Cost Basis

Various sources of cost data were used to develop this construction cost estimate. Construction costs were taken from RS Means Construction Cost Data. When applicable, recent bid tab information was used to establish costs for bid items.

Cost Quote

Cost quotes were received on the following items:

- Flygt 160 hp submersible pump from Whitney Equipment Comp Inc, 5/22/12
- Smith & Loveless lift pump from ADS Equipment Inc, 4/8/12

Excluded Costs

Construction costs do not include engineering, construction management, land acquisition (ROW) costs, hazardous materials mitigation, permitting, operations & maintenance costs or the client's financial, legal or administration costs.

Port Townsend Mill Rd Pump Station, Submersable, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 1

Project name	Port Townsend PS Sub Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Rev No. / Date	1/7-17-12
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
06					**SITEWORK**									
	31.0				Site/Civil									
		31-20			Earthworks, Site									
			CJM-005		**Sitework**									
				31-15-01-00	Site Preparation, Clearing and Grubbing									
					Clearing, Tree Removal, 6" - 12", Acre	0.20 acre	32.0		-	1,238	-	-	6,188.65 /acre	1,238
					Finish grading area to be paved with grader, small area	733.00 sy	29.3	2,020	-	-	2,527	-	6.20 /sy	4,546
					Compact Building Pads, Equipment Pads, and Misc. Out Structures	733.00 sy	8.1	547	-	-	383	-	1.27 /sy	930
					31-15-01-00 Site Preparation, Clearing and Grubbing	1.00 LS	69.5	2,566		1,238	2,910		6,713.96 /LS	6,714
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	733.00 sy	6.6		-	1,361	-	-	1.86 /sy	1,361
					Bituminous Pavement Import Aggregate Base	208.00 tn	2.7		-	7,981	-	-	38.37 /tn	7,981
					Bituminous Asphalt (tn), 4"	168.00 tn	1.3		-	20,794	-	-	123.77 /tn	20,794
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	733.00 SY	10.6			30,136			41.11 /SY	30,136
				31-45-01-00	Fencing, Chain Link									
					Security Fence, Chain Link, 8'	350.00 lf	45.5		-	10,830	-	-	30.94 /lf	10,830
					Fence Security Signage	8.00 ea	8.0		-	1,485	-	-	185.66 /ea	1,485
					Fence, double swing gates, 8' high, 12' opening	1.00 opng	15.0	911	637	-	26	-	1,574.77 /opng	1,575
					31-45-01-00 Fencing, Chain Link	350.00 LF	68.5	911	637	12,315	26		39.69 /LF	13,890
					CJM-005 Sitework		148.6	3,477	637	43,689	2,937			50,740
					31-20 Earthworks, Site	1.00 LS	148.6	3,477	637	43,689	2,937		50,739.64 /LS	50,740
					31.0 Site/Civil	1.00 LS	148.6	3,477	637	43,689	2,937		50,739.64 /LS	50,740
					06 SITEWORK		148.6	3,477	637	43,689	2,937			50,740
07					**YARD PIPING**									
	33.0				Buried Piping									
		33-00			Yard Piping									
			CJM-004		**Yard Piping**									
				33-00-07-10	Yard Pipe, PVC, 10"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,846.76 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	41.66 CY	1.2	85	-	-	106	-	4.58 /CY	191
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	9.47 cy	1.3	85	-	-	55	-	14.78 /cy	140
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	33.02 cy	1.0	73	-	-	60	-	4.02 /cy	133
					Pipe zone material	9.47 cy		-	328	-	-	-	34.66 /cy	328
					Pipe bedding material	2.86 cy		-	99	-	-	-	34.66 /cy	99
					Imported backfill material	33.02 cy		-	490	-	-	-	14.85 /cy	490
					Haul spoils, offsite, up to 10 miles	12.33 cy		-	-	153	-	-	12.38 /cy	153
					Dump fees, trench spoils	12.33 cy		-	76	-	-	-	6.19 /cy	76
					10" DI, MJ, Ell, 90	1.00 ea	4.2	357	388	-	174	-	919.19 /ea	919
					10" DI, MJ, Ell, 45	2.00 ea	8.4	714	633	-	348	-	847.71 /ea	1,695
					10" DI, MJ, tee	1.00 ea	5.8	493	633	-	240	-	1,366.61 /ea	1,367
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	45.00 LF		-	847	-	-	-	18.83 /LF	847
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	45.00 LF	6.8	582	-	-	283	-	19.22 /LF	865
					Pipe Marking, ID Tape	45.00 lf	0.5	41	7	-	-	-	1.08 /lf	49
					33-00-07-10 Yard Pipe, PVC, 10"	45.00 LF	29.1	2,431	3,503	153	1,978		179.20 /LF	8,064
				33-00-07-12	Yard Pipe, PVC, 12"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,846.80 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	30.50 CY	0.9	62	-	-	77	-	4.58 /CY	140
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	7.07 cy	0.9	64	-	-	41	-	14.78 /cy	105
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	23.89 cy	0.7	53	-	-	43	-	4.02 /cy	96
					Pipe zone material	7.07 cy		-	245	-	-	-	34.66 /cy	245
					Pipe bedding material	2.02 cy		-	70	-	-	-	34.66 /cy	70
					Imported backfill material	23.89 cy		-	355	-	-	-	14.85 /cy	355
					Haul spoils, offsite, up to 10 miles	9.09 cy		-	-	113	-	-	12.38 /cy	113
					Dump fees, trench spoils	9.09 cy		-	56	-	-	-	6.19 /cy	56
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 12"	30.00 LF		-	797	-	-	-	26.56 /LF	797
					Install PVC water distribution pipe, excav/bkfill NOT included, 12"	30.00 LF	5.0	429	-	-	209	-	21.25 /LF	637
					Pipe Marking, ID Tape	30.00 lf	0.3	28	5	-	-	-	1.08 /lf	32
					33-00-07-12 Yard Pipe, PVC, 12"	30.00 LF	7.9	635	1,528	113	1,082		111.90 /LF	3,357
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	1.00 ea	2.8	184	292	-	86	-	561.74 /ea	562
					Manholes, concrete, precast, 5' I.D., 8' deep	1.00 ea	16.0	1,064	2,414	-	499	-	3,977.17 /ea	3,977

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
					33-15-01-05 Yard Structures, Manholes, 60" Dia	1.00 EA	18.8	1,248	2,706		585		4,538.91 /EA	4,539
				33-20-01-10	Yard Valves, Gate Valves, 10"									
					Install gate valve, Flgd, DIP, 10"	3.00 ea	15.9	1,352	-	-	659	-	670.28 /ea	2,011
					Gate valve, iron body, dbl disk, Flgd, 150#, HWO, 10"	3.00 ea		-	2,321	-	-	-	773.58 /ea	2,321
					33-20-01-10 Yard Valves, Gate Valves, 10"	3.00 EA	15.9	1,352	2,321		659		1,443.86 /EA	4,332
					CJM-004 Yard Piping	**45.00 LF**	**71.6**	**5,665**	**10,057**	**265**	**4,304**		**450.92 /LF**	**20,291**
					33-00 Yard Piping	45.00 LF	71.6	5,665	10,057	265	4,304		450.92 /LF	20,291
		33-15			Yard Structures									
			CJM-003		**Meter Vault**									
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Excavator and Trucks, Small Crew, 6' depth	24.00 cy	1.3	89	-	-	81	-	7.09 /cy	170
					Grade for slabs / Scarify and Recompact, Dozer and Traxcavator or Loader, Small Crew	7.00 sy	0.3	23	-	-	14	-	5.21 /sy	36
					Import Aggregate Base - under slab, Dozer and Traxcavator or Loader, Small Crew	4.00 tn	0.4	26	99	-	15	-	35.18 /tn	141
					Import Aggregate Base - along walls, Dozer and Traxcavator or Loader, Small Crew	18.00 tn	1.7	118	446	-	70	-	35.18 /tn	633
					Load Excess for Hauling, Rubber Tire Loader, Cat 930	24.00 cy	0.2	15	-	-	11	-	1.07 /cy	26
					Haul / Remove Excess, 17 yd capacity, 5 miles RT	24.00 cy	0.7	41	-	-	43	-	3.51 /cy	84
					Dump Charges for For Excess, 17 yd tandem, per cy	24.00 cy		-	306	-	-	-	12.75 /cy	306
					31-25-01-00 Earthworks, Structural, Excavation	24.00 CY	4.6	312	851		234		58.18 /CY	1,396
				33-40-03-01	Pipeline Structures, Vaults									
					Meter Vault, 6'x6' x 10' d	1.00 ls				8,751			8,750.73 /ls	8,751
					33-40-03-01 Pipeline Structures, Vaults	1.00 EA				8,751			8,750.73 /EA	8,751
				40-20-19-10	Flow Meter, 10"									
					Install magnetic flow meter, 10"	1.00 ea	5.3	479	5,941	-	-	-	6,419.76 /ea	6,420
					40-20-19-10 Flow Meter, 10"	1.00 EA	5.3	479	5,941				6,419.76 /EA	6,420
					CJM-003 Meter Vault		**9.9**	**791**	**6,792**	**8,751**	**234**			**16,567**
					33-15 Yard Structures	1.00 EA	9.9	791	6,792	8,751	234		16,566.88 /EA	16,567
					33.0 Buried Piping	45.00 LF	81.5	6,456	16,849	9,016	4,538		819.07 /LF	36,858
					07 YARD PIPING		**81.5**	**6,456**	**16,849**	**9,016**	**4,538**			**36,858**
58					**WASTEWATER - PUMP STATION**									
	03.0				Concrete Work									
		03-10			Cast-In-Place Concrete Work									
			CJM-002		**Wet Well Concrete**									
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Concrete pumping, subcontract, all inclusive price	29.80 cy		-	-	478	-	-	16.05 /cy	478
					Slab on grade edge forms, 7" to 12"	100.50 sf	18.1	1,490	134	-	-	-	16.16 /sf	1,624
					Reinforcing in place, A615 Gr 60, priced per lbs.	4,469.44 lb		-	2,989	1,196	-	-	0.94 /lb	4,185
					Concrete, ready mix, 4000 psi	29.80 CY		-	4,105	-	-	-	137.79 /CY	4,105
					Add for concrete waste, 4000 psi	1.49 cy		-	205	-	-	-	137.79 /cy	205
					Add amount for Environmental Fee - per concrete truck load	4.00 load		-	32	-	-	-	8.03 /load	32
					Placing concrete, concrete pump	29.80 cy	22.3	1,473	-	-	-	-	49.42 /cy	1,473
					Finishing floors, monolithic, trowel finish (machine)	804.50 sf	16.1	1,224	22	-	-	-	1.55 /sf	1,245
					Curing, membrane spray	804.50 sf	1.6	106	43	-	-	-	0.19 /sf	149
					Concrete Coating, Chemical Resistant, CRC-3	804.50 sf		-	-	3,229	-	-	4.01 /sf	3,229
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	29.80 CY	58.1	4,292	7,531	4,903			561.28 /CY	16,726
				03-10-05-24	Cast-In-Place Concrete, Tremie Slab, 24" thick									
					Fine grade, for slab on grade, by hand	804.50 sf	5.6	371	11	-	-	-	0.48 /sf	382
					Concrete pumping, subcontract, all inclusive price	59.59 cy		-	-	957	-	-	16.05 /cy	957
					Concrete, ready mix, 4000 psi	59.59 CY		-	8,211	-	-	-	137.79 /CY	8,211
					Add for concrete waste, 4000 psi	2.98 cy		-	411	-	-	-	137.78 /cy	411
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump	59.59 cy	44.7	2,945	-	-	-	-	49.42 /cy	2,945
					03-10-05-24 Cast-In-Place Concrete, Tremie Slab, 24" thick	59.59 CY	50.3	3,316	8,689	957			217.51 /CY	12,962
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete pumping, subcontract, all inclusive price	189.87 cy		-	-	3,048	-	-	16.05 /cy	3,048
					Forms in place, structural walls, to 8' high, hand set	5,126.40 sf	769.0	63,326	6,858	-	-	-	13.69 /sf	70,184
					Waterstop, PVC, center bulb, 6" wide	1,281.60 lf	102.5	8,443	3,429	-	-	-	9.26 /lf	11,872
					Speed Dowels, #6	1,272.00 ea		-	34,032	-	-	-	26.76 /ea	34,032
					Reinforcing in place, A615 Gr 60, priced per lbs.	42,720.00 lb		-	28,574	11,430	-	-	0.94 /lb	40,003

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete, ready mix, 4000 psi	189.87 CY		-	26,161	-	-	-	137.79 /CY	26,161
					Add for concrete waste, 4000 psi	9.49 cy		-	1,308	-	-	-	137.79 /cy	1,308
					Add amount for Environmental Fee - per concrete truck load	24.00 load		-	193	-	-	-	8.03 /load	193
					Placing concrete, concrete pump, for structural wall >12" - 24" thick	189.87 cy	142.4	9,384	-	-	-	-	49.42 /cy	9,384
					Patch & plug tieholes	5,126.40 sf	76.9	5,067	137	-	-	-	1.02 /sf	5,204
					Sack rub	5,126.40 sf	205.1	13,513	206	-	-	-	2.68 /sf	13,718
					Curing, membrane spray	5,126.40 sf	10.3	676	274	-	-	-	0.19 /sf	950
					Below grade dampproofing, Bituminous Asphalt	2,562.00 sf		-	3,427	-	-	-	1.34 /sf	3,427
					Concrete Coating, Chemical Resistant, CRC-3	2,563.20 sf		-	-	10,287	-	-	4.01 /sf	10,287
					03-10-07-24 Cast-In-Place Concrete, Circular Walls, 24" thick	189.87 CY	1,306.1	100,409	104,598	24,764			1,210.15 /CY	229,771
				03-10-10-18	Cast-In-Place Concrete, Elevated Decks, 18" thick									
					Concrete pumping, subcontract, all inclusive price	61.30 cy		-	-	984	-	-	16.05 /cy	984
					Forms in place, elevated slab, soffit	1,018.00 sf	203.6	16,767	1,702	-	-	-	18.14 /sf	18,469
					Forms in place, elevated slab, edge form	169.50 sf	42.4	3,490	283	-	-	-	22.26 /sf	3,773
					Forms in place, elevated slab, box-out	36.00 sf	9.7	800	60	-	-	-	23.91 /sf	861
					Forms in place, monolithic beam, bottom	64.00 sf	12.8	1,054	128	-	-	-	18.48 /sf	1,183
					Forms in place, monolithic beam, sides	256.00 sf	38.4	3,162	428	-	-	-	14.03 /sf	3,590
					Slab shoring	20,360.00 cf	142.5	11,737	1,362	-	-	-	0.64 /cf	13,099
					Add labor for setting embedded frames	24.00 lf	24.0	1,976	-	-	-	-	82.35 /lf	1,976
					Reinforcing in place, A615 Gr 60, priced per lbs.	13,910.19 lb		-	9,304	3,722	-	-	0.94 /lb	13,026
					Concrete, ready mix, 4000 psi	61.30 CY		-	8,446	-	-	-	137.79 /CY	8,446
					Add for concrete waste, 4000 psi	3.07 cy		-	422	-	-	-	137.79 /cy	422
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump, for elevated slab over 12" thick	61.30 cy	27.6	1,818	-	-	-	-	29.65 /cy	1,818
					Finishing floors, monolithic, trowel finish (machine)	1,018.00 sf	20.4	1,548	27	-	-	-	1.55 /sf	1,576
					Curing, membrane spray	1,018.00 sf	2.0	134	54	-	-	-	0.19 /sf	189
					Concrete Coating, Chemical Resistant, CRC-2	1,018.00 sf		-	-	4,085	-	-	4.01 /sf	4,085
					03-10-10-18 Cast-In-Place Concrete, Elevated Decks, 18" thick	61.30 CY	523.4	42,487	22,274	8,791			1,199.88 /CY	73,553
					CJM-002 Wet Well Concrete		**1,937.9**	**150,505**	**143,092**	**39,414**				**333,011**
			CJM-009		**Wet Well Generator & Elect Pad**									
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Fine grade, for slab on grade, by hand	186.00 sf	1.3	86	2	-	-	-	0.48 /sf	88
					Fill, gravel subbase, under building slab on grade	3.45 cy	1.7	114	115	-	-	-	66.40 /cy	229
					Slab on grade edge forms, 7" to 12"	82.00 sf	14.8	1,216	110	-	-	-	16.16 /sf	1,325
					Reinforcing in place, A615 Gr 60, priced per lbs.	1,140.00 lb		-	763	305	-	-	0.94 /lb	1,068
					Concrete, ready mix, 4000 psi	6.89 CY		-	949	-	-	-	137.79 /CY	949
					Add for concrete waste, 4000 psi	0.35 cy		-	48	-	-	-	137.80 /cy	48
					Add amount for Environmental Fee - per concrete truck load	2.00 load		-	16	-	-	-	8.03 /load	16
					Placing concrete, direct chute	3.56 cy	1.8	117	-	-	-	-	32.94 /cy	117
					Finishing floors, monolithic, float finish	96.00 sf	1.9	146	1	-	-	-	1.53 /sf	147
					Curing, water	186.00 sf	0.6	41	12	-	-	-	0.29 /sf	53
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	6.89 CY	22.1	1,719	2,016	305			586.40 /CY	4,040
					CJM-009 Wet Well Generator & Elect Pad		**22.1**	**1,719**	**2,016**	**305**				**4,040**
					03-10 Cast-In-Place Concrete Work	347.45 CY	1,960.1	152,224	145,109	39,719			970.07 /CY	337,052
					03.0 Concrete Work	347.45 CY	1,960.1	152,224	145,109	39,719			970.07 /CY	337,052
04.0					Architectural									
		08-00			Openings									
			CJM-002		Wet Well Concrete									
				08-00-99-00	Openings, Other									
					Floor, indl, alum, 300 psf L.L., dbl leaf, 5' x 5' opening, 235#	1.00 opng	3.6	363	3,311	-	-	-	3,674.33 /opng	3,674
					08-00-99-00 Openings, Other	1.00 EA	3.6	363	3,311				3,674.33 /EA	3,674
					CJM-002 Wet Well Concrete		**3.6**	**363**	**3,311**					**3,674**
					08-00 Openings	1.00 SF	3.6	363	3,311				3,674.33 /SF	3,674
					04.0 Architectural	1.00 SF	3.6	363	3,311				3,674.33 /SF	3,674
26.0					Electrical Work									
		26-00			Electrical									
			CJM-007		Wet Well Electrical									
				26-00-99-00	Electrical, Other									
					Emergency Generator 350 KW, inlc battery, muffler, ATS & day tank	1.00 E	100.0	9,349	105,467	-	916	-	115,732.13 /E	115,732
					Power to Site	1.00 ls				20,816			20,815.90 /ls	20,816

Detail Report

Project: Port Townsend PS Sub
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Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
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				26-00-99-00	Electrical, Other									
					MCC	1.00 ls				13,877			13,877.26 /ls	13,877
					Other Site Electrical & Wiring	1.00 ls				20,816			20,815.89 /ls	20,816
					26-00-99-00 Electrical, Other	1.00 LS	100.0	9,349	105,467	55,509	916		171,241.18 /LS	171,241
				26-25-05-10	Electrical Equipment, VFDs - 150 HP									
					VFD 150 HP NEMA-1	2.00 E	80.0	7,479	47,183	-	1,055	-	27,858.30 /E	55,717
					26-25-05-10 Electrical Equipment, VFDs - 150 HP	2.00 EA	80.0	7,479	47,183		1,055		27,858.30 /EA	55,717
				26-30-01-00	Communications Systems									
					I&C Allowance	1.00 ls				20,816			20,815.89 /ls	20,816
					26-30-01-00 Communications Systems	1.00 LS				20,816			20,815.89 /LS	20,816
					CJM-007 Wet Well Electrical	**1.00 LS**	**180.0**	**16,828**	**152,650**	**76,325**	**1,971**		**247,773.67 /LS**	**247,774**
					26-00 Electrical	1.00 LS	180.0	16,828	152,650	76,325	1,971		247,773.67 /LS	247,774
					26.0 Electrical Work	1.00 LS	180.0	16,828	152,650	76,325	1,971		247,773.67 /LS	247,774
	31.0				Site/Civil									
		31-16			Earthworks, Sheeting/Shoring									
			CJM-006		**Wet Well Site/Excavation**									
				31-17-02-00	Earthworks, Caissons									
					Mobilization, caission equip/crane, set up, large	1.00 ea	237.0	17,748	-	-	18,426	-	36,174.35 /ea	36,174
					Caisson Shoe	107.00 lf						66,218	618.86 /lf	66,218
					31-17-02-00 Earthworks, Caissons	1.00 LS	237.0	17,748			18,426	66,218	102,392.70 /LS	102,393
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Generator and Pumps, Mob	1.00 ea	8.0		-	1,857	-	-	1,856.60 /ea	1,857
					Dewatering Minor, Set-up Generator and Install Pumps	4.00 ea	32.0	2,148	-	-	464	-	652.88 /ea	2,612
					Dewatering Minor, Sump Rock, delivered	5.00 cy		-	124	-	-	-	24.76 /cy	124
					Dewatering Minor, Large Generator and 4 Pumps, Rental, Monthly	3.00 mo		-	-	-	30,861	-	10,286.96 /mo	30,861
					Dewatering Minor, Generator and Pumps, Operation - Labor to maintain / check pumps/ fuel and lube	3.00 mo	270.0	17,059	-	-	2,408	-	6,488.80 /mo	19,466
					Dewatering Minor, Remove Generator and Pumps	4.00 ea	32.0	2,148	-	-	464	-	652.88 /ea	2,612
					Dewatering Minor, Generator and Pumps, Demob	1.00 ea	8.0		-	1,857	-	-	1,856.59 /ea	1,857
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	3.00 MO	350.0	21,354	124	3,713	34,196		19,795.76 /MO	59,387
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Caisson Crew, 22' depth	980.00 cy	209.1	13,700	-	-	14,040	-	28.31 /cy	27,740
					Load Excess for Hauling, Excavator, Cat 330	980.00 cy	4.9	387	-	-	699	-	1.11 /cy	1,086
					Haul / Remove Excess, 17 yd capacity, 10 miles RT	980.00 cy	33.7	2,020	-	-	2,082	-	4.19 /cy	4,102
					Dump Charges for For Excess, 17 yd tandem, per cy	980.00 cy		-	6,065	-	-	-	6.19 /cy	6,065
					31-25-01-00 Earthworks, Structural, Excavation	980.00 CY	247.7	16,107	6,065		16,822		39.79 /CY	38,993
					CJM-006 Wet Well Site/Excavation		**834.7**	**55,209**	**6,189**	**3,713**	**69,444**	**66,218**		**200,773**
					31-16 Earthworks, Sheeting/Shoring	1.00 LS	834.7	55,209	6,189	3,713	69,444	66,218	200,773.16 /LS	200,773
					31.0 Site/Civil	1.00 LS	834.7	55,209	6,189	3,713	69,444	66,218	200,773.16 /LS	200,773
	43.0				Process Equipment									
		43-05			Furnish and Install Process Equipment									
			CJM-008		**Wet Well Equipment**									
				44-05-49-04	Submersable Pumps									
					Submersable Pumps, 160 hp, w/out controls, Flygt	2.00 EA	192.0	16,132	172,866	-	2,775	-	95,887.02 /EA	191,774
					Set base elbow / pump assembly, 101 - 250 hp	2.00 ea	128.0	10,755	278	-	-	-	5,516.21 /ea	11,032
					Pump Control System	1.00 ls				41,632			41,631.79 /ls	41,632
					44-05-49-04 Submersable Pumps	2.00 EA	320.0	26,887	173,144	41,632	2,775		122,219.12 /EA	244,438
					CJM-008 Wet Well Equipment		**320.0**	**26,887**	**173,144**	**41,632**	**2,775**			**244,438**
					43-05 Furnish and Install Process Equipment	1.00 SF	320.0	26,887	173,144	41,632	2,775		244,438.24 /SF	244,438
					43.0 Process Equipment	1.00 SF	320.0	26,887	173,144	41,632	2,775		244,438.24 /SF	244,438
					58 WASTEWATER - PUMP STATION		**3,298.3**	**251,511**	**480,402**	**161,389**	**74,190**	**66,218**		**1,033,711**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Sub
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	261,444		3,528.495 hrs		
Material	497,888				
Subcontract	214,094				
Equipment	81,665		3,428.594 hrs		
Other	66,218				
Total Subcontractor OH&P	1,121,309	1,121,309			
General Conditions	64,703			7.000 %	
Total Taxes	64,703	1,186,012			
Mobilization/Demobilization	61,234			3.000 %	
Blder's Risk & Gen Liab Ins -%	20,411			1.000 %	
Payment & Performance Bond	23,677			1.160 %	
Total Owner-Provided Equipment	105,322	1,291,334			
Contingency - %	516,533			40.000 %	
Total Contingency	516,533	1,807,867			
Escalation on Estimate Total	64,722			3.580 %	
Construction Total	64,722	1,872,589			
Gross Sales Tax	168,533			9.000 %	
Construction Total (with GST)	168,533	2,041,122			

Port Townsend Mill Rd Pump Station, Lift Pump, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 1

Project name	Port Townsend PS Lift Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Rev No. / Date	1/7-17-12
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
06					**SITEWORK**									
	31.0				Site/Civil									
		31-20			Earthworks, Site									
			CJM-005		**Sitework**									
				31-15-01-00	Site Preparation, Clearing and Grubbing									
					Clearing, Tree Removal, 6" - 12", Acre	0.20 acre	32.0		-	1,238	-	-	6,190.95 /acre	1,238
					Finish grading area to be paved with grader, small area	733.00 sy	29.3	2,020	-	-	2,528	-	6.20 /sy	4,548
					Compact Building Pads, Equipment Pads, and Misc. Out Structures	733.00 sy	8.1	547	-	-	384	-	1.27 /sy	930
					31-15-01-00 Site Preparation, Clearing and Grubbing	1.00 LS	69.5	2,567		1,238	2,911		6,716.41 /LS	6,716
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	733.00 sy	6.6		-	1,361	-	-	1.86 /sy	1,361
					Bituminous Pavement Import Aggregate Base	208.00 tn	2.7		-	7,984	-	-	38.38 /tn	7,984
					Bituminous Asphalt (tn), 4"	168.00 tn	1.3		-	20,802	-	-	123.82 /tn	20,802
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	733.00 SY	10.6			30,147			41.13 /SY	30,147
				31-45-01-00	Fencing, Chain Link									
					Security Fence, Chain Link, 8'	350.00 lf	45.5		-	10,834	-	-	30.96 /lf	10,834
					Fence Security Signage	8.00 ea	8.0		-	1,486	-	-	185.73 /ea	1,486
					Fence, double swing gates, 8' high, 12' opening	1.00 opng	15.0	911	638	-	26	-	1,575.33 /opng	1,575
					31-45-01-00 Fencing, Chain Link	350.00 LF	68.5	911	638	12,320	26		39.70 /LF	13,895
					CJM-005 Sitework		**148.6**	**3,478**	**638**	**43,705**	**2,938**			**50,759**
					31-20 Earthworks, Site	1.00 LS	148.6	3,478	638	43,705	2,938		50,758.59 /LS	50,759
					31.0 Site/Civil	1.00 LS	148.6	3,478	638	43,705	2,938		50,758.59 /LS	50,759
					06 SITEWORK		**148.6**	**3,478**	**638**	**43,705**	**2,938**			**50,759**
07					**YARD PIPING**									
	33.0				Buried Piping									
		33-00			Yard Piping									
			CJM-004		**Yard Piping**									
				33-00-07-10	Yard Pipe, PVC, 10"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,847.84 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	41.66 CY	1.2	85	-	-	106	-	4.58 /CY	191
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	9.47 cy	1.3	86	-	-	55	-	14.79 /cy	140
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	33.02 cy	1.0	73	-	-	60	-	4.02 /cy	133
					Pipe zone material	9.47 cy		-	328	-	-	-	34.67 /cy	328
					Pipe bedding material	2.86 cy		-	99	-	-	-	34.67 /cy	99
					Imported backfill material	33.02 cy		-	491	-	-	-	14.86 /cy	491
					Haul spoils, offsite, up to 10 miles	12.33 cy		-	-	153	-	-	12.38 /cy	153
					Dump fees, trench spoils	12.33 cy		-	76	-	-	-	6.19 /cy	76
					10" DI, MJ, Ell, 90	1.00 ea	4.2	357	388	-	174	-	919.52 /ea	920
					10" DI, MJ, Ell, 45	2.00 ea	8.4	714	633	-	348	-	848.02 /ea	1,696
					10" DI, MJ, tee	1.00 ea	5.8	493	633	-	240	-	1,367.11 /ea	1,367
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	45.00 LF		-	847	-	-	-	18.83 /LF	847
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	45.00 LF	6.8	582	-	-	284	-	19.23 /LF	865
					Pipe Marking, ID Tape	45.00 lf	0.5	41	7	-	-	-	1.08 /lf	49
					33-00-07-10 Yard Pipe, PVC, 10"	45.00 LF	29.1	2,432	3,504	153	1,979		179.26 /LF	8,067
				33-00-07-12	Yard Pipe, PVC, 12"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	712	-	2,847.84 /mo	712
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	30.50 CY	0.9	62	-	-	77	-	4.58 /CY	140
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	7.07 cy	0.9	64	-	-	41	-	14.79 /cy	105
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	23.89 cy	0.7	53	-	-	43	-	4.02 /cy	96
					Pipe zone material	7.07 cy		-	245	-	-	-	34.67 /cy	245
					Pipe bedding material	2.02 cy		-	70	-	-	-	34.67 /cy	70
					Imported backfill material	23.89 cy		-	355	-	-	-	14.86 /cy	355
					Haul spoils, offsite, up to 10 miles	9.09 cy		-	-	113	-	-	12.38 /cy	113
					Dump fees, trench spoils	9.09 cy		-	56	-	-	-	6.19 /cy	56
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 12"	30.00 LF		-	797	-	-	-	26.57 /LF	797
					Install PVC water distribution pipe, excav/bkfill NOT included, 12"	30.00 LF	5.0	429	-	-	209	-	21.25 /LF	638
					Pipe Marking, ID Tape	30.00 lf	0.3	28	5	-	-	-	1.08 /lf	32
					33-00-07-12 Yard Pipe, PVC, 12"	30.00 LF	7.9	635	1,528	113	1,082		111.95 /LF	3,358
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	1.00 ea	2.8	184	292	-	86	-	561.94 /ea	562
					Manholes, concrete, precast, 5' I.D., 8' deep	1.00 ea	16.0	1,065	2,414	-	500	-	3,978.63 /ea	3,979

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
					33-15-01-05 Yard Structures, Manholes, 60" Dia	1.00 EA	18.8	1,248	2,707		586		4,540.57 /EA	4,541
				33-20-01-10	Yard Valves, Gate Valves, 10"									
					Install gate valve, Flgd, DIP, 10"	3.00 ea	15.9	1,352	-	-	659	-	670.52 /ea	2,012
					Gate valve, iron body, dbl disk, Flgd, 150#, HWO, 10"	3.00 ea		-	2,322	-	-	-	773.87 /ea	2,322
					33-20-01-10 Yard Valves, Gate Valves, 10"	3.00 EA	15.9	1,352	2,322		659		1,444.39 /EA	4,333
					CJM-004 Yard Piping	**45.00 LF**	**71.6**	**5,667**	**10,061**	**265**	**4,306**		**451.09 /LF**	**20,299**
					33-00 Yard Piping	45.00 LF	71.6	5,667	10,061	265	4,306		451.09 /LF	20,299
		33-15			Yard Structures									
			CJM-003		**Meter Vault**									
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Excavator and Trucks, Small Crew, 6' depth	24.00 cy	1.3	89	-	-	81	-	7.09 /cy	170
					Grade for slabs / Scarify and Recompact, Dozer and Traxcavator or Loader, Small Crew	7.00 sy	0.3	23	-	-	14	-	5.21 /sy	36
					Import Aggregate Base - under slab, Dozer and Traxcavator or Loader, Small Crew	4.00 tn	0.4	26	99	-	15	-	35.19 /tn	141
					Import Aggregate Base - along walls, Dozer and Traxcavator or Loader, Small Crew	18.00 tn	1.7	118	446	-	70	-	35.19 /tn	633
					Load Excess for Hauling, Rubber Tire Loader, Cat 930	24.00 cy	0.2	15	-	-	11	-	1.07 /cy	26
					Haul / Remove Excess, 17 yd capacity, 5 miles RT	24.00 cy	0.7	41	-	-	43	-	3.51 /cy	84
					Dump Charges for For Excess, 17 yd tandem, per cy	24.00 cy		-	306	-	-	-	12.75 /cy	306
					31-25-01-00 Earthworks, Structural, Excavation	24.00 CY	4.6	312	851		234		58.20 /CY	1,397
				33-40-03-01	Pipeline Structures, Vaults									
					Meter Vault, 6'x6' x 10' d	1.00 ls				8,754			8,754.02 /ls	8,754
					33-40-03-01 Pipeline Structures, Vaults	1.00 EA				8,754			8,754.02 /EA	8,754
				40-20-19-10	Flow Meter, 10"									
					Install magnetic flow meter, 10"	1.00 ea	5.3	479	5,943	-	-	-	6,422.15 /ea	6,422
					40-20-19-10 Flow Meter, 10"	1.00 EA	5.3	479	5,943				6,422.15 /EA	6,422
					CJM-003 Meter Vault		**9.9**	**791**	**6,794**	**8,754**	**234**			**16,573**
					33-15 Yard Structures	1.00 EA	9.9	791	6,794	8,754	234		16,573.07 /EA	16,573
					33.0 Buried Piping	45.00 LF	81.5	6,458	16,855	9,019	4,540		819.38 /LF	36,872
					07 YARD PIPING		**81.5**	**6,458**	**16,855**	**9,019**	**4,540**			**36,872**
58					**WASTEWATER - PUMP STATION**									
	03.0				Concrete Work									
		03-10			Cast-In-Place Concrete Work									
			CJM-002		**Wet Well Concrete**									
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Concrete pumping, subcontract, all inclusive price	29.80 cy		-	-	478	-	-	16.06 /cy	478
					Slab on grade edge forms, 7" to 12"	100.50 sf	18.1	1,490	134	-	-	-	16.17 /sf	1,625
					Reinforcing in place, A615 Gr 60, priced per lbs.	4,469.44 lb		-	2,991	1,196	-	-	0.94 /lb	4,187
					Concrete, ready mix, 4000 psi	29.80 CY		-	4,107	-	-	-	137.83 /CY	4,107
					Add for concrete waste, 4000 psi	1.49 cy		-	205	-	-	-	137.84 /cy	205
					Add amount for Environmental Fee - per concrete truck load	4.00 load		-	32	-	-	-	8.03 /load	32
					Placing concrete, concrete pump	29.80 cy	22.3	1,473	-	-	-	-	49.44 /cy	1,473
					Finishing floors, monolithic, trowel finish (machine)	804.50 sf	16.1	1,224	22	-	-	-	1.55 /sf	1,246
					Curing, membrane spray	804.50 sf	1.6	106	43	-	-	-	0.19 /sf	149
					Concrete Coating, Chemical Resistant, CRC-3	804.50 sf		-	-	3,230	-	-	4.02 /sf	3,230
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	29.80 CY	58.1	4,294	7,534	4,904			561.47 /CY	16,732
				03-10-05-24	Cast-In-Place Concrete, Tremie Slab, 24" thick									
					Fine grade, for slab on grade, by hand	804.50 sf	5.6	371	11	-	-	-	0.48 /sf	382
					Concrete pumping, subcontract, all inclusive price	59.59 cy		-	-	957	-	-	16.06 /cy	957
					Concrete, ready mix, 4000 psi	59.59 CY		-	8,214	-	-	-	137.83 /CY	8,214
					Add for concrete waste, 4000 psi	2.98 cy		-	411	-	-	-	137.84 /cy	411
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump	59.59 cy	44.7	2,946	-	-	-	-	49.44 /cy	2,946
					03-10-05-24 Cast-In-Place Concrete, Tremie Slab, 24" thick	59.59 CY	50.3	3,317	8,692	957			217.59 /CY	12,966
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete pumping, subcontract, all inclusive price	158.22 cy		-	-	2,541	-	-	16.06 /cy	2,541
					Forms in place, structural walls, to 8' high, hand set	4,272.00 sf	640.8	52,789	5,717	-	-	-	13.70 /sf	58,506
					Waterstop, PVC, center bulb, 6" wide	1,068.00 lf	85.4	7,039	2,858	-	-	-	9.27 /lf	9,897
					Speed Dowels, #6	1,060.00 ea		-	28,370	-	-	-	26.76 /ea	28,370
					Reinforcing in place, A615 Gr 60, priced per lbs.	35,600.00 lb		-	23,820	9,528	-	-	0.94 /lb	33,348

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				03-10-07-24	Cast-In-Place Concrete, Circular Walls, 24" thick									
					Concrete, ready mix, 4000 psi	158.22 CY		-	21,808	-	-	-	137.83 /CY	21,808
					Add for concrete waste, 4000 psi	7.91 cy		-	1,090	-	-	-	137.83 /cy	1,090
					Add amount for Environmental Fee - per concrete truck load	20.00 load		-	161	-	-	-	8.03 /load	161
					Placing concrete, concrete pump, for structural wall >12" - 24" thick	158.22 cy	118.7	7,822	-	-	-	-	49.44 /cy	7,822
					Patch & plug tieholes	4,272.00 sf	64.1	4,224	114	-	-	-	1.02 /sf	4,338
					Sack rub	4,272.00 sf	170.9	11,264	172	-	-	-	2.68 /sf	11,436
					Curing, membrane spray	4,272.00 sf	8.5	563	229	-	-	-	0.19 /sf	792
					Below grade dampproofing, Bituminous Asphalt	2,135.00 sf		-	2,857	-	-	-	1.34 /sf	2,857
					Concrete Coating, Chemical Resistant, CRC-3	2,136.00 sf		-	-	8,575	-	-	4.02 /sf	8,575
					03-10-07-24 Cast-In-Place Concrete, Circular Walls, 24" thick	158.22 CY	1,088.4	83,701	87,195	20,644			1,210.59 /CY	191,540
				03-10-10-18	Cast-In-Place Concrete, Elevated Decks, 18" thick									
					Concrete pumping, subcontract, all inclusive price	61.30 cy		-	-	984	-	-	16.06 /cy	984
					Forms in place, elevated slab, soffit	1,018.00 sf	203.6	16,772	1,703	-	-	-	18.15 /sf	18,475
					Forms in place, elevated slab, edge form	169.50 sf	42.4	3,491	284	-	-	-	22.27 /sf	3,774
					Forms in place, elevated slab, box-out	36.00 sf	9.7	801	60	-	-	-	23.92 /sf	861
					Forms in place, monolithic beam, bottom	64.00 sf	12.8	1,054	128	-	-	-	18.48 /sf	1,183
					Forms in place, monolithic beam, sides	256.00 sf	38.4	3,163	428	-	-	-	14.03 /sf	3,592
					Slab shoring	20,360.00 cf	142.5	11,741	1,362	-	-	-	0.64 /cf	13,103
					Add labor for setting embedded frames	24.00 lf	24.0	1,977	-	-	-	-	82.38 /lf	1,977
					Reinforcing in place, A615 Gr 60, priced per lbs.	13,910.19 lb		-	9,307	3,723	-	-	0.94 /lb	13,030
					Concrete, ready mix, 4000 psi	61.30 CY		-	8,449	-	-	-	137.83 /CY	8,449
					Add for concrete waste, 4000 psi	3.07 cy		-	422	-	-	-	137.83 /cy	422
					Add amount for Environmental Fee - per concrete truck load	7.00 load		-	56	-	-	-	8.03 /load	56
					Placing concrete, concrete pump, for elevated slab over 12" thick	61.30 cy	27.6	1,818	-	-	-	-	29.66 /cy	1,818
					Finishing floors, monolithic, trowel finish (machine)	1,018.00 sf	20.4	1,549	27	-	-	-	1.55 /sf	1,576
					Curing, membrane spray	1,018.00 sf	2.0	134	54	-	-	-	0.19 /sf	189
					Concrete Coating, Chemical Resistant, CRC-2	1,018.00 sf		-	-	4,087	-	-	4.02 /sf	4,087
					03-10-10-18 Cast-In-Place Concrete, Elevated Decks, 18" thick	61.30 CY	523.4	42,501	22,282	8,794			1,200.28 /CY	73,577
					CJM-002 Wet Well Concrete		**1,720.3**	**133,813**	**125,703**	**35,299**				**294,815**
			CJM-009		**Wet Well Generator & Elect Pad**									
				03-10-05-12	Cast-In-Place Concrete, Slabs on Grade, 12" thick									
					Fine grade, for slab on grade, by hand	186.00 sf	1.3	86	2	-	-	-	0.48 /sf	88
					Fill, gravel subbase, under building slab on grade	3.45 cy	1.7	114	115	-	-	-	66.41 /cy	229
					Slab on grade edge forms, 7" to 12"	82.00 sf	14.8	1,216	110	-	-	-	16.17 /sf	1,326
					Reinforcing in place, A615 Gr 60, priced per lbs.	1,140.00 lb		-	763	305	-	-	0.94 /lb	1,068
					Concrete, ready mix, 4000 psi	6.89 CY		-	950	-	-	-	137.83 /CY	950
					Add for concrete waste, 4000 psi	0.35 cy		-	48	-	-	-	137.88 /cy	48
					Add amount for Environmental Fee - per concrete truck load	2.00 load		-	16	-	-	-	8.03 /load	16
					Placing concrete, direct chute	3.56 cy	1.8	117	-	-	-	-	32.96 /cy	117
					Finishing floors, monolithic, float finish	96.00 sf	1.9	146	1	-	-	-	1.54 /sf	147
					Curing, water	186.00 sf	0.6	41	12	-	-	-	0.29 /sf	53
					03-10-05-12 Cast-In-Place Concrete, Slabs on Grade, 12" thick	6.89 CY	22.1	1,719	2,017	305			586.60 /CY	4,042
					CJM-009 Wet Well Generator & Elect Pad		**22.1**	**1,719**	**2,017**	**305**				**4,042**
					03-10 Cast-In-Place Concrete Work	315.80 CY	1,742.4	135,532	127,720	35,604			946.35 /CY	298,857
					03.0 Concrete Work	315.80 CY	1,742.4	135,532	127,720	35,604			946.35 /CY	298,857
04.0					Architectural									
		08-00			Openings									
			CJM-002		**Wet Well Concrete**									
				08-00-99-00	Openings, Other									
					Floor, incl, alum, 300 psf L.L., dbl leaf, 5' x 5' opening, 235#	1.00 opng	3.6	364	3,312	-	-	-	3,675.69 /opng	3,676
					08-00-99-00 Openings, Other	1.00 EA	3.6	364	3,312				3,675.69 /EA	3,676
					CJM-002 Wet Well Concrete		**3.6**	**364**	**3,312**					**3,676**
					08-00 Openings	1.00 SF	3.6	364	3,312				3,675.69 /SF	3,676
					04.0 Architectural	1.00 SF	3.6	364	3,312				3,675.69 /SF	3,676
26.0					Electrical Work									
		26-00			Electrical									
			CJM-007		**Wet Well Electrical**									
				26-00-99-00	Electrical, Other									
					Emergency Generator 350 KW, incl battery, muffler, ATS & day tank	1.00 E	100.0	9,352	105,503	-	916	-	115,770.67 /E	115,771
					Power to Site	1.00 ls				20,823			20,822.88 /ls	20,823

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
				26-00-99-00	Electrical, Other									
					MCC	1.00 ls				13,882			13,881.90 /ls	13,882
					Other Site Electrical & Wiring	1.00 ls				20,823			20,822.87 /ls	20,823
					26-00-99-00 Electrical, Other	1.00 LS	100.0	9,352	105,503	55,528	916		171,298.32 /LS	171,298
				26-25-05-10	Electrical Equipment, VFDs - 150 HP									
					VFD 150 HP NEMA-1	2.00 E	80.0	7,482	47,199	-	1,055	-	27,867.54 /E	55,735
					26-25-05-10 Electrical Equipment, VFDs - 150 HP	2.00 EA	80.0	7,482	47,199		1,055		27,867.54 /EA	55,735
				26-30-01-00	Communications Systems									
					I&C Allowance	1.00 ls				20,823			20,822.87 /ls	20,823
					26-30-01-00 Communications Systems	1.00 LS				20,823			20,822.87 /LS	20,823
					CJM-007 Wet Well Electrical	**1.00 LS**	**180.0**	**16,834**	**152,701**	**76,351**	**1,971**		**247,856.26 /LS**	**247,856**
					26-00 Electrical	1.00 LS	180.0	16,834	152,701	76,351	1,971		247,856.26 /LS	247,856
					26.0 Electrical Work	1.00 LS	180.0	16,834	152,701	76,351	1,971		247,856.26 /LS	247,856
	31.0				Site/Civil									
		31-16			Earthworks, Sheeting/Shoring									
			CJM-006		**Wet Well Site/Excavation**									
				31-17-02-00	Earthworks, Caissons									
					Mobilization, caission equip/crane, set up, large	1.00 ea	237.0	17,754	-	-	18,433	-	36,187.43 /ea	36,187
					Caisson Shoe	107.00 lf						66,243	619.10 /lf	66,243
					31-17-02-00 Earthworks, Caissons	1.00 LS	237.0	17,754			18,433	66,243	102,430.65 /LS	102,431
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Generator and Pumps, Mob	1.00 ea	8.0		-	1,857	-	-	1,857.29 /ea	1,857
					Dewatering Minor, Set-up Generator and Install Pumps	4.00 ea	32.0	2,149	-	-	464	-	653.11 /ea	2,612
					Dewatering Minor, Sump Rock, delivered	5.00 cy		-	124	-	-	-	24.76 /cy	124
					Dewatering Minor, Large Generator and 4 Pumps, Rental, Monthly	3.00 mo		-	-	-	30,872	-	10,290.82 /mo	30,872
					Dewatering Minor, Generator and Pumps, Operation - Labor to maintain / check pumps/ fuel and lube	3.00 mo	270.0	17,065	-	-	2,408	-	6,491.08 /mo	19,473
					Dewatering Minor, Remove Generator and Pumps	4.00 ea	32.0	2,149	-	-	464	-	653.11 /ea	2,612
					Dewatering Minor, Generator and Pumps, Demob	1.00 ea	8.0		-	1,857	-	-	1,857.28 /ea	1,857
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	3.00 MO	350.0	21,362	124	3,715	34,209		19,802.99 /MO	59,409
				31-25-01-00	Earthworks, Structural, Excavation									
					Structural Excavation, Caisson Crew, 22' depth	830.00 cy	177.1	11,607	-	-	11,896	-	28.32 /cy	23,502
					Load Excess for Hauling, Excavator, Cat 330	830.00 cy	4.2	328	-	-	593	-	1.11 /cy	920
					Haul / Remove Excess, 17 yd capacity, 10 miles RT	830.00 cy	28.6	1,712	-	-	1,764	-	4.19 /cy	3,476
					Dump Charges for For Excess, 17 yd tandem, per cy	830.00 cy		-	5,138	-	-	-	6.19 /cy	5,138
					31-25-01-00 Earthworks, Structural, Excavation	830.00 CY	209.8	13,646	5,138		14,252		39.80 /CY	33,037
					CJM-006 Wet Well Site/Excavation		**796.8**	**52,762**	**5,262**	**3,715**	**66,894**	**66,243**		**194,877**
					31-16 Earthworks, Sheeting/Shoring	1.00 LS	796.8	52,762	5,262	3,715	66,894	66,243	194,876.51 /LS	194,877
					31.0 Site/Civil	1.00 LS	796.8	52,762	5,262	3,715	66,894	66,243	194,876.51 /LS	194,877
	43.0				Process Equipment									
		43-05			Furnish and Install Process Equipment									
			CJM-008		**Wet Well Equipment**									
				44-05-49-04	Suction Lift Pump									
					Suction Lift Pump, 150 hp, w/ controls, Smith&Loveless	2.00 EA	192.0	16,137	305,402	-	2,776	-	162,157.86 /EA	324,316
					Set base elbow / pump assembly, 101 - 250 hp	2.00 ea	128.0	10,758	278	-	-	-	5,517.94 /ea	11,036
					44-05-49-04 Suction Lift Pump	2.00 EA	320.0	26,896	305,680		2,776		167,675.80 /EA	335,352
					CJM-008 Wet Well Equipment		**320.0**	**26,896**	**305,680**		**2,776**			**335,352**
					43-05 Furnish and Install Process Equipment	1.00 SF	320.0	26,896	305,680		2,776		335,351.60 /SF	335,352
					43.0 Process Equipment	1.00 SF	320.0	26,896	305,680		2,776		335,351.60 /SF	335,352
					58 WASTEWATER - PUMP STATION		**3,042.7**	**232,387**	**594,675**	**115,669**	**71,642**	**66,243**		**1,080,617**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend PS Lift
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date: 1/7-17-12
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	242,323		3,272.903 hrs		
Material	612,168				
Subcontract	168,394				
Equipment	79,119		3,390.684 hrs		
Other	66,243				
Total Subcontractor OH&P	1,168,247	1,168,247			
General Conditions	67,411			7.000 %	
Total Taxes	67,411	1,235,658			
Mobilization/Demobilization	63,797			3.000 %	
Blder's Risk & Gen Liab Ins -%	21,266			1.000 %	
Payment & Performance Bond	24,668			1.160 %	
Total Owner-Provided Equipment	109,731	1,345,389			
Contingency - %	538,156			40.000 %	
Total Contingency	538,156	1,883,545			
Escalation on Estimate Total	67,431			3.580 %	
Construction Total	67,431	1,950,976			
Gross Sales Tax	175,588			9.000 %	
Construction Total (with GST)	175,588	2,126,564			

Port Townsend Mill Rd Pump Station, Force Main, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend FM Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend FM
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-001		**10 dia Force Main**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	462.00 cy	18.5	1,240	-	-	659	-	4.11 /cy	1,900
					02-01-01-01 General Site Demolition, Aspalt Pavement	34,224.00 SF	18.5	1,240			659		0.06 /SF	1,900
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Generator and Pumps, Mob	1.00 ea	8.0		-	1,825	-	-	1,825.12 /ea	1,825
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	1.00 mo		-	-	-	6,124	-	6,124.48 /mo	6,124
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	1.00 MO	8.0			1,825	6,124		7,949.60 /MO	7,950
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	3,803.00 sy	34.2		-	6,941	-	-	1.83 /sy	6,941
					Bituminous Pavement Import Aggregate Base, 6"	1,109.00 tn	14.4		-	41,830	-	-	37.72 /tn	41,830
					Bituminous Asphalt (tn), 6"	1,300.00 tn	10.4		-	181,903	-	-	139.93 /tn	181,903
					Pavement Marking, 4" Pavement striping	4,278.00 lf	8.6		-	7,808	-	-	1.83 /lf	7,808
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	3,803.00 SY	67.6			238,482			62.71 /SY	238,482
				33-00-07-10	Yard Pipe, PVC, 10"									
					Traffic Control, Labor per Day	25.00 day	400.0	24,329	-	-	-	-	973.17 /day	24,329
					Trench Box, 8' x 24' x 10'	1.00 mo		-	-	-	2,799	-	2,798.51 /mo	2,799
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	3,960.38 CY	114.9	7,955	-	-	9,874	-	4.50 /CY	17,828
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	900.55 cy	119.8	8,001	-	-	5,096	-	14.54 /cy	13,097
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	3,139.10 cy	91.0	6,807	-	-	5,610	-	3.96 /cy	12,417
					Pipe zone material	900.55 cy		-	30,681	-	-	-	34.07 /cy	30,681
					Pipe bedding material	272.71 cy		-	9,291	-	-	-	34.07 /cy	9,291
					Imported backfill material	3,139.10 cy		-	45,834	-	-	-	14.60 /cy	45,834
					Haul spoils, offsite, up to 10 miles	1,173.26 cy		-	-	14,276	-	-	12.17 /cy	14,276
					Dump fees, trench spoils	1,173.26 ls		-	7,138	-	-		6.08 /ls	7,138
					10" DI, MJ, Ell, 90	1.00 ea	4.2	352	381	-	171	-	904.06 /ea	904
					10" DI, MJ, Ell, 45	1.00 ea	4.2	352	311	-	171	-	833.80 /ea	834
					10" DI, MJ, Ell, 22 1/2	8.00 ea	33.6	2,812	2,570	-	1,369	-	843.83 /ea	6,751
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	4,278.00 LF		-	79,172	-	-	-	18.51 /LF	79,172
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	4,278.00 LF	650.3	54,423	-	-	26,489	-	18.91 /LF	80,912
					Pipe Marking, ID Tape	4,278.00 lf	42.8	3,869	677	-	-	-	1.06 /lf	4,546
					33-00-07-10 Yard Pipe, PVC, 10"	4,278.00 LF	1,460.7	108,899	176,054	14,276	51,578		82.00 /LF	350,807
				33-20-07-01	Yard Valves, Other									
					Air Release Valve	1.00 ea				6,084			6,083.72 /ea	6,084
					33-20-07-01 Yard Valves, Other	1.00 EA				6,084			6,083.72 /EA	6,084
					CJM-001 10 dia Force Main	**4,278.00 LF**	**1,554.8**	**110,140**	**176,054**	**260,667**	**58,362**		**141.47 /LF**	**605,222**
					33-35 Pipelines	4,278.00 LF	1,554.8	110,140	176,054	260,667	58,362		141.47 /LF	605,222
					33.0 Buried Piping	4,278.00 LF	1,554.8	110,140	176,054	260,667	58,362		141.47 /LF	605,222
					92 OFFSITE - PIPELINES		**1,554.8**	**110,140**	**176,054**	**260,667**	**58,362**			**605,222**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend FM
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	110,140		1,554.774 hrs		
Material	176,054				
Subcontract	260,667				
Equipment	58,362		1,548.992 hrs		
Other					
Total Subcontractor OH&P	605,223	605,223			
General Conditions	34,923			7.000 %	
Total Taxes	34,923	640,146			
Mobilization/Demobilization	33,051			3.000 %	
Blder's Risk & Gen Liab Ins -%	11,017			1.000 %	
Payment & Performance Bond	12,780			1.160 %	
Total Owner-Provided Equipment	56,848	696,994			
Contingency - %	278,797			40.000 %	
Total Contingency	278,797	975,791			
Escalation on Estimate Total	34,933			3.580 %	
Construction Total	34,933	1,010,724			
Gross Sales Tax	90,965			9.000 %	
Construction Total (with GST)	90,965	1,101,689			

Port Townsend Mill Rd Pump Station, Alt 1, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 1 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 1
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	183.00 cy	7.3	491	-	-	261	-	4.11 /cy	752
					02-01-01-01 General Site Demolition, Aspalt Pavement	13,520.00 SF	7.3	491			261		0.06 /SF	752
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.25 mo		-	-	-	1,531	-	6,124.32 /mo	1,531
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.25 MO					1,531		6,124.32 /MO	1,531
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	1,502.00 sy	13.5		-	2,741	-	-	1.83 /sy	2,741
					Bituminous Pavement Import Aggregate Base, 6"	438.00 tn	5.7		-	16,521	-	-	37.72 /tn	16,521
					Bituminous Asphalt (tn), 6"	514.00 tn	4.1		-	71,920	-	-	139.92 /tn	71,920
					Pavement Marking, 4" Pavement striping	1,690.00 lf	3.4		-	3,084	-	-	1.83 /lf	3,084
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	1,502.00 SY	26.7			94,266			62.76 /SY	94,266
				31-45-01-00	Fencing, Chain Link									
					Traffic Control, Labor per Day	10.00 day	160.0	9,731	-	-	-	-	973.15 /day	9,731
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	700	-	2,798.44 /mo	700
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	1,422.68 CY	41.3	2,858	-	-	3,547	-	4.50 /CY	6,404
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	313.99 cy	41.8	2,790	-	-	1,777	-	14.54 /cy	4,566
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,143.27 cy	33.2	2,479	-	-	2,043	-	3.96 /cy	4,522
					Pipe zone material	313.99 cy		-	10,697	-	-	-	34.07 /cy	10,697
					Pipe bedding material	101.73 cy		-	3,466	-	-	-	34.07 /cy	3,466
					Imported backfill material	1,143.27 cy		-	16,692	-	-	-	14.60 /cy	16,692
					Haul spoils, offsite, up to 10 miles	415.72 cy		-	-	5,058	-	-	12.17 /cy	5,058
					Dump fees, trench spoils	415.72 ls		-	2,529	-	-		6.08 /ls	2,529
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	1,690.00 LF		-	20,830	-	-	-	12.33 /LF	20,830
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	1,690.00 LF	216.3	18,104	-	-	8,812	-	15.93 /LF	26,916
					Pipe Marking, ID Tape	1,690.00 lf	16.9	1,528	267	-	-	-	1.06 /lf	1,796
					31-45-01-00 Fencing, Chain Link	1,690.00 LF	509.4	37,491	54,481	5,058	16,878		67.40 /LF	113,908
					CJM-010 Gravity Pipe		**543.4**	**37,982**	**54,481**	**99,324**	**18,670**			**210,457**
					33-35 Pipelines	1,690.00 LF	543.4	37,982	54,481	99,324	18,670		124.53 /LF	210,457
					33.0 Buried Piping	1,690.00 LF	543.4	37,982	54,481	99,324	18,670		124.53 /LF	210,457
					92 OFFSITE - PIPELINES		**543.4**	**37,982**	**54,481**	**99,324**	**18,670**			**210,457**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 1
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	37,982		543.417 hrs		
Material	54,481				
Subcontract	99,324				
Equipment	18,670		466.883 hrs		
Other					
Total Subcontractor OH&P	210,457	210,457			
General Conditions	12,144			7.000 %	
Total Taxes	12,144	222,601			
Mobilization/Demobilization	11,493			3.000 %	
Blder's Risk & Gen Liab Ins -%	3,831			1.000 %	
Payment & Performance Bond	4,444			1.160 %	
Total Owner-Provided Equipment	19,768	242,369			
Contingency - %	96,948			40.000 %	
Total Contingency	96,948	339,317			
Escalation on Estimate Total	12,148			3.580 %	
Construction Total	12,148	351,465			
Gross Sales Tax	31,632			9.000 %	
Construction Total (with GST)	31,632	383,097			

Port Townsend Mill Rd Pump Station, Alt 2, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 2 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 2
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	238.00 cy	9.5	639	-	-	340	-	4.11 /cy	978
					02-01-01-01 General Site Demolition, Aspalt Pavement	17,600.00 SF	9.5	639			340		0.06 /SF	978
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.25 mo		-	-	-	1,531	-	6,123.52 /mo	1,531
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.25 MO					1,531		6,123.52 /MO	1,531
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	1,956.00 sy	17.6		-	3,569	-	-	1.83 /sy	3,569
					Bituminous Pavement Import Aggregate Base, 6"	570.00 tn	7.4		-	21,496	-	-	37.71 /tn	21,496
					Bituminous Asphalt (tn), 6"	669.00 tn	5.4		-	93,595	-	-	139.90 /tn	93,595
					Pavement Marking, 4" Pavement striping	2,200.00 lf	4.4		-	4,015	-	-	1.83 /lf	4,015
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	1,956.00 SY	34.8			122,675			62.72 /SY	122,675
				33-00-07-08	Yard Pipe, PVC, 8"									
					Traffic Control, Labor per Day	10.00 day	160.0	9,730	-	-	-	-	973.02 /day	9,730
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	700	-	2,798.04 /mo	700
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	1,852.01 CY	53.7	3,719	-	-	4,616	-	4.50 /CY	8,336
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	408.74 cy	54.4	3,631	-	-	2,312	-	14.54 /cy	5,943
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,488.28 cy	43.2	3,227	-	-	2,659	-	3.96 /cy	5,886
					Pipe zone material	408.74 cy		-	13,923	-	-	-	34.06 /cy	13,923
					Pipe bedding material	132.43 cy		-	4,511	-	-	-	34.06 /cy	4,511
					Imported backfill material	1,488.28 cy		-	21,727	-	-	-	14.60 /cy	21,727
					Haul spoils, offsite, up to 10 miles	541.17 cy		-	-	6,584	-	-	12.17 /cy	6,584
					Dump fees, trench spoils	541.17 ls		-	3,292	-	-		6.08 /ls	3,292
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	2,200.00 LF		-	27,112	-	-		12.32 /LF	27,112
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	2,200.00 LF	281.6	23,565	-	-	11,470	-	15.93 /LF	35,034
					Pipe Marking, ID Tape	2,200.00 lf	22.0	1,989	348	-	-	-	1.06 /lf	2,337
					33-00-07-08 Yard Pipe, PVC, 8"	2,200.00 LF	614.8	45,862	70,912	6,584	21,757		65.96 /LF	145,115
					CJM-010 Gravity Pipe		**659.1**	**46,500**	**70,912**	**129,258**	**23,628**			**270,299**
					33-35 Pipelines	2,200.00 LF	659.1	46,500	70,912	129,258	23,628		122.86 /LF	270,299
					33.0 Buried Piping	2,200.00 LF	659.1	46,500	70,912	129,258	23,628		122.86 /LF	270,299
					92 OFFSITE - PIPELINES		**659.1**	**46,500**	**70,912**	**129,258**	**23,628**			**270,299**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 2
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	46,500		659.117 hrs		
Material	70,912				
Subcontract	129,258				
Equipment	23,628		568.540 hrs		
Other					
Total Subcontractor OH&P	270,298	270,298			
General Conditions	15,597			7.000 %	
Total Taxes	15,597	285,895			
Mobilization/Demobilization	14,761			3.000 %	
Blder's Risk & Gen Liab Ins -%	4,920			1.000 %	
Payment & Performance Bond	5,708			1.160 %	
Total Owner-Provided Equipment	25,389	311,284			
Contingency - %	124,514			40.000 %	
Total Contingency	124,514	435,798			
Escalation on Estimate Total	15,602			3.580 %	
Construction Total	15,602	451,400			
Gross Sales Tax	40,626			9.000 %	
Construction Total (with GST)	40,626	492,026			

Port Townsend Mill Rd Pump Station, Com Alt 1&2, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Com 1&2 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Com 1&2
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	272.00 cy	10.9	730	-	-	388	-	4.11 /cy	1,118
					02-01-01-01 General Site Demolition, Aspalt Pavement	20,160.00 SF	10.9	730			388		0.06 /SF	1,118
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.50 mo		-	-	-	3,063	-	6,125.12 /mo	3,063
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.50 MO					3,063		6,125.12 /MO	3,063
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	2,240.00 sy	20.2		-	4,089	-	-	1.83 /sy	4,089
					Bituminous Pavement Import Aggregate Base, 6"	653.00 tn	8.5		-	24,633	-	-	37.72 /tn	24,633
					Bituminous Asphalt (tn), 6"	766.00 tn	6.1		-	107,194	-	-	139.94 /tn	107,194
					Pavement Marking, 4" Pavement striping	2,520.00 lf	5.0		-	4,600	-	-	1.83 /lf	4,600
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	2,240.00 SY	39.8			140,516			62.73 /SY	140,516
				33-00-07-10	Yard Pipe, PVC, 10"									
					Traffic Control, Labor per Day	15.00 day	240.0	14,599	-	-	-	-	973.26 /day	14,599
					Trench Box, 8' x 24' x 10'	0.50 mo		-	-	-	1,399	-	2,798.82 /mo	1,399
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	2,332.90 CY	67.7	4,686	-	-	5,817	-	4.50 /CY	10,503
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	530.48 cy	70.6	4,714	-	-	3,002	-	14.55 /cy	7,716
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,849.12 cy	53.6	4,010	-	-	3,305	-	3.96 /cy	7,315
					Pipe zone material	530.48 cy		-	18,075	-	-	-	34.07 /cy	18,075
					Pipe bedding material	160.64 cy		-	5,473	-	-	-	34.07 /cy	5,473
					Imported backfill material	1,849.12 cy		-	27,002	-	-	-	14.60 /cy	27,002
					Haul spoils, offsite, up to 10 miles	691.12 cy		-	-	8,410	-	-	12.17 /cy	8,410
					Dump fees, trench spoils	691.12 ls		-	4,205	-	-		6.08 /ls	4,205
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 10"	2,520.00 LF		-	46,642	-	-	-	18.51 /LF	46,642
					Install PVC water distribution pipe, excav/bkfill NOT included, 10"	2,520.00 LF	383.0	32,062	-	-	15,605	-	18.92 /LF	47,667
					Pipe Marking, ID Tape	2,520.00 lf	25.2	2,279	399	-	-	-	1.06 /lf	2,678
					33-00-07-10 Yard Pipe, PVC, 10"	2,520.00 LF	840.1	62,350	101,795	8,410	29,128		80.03 /LF	201,683
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	4.00 ea	11.0	723	1,149	-	339	-	552.50 /ea	2,210
					Manholes, concrete, precast, 5' I.D., 8' deep	4.00 ea	64.0	4,191	9,492	-	1,964	-	3,911.52 /ea	15,646
					Manholes, conc, precast, 5' I.D., for DS over 8', add	16.00 vlf	32.0	2,095	3,505	-	982	-	411.36 /vlf	6,582
					Drop Structure Piping	4.00 ea			1,460				365.06 /ea	1,460
					33-15-01-05 Yard Structures, Manholes, 60" Dia	4.00 EA	107.0	7,009	15,605		3,284		6,474.53 /EA	25,898
					CJM-010 Gravity Pipe		**997.8**	**70,089**	**117,400**	**148,926**	**35,863**			**372,278**
					33-35 Pipelines	2,520.00 LF	997.8	70,089	117,400	148,926	35,863		147.73 /LF	372,278
					33.0 Buried Piping	2,520.00 LF	997.8	70,089	117,400	148,926	35,863		147.73 /LF	372,278
					92 OFFSITE - PIPELINES		**997.8**	**70,089**	**117,400**	**148,926**	**35,863**			**372,278**

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	70,089		997.805 hrs		
Material	117,400				
Subcontract	148,926				
Equipment	35,863		948.431 hrs		
Other					
Total Subcontractor OH&P	372,278	372,278			
General Conditions	21,482			7.000 %	
Total Taxes	21,482	393,760			
Mobilization/Demobilization	20,330			3.000 %	
Blder's Risk & Gen Liab Ins -%	6,777			1.000 %	
Payment & Performance Bond	7,861			1.160 %	
Total Owner-Provided Equipment	34,968	428,728			
Contingency - %	171,491			40.000 %	
Total Contingency	171,491	600,219			
Escalation on Estimate Total	21,488			3.580 %	
Construction Total	21,488	621,707			
Gross Sales Tax	55,954			9.000 %	
Construction Total (with GST)	55,954	677,661			

Port Townsend Mill Rd Pump Station, Alt 3, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 3 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-001		**10 dia Force Main**									
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.25 mo		-	-	-	1,533	-	6,132.84 /mo	1,533
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.25 MO					1,533		6,132.84 /MO	1,533
				33-00-07-10	Yard Pipe, PVC, 10"									
					Trench Box, 8' x 24' x 10'	0.25 mo		-	-	-	701	-	2,802.32 /mo	701
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	1,574.21 CY	45.7	3,166	-	-	3,930	-	4.51 /CY	7,096
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	347.43 cy	46.2	3,091	-	-	1,969	-	14.56 /cy	5,059
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	1,265.03 cy	36.7	2,747	-	-	2,264	-	3.96 /cy	5,010
					Pipe zone material	347.43 cy		-	11,853	-	-	-	34.12 /cy	11,853
					Pipe bedding material	112.57 cy		-	3,840	-	-	-	34.12 /cy	3,840
					Imported backfill material	1,265.03 cy		-	18,496	-	-	-	14.62 /cy	18,496
					Haul spoils, offsite, up to 10 miles	460.00 cy		-	-	5,605	-	-	12.18 /cy	5,605
					Dump fees, trench spoils	460.00 ls		-	2,802	-	-		6.09 /ls	2,802
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	1,870.00 LF		-	23,080	-	-	-	12.34 /LF	23,080
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	1,870.00 LF	239.4	20,058	-	-	9,764	-	15.95 /LF	29,822
					Pipe Marking, ID Tape	1,870.00 lf	18.7	1,693	296	-	-	-	1.06 /lf	1,989
					33-00-07-10 Yard Pipe, PVC, 10"	1,870.00 LF	386.6	30,755	60,367	5,605	18,627		61.69 /LF	115,354
					CJM-001 10 dia Force Main	**1,870.00 LF**	**386.6**	**30,755**	**60,367**	**5,605**	**20,160**		**62.51 /LF**	**116,887**
					33-35 Pipelines	1,870.00 LF	386.6	30,755	60,367	5,605	20,160		62.51 /LF	116,887
					33.0 Buried Piping	1,870.00 LF	386.6	30,755	60,367	5,605	20,160		62.51 /LF	116,887
					92 OFFSITE - PIPELINES		**386.6**	**30,755**	**60,367**	**5,605**	**20,160**			**116,887**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	30,755		386.606 hrs		
Material	60,367				
Subcontract	5,605				
Equipment	20,160		497.904 hrs		
Other					
Total Subcontractor OH&P	116,887	116,887			
General Conditions	6,745			7.000 %	
Total Taxes	6,745	123,632			
Mobilization/Demobilization	6,383			3.000 %	
Blder's Risk & Gen Liab Ins -%	2,128			1.000 %	
Payment & Performance Bond	2,468			1.160 %	
Total Owner-Provided Equipment	10,979	134,611			
Contingency - %	53,844			40.000 %	
Total Contingency	53,844	188,455			
Escalation on Estimate Total	6,747			3.580 %	
Construction Total	6,747	195,202			
Gross Sales Tax	17,568			9.000 %	
Construction Total (with GST)	17,568	212,770			

Port Townsend Mill Rd Pump Station, Com Alt 1,2&3, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Com 1,2&3 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Com 1,2&3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	20.00 cy	0.8	54	-	-	29	-	4.11 /cy	82
					02-01-01-01 General Site Demolition, Aspalt Pavement	1,496.00 SF	0.8	54			29		0.06 /SF	82
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.10 mo		-	-	-	613	-	6,126.10 /mo	613
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.10 MO					613		6,126.10 /MO	613
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	166.00 sy	1.5		-	303	-	-	1.83 /sy	303
					Bituminous Pavement Import Aggregate Base, 6"	49.00 tn	0.6		-	1,849	-	-	37.73 /tn	1,849
					Bituminous Asphalt (tn), 6"	57.00 tn	0.5		-	7,978	-	-	139.97 /tn	7,978
					Pavement Marking, 4" Pavement striping	187.00 lf	0.4		-	341	-	-	1.83 /lf	341
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	166.00 SY	3.0			10,471			63.08 /SY	10,471
				33-00-07-12	Yard Pipe, PVC, 12"									
					Traffic Control, Labor per Day	2.00 day	32.0	1,947	-	-	-	-	973.42 /day	1,947
					Trench Box, 8' x 24' x 10'	0.10 mo		-	-	-	280	-	2,799.30 /mo	280
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	190.11 CY	5.5	382	-	-	474	-	4.50 /CY	856
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	44.08 cy	5.9	392	-	-	249	-	14.55 /cy	641
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	148.94 cy	4.3	323	-	-	266	-	3.96 /cy	589
					Pipe zone material	44.08 cy		-	1,502	-	-	-	34.08 /cy	1,502
					Pipe bedding material	12.58 cy		-	429	-	-	-	34.08 /cy	429
					Imported backfill material	148.94 cy		-	2,175	-	-	-	14.61 /cy	2,175
					Haul spoils, offsite, up to 10 miles	56.66 cy		-	-	690	-	-	12.17 /cy	690
					Dump fees, trench spoils	56.66 ls		-	345	-	-		6.09 /ls	345
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 12"	187.00 LF		-	4,884	-	-	-	26.12 /LF	4,884
					Install PVC water distribution pipe, excav/bkfill NOT included, 12"	187.00 LF	31.4	2,630	-	-	1,280	-	20.91 /LF	3,910
					Pipe Marking, ID Tape	187.00 lf	1.9	169	30	-	-	-	1.06 /lf	199
					33-00-07-12 Yard Pipe, PVC, 12"	187.00 LF	81.0	5,843	9,365	690	2,550		98.65 /LF	18,447
					CJM-010 Gravity Pipe		**84.7**	**5,897**	**9,365**	**11,161**	**3,191**			**29,613**
					33-35 Pipelines	187.00 LF	84.7	5,897	9,365	11,161	3,191		158.36 /LF	29,613
					33.0 Buried Piping	187.00 LF	84.7	5,897	9,365	11,161	3,191		158.36 /LF	29,613
					92 OFFSITE - PIPELINES		**84.7**	**5,897**	**9,365**	**11,161**	**3,191**			**29,613**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Com 1,2&3
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	5,897		84.742 hrs		
Material	9,365				
Subcontract	11,161				
Equipment	3,191		99.590 hrs		
Other					
Total Subcontractor OH&P	29,614	29,614			
General Conditions	1,709			7.000 %	
Total Taxes	1,709	31,323			
Mobilization/Demobilization	1,617			3.000 %	
Blder's Risk & Gen Liab Ins -%	539			1.000 %	
Payment & Performance Bond	625			1.160 %	
Total Owner-Provided Equipment	2,781	34,104			
Contingency - %	13,641			40.000 %	
Total Contingency	13,641	47,745			
Escalation on Estimate Total	1,709			3.580 %	
Construction Total	1,709	49,454			
Gross Sales Tax	4,451			9.000 %	
Construction Total (with GST)	4,451	53,905			

Port Townsend Mill Rd Pump Station, Alt 4, Port Townsend, WA
WW Pump Station, Schematic, 15% Design
425179, Rev 0

Project name	Port Townsend Alt 4 Port Townsend WA
Estimator	C Moore/SEA
Labor rate table	2_AA04 (2012)
Equipment rate table	1_EqRates_2011_75%
Job size	1 LS
Project	Port Townsend PS
Project Number	425179
Market Segment	Wastewater Pump Stat
Business Group	WBG
Project Conditions	New
Estimate Class 1-5	3
Estimate Category	Consult Engineer Est
Design Stage	Schematic Design
Project Manager	J Burnam
Report format	Sorted by 'Facility/Work Pkg/Trade Pkg/WorkActiv/Unit Price' 'Detail' summary Allocate addons Combine items

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 4
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Fac	Work Pkg	Trade Pkg	Work Activity	Unit Price	Description	Takeoff Quantity	Labor Man Hrs	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
92					**OFFSITE - PIPELINES**									
	33.0				Buried Piping									
		33-35			Pipelines									
			CJM-010		**Gravity Pipe**									
				02-01-01-01	General Site Demolition, Aspalt Pavement									
					Asphalt Demolition and Loading	378.00 cy	15.1	1,015	-	-	539	-	4.11 /cy	1,554
					02-01-01-01 General Site Demolition, Aspalt Pavement	28,000.00 SF	15.1	1,015			539		0.06 /SF	1,554
				31-19-01-00	Site Preparation, Dewatering, Sump Pump									
					Dewatering Minor, Large Generator and 1 Pumps, Rental, Monthly	0.75 mo		-	-	-	4,593	-	6,124.64 /mo	4,593
					31-19-01-00 Site Preparation, Dewatering, Sump Pump	0.75 MO					4,593		6,124.64 /MO	4,593
				31-40-02-00	Site Improvements, Paving, Bituminous Asphalt									
					Bituminous Pavement Subgrade Prep	3,111.00 sy	28.0		-	5,678	-	-	1.83 /sy	5,678
					Bituminous Pavement Import Aggregate Base, 6"	907.00 tn	11.8		-	34,212	-	-	37.72 /tn	34,212
					Bituminous Asphalt (tn), 6"	1,064.00 tn	8.5		-	148,885	-	-	139.93 /tn	148,885
					Pavement Marking, 4" Pavement striping	3,500.00 lf	7.0		-	6,388	-	-	1.83 /lf	6,388
					31-40-02-00 Site Improvements, Paving, Bituminous Asphalt	3,111.00 SY	55.3			195,163			62.73 /SY	195,163
				33-00-07-08	Yard Pipe, PVC, 8"									
					Traffic Control, Labor per Day	20.00 day	320.0	19,464	-	-	-	-	973.19 /day	19,464
					Trench Box, 8' x 24' x 10'	0.75 mo		-	-	-	2,099	-	2,798.59 /mo	2,099
					Excav. pipe trench, w/ 1:1 slopes, for 4" - 24" pipe	2,946.37 CY	85.4	5,918	-	-	7,346	-	4.50 /CY	13,264
					Backfill / Compact @ pipe zone, for 4" thru 24" pipe	650.27 cy	86.5	5,778	-	-	3,680	-	14.54 /cy	9,457
					Backfill / Compact above pipe zone, for 4" thru 24" pipe	2,367.71 cy	68.7	5,134	-	-	4,231	-	3.96 /cy	9,366
					Pipe zone material	650.27 cy		-	22,155	-	-	-	34.07 /cy	22,155
					Pipe bedding material	210.69 cy		-	7,178	-	-	-	34.07 /cy	7,178
					Imported backfill material	2,367.71 cy		-	34,572	-	-	-	14.60 /cy	34,572
					Haul spoils, offsite, up to 10 miles	860.96 cy		-	-	10,476	-	-	12.17 /cy	10,476
					Dump fees, trench spoils	860.96 ls		-	5,238	-	-	-	6.08 /ls	5,238
					FURNISH PVC water distribution pipe, C-900, class 150, DR 18, 8"	3,500.00 LF		-	43,141	-	-	-	12.33 /LF	43,141
					Install PVC water distribution pipe, excav/bkfill NOT included, 8"	3,500.00 LF	448.0	37,496	-	-	18,250	-	15.93 /LF	55,747
					Pipe Marking, ID Tape	3,500.00 lf	35.0	3,165	554	-	-	-	1.06 /lf	3,719
					33-00-07-08 Yard Pipe, PVC, 8"	3,500.00 LF	1,043.6	76,956	112,837	10,476	35,606		67.39 /LF	235,874
				33-15-01-05	Yard Structures, Manholes, 60" Dia									
					Catchbasins, frs and covs, lt traffic, 24" diam, 300 lb.	4.00 ea	11.0	723	1,149	-	339	-	552.45 /ea	2,210
					Manholes, concrete, precast, 5' I.D., 8' deep	4.00 ea	64.0	4,190	9,491	-	1,964	-	3,911.22 /ea	15,645
					Manholes, conc, precast, 5' I.D., for DS over 8', add	16.00 vlf	32.0	2,095	3,504	-	982	-	411.33 /vlf	6,581
					Drop Structure Piping	4.00 ea			1,460				365.03 /ea	1,460
					33-15-01-05 Yard Structures, Manholes, 60" Dia	4.00 EA	107.0	7,008	15,604		3,284		6,474.03 /EA	25,896
					CJM-010 Gravity Pipe		1,221.1	84,979	128,441	205,639	44,023			463,081
					33-35 Pipelines	4,278.00 LF	1,221.1	84,979	128,441	205,639	44,023		108.25 /LF	463,081
					33.0 Buried Piping	4,278.00 LF	1,221.1	84,979	128,441	205,639	44,023		108.25 /LF	463,081
					92 OFFSITE - PIPELINES		**1,221.1**	**84,979**	**128,441**	**205,639**	**44,023**			**463,081**

CH2MHILL

Job Size: 1 LS
Duration:

Detail Report

Project: Port Townsend Alt 4
Project No.: 425179
Design Stage: Schematic Design

Estimator: C Moore/SEA
Revision / Date:
Estimate Class: 3

Estimate Totals

Description	Amount	Totals	Hours	Rate	% of Total
Labor	84,979		1,221.052 hrs		
Material	128,441				
Subcontract	205,639				
Equipment	44,023		1,194.695 hrs		
Other					
Total Subcontractor OH&P	463,082	463,082			
General Conditions	26,721			7.000 %	
Total Taxes	26,721	489,803			
Mobilization/Demobilization	25,288			3.000 %	
Blder's Risk & Gen Liab Ins -%	8,429			1.000 %	
Payment & Performance Bond	9,778			1.160 %	
Total Owner-Provided Equipment	43,495	533,298			
Contingency - %	213,319			40.000 %	
Total Contingency	213,319	746,617			
Escalation on Estimate Total	26,729			3.580 %	
Construction Total	26,729	773,346			
Gross Sales Tax	69,601			9.000 %	
Construction Total (with GST)	69,601	842,947			

Appendix E:
Calculations

Gravity Line Evaluation for Critical Depth and Supercritical Flow

Port Townsend - Mill Road Pump Station and Force Main Predesign

Critical Depths

From Brater and King, 6th Edition

Table 8-10 (page 8-61)

Equation: $Q = K'_c d^{5/2}$ Solving for K'_c = $Q/d^{5/2}$

Where: Q = flow in cfs

K'c = Table Value

d = Pipe Diameter

Normal Depth

From Brater and King, 6th Edition

Table 7-14 (page 7-04)

Equation: $Q=(K'/n)d^{8/3}s^{1/2}$ Solving for $K' = Qn/(d^{8/3}s^{1/2})$

Where: Q = flow in cfs

K' = Table Value

d = Pipe Diameter

s = Slope ft/ft

n = Manning's Friction Factor = 0.013

Flow (gpm) divided by 448.80 = Flow cfs

Maximum Slope on Mill Road = 12.00% = 0.120 ft/ft

Maximum Slope on Thomas Street = 11.00% = 0.11 ft/ft

Critical Depth Calculations

Pipe Diameter = 8 inches = 0.67 ft

Flow (gpm)	Flow (cfs)	Critical Depth K'_c	D/d	D (ft)	D (inches)
200.00	0.45	1.2280	0.4676	0.31	3.74
400.00	0.89	2.4560	0.6714	0.45	5.37
600.00	1.34	3.6841	0.8182	0.55	6.55
800.00	1.78	4.9121	0.9122	0.61	7.30
1,000.00	2.23	6.1401	0.9689	0.65	7.75

Pipe Diameter = 10 inches = 0.83 ft

Flow (gpm)	Flow (cfs)	Critical Depth K'_c	D/d	D (ft)	D (inches)
200.00	0.45	0.7030	0.3500	0.23	2.80
400.00	0.89	1.4059	0.5019	0.33	4.02
600.00	1.34	2.1089	0.6204	0.41	4.96
800.00	1.78	2.8118	0.7191	0.48	5.75
1,000.00	2.23	3.5148	0.8010	0.53	6.41

Pipe Diameter = 12 inches = 1.00 ft

Flow (gpm)	Flow (cfs)	Critical Depth K'_c	D/d	D (ft)	D (inches)
200.00	0.45	0.4456	0.2763	0.18	2.21
400.00	0.89	0.8913	0.3957	0.26	3.17
600.00	1.34	1.3369	0.4888	0.33	3.91
800.00	1.78	1.7825	0.5684	0.38	4.55
1,000.00	2.23	2.2282	0.6384	0.43	5.11

Normal Depth Calculations - Mill Road

Pipe Diameter = 8 inches = 0.67 ft

Flow (gpm)	Flow (cfs)	K'	D/d	D (ft)	D (inches)
200.00	0.45	0.0493	0.2200	0.15	1.76
400.00	0.89	0.0986	0.3133	0.21	2.51
600.00	1.34	0.1479	0.3884	0.26	3.11
800.00	1.78	0.1972	0.4557	0.30	3.65
1,000.00	2.23	0.2465	0.5194	0.35	4.16

Pipe Diameter = 10 inches = 0.83 ft

Flow (gpm)	Flow (cfs)	K'	D/d	D (ft)	D (inches)
200.00	0.45	0.0272	0.1644	0.11	1.32
400.00	0.89	0.0544	0.2315	0.15	1.85
600.00	1.34	0.0816	0.2841	0.19	2.27
800.00	1.78	0.1088	0.3300	0.22	2.64
1,000.00	2.23	0.1360	0.3712	0.25	2.97

Pipe Diameter = 12 inches = 1.00 ft

Flow (gpm)	Flow (cfs)	K'	D/d	D (ft)	D (inches)
200.00	0.45	0.0167	0.1300	0.09	1.04
400.00	0.89	0.0334	0.1818	0.12	1.45
600.00	1.34	0.0502	0.2222	0.15	1.78
800.00	1.78	0.0669	0.2515	0.17	2.01
1,000.00	2.23	0.0836	0.2877	0.19	2.30

In all cases, at 12% slope, normal depth is less than critical depth - flow is in supercritical mode.

Highlighted columns represent a calculated value from the Tables identified above.

Port Townsend - Mill Road Pump Station and Force Main Preliminary Design

Peak Flow at Ultimate Buildout = 1185 gpm = 2.64 cfs

Goal - Maintain flows between 2.0 to 7.0 fps

Based on the following use a 10 inch force main in the 30 percent design.

Potential Force Main Diameters

6 inches	=	0.5 feet	Area =	0.20 ft^2
8 inches	=	0.7 feet	Area =	0.35 ft^2
10 inches	=	0.8 feet	Area =	0.55 ft^2

Flow Velocity (fps) = Q/A

Pumped Flow (gpm)	Pumped Flow (cfs)	Force Main Velocity 6 inch	Force Main Velocity 8 inch	Force Main Velocity 10 inch
200	0.45	2.27		
400	0.89	4.54		
500	1.11	5.67		
600	1.34	6.81		
800	1.78	9.08		
1000	2.23	11.35		
1185	2.64	13.45		
200	0.45		1.28	
400	0.89		2.55	
500	1.11		3.19	
600	1.34		3.83	
800	1.78		5.11	
1000	2.23		6.38	
1185	2.64		7.56	
200	0.45			0.82
400	0.89			1.63
500	1.11			2.04
600	1.34			2.45
800	1.78			3.27
1000	2.23			4.09
1185	2.64			4.84

Highlighted areas represent those that meet the stated criteria of maintaining velocities between 2.0 and 7.0 fps. The intent is to install the physical facilities such that ultimate buildout flows can be accommodated - realizing that mechanical equipment (say pumps) can be changed relatively simply over time without requiring the expenditure of significant costs to adapt to varying influent flow conditions.

Find pumps that can be modified to deliver between 500 gpm and 1200 gpm. Possibly through impeller changes.

Want to install the 10" force main. Installing either of the smaller mains to keep velocities higher would just mean that they would have to be replaced once the influent flows and the pumped flows got to the higher velocity range. By installing the 10 inch line pumped velocities don't vary too much and it will help to keep headlosses low.

Force Main Headloss Calculations

Headloss = S*Length

Slope = $(3.03/D^{1.16})(V/C)^{1.85}$

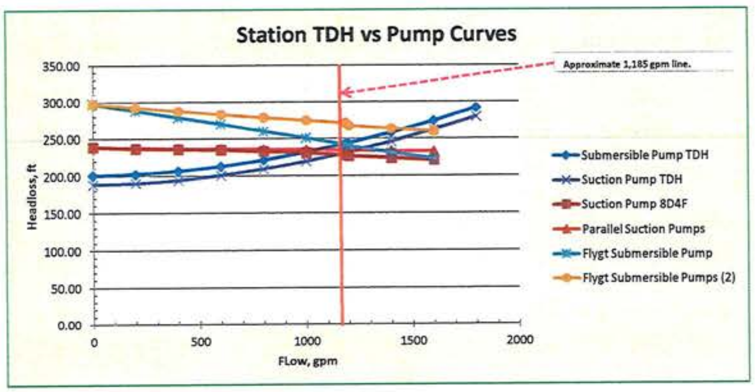
Force Main Length = 4,278 ft
Force Main Diameter 10 inches = 0.83 ft
Force Main Area 0.55 ft^2
Assume Force Main Material is DIP C = 130
Assumed Additional Losses to account for bends/angles in the Force Main, Pump Station Piping, etc. = 15.00% percent of calculated losses
Elevation of Forcemain at Pump Station = 19 ft (4 ft below ground surface)
Elevation of Forcemain at Discharge MH = 208 ft

Flow (gpm)	Flow (cfs)	Force Main Diameter (ft)	Velocity (fps)	Slope ft/ft	Headloss (S*L) (ft)	Additional Losses	Total HL (ft)	Static Head Suction Lift	TDH Suction Lift	Static Head Submer.	TDH Submer.
0	0.00	0.83	0.00	0	0.00	0.00	0.00	189	189.00	200.98	200.98
200	0.45	0.83	0.82	0.000316	1.35	0.20	1.56	189	190.56	200.98	202.53
400	0.89	0.83	1.63	0.00114	4.88	0.73	5.61	189	194.61	200.98	206.59
600	1.34	0.83	2.45	0.002415	10.33	1.55	11.88	189	200.88	200.98	212.86
800	1.78	0.83	3.27	0.004111	17.59	2.64	20.23	189	209.23	200.98	221.20
1000	2.23	0.83	4.09	0.006212	26.58	3.99	30.56	189	219.56	200.98	231.54
1185	2.64	0.83	4.84	0.008504	36.38	5.46	41.84	189	230.84	200.98	242.81
1200	2.67	0.83	4.90	0.008704	37.24	5.59	42.82	189	231.82	200.98	243.80
1400	3.12	0.83	5.72	0.011577	49.53	7.43	56.95	189	245.95	200.98	257.93
1600	3.57	0.83	6.54	0.014821	63.40	9.51	72.91	189	261.91	200.98	273.89
1800	4.01	0.83	7.35	0.018429	78.84	11.83	90.67	189	279.67	200.98	291.64

Pump Curves

Smith & Loveless 8D4F Suction Pump

Flow (gpm)	Head (ft)	Head (2 P's) (ft)
0	239	239
200	237	238
400	236	237
600	235	236.5
800	233	236
1000	231	235.4
1185	228	234.8
1200	227	234.2
1400	224	233.6
1600	221	233



Flygt MP 3315 HT

Flow (gpm)	Head (ft)	Head (2 P's) (ft)
0	298	298
200	288	293
400	279	288
600	270	283.5
800	260	279
1000	251	275.2
1185	242	271.4
1200	240	267.6
1400	231	263.8
1600	223	260

Port Townsend - Mill Road Pump Station and Force Main Preliminary Design

Active Storage Volume

Eqn. $T = V/I + V/(Q-I)$ Where: T = allowable minimum cycle time between starts (time to fill plus time to empty) (minutes
V = the active volume between LWL and HWL (fixed) (gallons)
I = inflow rate (gpm)
Q = pump rate (gpm)

Note: Worse case cycle time occurs when influent flow is 1/2 of pumping capacity.

Assumptions:

1 Duplex Pump Station - each pump capable of accommodating peak flow; operating in a lag/lead fashion to balance operating hours
2 Lag pump automatically called to operate if lead pump fails or cannot match influent flow
3 Want pumps to go through full on-off-on cycle no more than "X" time per hour. For a duplex station operating in lag/lead this allows for "2X' starts per hour. However active storage volume is based on a single pump to remain conservative.

Known variables:

T =	6 cycles per hour =		10 minutes	For an individual pump
I =	1185 gpm	At buildout		
Q =	1185 gpm			

Solving above equation for V: $V = TQ/4$

Required Active Storage Volume = 2962.5 gallons (say) 3000 gallons

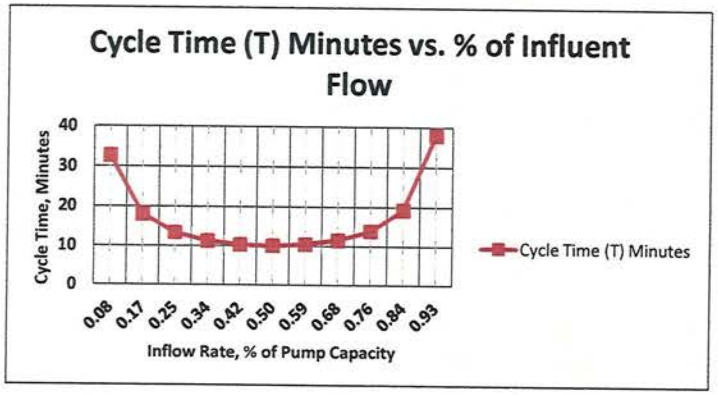
Check - cycle time when I = Q/2 : T = 10.12658 minutes

Graphing Cycle Time Curve:

Inflow Rate Vs. Percent (%) of Pump Capacity

Inflow Rate (gpm)	Percent of Pump Capacity (gpm)	Pump Capacity (gpm)	Cycle Time (T) (min)
1	0.00	1185	3002.534
100	0.08	1185	32.76498
200	0.17	1185	18.04569
300	0.25	1185	13.38983
400	0.34	1185	11.32166
500	0.42	1185	10.37956
592.5	0.50	1185	10.12658
700	0.59	1185	10.47128
800	0.68	1185	11.54221
900	0.76	1185	13.85965
1000	0.84	1185	19.21622
1100	0.93	1185	38.02139
1185	1.00	1185	#DIV/0!

Do not plot lowest and highest Inf. flow rates as they approach infinity.



Port Townsend - Mill Road Pump Station and Force Main Preliminary Design

Wet Well Sizing

Assumptions:

1 Desire is to design and install the physical facilities of the wet well for complete buildout of the area; but retain the capability to use the facilities during the interim before complete buildout occurs.

2 Used "X" feet as an active storage depth to allow for adjustments in depth for lower influent flows during the early years of the station.

3 Utilized a circular wet well, easier to clean, maintain than a rectangular one.

Circular Wet Well Sizing:

Circle Area: Pi(D^2)/4

Assumed Active Storage Volume Depth = 0.50 feet

7.48 gal/ft^3

Required Wet Well Diameter -

Active Volume = 3000 gallons = 401.0695 ft^3

Diameter =	Volume	Pi	Diameter					
	ft^3		ft					
	401.07	3.14	31.96	Say	32.00	ft	Use	45 foot diameter to allow for 1 hours storage at peak (ultimate buildout) flow
				Area =	804.2496	ft^2	1,590.44	ft^2

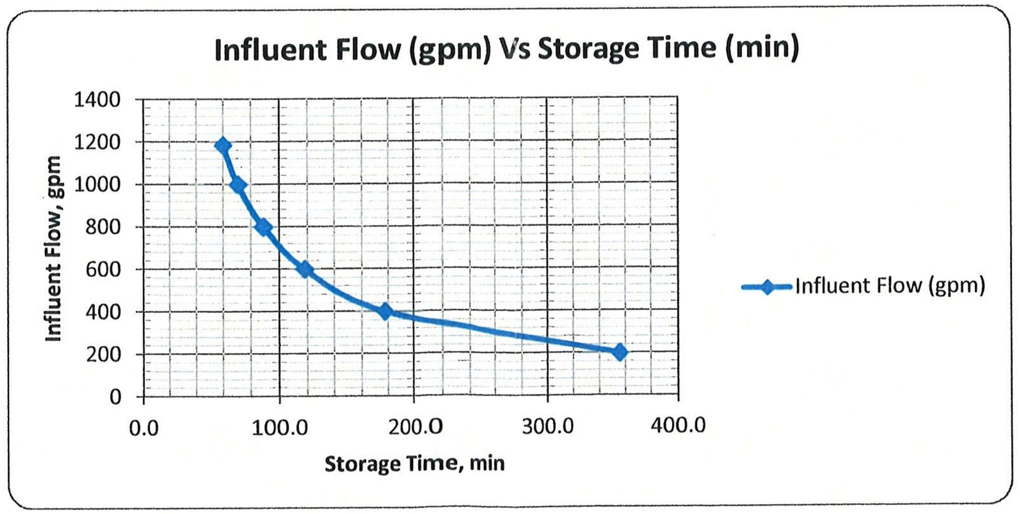
Active Storage Volume available using larger diameter Caisson = 5,948.23 gallons

Standby Storage Capacity -

Required if Station experiences complete loss of power or both pumps fail.

Storage Time @ Peak Inf. (min)	Peak Influent Flow (gpm)	Volume Required (gallons)	Volume Required (ft^3)	Depth in Wet Well (ft)
30	1,185	35,550	4,753	2.99
60	1,185	71,100	9,505	5.98
90	1,185	106,650	14,258	8.96
120	1,185	142,200	19,011	11.95
240	1,185	284,400	38,021	23.91

Note: depth indicated is for distance **below** invert of influent sewer only and does not include active storage volumes. Nor does it include depth from sewer invert to ground surface.



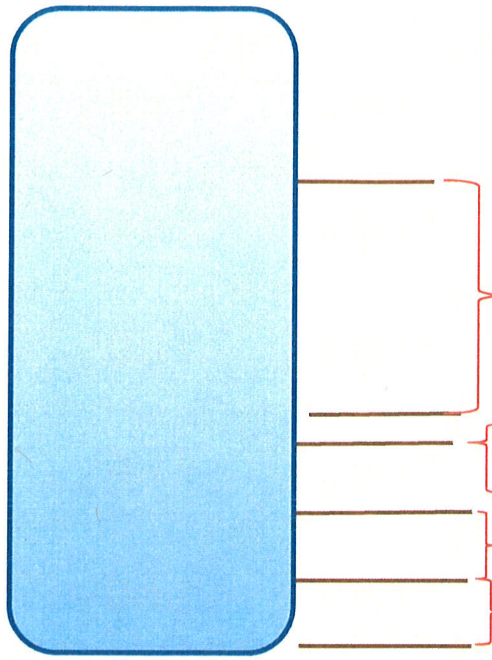
Potential Storage above High, High Alarm at different flow rates.

Assumption: Set storage to be equal to 30 minutes at buildout peak flows.

Influent Flow (gpm)	Storage Volume (ft^3)	Storage Time (min)	Storage Time (hours)
200	71,100	355.5	5.93
400	71,100	177.8	2.96
600	71,100	118.5	1.98
800	71,100	88.9	1.48
1000	71,100	71.1	1.19
1185	71,100	60.0	1.00

Note: Layout for Suction Lift Pumps only differs
by elimination of most of Dead Storage.

Figure 1
Generic Pump Layout



Influent to Wet Well	=	9.4765709 =	10.00
Standby Storage Volume	=	5.98 ft	
High, High Water Alarm	=	0.5 ft	
Pump On (Lag Pump)	=	0.50	
High Water Alarm			
Pump On (Lead Pump)			
Active Storage	=	0.50 ft	
Pump Off Elevation			
Dead Storage =		2.00 ft	
(Submersible pumps only)			
Bottom of Wet Well			

Actual Pump Station Depth:

Assumed Suction Pump Volute Elevation =	24.50		1.5 Assumed elevation of suction pump volute above GS.	
Surface Elevation =	23.00 ft			
Influent Sewer Elevation =	14.50 ft			
Standby Storage Elevations =	14.50 ft	to	8.52 ft =	5.98 ft
High, high water alarm Elev =	8.52 ft			
Lag Pump on Elevation =	8.02 ft		0.50 ft = Active Storage Volume	
High water alarm Elev =	8.02 ft			
Lead Pump On Elev =	7.52 ft			
Pump Off Elev =	7.02 ft			
Bottom of Dead Storage Elev =	5.02 ft			

Using submersible pumps the station wet well would be - 17.98 ft deep

If suction lift pumps were used the difference between pump off and surface elevation (assuming that the suction lift pumps were on top of the wet well and the volute was elevated 1.5 feet above the top of slab, cannot exceed 17.5 feet maximum. To make that work the top slab would have to be lowered by:

-0.02 ft

Appendix C

NPDES Permit

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DEPARTMENT OF
ECOLOGY
State of Washington

Issuance Date: November 13, 2015
Effective Date: December 1, 2015
Expiration Date: November 30, 2020

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM WASTE DISCHARGE PERMIT NO. WA0037052

State of Washington
DEPARTMENT OF ECOLOGY
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1342 et seq.

City of Port Townsend
250 Madison Street, Suite 2R
Port Townsend, WA 98368

is authorized to discharge in accordance with the Special and General Conditions that follow.

Plant Location:	5300 Kuhn Street Port Townsend, WA 98368	Receiving Water: Strait of Juan de Fuca
Treatment Type: (Oxidation Ditch)	Activated Sludge	

Rich Doenges
Southwest Region Manager
Water Quality Program
Washington State Department of Ecology

TABLE OF CONTENTS

TABLE OF CONTENTS 2

SUMMARY OF PERMIT REPORT SUBMITTALS 4

SPECIAL CONDITIONS 6

S1. DISCHARGE LIMITS 6
- A. Effluent Limits 6
- B. Mixing Zone Authorization 7

S2. MONITORING REQUIREMENTS 7
- A. Monitoring Schedule 7
- B. Sampling and Analytical Procedures 10
- C. Flow Measurement, Field Measurement, and Continuous Monitoring Devices 10
- D. Laboratory Accreditation 11

S3. REPORTING AND RECORDING REQUIREMENTS 11
- A. Discharge Monitoring Reports 12
- B. Permit Submittals and Schedules 13
- C. Records Retention 14
- D. Recording of Results 14
- E. Additional Monitoring by the Permittee 14
- F. Reporting Permit Violations 14
- G. Other Reporting 16
- H. Maintaining a Copy of this Permit 16

S4. FACILITY LOADING 17
- A. Design Criteria 17
- B. Plans for Maintaining Adequate Capacity 17
- C. Duty to Mitigate 18
- D. Notification of New or Altered Sources 18
- E. Infiltration and Inflow Evaluation 18
- F. Wasteload Assessment 18

S5. OPERATION AND MAINTENANCE 19
- A. Certified Operator 19
- B. Operation and Maintenance Program 19
- C. Short-term Reduction 20
- D. Electrical Power Failure 20
- E. Prevent Connection of Inflow 20
- F. Bypass Procedures 20
- G. Operations and Maintenance (O&M) Manual 23

S6. PRETREATMENT 24
- A. General Requirements 24
- B. Duty to Enforce Discharge Prohibitions 24
- C. Wastewater Discharge Permit Required 25
- D. Identification and Reporting of Existing, New, and Proposed Industrial Users 26
- E. Industrial User Survey 26

S7. SOLID WASTES 26
- A. Solid Waste Handling 26

B. Leachate 26

S8. APPLICATION FOR PERMIT RENEWAL OR MODIFICATION FOR FACILITY CHANGES 26

S9. ENGINEERING DOCUMENTS FOR OUTFALL REPLACEMENT 27

S10. ACUTE TOXICITY 27
A. Testing when there is No Permit Limit for Acute Toxicity 27
B. Sampling and Reporting Requirements 28

S11. CHRONIC TOXICITY 29
A. Testing when there is No Permit Limit for Chronic Toxicity 29
B. Sampling and Reporting Requirements 29

GENERAL CONDITIONS 31

G1. SIGNATORY REQUIREMENTS 31

G2. RIGHT OF INSPECTION AND ENTRY 32

G3. PERMIT ACTIONS 32

G4. REPORTING PLANNED CHANGES 34

G5. PLAN REVIEW REQUIRED 34

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES 34

G7. TRANSFER OF THIS PERMIT 34

G8. REDUCED PRODUCTION FOR COMPLIANCE 35

G9. REMOVED SUBSTANCES 35

G10. DUTY TO PROVIDE INFORMATION 35

G11. OTHER REQUIREMENTS OF 40 CFR 35

G12. ADDITIONAL MONITORING 35

G13. PAYMENT OF FEES 35

G14. PENALTIES FOR VIOLATING PERMIT CONDITIONS 35

G15. UPSET 36

G16. PROPERTY RIGHTS 36

G17. DUTY TO COMPLY 36

G18. TOXIC POLLUTANTS 36

G19. PENALTIES FOR TAMPERING 37

G20. COMPLIANCE SCHEDULES 37

G21. SERVICE AGREEMENT REVIEW 37

APPENDIX A 38

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S3.A.	Discharge Monitoring Report (DMR)	Monthly	January 15, 2016
S3.A.	Permit Renewal Application Monitoring Data	Annually	January 15, 2017
S3.F.	Reporting Permit Violations	As necessary	
S4.B.	Plans for Maintaining Adequate Capacity	As necessary	
S4.D.	Notification of New or Altered Sources	As necessary	
S4.E.	Infiltration and Inflow Evaluation	Annually	January 31, 2016
S4.F.	Wasteload Assessment	Annually	January 31, 2016
S5.F.	Bypass Notification	As necessary	
S6.B.4.	Notify Ecology when Industrial Users violate discharge prohibitions	As necessary	
S6.C.2.	Notify Ecology of any proposed discharger which may be a SIU	As necessary	
S6.D.	Submit copies of Industrial User notifications letters	As necessary	
S6.E.	Industrial User Survey Submittal	1/permit cycle	January 31, 2019
S8.	Application for Permit Renewal	1/permit cycle	June 1, 2020
S9.A.	Engineering Documents for Outfall Replacement	1/permit cycle	December 31, 2018
S9.D.	Approvable Plans & Specifications	1/permit cycle	December 31, 2019
S10.	Acute Toxicity Effluent Test Results - Submit with Permit Renewal Application	once in the last summer and once in the last winter prior to submission of the application for permit renewal	June 1, 2020
S11.	Chronic Toxicity Effluent Test Results with Permit Renewal Application	once in the last summer and once in the last winter prior to submission of the application for permit renewal	June 1, 2020
G1.	Notice of Change in Authorization	As necessary	

Permit Section	Submittal	Frequency	First Submittal Date
G4.	Reporting Planned Changes	As necessary	
G5.	Engineering Report for Construction or Modification Activities	As necessary	
G7.	Notice of Permit Transfer	As necessary	
G10.	Duty to Provide Information	As necessary	
G20.	Compliance Schedules	As necessary	
G21.	Contract Submittal	As necessary	

SPECIAL CONDITIONS

S1. DISCHARGE LIMITS

A. Effluent Limits

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. The discharge of any of the following pollutants more frequently than, or at a level in excess of, that identified and authorized by this permit violates the terms and conditions of this permit.

Beginning on the effective date of this permit, the Permittee may discharge treated domestic wastewater to the Strait of Juan de Fuca at the permitted location subject to compliance with the following limits:

Effluent Limits: Outfall 001 Latitude 48.141667 N Longitude -122.783333 W		
Parameter	**Average Monthly [a]**	**Average Weekly [b]**
Biochemical Oxygen Demand (5-day) (BOD_5)	30 milligrams/liter (mg/L) 513 pounds/day (lbs/day) 85% removal of influent BOD_5	45 mg/L 769 lbs/day
Total Suspended Solids (TSS)	30 mg/L 513 lbs/day 85% removal of influent TSS	45 mg/L 769 lbs/day
Total Residual Chlorine	0.5 mg/L	0.75mg/L
Parameter	**Minimum**	**Maximum**
pH	6.0 Standard Units	9.0 Standard Units
Parameter	**Monthly Geometric Mean**	**Weekly Geometric Mean**
Fecal Coliform Bacteria [c]	200/100 milliliter (mL)	400/100 mL
a	Average monthly effluent limit means the highest allowable average of daily discharges over a calendar month. To calculate the discharge value to compare to the limit, you add the value of each daily discharge measured during a calendar month and divide this sum by the total number of daily discharges measured. See footnote c for fecal coliform calculations.	
b	Average weekly discharge limit means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges' measured during that week. See footnote c for fecal coliform calculations.	
c	Ecology provides directions to calculate the monthly and the weekly geometric mean in publication No. 04-10-020, Information Manual for Treatment Plant Operators available at: http://www.ecy.wa.gov/pubs/0410020.pdf	

B. Mixing Zone Authorization

Mixing Zone for Outfall 001

The following paragraphs define the maximum boundaries of the mixing zones:

Chronic Mixing Zone

The mixing zone is a circle with radius of 321 feet (97.8 meters) measured from the center of each discharge port. The mixing zone extends from the bottom to the top of the water column. The concentration of pollutants at the edge of the chronic zone must meet chronic aquatic life criteria and human health criteria.

Acute Mixing Zone

The acute mixing zone is a circle with radius of 32.1 feet (9.8 meters) measured from the center of each discharge port. The mixing zone extends from the bottom to the top of the water column. The concentration of pollutants at the edge of the acute zone must meet acute aquatic life criteria.

Available Dilution (dilution factor)	
Acute Aquatic Life Criteria	25
Chronic Aquatic Life Criteria	781
Human Health Criteria - Carcinogen	781
Human Health Criteria - Non-carcinogen	781

S2. MONITORING REQUIREMENTS

A. Monitoring Schedule

The Permittee must monitor in accordance with the following schedule and the requirements specified in Appendix A.

Parameter	**Units**	**Minimum Sampling Frequency**	**Sample Type**
(1) Wastewater Influent			
Wastewater Influent means the raw sewage flow from the collection system into the treatment facility. Sample the wastewater entering the headworks of the treatment plant excluding any side-stream returns from inside the plant.			
Flow	MGD	Continuous [a]	Metered/Recorded
BOD_5	mg/L	1/week [b]	Composite Sample (24-Hour) [c]
BOD_5	lbs/day	1/week [b]	Calculated [d]

Parameter	Units	Minimum Sampling Frequency	Sample Type
TSS	mg/L	1/week [b]	Composite Sample (24-Hour) [c]
TSS	lbs/day	1/week [b]	Calculated [d]
(2) Final Wastewater Effluent			
Final Wastewater Effluent means wastewater exiting the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process. The Permittee may take effluent samples for the BOD_5 analysis before or after the disinfection process. If taken after, the Permittee must dechlorinate and reseed the sample. Chlorine residual should be taken after dechlorination.			
BOD_5	mg/L	1/week [b]	Composite Sample (24-Hour) [c]
BOD_5	lbs/day	1/week [b]	Calculated [d]
BOD_5	% removal	1/week [b]	Calculated [e]
TSS	mg/L	1/week [b]	Composite Sample (24-Hour) [c]
TSS	lbs/day	1/week [b]	Calculated [d]
TSS	% removal	1/week [b]	Calculated [e]
Chlorine (Total Residual)	mg/L	1/week [b]	Grab [f]
Fecal Coliform [g]	# /100 ml	1/week [b]	Grab [f]
pH [h]	Standard Units	1/day	Grab [f]
(3) Whole Effluent Toxicity Testing – Final Wastewater Effluent			
Acute Toxicity Testing		once in the last winter & once in the last summer	Composite Sample (24-Hour)
Chronic Toxicity Testing		once in the last winter & once in the last summer	Composite Sample (24-Hour)
Additional requirements specified in Special Condition S10 and S11.			
(4) Permit Renewal Application Requirements – Final Wastewater Effluent			
The Permittee must record and report the wastewater treatment plant flow discharged on the day it collects the sample for priority pollutant testing with the discharge monitoring report.			
Temperature [i]	Degrees Celsius	Once/July Once/December	Measurement

Parameter	Units	Minimum Sampling Frequency	Sample Type
Dissolved Oxygen	mg/L	Once per year	Grab
Total Kjeldahl Nitrogen	mg/L as N	Once per year	Composite Sample (24-Hour)
Total Ammonia	mg/L as N	Once per year	Composite Sample (24-Hour)
Nitrate plus Nitrite	mg/L as N	Once per year	Composite Sample (24-Hour)
Oil and Grease	mg/L	Once per year	Grab
Phosphorus (Total)	mg/L as P	Once per year	Composite Sample (24-Hour)
Total Dissolved Solids	mg/L	Once per year	Composite Sample (24-Hour)
Total Hardness	mg/L	Once per year	Composite Sample (24-Hour)
Cyanide	micrograms/ liter (µg/L)	Once per year	Grab
Total Phenolic Compounds	µg/L	Once per year	Grab
Priority Pollutants (PP) – Total Metals	µg/L; nanograms (ng/L) for mercury	Once per year	Composite Sample (24-Hour) Grab for Mercury
PP – Volatile Organic Compounds	µg/L	Once per year	Grab
PP – Acid-extractable Compounds	µg/L	Once per year	Composite Sample (24 hour)
PP – Base-neutral Compounds	µg/L	Once per year	Composite Sample (24 hour)

a	Continuous means uninterrupted except for brief lengths of time for calibration, power failure, or unanticipated equipment repair or maintenance. The time interval for the associated data logger must be no greater than 30 minutes. The Permittee must sample at least four times a day when continuous monitoring is not possible.
b	1/week means one time during each calendar week.
c	24-hour composite means a series of individual samples collected over a 24-hour period into a single container, and analyzed as one sample.
d	Calculated means figured concurrently with the respective sample, using the following formula: Concentration (in mg/L) X Flow (in MGD) X Conversion Factor (8.34) = lbs/day

Parameter		Units	Minimum Sampling Frequency	Sample Type
e	% removal = Influent concentration (mg/L) – Effluent concentration (mg/L) / Influent concentration (mg/L) x 100 Calculate the percent (%) removal of BOD_5 and TSS using the above equation.			
f	Grab means an individual sample collected over a 15 minute, or less, period.			
g	Report a numerical value for fecal coliforms following the procedures in Ecology's *Information Manual for Wastewater Treatment Plant Operators*, Publication Number 04-10-020 available at: http://www.ecy.wa.gov/programs/wq/permits/guidance.html . Do not report a result as too numerous to count (TNTC).			
h	Report the daily pH and the minimum and maximum for the monitoring period.			
i	Temperature grab sampling must occur when the effluent is at or near its daily maximum temperature, which usually occurs in the late afternoon. If measuring temperature continuously, the Permittee must determine and report a daily maximum from half-hour measurements in a 24-hour period. Continuous monitoring instruments must achieve an accuracy of 0.2 degrees C and the Permittee must verify accuracy annually.			

B. Sampling and Analytical Procedures

Samples and measurements taken to meet the requirements of this permit must represent the volume and nature of the monitored parameters. The Permittee must conduct representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions that may affect effluent quality.

Sampling and analytical methods used to meet the monitoring requirements specified in this permit must conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 Code of Federal Regulations (CFR) Part 136 [or as applicable in 40 CFR subchapters N (Parts 400–471) or O (Parts 501-503)] unless otherwise specified in this permit. The Department of Ecology (Ecology) may only specify alternative methods for parameters without permit limits and for those parameters without an Environmental Protection Agency (EPA) approved test method in 40 CFR Part 136.

C. Flow Measurement, Field Measurement, and Continuous Monitoring Devices

The Permittee must:

1. Select and use appropriate flow measurement, field measurement, and continuous monitoring devices and methods consistent with accepted scientific practices.

2. Install, calibrate, and maintain these devices to ensure the accuracy of the measurements is consistent with the accepted industry standard, the manufacturer's recommendation, and approved Operation and Maintenance (O&M) Manual procedures for the device and the wastestream.

3. Calibrate continuous monitoring instruments weekly unless it can demonstrate a longer period is sufficient based on monitoring records. The Permittee:

   a. May calibrate apparatus for continuous monitoring of dissolved oxygen by air calibration.

   b. Must calibrate continuous pH measurement instruments using a grab sample analyzed in the lab with a pH meter calibrated with standard buffers and analyzed within 15 minutes of sampling.

   c. Must calibrate continuous chlorine measurement instruments using a grab sample analyzed in the laboratory within 15 minutes of sampling.

4. Calibrate micro-recording temperature devices, known as thermistors, using protocols from Ecology's Quality Assurance Project Plan Development Tool (*Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams Version 1.0 10/26/2011*). This document is available online at: http://www.ecy.wa.gov/programs/eap/qa/docs/ECY_EAP_SOP_Cont_Temp_Mon_Ambient_v1_0EAP080.pdf. Calibration as specified in this document is not required if the Permittee uses recording devices certified by the manufacturer.

5. Use field measurement devices as directed by the manufacturer and do not use reagents beyond their expiration dates.

6. Establish a calibration frequency for each device or instrument in the O&M Manual that conforms to the frequency recommended by the manufacturer.

7. Calibrate flow-monitoring devices at a minimum frequency of at least one calibration per year.

8. Maintain calibration records for at least three years.

D. Laboratory Accreditation

The Permittee must ensure that all monitoring data required by Ecology for permit specified parameters is prepared by a laboratory registered or accredited under the provisions of chapter 173-50 Washington Administrative Code (WAC), *Accreditation of Environmental Laboratories*. Flow, temperature, settleable solids, conductivity, pH, and internal process control parameters are exempt from this requirement. The Permittee must obtain accreditation for conductivity and pH if it must receive accreditation or registration for other parameters.

S3. REPORTING AND RECORDING REQUIREMENTS

The Permittee must monitor and report in accordance with the following conditions. Falsification of information submitted to Ecology is a violation of the terms and conditions of this permit.

A. Discharge Monitoring Reports

The first monitoring period begins on the effective date of the permit (unless otherwise specified). The Permittee must:

1. Summarize, report, and submit monitoring data obtained during each monitoring period on the electronic Discharge Monitoring Report (DMR) form provided by Ecology within the Water Quality Permitting Portal. Include data for each of the parameters tabulated in Special Condition S2 and as required by the form. Report a value for each day sampling occurred (unless specifically exempted in the permit) and for the summary values (when applicable) included on the electronic form.

   To find out more information and to sign up for the Water Quality Permitting Portal go to: http://www.ecy.wa.gov/programs/wq/permits/paris/webdmr.html

2. Enter the "No Discharge" reporting code for an entire DMR, for a specific monitoring point, or for a specific parameter as appropriate, if the Permittee did not discharge wastewater or a specific pollutant during a given monitoring period.

3. Report single analytical values below detection as "less than the detection level (DL)" by entering < followed by the numeric value of the detection level (e.g. < 2.0) on the DMR. If the method used did not meet the minimum DL and quantitation level (QL) identified in the permit, report the actual QL and DL in the comments or in the location provided.

4. Do not report zero for bacteria monitoring. Report as required by the laboratory method.

5. Calculate and report an arithmetic average value for each day for bacteria if multiple samples were taken in one day.

6. Calculate the geometric mean values for bacteria (unless otherwise specified in the permit) using:

   a. The reported numeric value for all bacteria samples measured above the detection value except when it took multiple samples in one day. If the Permittee takes multiple samples in one day it must use the arithmetic average for the day in the geometric mean calculation.

   b. The detection value for those samples measured below detection.

7. Report the test method used for analysis in the comments if the laboratory used an alternative method not specified in the permit and as allowed in Appendix A.

8. Calculate average values and calculated total values (unless otherwise specified in the permit) using:

a. The reported numeric value for all parameters measured between the agency-required detection value and the agency-required quantitation value.

b. One-half the detection value (for values reported below detection) if the lab detected the parameter in another sample from the same monitoring point for the reporting period.

c. Zero (for values reported below detection) if the lab did not detect the parameter in another sample for the reporting period.

9. Report single-sample grouped parameters (for example: priority pollutants, PAHs, pulp and paper chlorophenolics, TTOs) on the WQWebDMR form and include: sample date, concentration detected, detection limit (DL) (as necessary), and laboratory quantitation level (QL) (as necessary).

   The Permittee must also submit an electronic copy of the laboratory report as an attachment using WQWebDMR. The contract laboratory reports must also include information on the chain of custody, QA/QC results, and documentation of accreditation for the parameter.

10. Ensure that DMRs are electronically submitted no later than the dates specified below, unless otherwise specified in this permit.

11. Submit DMRs for parameters with the monitoring frequencies specified in S2 (monthly, quarterly, annual, etc.) at the reporting schedule identified below. The Permittee must:

    a. Submit **monthly** DMRs by the 15th day of the following month.

    b. Submit **annual DMRs** (Permit Renewal Application Requirements), unless otherwise specified in the permit, by January 15th for the previous calendar year. The annual sampling period is the calendar year.

B. Permit Submittals and Schedules

The Permittee must use the Water Quality Permitting Portal – Permit Submittals application (unless otherwise specified in the permit) to submit all other written permit-required reports by the date specified in the permit.

When another permit condition requires submittal of a paper (hard-copy) report, the Permittee must ensure that it is postmarked or received by Ecology no later than the dates specified by this permit. Send these paper reports to Ecology at:

Water Quality Permit Coordinator
Department of Ecology
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

C. Records Retention

The Permittee must retain records of all monitoring information for a minimum of three years. Such information must include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. The Permittee must extend this period of retention during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

D. Recording of Results

For each measurement or sample taken, the Permittee must record the following information:

1. The date, exact place, method, and time of sampling or measurement.

2. The individual who performed the sampling or measurement.

3. The dates the analyses were performed.

4. The individual who performed the analyses.

5. The analytical techniques or methods used.

6. The results of all analyses.

E. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by Special Condition S2 of this permit, then the Permittee must include the results of such monitoring in the calculation and reporting of the data submitted in the Permittee's DMR unless otherwise specified by Special Condition S2.

F. Reporting Permit Violations

The Permittee must take the following actions when it violates or is unable to comply with any permit condition:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the noncompliance and correct the problem.

2. If applicable, immediately repeat sampling and analysis. Submit the results of any repeat sampling to Ecology within 30 days of sampling.

   a. Immediate Reporting

      The Permittee must immediately report to Ecology and the Department of Health, Shellfish Program, and the Local Health Jurisdiction (at the numbers listed below), all:

- Failures of the disinfection system.
- Collection system overflows.
- Plant bypasses discharging to marine surface waters.
- Any other failures of the sewage system (pipe breaks, etc.)

Southwest Regional Office	360-407-6300
Department of Health, Shellfish Program	360-236-3330 (business hours) 360-789-8962 (after business hours)
Jefferson County Public Health	360-385-9444

b. Twenty-Four-Hour Reporting

The Permittee must report the following occurrences of noncompliance by telephone, to Ecology at the telephone number listed above, within 24 hours from the time the Permittee becomes aware of any of the following circumstances:

i. Any noncompliance that may endanger health or the environment, unless previously reported under immediate reporting requirements.

ii. Any unanticipated bypass that causes an exceedance of an effluent limit in the permit (See Part S5.F, "Bypass Procedures").

iii. Any upset that causes an exceedance of an effluent limit in the permit (See G.15, "Upset").

iv. Any violation of a maximum daily or instantaneous maximum discharge limit for any of the pollutants in Section S1.A of this permit.

v. Any overflow prior to the treatment works, whether or not such overflow endangers health or the environment or exceeds any effluent limit in the permit.

c. Report within Five Days

The Permittee must also submit a written report within five days of the time that the Permittee becomes aware of any reportable event under subparts a or b, above. The report must contain:

i. A description of the noncompliance and its cause.

ii. The period of noncompliance, including exact dates and times.

iii. The estimated time the Permittee expects the noncompliance to continue if not yet corrected.

iv. Steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

v. If the noncompliance involves an overflow prior to the treatment works, an estimate of the quantity (in gallons) of untreated overflow.

d. Waiver of Written Reports

Ecology may waive the written report required in subpart c, above, on a case-by-case basis upon request if the Permittee has submitted a timely oral report.

e. All Other Permit Violation Reporting

The Permittee must report all permit violations, which do not require immediate or within 24 hours reporting, when it submits monitoring reports for S3.A ("Reporting"). The reports must contain the information listed in subpart c, above. Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

G. Other Reporting

1. Spills of Oil or Hazardous Materials

The Permittee must report a spill of oil or hazardous materials in accordance with the requirements of Revised Code of Washington (RCW) 90.56.280 and chapter 173-303-145. You can obtain further instructions at the following website: http://www.ecy.wa.gov/programs/spills/other/reportaspill.htm .

2. Failure to Submit Relevant or Correct Facts

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to Ecology, it must submit such facts or information promptly.

H. Maintaining a Copy of this Permit

The Permittee must keep a copy of this permit at the facility and make it available upon request to Ecology inspectors.

S4. FACILITY LOADING

A. Design Criteria

The flows or waste loads for the permitted facility must not exceed the following design criteria:

Maximum Month Design Flow (MMDF)	2.05 MGD
Annual Average Flow	1.44 MGD
BOD_5 Influent Loading for Maximum Month	3754 lbs/day
TSS Influent Loading for Maximum Month	4568 lbs/day
Design Population	12,000

B. Plans for Maintaining Adequate Capacity

1. Conditions Triggering Plan Submittal

The Permittee must submit a plan and a schedule for continuing to maintain capacity to Ecology when:

a. The actual flow or waste load reaches 85 percent of any one of the design criteria in S4.A for three consecutive months.

b. The projected plant flow or loading would reach design capacity within five years.

2. Plan and Schedule Content

The plan and schedule must identify the actions necessary to maintain adequate capacity for the expected population growth and to meet the limits and requirements of the permit. The Permittee must consider the following topics and actions in its plan.

a. Analysis of the present design and proposed process modifications

b. Reduction or elimination of excessive infiltration and inflow of uncontaminated ground and surface water into the sewer system

c. Limits on future sewer extensions or connections or additional waste loads

d. Modification or expansion of facilities

e. Reduction of industrial or commercial flows or wasteloads

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.

C. Duty to Mitigate

The Permittee must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

D. Notification of New or Altered Sources

1. The Permittee must submit written notice to Ecology whenever any new discharge or a substantial change in volume or character of an existing discharge into the wastewater treatment plant is proposed which:

   a. Would interfere with the operation of, or exceed the design capacity of, any portion of the wastewater treatment plant.

   b. Is not part of an approved general sewer plan or approved plans and specifications.

   c. Is subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act.

2. This notice must include an evaluation of the wastewater treatment plant's ability to adequately transport and treat the added flow and/or waste load, the quality and volume of effluent to be discharged to the treatment plant, and the anticipated impact on the Permittee's effluent [40 CFR 122.42(b)].

E. Infiltration and Inflow Evaluation

1. The Permittee must conduct an infiltration and inflow evaluation. Refer to the U.S. EPA publication, I/I Analysis and Project Certification, available as Publication No. 97-03 at:
   http://www.ecy.wa.gov/programs/wq/permits/guidance.html

2. The Permittee may use monitoring records to assess measurable infiltration and inflow.

3. The Permittee must prepare a report summarizing any measurable infiltration and inflow. If infiltration and inflow have increased by more than 15 percent from that found in the previous report based on equivalent rainfall, the report must contain a plan and a schedule to locate the sources of infiltration and inflow and to correct the problem.

4. The Permittee must submit a report summarizing the results of the evaluation and any recommendations for corrective actions by **January 31, 2016**, and **annually** thereafter.

F. Wasteload Assessment

The Permittee must conduct an annual assessment of its influent flow and waste load and submit a report to Ecology by **January 31, 2016**, and **annually** thereafter. The report must contain:

1. A description of compliance or noncompliance with the permit effluent limits.

2. A comparison between the existing and design:

   a. Monthly average dry weather and wet weather flows.

   b. Peak flows.

   c. BOD_5 loading.

   d. Total suspended solids loadings.

3. The percent change in the above parameters since the previous report (except for the first report).

4. The present and design population or population equivalent.

5. The projected population growth rate.

6. The estimated date upon which the Permittee expects the wastewater treatment plant to reach design capacity, according to the most restrictive of the parameters above.

Ecology may modify the interval for review and reporting if it determines that a different frequency is sufficient.

S5. OPERATION AND MAINTENANCE

The Permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), which are installed to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes keeping a daily operation logbook (paper or electronic), adequate laboratory controls, and appropriate quality assurance procedures. This provision of the permit requires the Permittee to operate backup or auxiliary facilities or similar systems only when the operation is necessary to achieve compliance with the conditions of this permit.

A. Certified Operator

This permitted facility must be operated by an operator certified by the state of Washington for at least a Class II plant. This operator must be in responsible charge of the day-to-day operation of the wastewater treatment plant. An operator certified for at least a Class I plant must be in charge during all regularly scheduled shifts.

B. Operation and Maintenance (O&M) Program

The Permittee must:

1. Institute an adequate operation and maintenance program for the entire sewage system.

2. 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.

3. Make maintenance records available for inspection at all times.

C. Short-Term Reduction

The Permittee must schedule any facility maintenance, which might require interruption of wastewater treatment and degrade effluent quality, during non-critical water quality periods and carry this maintenance out according to the approved O&M Manual or as otherwise approved by Ecology.

If a Permittee contemplates a reduction in the level of treatment that would cause a violation of permit discharge limits on a short-term basis for any reason, and such reduction cannot be avoided, the Permittee must:

1. Give written notification to Ecology, if possible, 30 days prior to such activities.

2. Detail the reasons for, length of time of, and the potential effects of the reduced level of treatment.

This notification does not relieve the Permittee of its obligations under this permit.

D. Electrical Power Failure

The Permittee must ensure that adequate safeguards prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of this permit 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 must maintain Reliability Class II (EPA 430-99-74-001) at the wastewater treatment plant. 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.

E. Prevent Connection of Inflow

The Permittee must strictly enforce its sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system.

F. Bypass Procedures

This permit prohibits a bypass, which is the intentional diversion of waste streams from any portion of a treatment facility. Ecology may take enforcement action against a Permittee for a bypass unless one of the following circumstances (1, 2, or 3) applies.

1. Bypass for essential maintenance without the potential to cause violation of permit limits or conditions.

   This permit authorizes a bypass if it allows for essential maintenance and does not have the potential to cause violations of limits or other conditions of this permit, or adversely impact public health as determined by Ecology prior to the bypass. The Permittee must submit prior notice, if possible, at least 10 days before the date of the bypass.

2. Bypass which is unavoidable, unanticipated, and results in noncompliance of this permit.

   This permit authorizes such a bypass only if:

   a. Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

   b. No feasible alternatives to the bypass exist, such as:

      - The use of auxiliary treatment facilities.

      - Retention of untreated wastes.

      - Maintenance during normal periods of equipment downtime, but not if the Permittee should have installed adequate backup equipment in the exercise of reasonable engineering judgment to prevent a bypass.

      - Transport of untreated wastes to another treatment facility.

   c. Ecology is properly notified of the bypass as required in Special Condition S3.F of this permit.

3. If bypass is anticipated and has the potential to result in noncompliance of this permit.

   a. The Permittee must notify Ecology at least 30 days before the planned date of bypass. The notice must contain:

      - A description of the bypass and its cause.

      - An analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing.

      - A cost-effectiveness analysis of alternatives including comparative resource damage assessment.

- The minimum and maximum duration of bypass under each alternative.

- A recommendation as to the preferred alternative for conducting the bypass.

- The projected date of bypass initiation.

- A statement of compliance with State Environmental Policy Act (SEPA).

- A request for modification of water quality standards as provided for in WAC 173-201A-410, if an exceedance of any water quality standard is anticipated.

- Details of the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

b. For probable construction bypasses, the Permittee must notify Ecology of the need to bypass as early in the planning process as possible. The Permittee must consider the analysis required above during the project planning and design process. The project-specific engineering report or facilities plan as well as the plans and specifications must include details of probable construction bypasses to the extent practical. In cases where the Permittee determines the probable need to bypass early, the Permittee must continue to analyze conditions up to and including the construction period in an effort to minimize or eliminate the bypass.

c. Ecology will consider the following prior to issuing an administrative order for this type of bypass:

- If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of this permit.

- If feasible alternatives to bypass exist, such as the use of auxiliary treatment facilities, retention of untreated wastes, stopping production, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.

- If the Permittee planned and scheduled the bypass to minimize adverse effects on the public and the environment.

After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, Ecology will approve or deny the request. Ecology will give the public an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Ecology will approve a request to bypass by issuing an administrative order under RCW 90.48.120.

G. Operations and Maintenance Manual

1. O&M Manual Submittal and Requirements

The Permittee must:

a. Review the O&M Manual at least annually.

b. Submit to Ecology for review and approval substantial changes or updates to the O&M Manual whenever it incorporates them into the manual.

c. Keep the approved O&M Manual at the permitted facility.

d. Follow the instructions and procedures of this manual.

2. O&M Manual Components

In addition to the requirements of WAC 173-240-080(1) through (5), the O&M Manual must be consistent with the guidance in Table G1-3 in the *Criteria for Sewage Works Design* (Orange Book), 2008. The O&M Manual must include:

a. Emergency procedures for cleanup in the event of wastewater system upset or failure.

b. A review of system components which if failed could pollute surface water or could impact human health. Provide a procedure for a routine schedule of checking the function of these components.

c. Wastewater system maintenance procedures that contribute to the generation of process wastewater.

d. Reporting protocols for submitting reports to Ecology to comply with the reporting requirements in the discharge permit.

e. 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 drains before beginning the overhaul of a stationary engine).

f. The treatment plant process control monitoring schedule.

g. Minimum staffing adequate to operate and maintain the treatment processes and carry out compliance monitoring required by the permit.

S6. PRETREATMENT

A. General Requirements

The Permittee must work with Ecology to ensure that all commercial and industrial users of the Publicly Owned Treatment Works (POTW) comply with the pretreatment regulations in 40 CFR Part 403 and any additional regulations that the Environmental Protection Agency (U.S. EPA) may promulgate under Section 307(b) (pretreatment) and 308 (reporting) of the Federal Clean Water Act.

B. Duty to Enforce Discharge Prohibitions

1. Under federal regulations [40 CFR 403.5(a) and (b)], the Permittee must not authorize or knowingly allow the discharge of any pollutants into its POTW which may be reasonably expected to cause pass-through or interference, or which otherwise violate general or specific discharge prohibitions contained in 40 CFR Part 403.5 or WAC 173-216-060.

2. The Permittee must not authorize or knowingly allow the introduction of any of the following into their treatment works:

a. Pollutants which create a fire or explosion hazard in the POTW (including, but not limited to waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21).

b. Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, or greater than 11.0 standard units, unless the works are specifically designed to accommodate such discharges.

c. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the POTW.

d. Any pollutant, including oxygen-demanding pollutants, (BOD_5, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW.

e. Petroleum oil, non-biodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through.

f. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity which may cause acute worker health and safety problems.

g. Heat in amounts that will inhibit biological activity in the POTW resulting in interference but in no case heat in such quantities such that the temperature at the POTW headworks exceeds 40 degrees Centigrade (104 degrees Fahrenheit) unless Ecology, upon request of the Permittee, approves, in writing, alternate temperature limits.

h. Any trucked or hauled pollutants, except at discharge points designated by the Permittee.

i. Wastewaters prohibited to be discharged to the POTW by the Dangerous Waste Regulations (chapter 173-303 WAC), unless authorized under the Domestic Sewage Exclusion (WAC 173-303-071).

3. The Permittee must also not allow the following discharges to the POTW unless approved in writing by Ecology:

a. Noncontact cooling water in significant volumes.

b. Stormwater and other direct inflow sources.

c. Wastewaters significantly affecting system hydraulic loading, which do not require treatment, or would not be afforded a significant degree of treatment by the system.

4. The Permittee must notify Ecology if any industrial user violates the prohibitions listed in this section (S6.B), and initiate enforcement action to promptly curtail any such discharge.

C. Wastewater Discharge Permit Required

The Permittee must:

1. Establish a process for authorizing non-domestic wastewater discharges that ensures all SIUs in all tributary areas meet the applicable State Waste Discharge Permit (SWDP) requirements in accordance with chapter 90.48 RCW and chapter 173-216 WAC.

2. Immediately notify Ecology of any proposed discharge of wastewater from a source, which may be a Significant Industrial User (SIU) [see fact sheet definitions or refer to 40 CFR 403.3(v)(i)(ii)].

3. Require all SIUs to obtain a SWDP from Ecology prior to accepting their non-domestic wastewater, or require proof that Ecology has determined they do not require a permit.

4. Require the documentation as described in S6.C.3 at the earliest practicable date as a condition of continuing to accept non-domestic wastewater discharges from a previously undiscovered, currently discharging and unpermitted SIU.

5. Require sources of non-domestic wastewater, which do not qualify as SIUs but merit a degree of oversight, to apply for a SWDP and provide it a copy of the application and any Ecology responses.

6. Keep all records documenting that its users have met the requirements of S6.C.

D. Identification and Reporting of Existing, New, and Proposed Industrial Users

1. The Permittee must take continuous, routine measures to identify all existing, new, and proposed SIUs and Potential Significant Industrial Users (PSIUs) discharging or proposing to discharge to the Permittee's sewer system (see **Appendix C** of the fact sheet for definitions).

2. Within 30 days of becoming aware of an unpermitted existing, new, or proposed industrial user who may be a SIU, the Permittee must notify such user by registered mail that, if classified as an SIU, they must apply to Ecology and obtain a State Waste Discharge Permit. The Permittee must send a copy of this notification letter to Ecology within this same 30-day period.

3. The Permittee must also notify all PSIUs, as they are identified, that if their classification should change to an SIU, they must apply to Ecology for a State Waste Discharge Permit within 30 days of such change.

E. Industrial User Survey

The Permittee must complete an industrial user survey listing all SIUs and PSIUs discharging to the POTW. The Permittee must submit the survey to Ecology by **January 31, 2019**. At a minimum, the Permittee must develop the list of SIUs and PSIUs by means of a telephone book search, a water utility billing records search, and a physical reconnaissance of the service area. Information on PSIUs must include, at a minimum, the business name, telephone number, address, description of the industrial process(s), and the known wastewater volumes and characteristics.

S7. SOLID WASTES

A. Solid Waste Handling

The Permittee must handle and dispose of all solid waste material in such a manner as to prevent its entry into state ground or surface water.

B. Leachate

The Permittee must not allow leachate from its solid waste material to enter state waters without providing all known, available, and reasonable methods of treatment, nor allow such leachate to cause violations of the State Surface Water Quality Standards, Chapter 173-201A WAC, or the State Ground Water Quality Standards, Chapter 173-200 WAC. The Permittee must apply for a permit or permit modification as may be required for such discharges to state ground or surface waters.

S8. APPLICATION FOR PERMIT RENEWAL OR MODIFICATION FOR FACILITY CHANGES

The Permittee must submit an application for renewal of this permit by **June 1, 2020**.

The Permittee must also submit a new application or supplement at least 180 days prior to commencement of discharges, resulting from the activities listed below, which may result in permit violations. These activities include any facility expansions, production increases, or other planned changes, such as process modifications, in the permitted facility.

S9. ENGINEERING DOCUMENTS FOR OUTFALL REPLACEMENT

A. The Permittee must prepare and submit an approvable engineering report or facility plan amendment in accordance with chapter 173-240 WAC to Ecology for review and approval by **December 31, 2018**. This report shall describe the options for a new outfall and select an outfall configuration that allows the Permittee to meet applicable State Water Quality Standards. The report must consider impacts to marine vegetation and impacts to commercial and/or recreational shellfish resources. Appropriate mitigation for any construction impacts should be discussed.

B. As required by RCW 90.48.112, the engineering report must address the feasibility of using reclaimed water as defined in RCW 90.46.010.

C. The report must contain any appropriate requirements as described in the following guidance:

1. *Criteria for Sewage Works Design* (Washington State Department of Ecology, Publication No. 98-37 WQ, 2008)

2. Design Criteria for Municipal Wastewater Land Treatment Systems for Public Health Protection (Washington State Department of Health, 1994)

3. Guidelines for Preparation of Engineering Reports for Industrial Wastewater Land Application Systems (Washington State Department of Ecology, Publication No. 93-36, 1993)

4. *Water Reclamation and Reuse Standards* (Washington State Department of Ecology and Department of Health Publication No. 97-23, 1997)

D. The Permittee must prepare and submit approvable plans and specifications to Ecology for review and approval in accordance with chapter 173-240 WAC by **December 31, 2019**. In addition to the electronic copy required by Special Condition S3.B, the Permittee must submit one paper copy to Ecology for its use to the address listed in Special Condition S3.B. If the Permittee wants Ecology to provide a stamped approved copy it must submit an additional paper copy (total of 2 paper copies).

E. Prior to the start of construction, the Permittee must submit to Ecology a quality assurance plan as required by chapter 173-240 WAC.

S10. ACUTE TOXICITY

A. Testing When There is No Permit Limit for Acute Toxicity

The Permittee must:

1. Conduct acute toxicity testing on final effluent once in the last summer and once in the last winter prior to submission of the application for permit renewal.

2. Conduct acute toxicity testing on a series of at least five concentrations of effluent, including 100 percent effluent and a control.

3. Use each of the following species and protocols for each acute toxicity test:

Acute Toxicity Tests	Species	Method
Fathead minnow 96-hour static-renewal test	*Pimephales promelas*	EPA-821-R-02-012
Daphnid 48-hour static test	*Ceriodaphnia dubia, Daphnia pulex,* or *Daphnia magna*	EPA-821-R-02-012

4. Submit the results to Ecology by **June 1, 2020** (with the permit renewal application).

B. Sampling and Reporting Requirements

1. The Permittee must submit all reports for toxicity testing in accordance with the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. Reports must contain toxicity data, bench sheets, and reference toxicant results for test methods. In addition, the Permittee must submit toxicity test data in electronic format (CETIS export file preferred) for entry into Ecology's database.

2. The Permittee must collect 24-hour composite effluent samples for toxicity testing. The Permittee must cool the samples to 0 - 6 degrees Celsius during collection and send them to the lab immediately upon completion. The lab must begin the toxicity testing as soon as possible but no later than 36 hours after sampling was completed.

3. The laboratory must conduct water quality measurements on all samples and test solutions for toxicity testing, as specified in the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*.

4. All toxicity tests must meet quality assurance criteria and test conditions specified in the most recent versions of the EPA methods listed in Subsection C and the Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. If Ecology determines any test results to be invalid or anomalous, the Permittee must repeat the testing with freshly collected effluent.

5. The laboratory must use control water and dilution water meeting the requirements of the EPA methods listed in Section A or pristine natural water of sufficient quality for good control performance.

6. The Permittee must conduct whole effluent toxicity tests on an unmodified sample of final effluent.

7. The Permittee may choose to conduct a full dilution series test during compliance testing in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of

concentrations must include the acute critical effluent concentration (ACEC). The ACEC equals 0.12 percent effluent.

8. All whole effluent toxicity tests, effluent screening tests, and rapid screening tests that involve hypothesis testing must comply with the acute statistical power standard of 29 percent as defined in WAC 173-205-020. If the test does not meet the power standard, the Permittee must repeat the test on a fresh sample with an increased number of replicates to increase the power.

S11. CHRONIC TOXICITY

A. Testing When There is No Permit Limit for Chronic Toxicity

The Permittee must:

1. Conduct chronic toxicity testing on final effluent once in the last winter and once in the last summer prior to submission of the application for permit renewal.

2. Conduct chronic toxicity testing on a series of at least five concentrations of effluent and a control. This series of dilutions must include the acute critical effluent concentration (ACEC). The ACEC equals 0.12 percent effluent. The series of dilutions should also contain the CCEC.

3. Compare the ACEC to the control using hypothesis testing at the 0.05 level of significance as described in Appendix H, EPA/600/4-89/001.

4. Submit the results to Ecology **June 1, 2020** (with the permit renewal application).

5. Perform chronic toxicity tests with all of the following species and the most recent version of the following protocols:

Saltwater Chronic Test	Species	Method
Topsmelt survival and growth	*Atherinops affinis*	EPA/600/R-95/136
Mysid shrimp survival and growth	*Americamysis bahia* (formerly *Mysidopsis bahia*)	EPA-821-R-02-014

B. Sampling and Reporting Requirements

1. The Permittee must submit all reports for toxicity testing in accordance with the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. Reports must contain toxicity data, bench sheets, and reference toxicant results for test methods. In addition, the Permittee must submit toxicity test data in electronic format (CETIS export file preferred) for entry into Ecology's database.

2. The Permittee must collect 24-hour composite effluent samples for toxicity testing. The Permittee must cool the samples to 0 - 6 degrees Celsius during collection and send them to the lab immediately upon completion. The lab must

begin the toxicity testing as soon as possible but no later than 36 hours after sampling was completed.

3. The laboratory must conduct water quality measurements on all samples and test solutions for toxicity testing, as specified in the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*.

4. All toxicity tests must meet quality assurance criteria and test conditions specified in the most recent versions of the EPA methods listed in Section C and the Ecology Publication no. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. If Ecology determines any test results to be invalid or anomalous, the Permittee must repeat the testing with freshly collected effluent.

5. The laboratory must use control water and dilution water meeting the requirements of the EPA methods listed in Subsection C. or pristine natural water of sufficient quality for good control performance.

6. The Permittee must conduct whole effluent toxicity tests on an unmodified sample of final effluent.

7. The Permittee may choose to conduct a full dilution series test during compliance testing in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the CCEC and the ACEC. The CCEC and the ACEC may either substitute for the effluent concentrations that are closest to them in the dilution series or be extra effluent concentrations.

8. All whole effluent toxicity tests that involve hypothesis testing must comply with the chronic statistical power standard of 39 percent as defined in WAC 173-205-020. If the test does not meet the power standard, the Permittee must repeat the test on a fresh sample with an increased number of replicates to increase the power.

GENERAL CONDITIONS

G1. SIGNATORY REQUIREMENTS

A. All applications, reports, or information submitted to Ecology must be signed and certified.

1. In the case of corporations, by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:

   - A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision making functions for the corporation, or

   - The manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

b. In the case of a partnership, by a general partner.

c. In the case of sole proprietorship, by the proprietor.

d. In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official.

Applications for permits for domestic wastewater facilities that are either owned or operated by, or under contract to, a public entity shall be submitted by the public entity.

B. All reports required by this permit and other information requested by Ecology must be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

1. The authorization is made in writing by a person described above and submitted to Ecology.

2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

C. Changes to authorization. If an authorization under paragraph G1.B, above, is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph G1.B, above, must be submitted to Ecology prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section must make the following certification:

> "I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G2. RIGHT OF INSPECTION AND ENTRY

The Permittee must allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records must be kept under the terms and conditions of this permit.

B. To have access to and copy, at reasonable times and at reasonable cost, any records required to be kept under the terms and conditions of this permit.

C. To inspect, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, methods, or operations regulated or required under this permit.

D. To sample or monitor, at reasonable times, any substances or parameters at any location for purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act.

G3. PERMIT ACTIONS

This permit may be modified, revoked and reissued, or terminated either at the request of any interested person (including the Permittee) or upon Ecology's initiative. However, the permit may only be modified, revoked and reissued, or terminated for the reasons specified in 40 CFR 122.62, 40 CFR 122.64 or WAC 173-220-150 according to the procedures of 40 CFR 124.5.

A. The following are causes for terminating this permit during its term, or for denying a permit renewal application:

1. Violation of any permit term or condition.

2. Obtaining a permit by misrepresentation or failure to disclose all relevant facts.

3. A material change in quantity or type of waste disposal.

4. A determination that the permitted activity endangers human health or the environment, or contributes to water quality standards violations and can only be regulated to acceptable levels by permit modification or termination.

5. A change in any condition that requires either a temporary or permanent reduction, or elimination of any discharge or sludge use or disposal practice controlled by the permit.

6. Nonpayment of fees assessed pursuant to RCW 90.48.465.

7. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090.

B. The following are causes for modification but not revocation and reissuance except when the Permittee requests or agrees:

1. A material change in the condition of the waters of the state.

2. New information not available at the time of permit issuance that would have justified the application of different permit conditions.

3. Material and substantial alterations or additions to the permitted facility or activities which occurred after this permit issuance.

4. Promulgation of new or amended standards or regulations having a direct bearing upon permit conditions, or requiring permit revision.

5. The Permittee has requested a modification based on other rationale meeting the criteria of 40 CFR Part 122.62.

6. Ecology has determined that good cause exists for modification of a compliance schedule, and the modification will not violate statutory deadlines.

7. Incorporation of an approved local pretreatment program into a municipality's permit.

C. The following are causes for modification or alternatively revocation and reissuance:

1. When cause exists for termination for reasons listed in A.1 through A.7 of this section, and Ecology determines that modification or revocation and reissuance is appropriate.

2. When Ecology has received notification of a proposed transfer of the permit. A permit may also be modified to reflect a transfer after the effective date of an automatic transfer (General Condition G7) but will not be revoked and reissued after the effective date of the transfer except upon the request of the new Permittee.

G4. REPORTING PLANNED CHANGES

The Permittee must, as soon as possible, but no later than 180 days prior to the proposed changes, give notice to Ecology of planned physical alterations or additions to the permitted facility, production increases, or process modification which will result in:

A. The permitted facility being determined to be a new source pursuant to 40 CFR 122.29(b).

B. A significant change in the nature or an increase in quantity of pollutants discharged.

C. A significant change in the Permittee's sludge use or disposal practices. Following such notice, and the submittal of a new application or supplement to the existing application, along with required engineering plans and reports, this permit may be modified, or revoked and reissued pursuant to 40 CFR 122.62(a) to specify and limit any pollutants not previously limited. Until such modification is effective, any new or increased discharge in excess of permit limits or not specifically authorized by this permit constitutes a violation.

G5. PLAN REVIEW REQUIRED

Prior to constructing or modifying any wastewater control facilities, an engineering report and detailed plans and specifications must be submitted to Ecology for approval in accordance with chapter 173-240 WAC. Engineering reports, plans, and specifications must be submitted at least 180 days prior to the planned start of construction unless a shorter time is approved by Ecology. Facilities must be constructed and operated in accordance with the approved plans.

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in this permit excuses the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. TRANSFER OF THIS PERMIT

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the Permittee must notify the succeeding owner or controller of the existence of this permit by letter, a copy of which must be forwarded to Ecology.

A. Transfers by Modification

Except as provided in paragraph (B) below, this permit may be transferred by the Permittee to a new owner or operator only if this permit has been modified or revoked and reissued under 40 CFR 122.62(b)(2), or a minor modification made under 40 CFR 122.63(d), to identify the new Permittee and incorporate such other requirements as may be necessary under the Clean Water Act.

B. Automatic Transfers

This permit may be automatically transferred to a new Permittee if:

1. The Permittee notifies Ecology at least 30 days in advance of the proposed transfer date.

2. The notice includes a written agreement between the existing and new Permittees containing a specific date transfer of permit responsibility, coverage, and liability between them.

3. Ecology does not notify the existing Permittee and the proposed new Permittee of its intent to modify or revoke and reissue this permit. A modification under this subparagraph may also be minor modification under 40 CFR 122.63. If this notice is not received, the transfer is effective on the date specified in the written agreement.

G8. REDUCED PRODUCTION FOR COMPLIANCE

The Permittee, in order to maintain compliance with its permit, must control production and/or all discharges upon reduction, loss, failure, or bypass of the treatment facility until the facility is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things, the primary source of power of the treatment facility is reduced, lost, or fails.

G9. REMOVED SUBSTANCES

Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters must not be resuspended or reintroduced to the final effluent stream for discharge to state waters.

G10. DUTY TO PROVIDE INFORMATION

The Permittee must submit to Ecology, within a reasonable time, all information which Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also submit to Ecology upon request, copies of records required to be kept by this permit.

G11. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G12. ADDITIONAL MONITORING

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G13. PAYMENT OF FEES

The Permittee must submit payment of fees associated with this permit as assessed by Ecology.

G14. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit is deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to

$10,000 and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit may incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to $10,000 for every such violation. Each and every such violation is a separate and distinct offense, and in case of a continuing violation, every day's continuance is deemed to be a separate and distinct violation.

G15. UPSET

Definition – "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limits if the requirements of the following paragraph are met.

A Permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

A. An upset occurred and that the Permittee can identify the cause(s) of the upset.

B. The permitted facility was being properly operated at the time of the upset.

C. The Permittee submitted notice of the upset as required in Special Condition S3.E.

D. The Permittee complied with any remedial measures required under S3.E of this permit.

In any enforcement action the Permittee seeking to establish the occurrence of an upset has the burden of proof.

G16. PROPERTY RIGHTS

This permit does not convey any property rights of any sort, or any exclusive privilege.

G17. DUTY TO COMPLY

The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

G18. Toxic pollutants

The Permittee must comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G19. PENALTIES FOR TAMPERING

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this condition, punishment shall be a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or by both.

G20. COMPLIANCE SCHEDULES

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit must be submitted no later than 14 days following each schedule date.

G21. SERVICE AGREEMENT REVIEW

The Permittee must submit to Ecology any proposed service agreements and proposed revisions or updates to existing agreements for the operation of any wastewater treatment facility covered by this permit. The review is to ensure consistency with chapters 90.46 and 90.48 RCW as required by RCW 70.150.040(9). In the event that Ecology does not comment within a 30-day period, the Permittee may assume consistency and proceed with the service agreement or the revised/updated service agreement.

APPENDIX A

LIST OF POLLUTANTS WITH ANALYTICAL METHODS, DETECTION LIMITS AND QUANTITATION LEVELS

The Permittee must use the specified analytical methods, detection limits (DLs) and quantitation levels (QLs) in the following table for permit and application required monitoring unless:

- Another permit condition specifies other methods, detection levels, or quantitation levels.
-
- The method used produces measurable results in the sample and EPA has listed it as an EPA-approved method in 40 CFR Part 136.

If the Permittee uses an alternative method, not specified in the permit and as allowed above, it must report the test method, DL, and QL on the discharge monitoring report or in the required report.

If the Permittee is unable to obtain the required DL and QL in its effluent due to matrix effects, the Permittee must submit a matrix-specific detection limit (MDL) and a quantitation limit (QL) to Ecology with appropriate laboratory documentation.

When the permit requires the Permittee to measure the base neutral compounds in the list of priority pollutants, it must measure all of the base neutral pollutants listed in the table below. The list includes EPA required base neutral priority pollutants and several additional polynuclear aromatic hydrocarbons (PAHs). The Water Quality Program added several PAHs to the list of base neutrals below from Ecology’s Persistent Bioaccumulative Toxics (PBT) List. It only added those PBT parameters of interest to Appendix A that did not increase the overall cost of analysis unreasonably.

Ecology added this appendix to the permit in order to reduce the number of analytical “non-detects” in permit-required monitoring and to measure effluent concentrations near or below criteria values where possible at a reasonable cost.

The lists below include conventional pollutants (as defined in CWA section 502(6) and 40 CFR Part 122.), toxic or priority pollutants as defined in CWA section 307(a)(1) and listed in 40 CFR Part 122 Appendix D, 40 CFR Part 401.15 and 40 CFR Part 423 Appendix A), and nonconventionals. 40 CFR Part 122 Appendix D (Table V) also identifies toxic pollutants and hazardous substances which are required to be reported by dischargers if expected to be present. This permit appendix A list does not include those parameters.

CONVENTIONAL POLLUTANTS				
Pollutant	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
Biochemical Oxygen Demand		SM5210-B		2 mg/L
Biochemical Oxygen Demand,		SM5210-B [3]		2 mg/L

Soluble				
Fecal Coliform		SM 9221E,9222	N/A	Specified in method - sample aliquot dependent
Oil and Grease (HEM) (Hexane Extractable Material)		1664 A or B	1,400	5,000
pH		SM4500-H^+ B	N/A	N/A
Total Suspended Solids		SM2540-D		5 mg/L

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Alkalinity, Total		SM2320-B		5 mg/L as CaCO3
Aluminum, Total	7429-90-5	200.8	2.0	10
Ammonia, Total (as N)		SM4500-NH3-B and C/D/E/G/H		20
Barium Total	7440-39-3	200.8	0.5	2.0
BTEX (benzene +toluene + ethylbenzene + m,o,p xylenes)		EPA SW 846 8021/8260	1	2
Boron, Total	7440-42-8	200.8	2.0	10.0
Chemical Oxygen Demand		SM5220-D		10 mg/L
Chloride		SM4500-Cl B/C/D/E and SM4110 B		Sample and limit dependent
Chlorine, Total Residual		SM4500 Cl G		50.0
Cobalt, Total	7440-48-4	200.8	0.05	0.25
Color		SM2120 B/C/E		10 color units

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Dissolved oxygen		SM4500-OC/OG		0.2 mg/L
Flow		Calibrated device		
Fluoride	16984-48-8	SM4500-F E	25	100
Hardness, Total		SM2340B		200 as CaCO3
Iron, Total	7439-89-6	200.7	12.5	50
Magnesium, Total	7439-95-4	200.7	10	50
Manganese, Total	7439-96-5	200.8	0.1	0.5
Molybdenum, Total	7439-98-7	200.8	0.1	0.5
Nitrate + Nitrite Nitrogen (as N)		SM4500-NO3-E/F/H		100
Nitrogen, Total Kjeldahl (as N)		SM4500-N_{org}B/C and SM4500NH_3-B/C/D/EF/G/H		300
NWTPH Dx [4]		Ecology NWTPH Dx	250	250
NWTPH Gx [5]		Ecology NWTPH Gx	250	250
Phosphorus, Total (as P)		SM 4500 PB followed by SM4500-PE/PF	3	10
Salinity		SM2520-B		3 practical salinity units or scale (PSU or PSS)
Settleable Solids		SM2540 -F		Sample and limit dependent

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Soluble Reactive Phosphorus (as P)		SM4500-P E/F/G	3	10
Sulfate (as mg/L SO_4)		SM4110-B		0.2 mg/L
Sulfide (as mg/L S)		SM4500-S^2F/D/E/G		0.2 mg/L
Sulfite (as mg/L SO_3)		SM4500-SO3B		2 mg/L
Temperature (max. 7-day avg.)		Analog recorder or Use micro-recording devices known as thermistors		0.2º C
Tin, Total	7440-31-5	200.8	0.3	1.5
Titanium, Total	7440-32-6	200.8	0.5	2.5
Total Coliform		SM 9221B, 9222B, 9223B	N/A	Specified in method - sample aliquot dependent
Total Organic Carbon		SM5310-B/C/D		1 mg/L
Total dissolved solids		SM2540 C		20 mg/L

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL) [2]** ***µg/L unless specified***
METALS, CYANIDE & TOTAL PHENOLS					
Antimony, Total	114	7440-36-0	200.8	0.3	1.0
Arsenic, Total	115	7440-38-2	200.8	0.1	0.5
Beryllium, Total	117	7440-41-7	200.8	0.1	0.5
Cadmium, Total	118	7440-43-9	200.8	0.05	0.25
Chromium (hex) dissolved	119	18540-29-9	SM3500-Cr C	0.3	1.2
Chromium, Total	119	7440-47-3	200.8	0.2	1.0
Copper, Total	120	7440-50-8	200.8	0.4	2.0
Lead, Total	122	7439-92-1	200.8	0.1	0.5
Mercury, Total	123	7439-97-6	1631E	0.0002	0.0005
Nickel, Total	124	7440-02-0	200.8	0.1	0.5
Selenium, Total	125	7782-49-2	200.8	1.0	1.0
Silver, Total	126	7440-22-4	200.8	0.04	0.2
Thallium, Total	127	7440-28-0	200.8	0.09	0.36
Zinc, Total	128	7440-66-6	200.8	0.5	2.5
Cyanide, Total	121	57-12-5	335.4	5	10
Cyanide, Weak Acid Dissociable	121		SM4500-CN I	5	10
Cyanide, Free Amenable to Chlorination (Available Cyanide)	121		SM4500-CN G	5	10
Phenols, Total	65		EPA 420.1		50

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL)[2]** ***µg/L unless specified***
ACID COMPOUNDS					
2-Chlorophenol	24	95-57-8	625	1.0	2.0
2,4-Dichlorophenol	31	120-83-2	625	0.5	1.0
2,4-Dimethylphenol	34	105-67-9	625	0.5	1.0
4,6-dinitro-o-cresol (2-methyl-4,6,-dinitrophenol)	60	534-52-1	625/1625B	1.0	2.0
2,4 dinitrophenol	59	51-28-5	625	1.0	2.0
2-Nitrophenol	57	88-75-5	625	0.5	1.0
4-Nitrophenol	58	100-02-7	625	0.5	1.0
Parachlorometa cresol (4-chloro-3-methylphenol)	22	59-50-7	625	1.0	2.0
Pentachlorophenol	64	87-86-5	625	0.5	1.0
Phenol	65	108-95-2	625	2.0	4.0
2,4,6-Trichlorophenol	21	88-06-2	625	2.0	4.0

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL)[2]** ***µg/L unless specified***
VOLATILE COMPOUNDS					
Acrolein	2	107-02-8	624	5	10
Acrylonitrile	3	107-13-1	624	1.0	2.0
Benzene	4	71-43-2	624	1.0	2.0

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
VOLATILE COMPOUNDS					
Bromoform	47	75-25-2	624	1.0	2.0
Carbon tetrachloride	6	56-23-5	624/601 or SM6230B	1.0	2.0
Chlorobenzene	7	108-90-7	624	1.0	2.0
Chloroethane	16	75-00-3	624/601	1.0	2.0
2-Chloroethylvinyl Ether	19	110-75-8	624	1.0	2.0
Chloroform	23	67-66-3	624 or SM6210B	1.0	2.0
Dibromochloromethane (chlordibromomethane)	51	124-48-1	624	1.0	2.0
1,2-Dichlorobenzene	25	95-50-1	624	1.9	7.6
1,3-Dichlorobenzene	26	541-73-1	624	1.9	7.6
1,4-Dichlorobenzene	27	106-46-7	624	4.4	17.6
Dichlorobromomethane	48	75-27-4	624	1.0	2.0
1,1-Dichloroethane	13	75-34-3	624	1.0	2.0
1,2-Dichloroethane	10	107-06-2	624	1.0	2.0
1,1-Dichloroethylene	29	75-35-4	624	1.0	2.0
1,2-Dichloropropane	32	78-87-5	624	1.0	2.0
1,3-dichloropropene (mixed isomers) (1,2-dichloropropylene) [6]	33	542-75-6	624	1.0	2.0
Ethylbenzene	38	100-41-4	624	1.0	2.0
Methyl bromide	46	74-83-9	624/601	5.0	10.0

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL) [2]** ***µg/L unless specified***
VOLATILE COMPOUNDS					
(Bromomethane)					
Methyl chloride (Chloromethane)	45	74-87-3	624	1.0	2.0
Methylene chloride	44	75-09-2	624	5.0	10.0
1,1,2,2-Tetrachloroethane	15	79-34-5	624	1.9	2.0
Tetrachloroethylene	85	127-18-4	624	1.0	2.0
Toluene	86	108-88-3	624	1.0	2.0
1,2-Trans-Dichloroethylene (Ethylene dichloride)	30	156-60-5	624	1.0	2.0
1,1,1-Trichloroethane	11	71-55-6	624	1.0	2.0
1,1,2-Trichloroethane	14	79-00-5	624	1.0	2.0
Trichloroethylene	87	79-01-6	624	1.0	2.0
Vinyl chloride	88	75-01-4	624/SM6200B	1.0	2.0

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL) [2]** ***µg/L unless specified***
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Acenaphthene	1	83-32-9	625	0.2	0.4
Acenaphthylene	77	208-96-8	625	0.3	0.6
Anthracene	78	120-12-7	625	0.3	0.6
Benzidine	5	92-87-5	625	12	24

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL) [2]** ***µg/L unless specified***
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Benzyl butyl phthalate	67	85-68-7	625	0.3	0.6
Benzo(*a*)anthracene	72	56-55-3	625	0.3	0.6
Benzo(b)fluoranthene (3,4-benzofluoranthene) [7]	74	205-99-2	610/625	0.8	1.6
Benzo(j)fluoranthene [7]		**205-82-3**	625	0.5	1.0
Benzo(k)fluoranthene (11,12-benzofluoranthene) [7]	75	207-08-9	610/625	0.8	1.6
Benzo(r,s,t)pentaphene		**189-55-9**	625	0.5	1.0
Benzo(*a*)pyrene	73	50-32-8	610/625	0.5	1.0
Benzo(*ghi*)Perylene	79	191-24-2	610/625	0.5	1.0
Bis(*2-chloroethoxy)*methane	43	111-91-1	625	5.3	21.2
Bis(*2-chloroethyl*)ether	18	111-44-4	611/625	0.3	1.0
Bis(*2-chloroisopropyl*)ether	42	39638-32-9	625	0.3	0.6
Bis(*2-ethylhexyl*)phthalate	66	117-81-7	625	0.1	0.5
4-Bromophenyl phenyl ether	41	101-55-3	625	0.2	0.4
2-Chloronaphthalene	20	91-58-7	625	0.3	0.6
4-Chlorophenyl phenyl ether	40	7005-72-3	625	0.3	0.5
Chrysene	76	218-01-9	610/625	0.3	0.6
Dibenzo (a,h)acridine		**226-36-8**	610M/625M	2.5	10.0
Dibenzo (a,j)acridine		**224-42-0**	610M/625M	2.5	10.0
Dibenzo(a-*h*)anthracene (1,2,5,6-dibenzanthracene)	82	53-70-3	625	0.8	1.6

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL) [2]** ***µg/L unless specified***
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Dibenzo(a,e)pyrene		192-65-4	610M/625M	2.5	10.0
Dibenzo(a,h)pyrene		189-64-0	625M	2.5	10.0
3,3-Dichlorobenzidine	28	91-94-1	605/625	0.5	1.0
Diethyl phthalate	70	84-66-2	625	1.9	7.6
Dimethyl phthalate	71	131-11-3	625	1.6	6.4
Di-n-butyl phthalate	68	84-74-2	625	0.5	1.0
2,4-dinitrotoluene	35	121-14-2	609/625	0.2	0.4
2,6-dinitrotoluene	36	606-20-2	609/625	0.2	0.4
Di-n-octyl phthalate	69	117-84-0	625	0.3	0.6
1,2-Diphenylhydrazine (*as Azobenzene*)	37	122-66-7	1625B	5.0	20
Fluoranthene	39	206-44-0	625	0.3	0.6
Fluorene	80	86-73-7	625	0.3	0.6
Hexachlorobenzene	9	118-74-1	612/625	0.3	0.6
Hexachlorobutadiene	52	87-68-3	625	0.5	1.0
Hexachlorocyclopentadiene	53	77-47-4	1625B/625	0.5	1.0
Hexachloroethane	12	67-72-1	625	0.5	1.0
Indeno(*1,2,3-cd*)Pyrene	83	193-39-5	610/625	0.5	1.0
Isophorone	54	78-59-1	625	0.5	1.0
3-Methyl cholanthrene		**56-49-5**	625	2.0	8.0
Naphthalene	55	91-20-3	625	0.3	0.6

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Nitrobenzene	56	98-95-3	625	0.5	1.0
N-Nitrosodimethylamine	61	62-75-9	607/625	2.0	4.0
N-Nitrosodi-n-propylamine	63	621-64-7	607/625	0.5	1.0
N-Nitrosodiphenylamine	62	86-30-6	625	0.5	1.0
Perylene		**198-55-0**	625	1.9	7.6
Phenanthrene	81	85-01-8	625	0.3	0.6
Pyrene	84	129-00-0	625	0.3	0.6
1,2,4-Trichlorobenzene	8	120-82-1	625	0.3	0.6

PRIORITY POLLUTANT	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
DIOXIN					
2,3,7,8-Tetra-Chlorodibenzo-P-Dioxin (2,3,7,8 TCDD)	129	1746-01-6	1613B	1.3 pg/L	5 pg/L

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
PESTICIDES/PCBs					
Aldrin	89	309-00-2	608	0.025	0.05
alpha-BHC	102	319-84-6	608	0.025	0.05
beta-BHC	103	319-85-7	608	0.025	0.05
gamma-BHC (Lindane)	104	58-89-9	608	0.025	0.05
delta-BHC	105	319-86-8	608	0.025	0.05
Chlordane [8]	91	57-74-9	608	0.025	0.05
4,4'-DDT	92	50-29-3	608	0.025	0.05
4,4'-DDE	93	72-55-9	608	0.025	0.05
4,4' DDD	94	72-54-8	608	0.025	0.05
Dieldrin	90	60-57-1	608	0.025	0.05
alpha-Endosulfan	95	959-98-8	608	0.025	0.05
beta-Endosulfan	96	33213-65-9	608	0.025	0.05
Endosulfan Sulfate	97	1031-07-8	608	0.025	0.05
Endrin	98	72-20-8	608	0.025	0.05
Endrin Aldehyde	99	7421-93-4	608	0.025	0.05
Heptachlor	100	76-44-8	608	0.025	0.05
Heptachlor Epoxide	101	1024-57-3	608	0.025	0.05
PCB-1242 [9]	106	53469-21-9	608	0.25	0.5
PCB-1254	107	11097-69-1	608	0.25	0.5
PCB-1221	108	11104-28-2	608	0.25	0.5
PCB-1232	109	11141-16-5	608	0.25	0.5

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
PESTICIDES/PCBs					
PCB-1248	110	12672-29-6	608	0.25	0.5
PCB-1260	111	11096-82-5	608	0.13	0.5
PCB-1016 [9]	112	12674-11-2	608	0.13	0.5
Toxaphene	113	8001-35-2	608	0.24	0.5

1. Detection level (DL) or detection limit means the minimum concentration of an analyte (substance) that can be measured and reported with a 99% confidence that the analyte concentration is greater than zero as determined by the procedure given in 40 CFR part 136, Appendix B.

2. Quantitation Level (QL) also known as Minimum Level of Quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the lab has used all method-specified sample weights, volumes, and cleanup procedures. The QL is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10^n, where n is an integer. (64 FR 30417).

   ALSO GIVEN AS: The smallest detectable concentration of analyte greater than the Detection Limit (DL) where the accuracy (precision & bias) achieves the objectives of the intended purpose. (Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs Submitted to the US Environmental Protection Agency December 2007).

3. Soluble Biochemical Oxygen Demand method note: First, filter the sample through a Millipore Nylon filter (or equivalent) - pore size of 0.45-0.50 um (prep all filters by filtering 250 ml of laboratory grade deionized water through the filter and discard). Then, analyze sample as per method 5210-B.

4. NWTPH Dx - Northwest Total Petroleum Hydrocarbons Diesel Extended Range – see http://www.ecy.wa.gov/biblio/97602.html

5. NWTPH Gx - Northwest Total Petroleum Hydrocarbons Gasoline Extended Range – see http://www.ecy.wa.gov/biblio/97602.html

6. 1, 3-dichloroproylene (mixed isomers) You may report this parameter as two separate parameters: cis-1, 3-dichlorpropropene (10061-01-5) and trans-1, 3-dichloropropene (10061-02-6).

7. Total Benzofluoranthenes - Because Benzo(b)fluoranthene, Benzo(j)fluoranthene and Benzo(k)fluoranthene co-elute you may report these three isomers as total benzofluoranthenes.

8. Chlordane – You may report alpha-chlordane (5103-71-9) and gamma-chlordane (5103-74-2) in place of chlordane (57-74-9). If you report alpha and gamma-chlordane, the DL/PQLs that apply are 0.025/0.050.

9. PCB 1016 & PCB 1242 – You may report these two PCB compounds as one parameter called PCB 1016/1242.

FACT SHEET FOR CITY OF PORT TOWNSEND WASTEWATER TREATMENT PLANT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT NO. WA0037052

Purpose of This Fact Sheet

This fact sheet explains and documents the decisions the Department of Ecology (Ecology) made in drafting the proposed National Pollutant Discharge Elimination System (NPDES) permit for the city of Port Townsend Wastewater Treatment Plant.

This fact sheet complies with Section 173-220-060 of the Washington Administrative Code (WAC), which requires Ecology to prepare a draft permit and accompanying fact sheet for public evaluation before issuing an NPDES permit.

Ecology makes the draft permit and fact sheet available for public review and comment at least 30 days before issuing the final permit. Copies of the fact sheet and draft permit for the city of Port Townsend Wastewater Treatment Plant, NPDES permit WA0037052, are available for public review. For more details on preparing and filing comments about these documents, please see **Appendix A - Public Involvement Information**.

The city of Port Townsend reviewed the draft permit and fact sheet for factual accuracy. Ecology corrected any errors or omissions regarding the facility's location, history, wastewater discharges, or receiving water prior to publishing this draft fact sheet for public notice.

After the public comment period closes, Ecology will summarize substantive comments and provide responses to them. Ecology will include the summary and responses to comments in this fact sheet as **Appendix E - Response to Comments**, and publish it when issuing the final NPDES permit. Ecology generally will not revise the rest of the fact sheet. The full document will become part of the legal history contained in the facility's permit file.

Summary

The city of Port Townsend operates an activated sludge wastewater treatment plant that discharges to the Strait of Juan de Fuca. Ecology issued the previous permit for this facility on June 4, 2009, and modified it on October 12, 2011.

The proposed permit contains the same effluent limits for Biochemical Oxygen Demand, Total Suspended Solids, Fecal Coliform Bacteria, and pH as the permit issued in 2009. The proposed permit includes new limits for Total Residual Chlorine. It does not include any other significant changes.

TABLE OF CONTENTS

I. INTRODUCTION 1
II. BACKGROUND INFORMATION 2
A. Facility Description 4
History 4
Collection System Status 4
Treatment Processes 4
Solid Wastes/Residual Solids 4
Discharge Outfall 5
B. Description of the Receiving Water 5
C. Wastewater Influent Characterization 5
D. Wastewater Effluent Characterization 6
E. Summary of Compliance with Previous Permit Issued on June 4, 2009 6
F. State Environmental Policy Act (SEPA) Compliance 7
III. PROPOSED PERMIT LIMITS 7
A. Design Criteria 8
B. Technology-Based Effluent Limits 8
C. Surface Water Quality-Based Effluent Limits 10
Numerical Criteria for the Protection of Aquatic Life and Recreation 10
Numerical Criteria for the Protection of Human Health 10
Narrative Criteria 10
Antidegradation 11
Mixing Zones 12
D. Designated Uses and Surface Water Quality Criteria 17
E. Water Quality Impairments 18
F. Evaluation of Surface Water Quality-Based Effluent Limits for Narrative Criteria 18
G. Evaluation of Surface Water Quality-Based Effluent Limits for Numeric Criteria 18
Reasonable Potential Analysis 22
H. Human Health 22
I. Sediment Quality 22
J. Whole Effluent Toxicity 23
K. Groundwater Quality Limits 24
L. Comparison of Effluent Limits with the Previous Permit Modified on October 12, 2011 24
IV. MONITORING REQUIREMENTS 25
A. Wastewater Monitoring 25
B. Lab Accreditation 25

C. Effluent Limits Which are Near Detection or Quantitation Levels ... 26

V. OTHER PERMIT CONDITIONS ... 26

A. Reporting and Record Keeping ... 26

B. Prevention of Facility Overloading ... 26

C. Operation and Maintenance ... 27

D. Pretreatment ... 27

Duty to Enforce Discharge Prohibitions ... 27

Federal and State Pretreatment Program Requirements ... 28

Routine Identification and Reporting of Industrial Users ... 28

Requirements for Performing an Industrial User Survey ... 28

E. Solid Wastes ... 29

F. Engineering Documents ... 29

G. General Conditions ... 30

VI. PERMIT ISSUANCE PROCEDURES ... 30

A. Permit Modifications ... 30

B. Proposed Permit Issuance ... 30

VII. REFERENCES FOR TEXT AND APPENDICES ... 30

APPENDIX A--PUBLIC INVOLVEMENT INFORMATION ... 32

APPENDIX B --YOUR RIGHT TO APPEAL ... 33

APPENDIX C--GLOSSARY ... 34

APPENDIX D--TECHNICAL CALCULATIONS ... 41

APPENDIX E--RESPONSE TO COMMENTS ... 42

Table 1 - General Facility Information 2

Table 2 - Ambient Background Data 5

Figure 1 Facility Location Map ... 3

I. INTRODUCTION

The Federal Clean Water Act (FCWA, 1972, and later amendments in 1977, 1981, and 1987) established water quality goals for the navigable (surface) waters of the United States. One mechanism for achieving the goals of the Clean Water Act is the National Pollutant Discharge Elimination System (NPDES), administered by the federal Environmental Protection Agency (EPA). The EPA authorized the state of Washington to manage the NPDES permit program in our state. Our state legislature accepted the delegation and assigned the power and duty for conducting NPDES permitting and enforcement to the Department of Ecology (Ecology). The Legislature defined Ecology's authority and obligations for the wastewater discharge permit program in 90.48 Revised Code of Washington (RCW).

The following regulations apply to domestic wastewater NPDES permits:

- Procedures Ecology follows for issuing NPDES permits [chapter 173-220 Washington Administrative Code (WAC)]
- Technical criteria for discharges from municipal wastewater treatment facilities (chapter 173-221 WAC)
- Water quality criteria for surface waters (chapter 173-201A WAC)
- Water quality criteria for groundwaters (chapter 173-200 WAC)
- Whole effluent toxicity testing and limits (chapter 173-205 WAC)
- Sediment management standards (chapter 173-204 WAC)
- Submission of plans and reports for construction of wastewater facilities (chapter 173-240 WAC)

These rules require any treatment facility owner/operator to obtain an NPDES permit before discharging wastewater to state waters. They also help define the basis for limits on each discharge and for requirements imposed by the permit.

Under the NPDES permit program and in response to a complete and accepted permit application, Ecology must prepare a draft permit and accompanying fact sheet, and make them available for public review before final issuance. Ecology must also publish an announcement (public notice) telling people where they can read the draft permit, and where to send their comments, during a period of 30 days (WAC 173-220-050). (See **Appendix A-Public** Involvement Information for more detail about the public notice and comment procedures). After the public comment period ends, Ecology may make changes to the draft NPDES permit in response to comment(s). Ecology will summarize the responses to comments and any changes to the permit in **Appendix E**.

II. BACKGROUND INFORMATION

Table 1 - General Facility Information

Facility Information	
Applicant	City of Port Townsend
Facility Name and Address	City of Port Townsend Wastewater Treatment Facility 5300 Kuhn Street Port Townsend, WA 98368
Contact at Facility	Name: John Merchant, Operations Manager Telephone #: 360-379-4432
Responsible Official	Name: David Timmons Title: City Manager Address: 250 Madison Street, Suite 201 Port Townsend, WA 98368 Telephone #: 360-379-5043
Type of Treatment	Activated Sludge (Oxidation Ditch)
Facility Location (NAD83/WGS84 reference datum)	Latitude: 48.1384 Longitude: -122.78167
Discharge Waterbody Name and Location (NAD83/WGS84 reference datum)	Strait of Juan de Fuca Latitude: 48.141667 Longitude: -122.783333
Permit Status	
Renewal Date of Previous Permit	July 1, 2009
Application for Permit Renewal Submittal Date	December 16, 2013
Date of Ecology Acceptance of Application	January 2, 2014
Inspection Status	
Date of Last Non-sampling Inspection Date	March 3, 2015

Figure 1 - Facility Location Map

A. Facility Description

History

In 1967, the city of Port Townsend constructed a Wastewater Treatment Plant (WWTP) that provided primary treatment and disinfection. The system provided primary treatment for average flows of 0.61 million gallons per day (MGD). In 1988, Ecology approved an engineering report for constructing the upgrade to secondary treatment.

The construction of the new activated sludge treatment plant was completed in 1993. No major changes have been made since initial construction of the activated sludge treatment plant.

Collection System Status

The city of Port Townsend (City) sewer system consists of about 76.6 miles of sewer lines. Of these lines, 70.3 miles are gravity sewers, 2.3 miles are force mains, and 4 miles are sewer mains within Fort Warden State Park. About half of the system was constructed prior to 1960.

The oldest parts of the collection system are in the downtown area and date back as far as 1908 when construction of the first sanitary sewer was begun. These early systems included a combination of wastewater and stormwater. The combined sewers in the downtown area were separated starting in the 1960s. Infiltration and inflow levels have been maintained at reasonable levels, with additional projects to remove Infiltration and Inflow (I&I) still listed in the City's Sewer Comprehensive Plan.

Treatment Processes

You can find basic information describing wastewater treatment processes included in a booklet at the Water Environment Federation website at: http://www.wef.org/publicinformation/default.aspx

The facility consists of influent pumping, mechanical cleaned fine screen, grit removal, flow meter (Parshall flume), activated sludge (two oxidation ditches), two secondary clarifiers, chlorine contact basins, and an outfall into marine waters.

Solid Wastes/Residual Solids

The treatment facilities remove solids during the treatment of the wastewater at the headworks (grit and screenings), and at the primary and secondary clarifiers, in addition to incidental solids (rags, scum, and other debris) removed as part of the routine maintenance of the equipment. Port Townsend drains grit, rags, scum, and screenings and disposes this solid waste at the local landfill. Solids removed from the secondary clarifiers are treated in two aerobic disaster/holding tanks and a belt gravity filter press is used for sludge thickening. The solids are then trucked to the City's composting facility located at the Jefferson County Waste Management Facility. The composted product is sold and is applied to land. This facility has met the solid waste requirements for screening, as required by WAC 173-308-205.

Discharge Outfall

The treated and disinfected effluent flows into the Strait of Juan de Fuca through an old, leaky outfall. The original section of the outfall was built in the 1940s and was then extended in 1966 to discharge approximately 700 feet offshore at a depth of about 21 feet at MLLW. The original section of outfall was constructed with 3-foot lengths of 18-inch diameter concrete pipe. This original section of pipe is about 450 feet long with about 150 joints, many of which may be leaking. The 1960s extension is 18-inch diameter cast iron pipe in 18-foot lengths. At about 50 years old, the structural integrity of this pipe is questionable. The diffuser is cast iron with a total of five, 6-inch ports, and spaced 9 feet apart.

The useful life expectancy of the off-shore portion of the outfall appears to be coming to an end. The 2000 Facility Plan first looked at alternatives for the outfall. The City replaced the on-shore portion of the outfall in 2005. This was needed due to recurrent blockages caused by root intrusion resulting in surcharging at maintenance holes along the outfall. A 2009 Facility Plan Amendment recommended replacement of the off-shore portion of the outfall as well. This work has not been completed yet, but the permit requires progress to be made in efforts to replace the outfall.

B. Description of the Receiving Water

The City's WWTP discharges to the Strait of Juan de Fuca. There is no other nearby point source outfall. Nearby non-point sources of pollutants include storm water. There are no receiving waterbody impairments.

The ambient background data used for this permit includes the following from Ecology marine water monitoring station ADM002 – Admiralty Inlet (north) – Quimper Point 2013:

Table 2 - Ambient Background Data

Parameter	Value Used
Temperature (highest annual 1-DADMax)	11.1° C
Temperature (average)	8.5° C
pH	7.5 standard units
Dissolved Oxygen	6.3 mg/L
Density	26.4 sigma-t
Salinity	31.6 psu

C. Wastewater Influent Characterization

The City reported the concentration of influent pollutants in discharge monitoring reports. The influent wastewater from 2010 to 2014 is characterized as follows:

Parameter	Units	Average Value	Maximum Value
Biochemical Oxygen Demand (BOD_5)	mg/L	**334**	**462**
BOD_5	lbs/day	**2228**	**3063**
Total Suspended Solids (TSS)	mg/L	**343**	**492**
TSS	lbs/day	**2280**	**3176**
Flow	MGD	**0.82**	**2.03**

D. Wastewater Effluent Characterization

The City reported the concentration of pollutants in the discharge in the permit application and in discharge monitoring reports. The tabulated data represents the quality of the wastewater effluent discharged from 2010 to 2014. The wastewater effluent is characterized as follows:

Parameter	Units	Average Value	Maximum Value
BOD_5	mg/L	**4.2**	**7.8**
BOD_5	lbs/day	**28.4**	**73**
TSS	mg/L	**3.3**	**7.4**
TSS	lbs/day	**22.5**	**70.1**
Total Ammonia	mg/L	**0.37**	**1.4**
Total Ammonia	lbs/day	**2.38**	**11.1**
Total Nitrate + Nitrite	mg/L	**6.1**	**15.4**
Total Nitrogen	mg/L	**7.7**	**17.1**
Total Phosphate (Ortho-phosphate)	mg/L	**3.9**	**8.1**
Total Phosphorus	mg/L	**4.4**	**7.7**
Parameter	**Units**	**Maximum Monthly Geometric Mean**	**Maximum Weekly Geometric Mean**
Fecal Coliform	#/100 mL	22	109
Parameter	**Units**	**Minimum Value**	**Maximum Value**
pH	Standard Units	**6.5**	**7.6**

E. Summary of Compliance with Previous Permit Issued on June 4, 2009

The previous permit placed effluent limits on BOD_5, TSS, Fecal Coliform Bacteria, and pH.

The City's WWTP has complied with the effluent limits and permit conditions throughout the duration of the permit issued on June 4, 2009. Ecology assessed compliance based on its review of the facility's information in the Ecology Permitting and Reporting Information System (PARIS), Discharge Monitoring Reports (DMRs) and on inspections.

The following table summarizes compliance with report submittal requirements over the permit term.

Submittal Name	Due Date	Received Date
Outfall Evaluation	1/1/2014	12/16/2013
Acute Toxicity Testing	1/1/2014	12/16/2013
Chronic Toxicity Testing	1/1/2014	12/16/2013
Wasteload Assessment	1/31/2010	1/13/2010
Wasteload Assessment	1/31/2011	1/6/2011
Wasteload Assessment	1/31/2012	1/6/2012
Wasteload Assessment	1/31/2013	1/4/2013
Wasteload Assessment	1/31/2014	1/8/2014
Wasteload Assessment	1/31/2015	1/14/2015
Infiltration and Inflow Evaluation	1/31/2010	1/13/2010
Infiltration and Inflow Evaluation	1/31/2011	1/6/2011
Infiltration and Inflow Evaluation	1/31/2012	1/6/2012
Infiltration and Inflow Evaluation	1/31/2013	1/4/2013
Infiltration and Inflow Evaluation	1/31/2014	1/8/2014
Infiltration and Inflow Evaluation	1/31/2015	1/14/2015
Industrial User Survey	1/1/2014	12/16/2013
Application for Permit Renewal	1/1/2014	12/16/2013

F. State Environmental Policy Act (SEPA) Compliance

State law exempts the issuance, reissuance or modification of any wastewater discharge permit from the SEPA process as long as the permit contains conditions that are no less stringent than federal and state rules and regulations (RCW 43.21C.0383). The exemption applies only to existing discharges, not to new discharges.

III. PROPOSED PERMIT LIMITS

Federal and state regulations require that effluent limits in an NPDES permit must be either technology- or water quality-based.

- Technology-based limits are based upon the treatment methods available to treat specific pollutants. Technology-based limits are set by the EPA and published as a regulation, or Ecology develops the limit on a case-by-case basis (40 CFR 125.3, and chapter 173-220 WAC).
- Water quality-based limits are calculated so that the effluent will comply with the Surface Water Quality Standards (chapter 173-201A WAC), Ground Water Standards (chapter 173-200 WAC), Sediment Quality Standards (chapter 173-204 WAC), or the National Toxics Rule (40 CFR 131.36).
- Ecology must apply the most stringent of these limits to each parameter of concern. These limits are described below.

The limits in this permit reflect information received in the application and from supporting reports (engineering, hydrogeology, etc.). Ecology evaluated the permit application and determined the limits needed to comply with the rules adopted by the state of Washington. Ecology does not develop effluent limits for all reported pollutants. Some pollutants are not treatable at the concentrations reported, are not controllable at the source, are not listed in regulation, and do not have a reasonable potential to cause a water quality violation.

Ecology does not usually develop limits for pollutants not reported in the permit application but may be present in the discharge. The permit does not authorize discharge of the non-reported pollutants. During the five-year permit term, the facility's effluent discharge conditions may change from those conditions reported in the permit application. The facility must notify Ecology if significant changes occur in any constituent [40 CFR 122.42(a)]. Until Ecology modifies the permit to reflect additional discharge of pollutants, a permitted facility could be violating its permit.

A. Design Criteria

Under WAC 173-220-150 (1)(g), flows and waste loadings must not exceed approved design criteria. Ecology approved design criteria for this facility's treatment plant in the facility plan dated November 2000 and prepared by Gray & Osborne, Inc. The table below includes design criteria from the referenced report.

Table 6 - Design Criteria for City of Port Townsend WWTP

Parameter	Design Quantity
Maximum Month Design Flow (MMDF)	2.05 MGD
Average Annual Flow	1.44 MGD
BOD_5 Loading for Maximum Month	3754 lb/day
TSS Loading for Maximum Month	4568 lb/day
Design Population	12,000

B. Technology-Based Effluent Limits

Federal and state regulations define technology-based effluent limits for domestic wastewater treatment plants. These effluent limits are given in 40 CFR Part 133 (federal) and in chapter 173-221 WAC (state). These regulations are performance standards that constitute all known, available, and reasonable methods of prevention, control, and treatment (AKART) for domestic wastewater.

The table below identifies technology-based limits for pH, fecal coliform, BOD_5, and TSS, as listed in chapter 173-221 WAC. Section III.F of this fact sheet describes the potential for water quality-based limits.

Table 7 - Technology-Based Limits

Parameter	**Average Monthly Limit**	**Average Weekly Limit**
BOD_5 (concentration)	30 mg/L	45 mg/L
BOD_5 (concentration)	In addition, the BOD_5 effluent concentration must not exceed 15 percent of the average influent concentration.	
TSS (concentration)	30 mg/L	45 mg/L
TSS (concentration)	In addition, the TSS effluent concentration must not exceed 15 percent of the average influent concentration.	
Chlorine	0.5 mg/L	0.75 mg/L
Parameter	**Monthly Geometric Mean Limit**	**Weekly Geometric Mean Limit**
Fecal Coliform Bacteria	200 organisms/100 mL	400 organisms/100 mL
Parameter	**Daily Minimum**	**Daily Maximum**
pH	6.0 Standard Units	9.0 Standard Units

Ecology derived the technology-based monthly average limit for chlorine from standard operating practices. The Water Pollution Control Federation's *Chlorination of Wastewater* (1976) states that a properly designed and maintained wastewater treatment plant can achieve adequate disinfection if a 0.5 mg/L chlorine residual is maintained after fifteen minutes of contact time. See also Metcalf and Eddy, *Wastewater Engineering, Treatment, Disposal and Reuse*, Third Edition, 1991. A treatment plant that provides adequate chlorination contact time can meet the 0.5 mg/L chlorine limit on a monthly average basis. According to WAC 173-221-030(11)(b), the corresponding weekly average is 0.75 mg/L.

Technology-based mass limits are based on WAC 173-220-130(3)(b) and 173-221-030(11)(b). Ecology calculated the monthly and weekly average mass limits for BOD_5 and Total Suspended Solids as follows:

Mass Limit = CL x DF x CF

where:

CL = Technology-based concentration limits listed in the above table

DF = Maximum Monthly Average Design flow (MGD)

CF = Conversion factor of 8.34

Table 8 - Technology-Based Mass Limits

Parameter	Concentration Limit (mg/L)	Mass Limit (lbs/day)
BOD_5 Monthly Average	30	513
BOD_5 Weekly Average	45	769
TSS Monthly Average	30	513
TSS Weekly Average	45	769

C. Surface Water Quality-Based Effluent Limits

The Washington State surface water quality standards (chapter 173-201A WAC) are designed to protect existing water quality and preserve the beneficial uses of Washington's surface waters. Waste discharge permits must include conditions that ensure the discharge will meet the surface water quality standards (WAC 173-201A-510). Water quality-based effluent limits may be based on an individual waste load allocation or on a waste load allocation developed during a basin wide Total Maximum Daily Load Study (TMDL).

Numerical Criteria for the Protection of Aquatic Life and Recreation

Numerical water quality criteria are listed in the water quality standards for surface waters (chapter 173-201A WAC). They specify the maximum levels of pollutants allowed in receiving water to protect aquatic life and recreation in and on the water. Ecology uses numerical criteria along with chemical and physical data for the wastewater and receiving water to derive the effluent limits in the discharge permit. When surface water quality-based limits are more stringent or potentially more stringent than technology-based limits, the discharge must meet the water quality-based limits.

Numerical Criteria for the Protection of Human Health

The U.S. EPA has published 91 numeric water quality criteria for the protection of human health that are applicable to dischargers in Washington State (EPA, 1992). These criteria are designed to protect humans from exposure to pollutants linked to cancer and other diseases, based on consuming fish and shellfish and drinking contaminated surface waters. The water quality standards also include radionuclide criteria to protect humans from the effects of radioactive substances.

Narrative Criteria

Narrative water quality criteria (e.g., WAC 173-201A-240(1); 2006) limit the toxic, radioactive, or other deleterious material concentrations that the facility may discharge to levels below those which have the potential to:

- Adversely affect designated water uses

- Cause acute or chronic toxicity to biota
- Impair aesthetic values
- Adversely affect human health

Narrative criteria protect the specific designated uses of all fresh waters (WAC 173-201A-200, 2006) and of all marine waters (WAC 173-201A-210, 2006) in the state of Washington.

Antidegradation

Description--The purpose of Washington's Antidegradation Policy (WAC 173-201A-300-330; 2006) is to:

- Restore and maintain the highest possible quality of the surface waters of Washington.
- Describe situations under which water quality may be lowered from its current condition.
- Apply to human activities that are likely to have an impact on the water quality of surface water.
- Ensure that all human activities likely to contribute to a lowering of water quality, at a minimum, apply all known, available, and reasonable methods of prevention, control, and treatment (AKART).
- Apply three tiers of protection (described below) for surface waters of the state.

Tier I ensures existing and designated uses are maintained and protected and applies to all waters and all sources of pollutions. Tier II ensures that waters of a higher quality than the criteria assigned are not degraded unless such lowering of water quality is necessary and in the overriding public interest. Tier II applies only to a specific list of polluting activities. Tier III prevents the degradation of waters formally listed as "outstanding resource waters," and applies to all sources of pollution.

A facility must prepare a Tier II analysis when all three of the following conditions are met:

- The facility is planning a new or expanded action.
- Ecology regulates or authorizes the action.
- The action has the potential to cause measurable degradation to existing water quality at the edge of a chronic mixing zone.

Facility Specific Requirements--This facility must meet Tier I requirements.

- Dischargers must maintain and protect existing and designated uses. Ecology must not allow any degradation that will interfere with, or become injurious to, existing or designated uses, except as provided for in chapter 173-201A WAC.

Ecology's analysis described in this section of the fact sheet demonstrates that the proposed permit conditions will protect existing and designated uses of the receiving water.

Mixing Zones

A mixing zone is the defined area in the receiving water surrounding the discharge port(s), where wastewater mixes with receiving water. Within mixing zones the pollutant concentrations may exceed water quality numeric standards, so long as the discharge doesn't interfere with designated uses of the receiving water body (for example, recreation, water supply, and aquatic life and wildlife habitat, etc.) The pollutant concentrations outside of the mixing zones must meet water quality numeric standards.

State and federal rules allow mixing zones because the concentrations and effects of most pollutants diminish rapidly after discharge, due to dilution. Ecology defines mixing zone sizes to limit the amount of time any exposure to the end-of-pipe discharge could harm water quality, plants, or fish.

The state's water quality standards allow Ecology to authorize mixing zones for the facility's permitted wastewater discharges only if those discharges already receive all known, available, and reasonable methods of prevention, control, and treatment (AKART). Mixing zones typically require compliance with water quality criteria within a specified distance from the point of discharge and must not use more than 25 percent of the available width of the water body for dilution [WAC 173-201A-400 (7)(a)(ii-iii)].

Ecology uses modeling to estimate the amount of mixing within the mixing zone. Through modeling Ecology determines the potential for violating the water quality standards at the edge of the mixing zone and derives any necessary effluent limits. Steady-state models are the most frequently used tools for conducting mixing zone analyses. Ecology chooses values for each effluent and for receiving water variables that correspond to the time period when the most critical condition is likely to occur (see Ecology's *Permit Writer's Manual*). Each critical condition parameter, by itself, has a low probability of occurrence and the resulting dilution factor is conservative. The term "reasonable worst-case" applies to these values.

The mixing zone analysis produces a numerical value called a dilution factor (DF). A dilution factor represents the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. For example, a dilution factor of 4 means the effluent is 25 percent and the receiving water is 75 percent of the total volume of water at the boundary of the mixing zone. Ecology uses dilution factors with the water quality criteria to calculate reasonable potentials and effluent limits. Water quality standards include both aquatic life-based criteria and human health-based criteria. The former are applied at both the acute and chronic mixing zone boundaries; the latter are applied only at the chronic boundary. The concentration of pollutants at the boundaries of any of these mixing zones may not exceed the numerical criteria for that zone.

Each aquatic life *acute* criterion is based on the assumption that organisms are not exposed to that concentration for more than one hour and more often than one exposure in three years. Each aquatic life *chronic* criterion is based on the assumption that organisms are not exposed to that concentration for more than four consecutive days and more often than once in three years.

The two types of human health-based water quality criteria distinguish between those pollutants linked to non-cancer effects (non-carcinogenic) and those linked to cancer effects (carcinogenic). The human health-based water quality criteria incorporate several exposure and risk assumptions. These assumptions include:

- A 70-year lifetime of daily exposures
- An ingestion rate for fish or shellfish measured in kg/day
- An ingestion rate of two liters/day for drinking water
- A one-in-one-million cancer risk for carcinogenic chemicals

This permit authorizes a small acute mixing zone, surrounded by a chronic mixing zone around the point of discharge (WAC 173-201A-400). The water quality standards impose certain conditions before allowing the discharger a mixing zone:

1. Ecology must specify both the allowed size and location in a permit.

   The proposed permit specifies the size and location of the allowed mixing zone (as specified below).

2. The facility must fully apply "all known, available, and reasonable methods of prevention, control and treatment" (AKART) to its discharge.

   Ecology has determined that the treatment provided at the City of Port Townsend WWTP meets the requirements of AKART (see "Technology-based Limits").

3. Ecology must consider critical discharge conditions.

   Surface water quality-based limits are derived for the water body's critical condition (the receiving water and waste discharge condition with the highest potential for adverse impact on the aquatic biota, human health, and existing or designated waterbody uses). The critical discharge condition is often pollutant-specific or waterbody-specific.

   Critical discharge conditions are those conditions that result in reduced dilution or increased effect of the pollutant. Factors affecting dilution include the depth of water, the density stratification in the water column, the currents, and the rate of discharge. Density stratification is determined by the salinity and temperature of the receiving water. Temperatures are warmer in the surface waters in summer. Therefore, density stratification is generally greatest during the summer months. Density stratification affects how far up in the water column a freshwater plume may rise. The rate of mixing is greatest when an effluent is rising. The effluent stops rising when the mixed effluent is the same density as the surrounding water. After the effluent stops rising, the rate of mixing is much more gradual. Water depth can affect dilution when a plume might rise to the surface when there is little or no stratification. Ecology uses the water depth at mean lower low water (MLLW) for marine waters. Ecology's *Permit Writer's Manual* describes additional guidance on criteria/design conditions for determining dilution factors. The manual can be obtained from Ecology's website at: https://fortress.wa.gov/ecy/publications/SummaryPages/92109.html.

Table 9 - Critical Conditions Used to Model the Discharge

Critical Condition	Value
Water depth at MLLW	28.82 feet
Density profile with a difference of 0.85 sigma-t units between 28 feet and the surface	0 to 0.85 sigma-t
10^{th} and 90^{th} percentile current speeds for acute mixing zone	0.40 and 0.82 m/sec
50th percentile current speeds for chronic and human health mixing zones	0.61 m/sec
Maximum average monthly effluent flow for chronic and human health non-carcinogen	2.05 million gallons per day (MGD)
Annual average flow for human health carcinogen	1.44 MGD
Maximum daily flow for acute mixing zone	10.65 MGD
1 DAD MAX effluent temperature	20 degrees C

Ecology obtained ambient data at critical conditions in the vicinity of the outfall from historical data and the monitoring studies conducted in 1990 and 2008. Ecology obtained historical ambient data from ambient station ADM002 located near the outfall.

4. Supporting information must clearly indicate the mixing zone would not:

- Have a reasonable potential to cause the loss of sensitive or important habitat
- Substantially interfere with the existing or characteristic uses
- Result in damage to the ecosystem
- Adversely affect public health

Ecology established Washington State water quality criteria for toxic chemicals using EPA criteria. EPA developed the criteria using toxicity tests with numerous organisms and set the criteria to generally protect the species tested and to fully protect all commercially and recreationally important species.

EPA sets acute criteria for toxic chemicals assuming organisms are exposed to the pollutant at the criteria concentration for one hour. They set chronic standards assuming organisms are exposed to the pollutant at the criteria concentration for four days. Dilution modeling under critical conditions generally shows that both acute and chronic criteria concentrations are reached within minutes of discharge.

The discharge plume does not impact drifting and non-strong swimming organisms because they cannot stay in the plume close to the outfall long enough to be affected. Strong swimming fish could maintain a position within the plume, but they can also avoid the discharge by swimming away. Mixing zones generally do not affect benthic organisms (bottom dwellers) because the buoyant plume rises in the water column. Ecology has additionally determined that the effluent will not exceed 33 degrees C for more than two seconds after discharge; and that the temperature of the water will not create lethal conditions or blockages to fish migration.

Ecology evaluates the cumulative toxicity of an effluent by testing the discharge with whole effluent toxicity (WET) testing.

Ecology reviewed the above information, the specific information on the characteristics of the discharge, the receiving water characteristics, and the discharge location. Based on this review, Ecology concluded that the discharge does not have a reasonable potential to cause the loss of sensitive or important habitat, substantially interfere with existing or characteristics uses, result in damage to the ecosystem, or adversely affect public health if the permit limits are met.

5. The discharge/receiving water mixture must not exceed water quality criteria outside the boundary of a mixing zone.

   Ecology conducted a reasonable potential analysis; using procedures established by the EPA and by Ecology, for each pollutant and concluded the discharge/receiving water mixture will not violate water quality criteria outside the boundary of the mixing zone if permit limits are met.

6. The size of the mixing zone and the concentrations of the pollutants must be minimized.

   At any given time, the effluent plume uses only a portion of the acute and chronic mixing zone, which minimizes the volume of water involved in mixing. Because tidal currents change direction, the plume orientation within the mixing zone changes. The plume mixes as it rises through the water column therefore much of the receiving water volume at lower depths in the mixing zone is not mixed with discharge. Similarly, because the discharge may stop rising at some depth due to density stratification, waters above that depth will not mix with the discharge. Ecology determined it is impractical to specify in the permit the actual, much more limited volume in which the dilution occurs as the plume rises and moves with the current.

Ecology minimizes the size of mixing zones by requiring dischargers to install diffusers when they are appropriate to the discharge and the specific receiving waterbody. When a diffuser is installed, the discharge is more completely mixed with the receiving water in a shorter time. Ecology also minimizes the size of the mixing zone (in the form of the dilution factor) using design criteria with a low probability of occurrence. For example, Ecology uses the expected 95th percentile pollutant concentration, the 90th percentile background concentration, the centerline dilution factor, and the lowest flow occurring once in every ten years to perform the reasonable potential analysis.

Because of the above reasons, Ecology has effectively minimized the size of the mixing zone authorized in the proposed permit.

7. Maximum size of mixing zone.

   The authorized mixing zone does not exceed the maximum size restriction.

8. Acute mixing zone.

   - The discharge/receiving water mixture must comply with acute criteria as near to the point of discharge as practicably attainable.

     Ecology determined the acute criteria will be met at 10 percent of the distance of the chronic mixing zone.

   - The pollutant concentration, duration, and frequency of exposure to the discharge will not create a barrier to migration or translocation of indigenous organisms to a degree that has the potential to cause damage to the ecosystem.

     As described above, the toxicity of any pollutant depends upon the exposure, the pollutant concentration, and the time the organism is exposed to that concentration. Authorizing a limited acute mixing zone for this discharge assures that it will not create a barrier to migration. The effluent from this discharge will rise as it enters the receiving water, assuring that the rising effluent will not cause translocation of indigenous organisms near the point of discharge (below the rising effluent).

   - Comply with size restrictions.

     The mixing zone authorized for this discharge complies with the size restrictions published in chapter 173-201A WAC.

9. Overlap of mixing zones.

   This mixing zone does not overlap another mixing zone.

D. Designated Uses and Surface Water Quality Criteria

Applicable designated uses and surface water quality criteria are defined in chapter 173-201A WAC. In addition, the U.S. EPA set human health criteria for toxic pollutants (EPA 1992). The tables included below summarize the criteria applicable to the receiving water's designated uses.

- Aquatic life uses are designated using the following general categories. All indigenous fish and non-fish aquatic species must be protected in waters of the state.

  1. Extraordinary quality salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning.

  2. Excellent quality salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning.

  3. Good quality salmonid migration and rearing; other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning.

  4. Fair quality salmonid and other fish migration.

  The *Aquatic Life Uses* and the associated criteria for this receiving water are identified below.

  Table 10 - Marine Aquatic Life Uses and Associated Criteria

Extraordinary Quality	
Temperature Criteria – Highest 1D MAX	13°C (55.4°F)
Dissolved Oxygen Criteria – Lowest 1-Day Minimum	7.0 mg/L
Turbidity Criteria	• 5 NTU over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
pH Criteria	pH must be within the range of 7.0 to 8.5 with a human-caused variation within the above range of less than 0.2 units.

- To protect shellfish harvesting, fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, and not have more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies/100 mL.

- The *recreational uses* are primary contact recreation and secondary contact recreation.

The recreational uses for this receiving water are identified below.

Table 11 - Recreational Uses

Recreational Use	**Criteria**
Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 14 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 43 colonies /100 mL.

- The *miscellaneous marine water uses* are wildlife habitat, harvesting, commerce and navigation, boating, and aesthetics.

E. Water Quality Impairments

Ecology has not documented any water quality impairments in the receiving water in the vicinity of the outfall.

F. Evaluation of Surface Water Quality-Based Effluent Limits for Narrative Criteria

Ecology must consider the narrative criteria described in WAC 173-201A-160 when it determines permit limits and conditions. Narrative water quality criteria limit the toxic, radioactive, or other deleterious material concentrations that the facility may discharge which have the potential to adversely affect designated uses, cause acute or chronic toxicity to biota, impair aesthetic values, or adversely affect human health.

Ecology considers narrative criteria when it evaluates the characteristics of the wastewater and when it implements AKART as described above in the technology-based limits section. When Ecology determines if a facility is meeting AKART it considers the pollutants in the wastewater and the adequacy of the treatment to prevent the violation of narrative criteria.

In addition, Ecology considers the toxicity of the wastewater discharge by requiring WET testing when there is a reasonable potential for the discharge to contain toxics. Ecology's analysis of the need for WET testing for this discharge is described later in the fact sheet.

G. Evaluation of Surface Water Quality-Based Effluent Limits for Numeric Criteria

Pollutants in an effluent may affect the aquatic environment near the point of discharge (near-field) or at a considerable distance from the point of discharge (far-field). Toxic pollutants, for example, are near-field pollutants; their adverse effects diminish rapidly with mixing in the receiving water. Conversely, a pollutant such as biochemical oxygen demand (BOD_5) is a far-field pollutant whose adverse effect occurs away from the discharge even after dilution has occurred. Thus, the method of calculating surface water quality-based effluent limits varies with the point at which the pollutant has its maximum effect.

With technology-based controls (AKART), predicted pollutant concentrations in the discharge exceed water quality criteria. Ecology therefore authorizes a mixing zone in accordance with the geometric configuration, flow restriction, and other restrictions imposed on mixing zones by chapter 173-201A WAC.

The diffuser at Outfall 001 is 36 feet long with a diameter of 18 inches. The diffuser has a total of five 6-inch diameter ports. The distance between ports is nine feet. The diffuser depth is listed as 21 to 29 feet in various studies. A mean lower low water (MLLW) depth of 21 feet was used in the permit. Ecology obtained this information from various reports.

Chronic Mixing Zone --WAC 173-201A-400(7)(c) specifies that mixing zones must not extend in any horizontal direction from the discharge ports for a distance greater than 300 feet plus the depth of water over the discharge ports as measured during MLLW.

The horizontal distance of the chronic mixing zone is 321 feet. The mixing zone extends from the bottom to the top of the water column.

Acute Mixing Zone --WAC 173-201A-400(8)(b) specifies that in oceanic waters a zone where acute criteria may be exceeded must not extend beyond 10 percent of the distance established for the chronic zone. The horizontal distance of the acute mixing zone is 32.1 feet. The mixing zone extends from the bottom to the top of the water column.

Ecology determined the dilution factors that occur within these zones at the critical condition using the model PLUMES. The dilution factors are listed below.

Table 12 - Dilution Factors (DF)

Criteria	Acute	Chronic
Aquatic Life	25	781
Human Health, Carcinogen		781
Human Health, Non-carcinogen		781

Ecology determined the impacts of dissolved oxygen deficiency, pH, fecal coliform, chlorine, ammonia, metals, and temperature as described below, using the dilution factors in the above table. The derivation of surface water quality-based limits also takes into account the variability of pollutant concentrations in both the effluent and the receiving water.

Dissolved Oxygen--BOD_5 and Ammonia Effects--Natural decomposition of organic material in wastewater effluent impacts dissolved oxygen in the receiving water at distances far outside of the regulated mixing zone. The BOD_5 of an effluent sample indicates the amount of biodegradable material in the wastewater and estimates the magnitude of oxygen consumption the wastewater will generate in the receiving water. The amount of ammonia-based nitrogen in the wastewater also provides an indication of oxygen demand potential in the receiving water.

With technology-based limits, this discharge results in a small amount of BOD_5 relative to the large amount of dilution in the receiving water at critical conditions. Technology-based limits will ensure that dissolved oxygen criteria are met in the receiving water.

pH--Compliance with the technology-based limits of 6.0 to 9.0 will assure compliance with the water quality standards of surface waters because of the high buffering capacity of marine water.

Fecal Coliform--Ecology modeled the numbers of fecal coliform by simple mixing analysis using the technology-based limit of 400 organisms per 100 mL and a dilution factor of 781.

Under critical conditions, modeling predicts no violation of the water quality criterion for fecal coliform. Therefore, the proposed permit includes the technology-based effluent limit for fecal coliform bacteria.

Turbidity--Ecology evaluated the impact of turbidity based on the range of total suspended solids in the effluent and turbidity of the receiving water. Ecology expects no violations of the turbidity criteria outside the designated mixing zone provided the facility meets its technology-based total suspended solids permit limits.

Toxic Pollutants--Federal regulations (40 CFR 122.44) require Ecology to place limits in NPDES permits on toxic chemicals in an effluent whenever there is a reasonable potential for those chemicals to exceed the surface water quality criteria. Ecology does not exempt facilities with technology-based effluent limits from meeting the surface water quality standards.

The following toxic pollutants are present in the discharge: chlorine, ammonia, and (presumably) heavy metals. Ecology conducted a reasonable potential analysis on ammonia to determine whether it would require effluent limits in this permit.

Ammonia's toxicity depends on that portion which is available in the unionized form. The amount of unionized ammonia depends on the temperature, pH, and salinity of the receiving marine water. To evaluate ammonia toxicity, Ecology used the available receiving water information for ambient station ADM002 and Ecology spreadsheet tools. We found no potential for a violation, largely because of low values in the effluent.

For chlorine, we did not calculate a reasonable potential as the previous permit did not require chlorine effluent monitoring and, as a result, we do not have data for the calculation. The facility de-chlorinates before discharge, and it was a reasonable assumption on the part of the previous permit writer that both the effluent and the receiving water have (at most) low levels of chlorine such that there is no potential to violate standards. In such a case, we typically would not require monitoring. However, our current practice is to require effluent monitoring when chlorine is used for disinfection and the new permit includes that requirement.

Similarly for metals, we did not calculate a reasonable potential for metals as the previous permit did not require effluent metals monitoring. We historically did not require metals monitoring for facilities that were not majors unless we had reason to believe that there could be a problem due to, for example, low available dilution. The current permit does require annual effluent metals monitoring, and it requires the Permittee to move forward on diffuser replacement, to ensure that dilution is in fact available.

Temperature--The state temperature standards [WAC 173-201A-200-210 and 600-612] include multiple elements:

- Annual summer maximum threshold criteria (June 15th to September 15th)
- Supplemental spawning and rearing season criteria (September 15th to June 15th)
- Incremental warming restrictions

- Protections Against Acute Effects

  Ecology evaluates each criterion independently to determine reasonable potential and derive permit limits.

- Annual Summer Maximum and Supplementary Spawning/Rearing Criteria

  Each water body has an annual maximum temperature criterion [WAC 173-201A-200(1)(c), 210(1)(c), and Table 602]. These threshold criteria (e.g., 12, 16, 17.5, 20°C) protect specific categories of aquatic life by controlling the effect of human actions on summer temperatures.

  Some waters have an additional threshold criterion to protect the spawning and incubation of salmonids (9°C for char and 13°C for salmon and trout) [WAC 173-201A-602, Table 602]. These criteria apply during specific date-windows.

  The threshold criteria apply at the edge of the chronic mixing zone. Criteria for most fresh waters are expressed as the highest 7-Day average of daily maximum temperature (7-DADMax). The 7-DADMax temperature is the arithmetic average of seven consecutive measures of daily maximum temperatures. Criteria for marine waters and some fresh waters are expressed as the highest 1-Day annual maximum temperature (1-DMax).

- Incremental Warming Criteria

  The water quality standards limit the amount of warming human sources can cause under specific situations [WAC 173-201A-200(1)(c)(i)-(ii), 210(1)(c)(i)-(ii)]. The incremental warming criteria apply at the edge of the chronic mixing zone.

  At locations and times when background temperatures are cooler than the assigned threshold criterion, point sources are permitted to warm the water by only a defined increment. These increments are permitted only to the extent doing so does not cause temperatures to exceed either the annual maximum or supplemental spawning criteria.

  At locations and times when a threshold criterion is being exceeded due to natural conditions, all human sources, considered cumulatively, must not warm the water more than 0.3°C above the naturally warm condition.

  When Ecology has not yet completed a TMDL, our policy allows each point source to warm water at the edge of the chronic mixing zone by 0.3°C. This is true regardless of the background temperature and even if doing so would cause the temperature at the edge of a standard mixing zone to exceed the numeric threshold criteria. Allowing a 0.3°C warming for each point source is reasonable and protective where the dilution factor is based on 25 percent or less of the critical flow. This is because the fully mixed effect on temperature will only be a fraction of the 0.3°C cumulative allowance (0.075°C or less) for all human sources combined.

- Protections for Temperature Acute Effects

  Instantaneous lethality to passing fish: The upper 99th percentile daily maximum effluent temperature must not exceed 33°C, unless a dilution analysis indicates ambient temperatures will not exceed 33°C two seconds after discharge.

  General lethality and migration blockage: Measurable (0.3°C) increases in temperature at the edge of a chronic mixing zone are not allowed when the receiving water temperature exceeds either a 1DMax of 23°C or a 7DADMax of 22°C.

  Lethality to incubating fish: Human actions must not cause a measurable (0.3°C) warming above 17.5°C at locations where eggs are incubating.

Reasonable Potential Analysis

Annual Summer Maximum and Incremental Warming Criteria: Ecology calculated the reasonable potential for the discharge to exceed the annual summer maximum and the incremental warming criteria at the edge of the chronic mixing zone during critical conditions. No reasonable potential exists to exceed the temperature criterion where:

(Criterion + 0.3) > [Criterion + (Teffluent95 – Criterion)/DF].

(13 + 0.3) > (13 + (25– 13)/781).

Therefore, the proposed permit does not include a temperature limit. Ecology will reevaluate the reasonable potential during the next permit renewal.

H. Human Health

Washington's water quality standards include 91 numeric human health-based criteria that Ecology must consider when writing NPDES permits. These criteria were established in 1992 by the U.S. EPA in its National Toxics Rule (40 CFR 131.36). The National Toxics Rule allows states to use mixing zones to evaluate whether discharges comply with human health criteria.

Ecology determined the applicant's discharge is unlikely to contain chemicals regulated to protect human health, and does not contain chemicals of concern based on existing effluent data or knowledge of discharges to the wastewater treatment system. Ecology will reevaluate this discharge for impacts to human health at the next permit reissuance.

I. Sediment Quality

The aquatic sediment standards (chapter 173-204 WAC) protect aquatic biota and human health. Under these standards Ecology may require a facility to evaluate the potential for its discharge to cause a violation of sediment standards (WAC 173-204-400). You can obtain additional information about sediments at the Aquatic Lands Cleanup Unit website. http://www.ecy.wa.gov/programs/tcp/smu/sediment.html

Given the plans to replace the outfall and through a review of the discharger characteristics and of the effluent characteristics, Ecology determined that this discharge has no reasonable potential to violate the sediment management standards.

J. Whole Effluent Toxicity

The water quality standards for surface waters forbid discharge of effluent that has the potential to cause toxic effects in the receiving waters. Many toxic pollutants cannot be measured by commonly available detection methods. However, laboratory tests can measure toxicity directly by exposing living organisms to the wastewater and measuring their responses. These tests measure the aggregate toxicity of the whole effluent, so this approach is called whole effluent toxicity (WET) testing. Some WET tests measure acute toxicity and other WET tests measure chronic toxicity.

- *Acute toxicity tests measure mortality as the significant response* to the toxicity of the effluent. Dischargers who monitor their wastewater with acute toxicity tests find early indications of any potential lethal effect of the effluent on organisms in the receiving water.

- *Chronic toxicity tests measure various sublethal toxic responses*, such as reduced growth or reproduction. Chronic toxicity tests often involve either a complete life cycle test on an organism with an extremely short life cycle, or a partial life cycle test during a critical stage of a test organism's life. Some chronic toxicity tests also measure organism survival.

Laboratories accredited by Ecology for WET testing know how to use the proper WET testing protocols, fulfill the data requirements, and submit results in the correct reporting format. Accredited laboratory staff knows about WET testing and how to calculate an NOEC, LC50, EC50, IC25, etc. Ecology gives all accredited labs the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* (https://fortress.wa.gov/ecy/publications/SummaryPages/9580.html), which is referenced in the permit. Ecology recommends that the City of Port Townsend send a copy of the acute or chronic toxicity sections(s) of its NPDES permit to the laboratory.

WET testing conducted during effluent characterization showed no reasonable potential for effluent discharges to cause receiving water acute toxicity. The proposed permit will not include an acute WET limit. The city of Port Townsend must retest the effluent before submitting an application for permit renewal.

- If this facility makes process or material changes which, in Ecology's opinion, increase the potential for effluent toxicity, then Ecology may (in a regulatory order, by permit modification, or in the permit renewal) require the facility to conduct additional effluent characterization. The city of Port Townsend may demonstrate to Ecology that effluent toxicity has not increased by performing additional WET testing and/or chemical analyses after the process or material changes have been made. Ecology recommends that the Permittee check with it first to make sure that Ecology will consider the demonstration adequate to support a decision to not require an additional effluent characterization.

- If WET testing conducted for submittal with a permit application fails to meet the performance standards in WAC 173-205-020, Ecology will assume that effluent toxicity has increased.

WET testing conducted during effluent characterization showed no reasonable potential for effluent discharges to cause receiving water chronic toxicity. The proposed permit will not include a chronic WET limit. The City of Port Townsend must retest the effluent before submitting an application for permit renewal.

- If this facility makes process or material changes which, in Ecology's opinion, increase the potential for effluent toxicity, then Ecology may (in a regulatory order, by permit modification, or in the permit renewal) require the facility to conduct additional effluent characterization

- If WET testing conducted for submittal with a permit application fails to meet the performance standards in WAC 173-205-020, Ecology will assume that effluent toxicity has increased. The City of Port Townsend may demonstrate to Ecology that effluent toxicity has not increased by performing additional WET testing after the process or material changes have been made.

K. Groundwater Quality Limits

The groundwater quality standards (chapter 173-200 WAC) protect beneficial uses of groundwater. Permits issued by Ecology must not allow violations of those standards (WAC 173-200-100).

The city of Port Townsend does not discharge wastewater to the ground. No permit limits are required to protect groundwater.

L. Comparison of Effluent Limits with the Previous Permit Modified on October 12, 2011

Table 13 - Comparison of Previous and Proposed Effluent Limits

		Previous Effluent Limits: Outfall # 001		**Proposed Effluent Limits: Outfall # 001**	
Parameter	**Basis of Limit**	**Average Monthly**	**Average Weekly**	**Average Monthly**	**Average Weekly**
BOD_5	Technology	30 mg/L, 513 lbs/day, & 85% removal	45 mg/L & 769 lbs/day	30 mg/L, 513 lbs/day, & 85% removal	45 mg/L & 769 lbs/day
TSS	Technology	30 mg/L, 513 lbs/day, & 85% removal	45 mg/L & 769 lbs/day	30 mg/L, 513 lbs/day, & 85% removal	45 mg/L & 769 lbs/day
Total Residual Chlorine	Technology	NA	NA	0.5 mg/K	0.75 mg/L

Parameter		**Monthly Geometric Mean Limit**	**Weekly Geometric Mean Limit**	**Monthly Geometric Mean Limit**	**Weekly Geometric Mean Limit**
Fecal Coliform Bacteria	Technology	200/100 mL	400/100 mL	200/100 mL	400/100 mL
Parameter		**Limit**		**Limit**	
pH	Technology	Daily minimum is equal to or greater than 6.0 and the daily maximum is less than or equal to 9.0		Minimum is 6.0 Maximum is 9.0	

IV. MONITORING REQUIREMENTS

Ecology requires monitoring, recording, and reporting (WAC 173-220-210 and 40 CFR 122.41) to verify that the treatment process is functioning correctly and that the discharge complies with the permit's effluent limits.

If a facility uses a contract laboratory to monitor wastewater, it must ensure that the laboratory uses the methods and meets or exceeds the method detection levels required by the permit. The permit describes when facilities may use alternative methods. It also describes what to do in certain situations when the laboratory encounters matrix effects. When a facility uses an alternative method as allowed by the permit, it must report the test method, Detection Level (DL), and Quantitation Level (QL) on the DMR or in the required report.

A. Wastewater Monitoring

The monitoring schedule is detailed in the proposed permit under Special Condition S2. Specified monitoring frequencies take into account the quantity and variability of the discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring. The required monitoring frequency is consistent with agency guidance given in the current version of Ecology's *Permit Writer's Manual* (Publication Number 92-09) for oxidation ditches.

Ecology had included some additional monitoring of nutrients in the previous permit to establish a baseline for this discharger. It will use this data in the future as it develops TMDLs for dissolved oxygen and establishes WLAs for nutrients.

Monitoring of sludge quantity and quality is necessary to determine the appropriate uses of the sludge. Biosolids monitoring is required by the current state and local solid waste management program and also by EPA under 40 CFR 503.

B. Lab Accreditation

Ecology requires that facilities must use a laboratory registered or accredited under the provisions of chapter 173-50 WAC, Accreditation of Environmental Laboratories, to prepare all monitoring data (with the exception of certain parameters). Ecology accredited the laboratory at this facility for:

Table 14 - Accredited Parameters

Parameter Name	Category	Method Name	Matrix Description
TSS	General Chemistry	SM 2540 D-97	Non-Potable Water
Total Residual Chlorine	General Chemistry	SM 4500-Cl G-00	Non-Potable Water
pH	General Chemistry	SM 4500-H+ B-00	Non-Potable Water
Dissolved Oxygen	General Chemistry	SM 4500-O G-01	Non-Potable Water
BOD_5	General Chemistry	SM 5210 B-01	Non-Potable Water
Fecal Coliform	Microbiology	SM 9222 D (m-FC)-97	Non-Potable Water

C. Effluent Limits which are Near Detection or Quantitation Levels

The Method Detection Level (MDL) also known as DL is the minimum concentration of a pollutant that a laboratory can measure and report with a 99 percent confidence that its concentration is greater than zero (as determined by a specific laboratory method). The QL is the level at which a laboratory can reliably report concentrations with a specified level of error. Estimated concentrations are the values between the DL and the QL. Ecology requires permitted facilities to report estimated concentrations. When reporting maximum daily effluent concentrations, Ecology requires the facility to report "less than X" where X is the required detection level if the measured effluent concentration falls below the detection level.

V. OTHER PERMIT CONDITIONS

A. Reporting and Record Keeping

Ecology based Special Condition S3 on its authority to specify any appropriate reporting and record keeping requirements to prevent and control waste discharges (WAC 173-220-210).

B. Prevention of Facility Overloading

Overloading of the treatment plant is a violation of the terms and conditions of the permit. To prevent this from occurring, RCW 90.48.110 and WAC 173-220-150 requires the City of Port Townsend to:

- Take the actions detailed in proposed permit Special Condition S.4.
- Design and construct expansions or modifications before the treatment plant reaches existing capacity.
- Report and correct conditions that could result in new or increased discharges of pollutants.

Special Condition S4 restricts the amount of flow.

If a municipality intends to apply for Ecology-administered funding for the design or construction of a facility project, the plan must meet the standard of a "Facility Plan", as defined in WAC 173-98-030. A complete "Facility Plan" includes all elements of an "Engineering Report" along with State Environmental Review Process (SERP) documentation to demonstrate compliance with 40 CFR 35.3140 and 40 CFR 35.3145, and a cost effectiveness analysis as required by WAC 173-98-730. The municipality should contact Ecology's regional office as early as practical before planning a project that may include Ecology-administered funding.

C. Operation and Maintenance

The proposed permit contains Special Condition S.5 as authorized under RCW 90.48.110, WAC 173-220-150, chapter 173-230 WAC, and WAC 173-240-080. Ecology included it to ensure proper operation and regular maintenance of equipment, and to ensure that the city of Port Townsend takes adequate safeguards so that it uses constructed facilities to their optimum potential in terms of pollutant capture and treatment.

D. Pretreatment

Duty to Enforce Discharge Prohibitions

This provision prohibits the Publicly Owned Treatment Works (POTW) from authorizing or permitting an industrial discharger to discharge certain types of waste into the sanitary sewer.

- The first section of the pretreatment requirements prohibits the POTW from accepting pollutants which causes "pass-through" or "interference". This general prohibition is from 40 CFR §403.5(a). **Appendix C** of this fact sheet defines these terms.

- The second section reinforces a number of specific state and federal pretreatment prohibitions found in WAC 173-216-060 and 40 CFR §403.5(b). These reinforce that the POTW may not accept certain wastes, which:

  1. Are prohibited due to dangerous waste rules
  2. Are explosive or flammable
  3. Have too high or low of a pH (too corrosive, acidic or basic)
  4. May cause a blockage such as grease, sand, rocks, or viscous materials
  5. Are hot enough to cause a problem
  6. Are of sufficient strength or volume to interfere with treatment
  7. Contain too much petroleum-based oils, mineral oil, or cutting fluid
  8. Create noxious or toxic gases at any point

40 CFR Part 403 contains the regulatory basis for these prohibitions, with the exception of the pH provisions which are based on WAC 173-216-060.

- The third section of pretreatment conditions reflects state prohibitions on the POTW accepting certain types of discharges unless the discharge has received prior written authorization from Ecology. These discharges include:

  1. Cooling water in significant volumes
  2. Stormwater and other direct inflow sources
  3. Wastewaters significantly affecting system hydraulic loading, which do not require treatment

Federal and State Pretreatment Program Requirements

Ecology administers the Pretreatment Program under the terms of the addendum to the "Memorandum of Understanding between Washington Department of Ecology and the United States Environmental Protection Agency, Region 10" (1986) and 40 CFR, part 403. Under this delegation of authority, Ecology issues wastewater discharge permits for significant industrial users (SIUs) discharging to POTWs which have not been delegated authority to issue wastewater discharge permits. Ecology must approve, condition, or deny new discharges or a significant increase in the discharge for existing significant industrial users (SIUs) [40 CFR 403.8 (f)(1)(i) and(iii)].

Industrial dischargers must obtain a permit from Ecology before discharging waste to the city of Port Townsend WWTP [WAC 173-216-110(5)]. Industries discharging wastewater that is similar in character to domestic wastewater do not require a permit.

Routine Identification and Reporting of Industrial Users

The permit requires non-delegated POTWs to take "continuous, routine measures to identify all existing, new, and proposed significant industrial users (SIUs) and potential significant industrial users (PSIUs)" discharging to their sewer system. Examples of such routine measures include regular review of water and sewer billing records; business license and building permit applications, advertisements, and personal reconnaissance. System maintenance personnel should be trained on what to look for so they can identify and report new industrial dischargers in the course of performing their jobs. The POTW may not allow SIUs to discharge prior to receiving a permit, and must notify all industrial dischargers (significant or not) in writing of their responsibility to apply for a State Waste Discharge Permit. The POTW must send a copy of this notification to Ecology.

Requirements for Performing an Industrial User Survey

This POTW has the potential to serve significant industrial or commercial users and must conduct an Industrial User (IU) survey. The purpose of the IU Survey is to identify all facilities that may be subject to pretreatment standards or requirements so that Ecology can take appropriate measures to control these discharges. The POTW should identify each such user, and require them to apply for a permit before allowing their discharge to the POTW to commence. For SIUs, the POTW must require they actually are issued a permit prior to accepting their discharge. The steps the POTW must document in their IU Survey submittal include:

1. The POTW must develop a master list of businesses that may be subject to pretreatment standards and requirements and show their disposition. This list must be based on several sources of information including business licenses, and water and sewer billing records.

2. The POTW must canvas all the potential sources, having them either complete a survey form or ruling them out by confirming they only generate domestic wastewater.

3. The POTW must develop a list of the SIUs and potential SIUs in all areas served by the POTW. The list must contain sufficient information on each to allow Ecology to decide which discharges merit further controls such as a state waste discharge permit.

Ecology describes the information needed in IU Survey submittals to allow Ecology to make permitting decision in the manual “Performing an Industrial User Survey”. Properly completing an Industrial User Survey helps Ecology control discharges that may otherwise harm the POTW including its collection system, processes, and receiving waters. Where surveys are incomplete, Ecology may take such enforcement as appropriate and/or require the POTW to develop a fully delegated pretreatment program.

The proposed permit requires the city of Port Townsend to conduct an industrial user survey to determine the extent of compliance of all industrial users of the sanitary sewer and wastewater treatment facility with federal pretreatment regulations [40 CFR Part 403 and Sections 307(b) and 308 of the Clean Water Act)], with state regulations (chapter 90.48 RCW and chapter 173-216 WAC), and with local ordinances.

E. Solid Wastes

To prevent water quality problems the facility is required in permit Special Condition S7 to store and handle all residual solids (grit, screenings, scum, sludge, and other solid waste) in accordance with the requirements of RCW 90.48.080 and state water quality standards.

The final use and disposal of sewage sludge from this facility is regulated by U.S. EPA under 40 CFR 503, and by Ecology under chapter 70.95J RCW, chapter 173-308 WAC “Biosolids Management,” and chapter 173-350 WAC “Solid Waste Handling Standards.” The disposal of other solid waste is under the jurisdiction of the Jefferson County Health Department.

Requirements for monitoring sewage sludge and record keeping are included in this permit. Ecology will use this information, required under 40 CFR 503, to develop or update local limits.

F. Engineering Documents

The proposed permit includes a schedule for completion and submittal of engineering documents for outfall replacement. The city of Port Townsend had submitted a 2009 Facility Plan Amendment that selected a shorter outfall than the existing outfall as the preferred alternative for outfall replacement. State agencies did not feel the plan considered impacts to marine vegetation or shellfish resources. The feasibility of using reclaimed water should have also been discussed. A new plan needs to be developed that addresses stated concerns and allows the outfall replacement to move forward.

G. General Conditions

Ecology bases the standardized General Conditions on state and federal law and regulations. They are included in all individual domestic wastewater NPDES permits issued by Ecology.

VI. PERMIT ISSUANCE PROCEDURES

A. Permit Modifications

Ecology may modify this permit to impose numerical limits, if necessary to comply with water quality standards for surface waters, with sediment quality standards, or with water quality standards for groundwaters, based on new information from sources such as inspections, effluent monitoring, outfall studies, and effluent mixing studies.

Ecology may also modify this permit to comply with new or amended state or federal regulations.

B. Proposed Permit Issuance

This proposed permit meets all statutory requirements for Ecology to authorize a wastewater discharge. The permit includes limits and conditions to protect human health and aquatic life, and the beneficial uses of waters of the state of Washington. Ecology proposes to issue this permit for a term of five years.

VII. REFERENCES FOR TEXT AND APPENDICES

CH2MHILL

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1985. *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water*. EPA/600/6-85/002a.

1983. *Water Quality Standards Handbook*. USEPA Office of Water, Washington, D.C.

Gray & Osborne, Inc.

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Moran, Bridget and Birch, Peter

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1972. *Characterization of Stream Reaeration Capacity*. EPA-R3-72-012. (Cited in EPA 1985 op.cit.)

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December 2011. *Permit Writer's Manual*. Publication Number 92-109 (https://fortress.wa.gov/ecy/publications/SummaryPages/92109.html)

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October 2010 (revised). *Water Quality Program Guidance Manual – Procedures to Implement the State's Temperature Standards through NPDES Permits*. Publication Number 06-10-100 (https://fortress.wa.gov/ecy/publications/summarypages/0610100.html)

Laws and Regulations (http://www.ecy.wa.gov/laws-rules/index.html)

Permit and Wastewater Related Information (http://www.ecy.wa.gov/programs/wq/permits/guidance.html)

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APPENDIX A--PUBLIC INVOLVEMENT INFORMATION

Ecology proposes to reissue a permit to the city of Port Townsend Wastewater Treatment Plant. The permit includes wastewater discharge limits and other conditions. This fact sheet describes the facility and Ecology's reasons for requiring permit conditions.

Ecology placed a Public Notice of Application on June 12, 2013; June 19, 2013; June 11, 2014; and June 18, 2014, in the *Port Townsend Leader* to inform the public about the submitted application and to invite comment on the reissuance of this permit.

Ecology will place a Public Notice of Draft on July 29, 2015, in the *Port Townsend Leader* to inform the public and to invite comment on the proposed draft National Pollutant Discharge Elimination System permit and fact sheet.

The notice:

- Tells where copies of the draft permit and fact sheet are available for public evaluation (a local public library, the closest regional or field office, posted on our website).
- Offers to provide the documents in an alternate format to accommodate special needs.
- Asks people to tell us how well the proposed permit would protect the receiving water.
- Invites people to suggest fairer conditions, limits, and requirements for the permit.
- Invites comments on Ecology's determination of compliance with antidegradation rules.
- Urges people to submit their comments, in writing, before the end of the comment period.
- Tells how to request a public hearing about the proposed NPDES permit.
- Explains the next step(s) in the permitting process.

Ecology has published a document entitled *Frequently Asked Questions about Effective Public Commenting,* which is available on our website at https://fortress.wa.gov/ecy/publications/SummaryPages/0307023.html.

You may obtain further information from Ecology by telephone, 360-407-6278, by email at carey.cholski@ecy.wa.gov, or by writing to the address listed below.

Water Quality Permit Coordinator
Department of Ecology
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

The primary author of this permit and fact sheet is Dave Dougherty.

APPENDIX B --YOUR RIGHT TO APPEAL

You have a right to appeal this permit to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of the final permit. The appeal process is governed by chapter 43.21B RCW and chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2) (see glossary).

To appeal you must do the following within 30 days of the date of receipt of this permit:

- File your appeal and a copy of this permit with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.

- Serve a copy of your appeal and this permit on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in chapter 43.21B RCW and chapter 371-08 WAC.

ADDRESS AND LOCATION INFORMATION

Street Addresses	Mailing Addresses
Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive Southeast Lacey, WA 98503 **Pollution Control Hearings Board** 1111 Israel Road Southwest, Suite 301 Tumwater, WA 98501	**Department of Ecology** Attn: Appeals Processing Desk P.O. Box 47608 Olympia, WA 98504-7608 **Pollution Control Hearings Board** PO Box 40903 Olympia, WA 98504-0903

APPENDIX C--GLOSSARY

1-DMax or 1-day Maximum Temperature -- The highest water temperature reached on any given day. This measure can be obtained using calibrated maximum/minimum thermometers or continuous monitoring probes having sampling intervals of thirty minutes or less.

7-DADMax or 7-day Average Of The Daily Maximum Temperatures -- The arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date.

Acute Toxicity --The lethal effect of a compound on an organism that occurs in a short time period, usually 48 to 96 hours.

AKART -- The acronym for "all known, available, and reasonable methods of prevention, control and treatment." AKART is a technology-based approach to limiting pollutants from wastewater discharges, which requires an engineering judgment and an economic judgment. AKART must be applied to all wastes and contaminants prior to entry into waters of the state in accordance with RCW 90.48.010 and 520, WAC 173-200-030(2)(c)(ii), and WAC 173-216-110(1)(a).

Alternate Point of Compliance -- An alternative location in the ground water from the point of compliance where compliance with the ground water standards is measured. It may be established in the ground water at locations some distance from the discharge source, up to, but not exceeding the property boundary and is determined on a site specific basis following an AKART analysis. An "early warning value" must be used when an alternate point is established. An alternate point of compliance must be determined and approved in accordance with WAC 173-200-060(2).

Ambient Water Quality -- The existing environmental condition of the water in a receiving water body.

Ammonia -- Ammonia is produced by the breakdown of nitrogenous materials in wastewater. Ammonia is toxic to aquatic organisms, exerts an oxygen demand, and contributes to eutrophication. It also increases the amount of chlorine needed to disinfect wastewater.

Annual Average Design Flow (AADF -- average of the daily flow volumes anticipated to occur over a calendar year.

Average Monthly Discharge Limit -- The average of the measured values obtained over a calendar month's time.

Background Water Quality -- The concentrations of chemical, physical, biological or radiological constituents or other characteristics in or of ground water at a particular point in time upgradient of an activity that has not been affected by that activity, [WAC 173-200-020(3)]. Background water quality for any parameter is statistically defined as the 95 percent upper tolerance interval with a 95 percent confidence based on at least eight hydraulically upgradient water quality samples. The eight samples are collected over a period of at least one year, with no more than one sample collected during any month in a single calendar year.

Best Management Practices (BMPs) -- Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the state. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

BOD5 -- Determining the five-day Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The BOD5 is used in modeling to measure the reduction of dissolved oxygen in receiving waters after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although BOD_5 is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Bypass -- The intentional diversion of waste streams from any portion of a treatment facility.

Categorical Pretreatment Standards -- National pretreatment standards specifying quantities or concentrations of pollutants or pollutant properties, which may be discharged to a POTW by existing or new industrial users in specific industrial subcategories.

Chlorine -- A chemical used to disinfect wastewaters of pathogens harmful to human health. It is also extremely toxic to aquatic life.

Chronic Toxicity -- The effect of a compound on an organism over a relatively long time, often 1/10 of an organism's lifespan or more. Chronic toxicity can measure survival, reproduction or growth rates, or other parameters to measure the toxic effects of a compound or combination of compounds.

Clean Water Act (CWA -- The federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117; USC 1251 et seq.

Compliance Inspection-Without Sampling -- A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

Compliance Inspection-With Sampling -- A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations. In addition it includes as a minimum, sampling and analysis for all parameters with limits in the permit to ascertain compliance with those limits; and, for municipal facilities, sampling of influent to ascertain compliance with the 85 percent removal requirement. Ecology may conduct additional sampling.

Composite Sample -- A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots).

Construction Activity -- Clearing, grading, excavation, and any other activity, which disturbs the surface of the land. Such activities may include road building; construction of residential houses, office buildings, or industrial buildings; and demolition activity.

Continuous Monitoring -- Uninterrupted, unless otherwise noted in the permit.

Critical Condition -- The time during which the combination of receiving water and waste discharge conditions have the highest potential for causing toxicity in the receiving water environment. This situation usually occurs when the flow within a water body is low, thus, its ability to dilute effluent is reduced.

Date of Receipt – This is defined in RCW 43.21B.001(2) as five business days after the date of mailing; or the date of actual receipt, when the actual receipt date can be proven by a preponderance of the evidence. The recipient's sworn affidavit or declaration indicating the date of receipt, which is unchallenged by the agency, constitutes sufficient evidence of actual receipt. The date of actual receipt, however, may not exceed 45 days from the date of mailing.

Detection Limit -- See Method Detection Level.

Dilution Factor (DF) -- A measure of the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. Expressed as the inverse of the percent effluent fraction, for example, a dilution factor of 10 means the effluent comprises 10 percent by volume and the receiving water 90 percent.

Distribution Uniformity -- The uniformity of infiltration (or application in the case of sprinkle or trickle irrigation) throughout the field expressed as a percent relating to the average depth infiltrated in the lowest one-quarter of the area to the average depth of water infiltrated.

Early Warning Value -- The concentration of a pollutant set in accordance with WAC 173-200-070 that is a percentage of an enforcement limit. It may be established in the effluent, ground water, surface water, the vadose zone or within the treatment process. This value acts as a trigger to detect and respond to increasing contaminant concentrations prior to the degradation of a beneficial use.

Enforcement Limit -- The concentration assigned to a contaminant in the ground water at the point of compliance for the purpose of regulation, [WAC 173-200-020(11)]. This limit assures that a ground water criterion will not be exceeded and that background water quality will be protected.

Engineering Report -- A document that thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report must contain the appropriate information required in WAC 173-240-060 or 173-240-130.

Fecal Coliform Bacteria -- Fecal coliform bacteria are used as indicators of pathogenic bacteria in the effluent that are harmful to humans. Pathogenic bacteria in wastewater discharges are controlled by disinfecting the wastewater. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated wastewater and/or the presence of animal feces.

Grab Sample -- A single sample or measurement taken at a specific time or over as short a period of time as is feasible.

Groundwater -- Water in a saturated zone or stratum beneath the surface of land or below a surface water body.

Industrial User -- A discharger of wastewater to the sanitary sewer that is not sanitary wastewater or is not equivalent to sanitary wastewater in character.

Industrial Wastewater -- Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business; from the development of any natural resource; or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities.

Interference -- A discharge which, alone or in conjunction with a discharge or discharges from other sources, both:

- Inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal; and

- Therefore is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent State or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including State regulations contained in any State sludge management plan prepared pursuant to subtitle D of the SWDA), sludge regulations appearing in 40 CFR Part 507, the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act.

Local Limits -- Specific prohibitions or limits on pollutants or pollutant parameters developed by a POTW.

Major Facility -- A facility discharging to surface water with an EPA rating score of > 80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Maximum Daily Discharge Limit -- The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is calculated as the average measurement of the pollutant over the day.

Maximum Day Design Flow (MDDF) -- The largest volume of flow anticipated to occur during a one-day period, expressed as a daily average.

Maximum Month Design Flow (MMDF) -- The largest volume of flow anticipated to occur during a continuous 30-day period, expressed as a daily average.

Maximum Week Design Flow (MWDF) -- The largest volume of flow anticipated to occur during a continuous seven-day period, expressed as a daily average.

Method Detection Level (MDL) -- The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the pollutant concentration is above zero and is determined from analysis of a sample in a given matrix containing the pollutant.

Minor Facility -- A facility discharging to surface water with an EPA rating score of < 80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Mixing Zone -- An area that surrounds an effluent discharge within which water quality criteria may be exceeded. The permit specifies the area of the authorized mixing zone that Ecology defines following procedures outlined in state regulations (chapter 173-201A WAC).

National Pollutant Discharge Elimination System (NPDES) -- The NPDES (Section 402 of the Clean Water Act) is the federal wastewater permitting system for discharges to navigable waters of the United States. Many states, including the state of Washington, have been delegated the authority to issue these permits. NPDES permits issued by Washington State permit writers are joint NPDES/State permits issued under both state and federal laws.

pH -- The pH of a liquid measures its acidity or alkalinity. It is the negative logarithm of the hydrogen ion concentration. A pH of 7.0 is defined as neutral and large variations above or below this value are considered harmful to most aquatic life.

Pass-through -- A discharge which exits the POTW into waters of the State in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation), or which is a cause of a violation of State water quality standards.

Peak Hour Design Flow (PHDF) -- The largest volume of flow anticipated to occur during a one-hour period, expressed as a daily or hourly average.

Peak Instantaneous Design Flow (PIDF) -- The maximum anticipated instantaneous flow.

Point of Compliance -- The location in the ground water where the enforcement limit must not be exceeded and a facility must comply with the Ground Water Quality Standards. Ecology determines this limit on a site-specific basis. Ecology locates the point of compliance in the ground water as near and directly downgradient from the pollutant source as technically, hydrogeologically, and geographically feasible, unless it approves an alternative point of compliance.

Potential Significant Industrial User (PSIU) --A potential significant industrial user is defined as an Industrial User that does not meet the criteria for a Significant Industrial User, but which discharges wastewater meeting one or more of the following criteria:

a. Exceeds 0.5 percent of treatment plant design capacity criteria and discharges <25,000 gallons per day or;

b. Is a member of a group of similar industrial users which, taken together, have the potential to cause pass through or interference at the POTW (e.g. facilities which develop photographic film or paper, and car washes). Ecology may determine that a discharger initially classified as a potential significant industrial user should be managed as a significant industrial user.

Quantitation Level (QL) -- Also known as Minimum Level of Quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the lab has used all method-specified sample weights, volumes, and cleanup procedures. The QL is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10^n, where n is an integer (64 FR 30417). ALSO GIVEN AS: The smallest detectable concentration of analyte greater than the Detection Limit (DL) where the accuracy (precision & bias) achieves the objectives of the intended purpose. (Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs Submitted to the US Environmental Protection Agency December 2007).

Reasonable Potential -- A reasonable potential to cause a water quality violation, or loss of sensitive and/or important habitat.

Responsible Corporate Officer -- A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or have gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures (40 CFR 122.22).

Significant Industrial User (SIU) --

a. All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; and

b. Any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling, and boiler blow-down wastewater); contributes a process wastestream that makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority* on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement [in accordance with 40 CFR 403.8(f)(6)].

Upon finding that the industrial user meeting the criteria in paragraph 2, above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the Control Authority* may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with 40 CFR 403.8(f)(6), determine that such industrial user is not a significant industrial user.

*The term "Control Authority" refers to the Washington State Department of Ecology in the case of non-delegated POTWs or to the POTW in the case of delegated POTWs.

Slug Discharge -- Any discharge of a non-routine, episodic nature, including but not limited to an accidental spill or a non-customary batch discharge to the POTW. This may include any pollutant released at a flow rate that may cause interference or pass through with the POTW or in any way violate the permit conditions or the POTW’s regulations and local limits.

Soil Scientist -- An individual who is registered as a Certified or Registered Professional Soil Scientist or as a Certified Professional Soil Specialist by the American Registry of Certified Professionals in

Agronomy, Crops, and Soils or by the National Society of Consulting Scientists or who has the credentials for membership. Minimum requirements for eligibility are: possession of a baccalaureate, masters, or doctorate degree from a U.S. or Canadian institution with a minimum of 30 semester hours or 45 quarter hours professional core courses in agronomy, crops or soils, and have five, three, or one years, respectively, of professional experience working in the area of agronomy, crops, or soils.

Solid Waste -- All putrescible and non-putrescible solid and semisolid wastes including, but not limited to, garbage, rubbish, ashes, industrial wastes, swill, sewage sludge, demolition and construction wastes, abandoned vehicles or parts thereof, contaminated soils and contaminated dredged material, and recyclable materials.

Soluble BOD_5 -- Determining the soluble fraction of Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of soluble organic material present in an effluent that is utilized by bacteria. Although the soluble BOD_5 test is not specifically described in Standard Methods, filtering the raw sample through at least a 1.2 um filter prior to running the standard BOD_5 test is sufficient to remove the particulate organic fraction.

State Waters -- Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

Stormwater--That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

Technology-Based Effluent Limit -- A permit limit based on the ability of a treatment method to reduce the pollutant.

Total Coliform Bacteria--A microbiological test, which detects and enumerates the total coliform group of bacteria in water samples.

Total Dissolved Solids--That portion of total solids in water or wastewater that passes through a specific filter.

Total Suspended Solids (TSS) -- Total suspended solids is the particulate material in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Upset -- An exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

Water Quality-Based Effluent Limit -- A limit imposed on the concentration of an effluent parameter to prevent the concentration of that parameter from exceeding its water quality criterion after discharge into receiving waters.

APPENDIX D--TECHNICAL CALCULATIONS

Several of the Excel® spreadsheet tools used to evaluate a discharger's ability to meet Washington State water quality standards can be found in the PermitCalc workbook on Ecology's webpage at: http://www.ecy.wa.gov/programs/wq/permits/guidance.html.

Simple Mixing:

Ecology uses simple mixing calculations to assess the impacts of certain conservative pollutants, such as the expected increase in fecal coliform bacteria at the edge of the chronic mixing zone boundary. Simple mixing uses a mass balance approach to proportionally distribute a pollutant load from a discharge into the authorized mixing zone. The approach assumes no decay or generation of the pollutant of concern within the mixing zone. The predicted concentration at the edge of a mixing zone (C_{mz}) is based on the following calculation:

$$C_{mz} = Ca + \frac{(Ce - Ca)}{DF}$$

where:

Ce = Effluent Concentration
Ca = Ambient Concentration
DF = Dilution Factor

Reasonable Potential Analysis:

The spreadsheets Input 2 – Reasonable Potential, and LimitCalc in Ecology's PermitCalc Workbook determine reasonable potential (to violate the aquatic life and human health water quality standards) and calculate effluent limits. The process and formulas for determining reasonable potential and effluent limits in these spreadsheets are taken directly from the *Technical Support Document for Water Quality-based Toxics Control*, (EPA 505/2-90-001). The adjustment for autocorrelation is from EPA (1996a), and EPA (1996b).

APPENDIX E--RESPONSE TO COMMENTS

A public comment period was held from July 29, 2015, to August 28, 2015. During the comment period, the following comments were received from Mr. Kenneth Clow, Public Works Director, City of Port Townsend (City).

Comment 1:

Special Condition S5 - Operation and Maintenance. The final sentence of the introductory paragraph – *This provision of the permit requires the Permittee to operate backup or auxiliary facilities or similar systems only when the operation is necessary to achieve compliance with conditions of this permit* – is unclear. We are not sure what this requirement allows or does not allow the Permittee to do. Please clarify what this means for the operation of our wastewater treatment and collection systems.

Response 1:

The sentence is part of the standard boilerplate language used for NPDES permits. The final sentence appears to clarify the first sentence of the same paragraph. The first sentence reads: *The Permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), which are installed to achieve compliance with the terms and conditions of this permit.* This first sentence could be construed as meaning even redundant backup or auxiliary systems would need to be operated *at all times*. The final sentence in question therefore clarifies that backup or auxiliary systems only need to operate as necessary. If the Permittee is still not sure how to apply this requirement, Ecology would be happy to discuss further the application to specific components of the wastewater treatment and collection systems.

Comment 2:

Special Condition S9 – Engineering Documents for Outfall Replacement – Concern with schedule. Currently, the City has identified this project in our six-year Capital Improvements Program (CIP) with engineering/design scheduled in 2019 and construction to begin in 2020. One reason for this schedule concerns the impact of the project cost on City utility ratepayers. The City is preparing to break ground on a new water treatment facility mandated by federal and state regulations and a replacement for our 5 million gallon water storage reservoir. These new facilities are expected to cost in the neighborhood of $25 million to be paid for by the utility's approximately 4700 water customers. New surcharges to pay for the water projects will nearly double the water charges paid by our customers. We are trying to avoid adding to the rates for sewer projects for as long as reasonably possible. With that in mind the City desires to maintain our current schedule of engineering/design completion in 2019 and construction initiation in 2020. Also the exact schedule for securing funding for this project has not been developed. Funding cycles for Public Works Trust Fund and other grant and loan programs need to be taken into account as the wastewater utility fund does not have sufficient cash on hand to fully pay for a project of this scope.

We recognize that the proposed completion date for an approvable engineering report of December 31, 2018 (Special Condition S9.A) is not too far from the City's current schedule. If this date remains in the permit the City requests that the submission date for approvable plans and specifications of June 30, 2019 (Special Condition S9.D) be extended by six months to December 31, 2019. Given the regulatory climate, intergovernmental/tribal coordination, and permitting requirements for this type of project we believe that six months is not sufficient time to produce the project documents that would conform to the permit conditions as these conditions evolve throughout the design process.

Response 2:

Ecology changed the due date for plans and specifications in Special Condition S9.D to December 31, 2019, as requested. Ecology realizes it may take time to work through the permitting and funding issues associated with the outfall. Ecology would also be willing to help the Permittee with grant and loan programs. Ecology administers the Clean Water State Revolving Fund and the Centennial Clean Water Fund with application periods each fall. Funding for planning and design is available and can be applied for in the fall and then funds would become available the following July. The permit does not include a deadline for outfall construction, as Ecology understands that the schedule for final construction may depend on success in securing funding.

Comment 3:

Special Condition S9 – Engineering Documents for Outfall Replacement – Alternative Selection Criteria. Special Condition S9.A requires that the engineering report "shall describe the options for a new outfall and *select an alternative that is an improvement over the present discharge location (emphasis added)."* The City takes exception to the highlighted criteria. The project is being undertaken because the existing outfall is reaching the end of its useful life and is failing. We are not aware that the current location of the outfall is a problem. We recognize that the design of a new outfall is subject to a variety of factors – functional, environmental, and economic. The best alternative will meet the state and federal design requirements for outfall structures while minimizing the impacts to the surrounding environment and to the utility ratepayers. This portion of the condition should read "… and select an alternative that is an improvement over the present outfall."

Response 3:

To be more consistent with Ecology's authority and responsibility, the sentence was changed to "This report shall describe the options for a new outfall and select an outfall configuration that allows the Permittee to meet applicable State Water Quality Standards." Some of the language for Special Condition S9 was taken from the February 22, 2010, joint letter from Washington State Department of Natural Resources (DNR) and the Department of Fish and Wildlife (DFW) to David Timmons of the city of Port Townsend. The conclusion to this letter states in part: "In order to protect marine vegetation and re-open North Beach to shellfish harvest, we believe that the outfall design needs to be located further offshore in deeper water." The permit condition for an *improvement over the present location* was a paraphrase of the letter conclusion. While Ecology changed the permit to better reflect our issues, the Permittee needs to meet the requirements of all agencies, and should realize that some of the mitigation required for construction impacts may involve an ultimate outcome that is an improvement of the present condition.

Comment 4:

Given the scope and complexity of the outfall project from a technical, permitting, and funding perspective we believe that the best solution would be to remove Special Condition S9 from the permit completely and to address the Department of Ecology concerns with the outfall through a separate Administrative Order process. This would give the Department and the City sufficient time to work together to develop appropriate, realistic schedules and the project scope.

Response 4:

Ecology tried to develop Special Condition S9 as a reasonable schedule to complete outfall construction, taking into consideration the complexity of the outfall project. The schedule is also intended as a means to enforce the schedule that the Permittee already seemed to be on. Ecology's interest is to see the outfall project that had started, then seemed to have stopped, get started again. At this point, an Adminstrive Order would be additional work and delay that would not seem to provide any benefit over the present permit condition.

These were the only comments received during the 30-day public comment period. After the comment period closed, some comments from Richard A. Smith on behalf of Puget Soundkeeper Alliance were submitted. As these comments did not cause any changes to the permit or fact sheet, and were not submitted during the comment period, they were responded to in a separate letter.

Appendix D

PSNGP

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Issuance Date: December 1, 2021
Effective Date: January 1, 2022
Expiration Date: December 31, 2026

PUGET SOUND NUTRIENT GENERAL PERMIT

A NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM AND STATE WASTE DISCHARGE GENERAL PERMIT

State of Washington
Department of Ecology
Olympia, Washington

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1251 et seq.

Until this permit expires, is modified or revoked, Permittees that have properly obtained coverage under this general permit are authorized to discharge nutrients in accordance with the conditions, which follow.

DEPARTMENT OF ECOLOGY
State of Washington

Vincent McGowan, P.E.
Water Quality Program Manager
Washington State Department of Ecology

TABLE OF CONTENTS

SUMMARY OF PERMIT REPORT SUBMITTALS 5

SPECIAL CONDITIONS 7
S1. PERMIT COVERAGE 7
A. Coverage Area And Eligible Discharges 7
B. Limits on Coverage 9
S2. APPLICATION FOR COVERAGE 10
A. Obtaining Permit Coverage 10
B. How to Apply for Permit Coverage 10
C. Permit Coverage Effective Date 10
D. Modification of Permit Coverage 11
S3. COMPLIANCE WITH STANDARDS 11
S4. NARRATIVE EFFLUENT LIMITS FOR WWTPS WITH DOMINANT TIN LOADS 11
A. Applicability and Narrative Effluent Limits 11
B. TIN Action Levels 12
C. Nitrogen Optimization Plan and Report 13
D. Action Level Exceedance Corrective Actions 15
E. Nutrient Reduction Evaluation 16
S5. NARRATIVE EFFLUENT LIMITS FOR WWTPS WITH MODERATE TIN LOADS 18
A. Applicability and Narrative Effluent Limits 18
B. TIN Action Levels 19
C. Nitrogen Optimization Plan and Report 20
D. Action Level Exceedance Corrective Actions 22
E. Nutrient Reduction Evaluation 24
S6. NARRATIVE EFFLUENT LIMITS FOR WWTPS WITH SMALL TIN LOADS 26
A. Applicability and Narrative Effluent Limits 26
B. Nitrogen Optimization Plan and Report 28
C. AKART Analysis 30
S7. MONTORING SCHEDULES AND SAMPLING REQUIREMENTS 32
A. Monitoring Requirements For Dominant Loaders 32
B. Monitoring Requirements For Moderate Loaders 35
C. Monitoring Requirements For Small Loaders 38
D. Sampling And Analytical Procedures 41
E. Flow Measurement 41
F. Laboratory Accreditation 41
G. Request For Reduction In Monitoring 41
S8. DISCHARGES TO 303(D) OR TMDL WATER BODIES 42
S9. REPORTING AND RECORDKEEPING REQUIREMENTS 43
A. Discharge Monitoring Reports 43
B. Monitoring Requirements 43
C. Annual Report for Dominant Loaders 44

D. Annual Report for Moderate Loaders 44
E. Reporting for Small Loaders 45
F. Records Retention 45
G. Noncompliance Notification 45
H. Access to Plans and Records 46
S10. PERMIT FEES 46

GENERAL CONDITIONS 47
G1. DISCHARGE VIOLATIONS 47
G2. SIGNATORY REQUIREMENTS 47
G3. RIGHT OF INSPECTION AND ENTRY 48
G4. GENERAL PERMIT MODIFICATION AND REVOCATION 48
G5. REVOCATION OF COVERAGE UNDER THE PERMIT 48
G6. COMPLIANCE WITH OTHER LAWS AND STATUTES 49
G7. DUTY TO REAPPLY 49
G8. TRANSFER OF GENERAL PERMIT COVERAGE 49
G9. REMOVED SUBSTANCES 49
G10. DUTY TO PROVIDE INFORMATION 49
G11. OTHER REQUIREMENTS OF 40 CFR 49
G12. ADDITIONAL MONITORING 49
G13. PENALTIES FOR VIOLATING PERMIT CONDITIONS 50
G14. PROPERTY RIGHTS 50
G15. DUTY TO COMPLY 50
G16. TOXIC POLLUTANTS 50
G17. PENALTIES FOR TAMPERING 50
G18. REPORTING PLANNED CHANGES 50
G19. REPORTING OTHER INFORMATION 50
G20. REPORTING ANTICIPATED NON-COMPLIANCE 51
G21. APPEALS 51
G22. SEVERABILITY 51
G23. BYPASS PROHIBITED 51

APPENDIX A – DEFINITIONS 52

APPENDIX B – ACRONYMS 56

APPENDIX C – ANNUAL REPORT QUESTIONS FOR DOMINANT LOADERS 57

APPENDIX D – ANNUAL REPORT QUESTIONS FOR MODERATE LOADERS 59

APPENDIX E – ONE TIME REPORT QUESTIONS FOR SMALL LOADERS 61

LIST OF TABLES

Table 1. Summary of Permit Report Submittals 5
Table 2. Summary of Required On-Site Documentation 6
Table 3. List of Domestic WWTPs Discharging to Puget Sound 7
Table 4. Narrative Effluent Limitations for Dominant TIN Loaders 12
Table 5. Dominant WWTPs and Total Inorganic Nitrogen Action Levels 12
Table 6. Bubbled Action Levels for Corrective Action Assessment 13
Table 7. Narrative Effluent Limitations for Moderate TIN Loaders 19
Table 8. Moderate WWTPs and Total Inorganic Nitrogen Action Levels 19
Table 9. Bubbled Action Levels for Corrective Action Assessment 20
Table 10. Narrative Effluent Limitations for WWTPs with Small TIN Loads 26
Table 11. Permittees with Small TIN Loads 27
Table 12. Influent Sampling Requirements for S4 Permittees 32
Table 13. Effluent Sampling Requirements for S4 Permittees 33
Table 14. Footnotes for Influent and Effluent Monitoring Tables 12 and 13 34
Table 15. Influent Sampling Requirements for S5 Permittees 35
Table 16. Effluent Sampling Requirements for S5 Permittees 36
Table 17. Footnotes for Influent and Effluent Monitoring Tables 15 and 16 37
Table 18. Influent Sampling Requirements for S6 Permittees 38
Table 19. Effluent Sampling Requirements for S6 Permittees 39
Table 20. Footnotes for Influent and Effluent Monitoring Tables 18 and 19 40

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions within this permit for additional submittal requirements. Appendix A provides a list of definitions. Appendix B provides a list of acronyms.

Table 1. Summary of Permit Report Submittals

Permit Section	Submittal	Frequency	First Submittal Date
S2.A.1	Permit Application (Notice of Intent)	Once	For new Permittees: No later than 90 days following permit issuance
S4.C	Nitrogen Optimization Report for Dominant Loaders	Annually	March 31, 2023
S4.D	Corrective Action Engineering Report	As necessary	
S4.E	Nutrient Reduction Evaluation for Dominant Loaders	1/permit cycle	December 31, 2025
S5.C	Nitrogen Optimization Report for Moderate Loaders	Annually	March 31, 2023
S5.D	Corrective Action Engineering Report	As necessary	
S5.E	Nutrient Reduction Evaluation for Moderate Loaders	1/permit cycle	December 31, 2025
S6.B	Nitrogen Optimization Report for Small Loaders	1/permit cycle	March 31, 2026
S5.D	AKART Evaluation for Small Loaders	1/permit cycle	December 31, 2025
S9.A	Discharge Monitoring Reports (DMRs)	Monthly	Within 15 days of applicable monitoring period
G2	Notice of Change in Authorization	As necessary	As necessary
G7	Application for Permit Renewal	1/permit cycle	No later than 180 days before expiration
G20	Reporting Anticipated Non-Compliance	As necessary	As necessary

Table 2. Summary of Required On-Site Documentation

Permit Condition(s)	Document Title
S9.B.3	Original Sampling Records (Field notes, as applicable and Laboratory Reports)
S9.G.1.a	Copy of Permit Coverage Letter
S9.G.1.b	Copy of Puget Sound Nutrient General Permit
S9.G.1.c	Copies of Discharge Monitoring Reports
S9.G.1.d	Copies of attachment to the Annual or Single NOP Reports (as applicable)
S9.G.1.e	Copy of the Nutrient Reduction Evaluation or AKART Analysis (as applicable)

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[1] https://ecology.wa.gov/About-us/Accountability-transparency/Our-website/Accessibility

SPECIAL CONDITIONS

S1. PERMIT COVERAGE

A. COVERAGE AREA AND ELIGIBLE DISCHARGES

This Puget Sound Nutrient General Permit (PSNGP) applies to the 58 publically owned ***domestic wastewater*** treatment plants (WWTPs) discharging into ***Washington Waters of the Salish Sea***, except for federal and Tribal lands and waters as specified in Special Condition S1.D. Table 3 identifies the WWTPs covered by this permit along with their individual ***NPDES*** permit number for reference. This proposed permit assigns a category to each WWTP based on their percentage of the ***total inorganic nitrogen*** **(TIN)** load currently discharged to Washington Waters of the Salish Sea. Special Condition S4 lists permit conditions and limits for the WWTPs with the **dominant (D) TIN loads**. Special Condition S5 lists the conditions and limits for the WWTPs with **moderate (M) loads**. Special Condition S6 lists the conditions and limits for the WWTPs with **small (S) loads**.

Table 3. List of Domestic WWTPs Discharging to Puget Sound

Wastewater Treatment Plant	Individual NPDES Permit Number	Category
Alderwood Sewage Treatment Plant (STP)	WA0020826	S
Anacortes WWTP	WA0020257	M
Bainbridge Island WWTP	WA0020907	S
Birch Bay Sewage Treatment Plant (STP)	WA0029556	M
Boston Harbor STP	WA0040291	S
Bremerton WWTP	WA0029289	M
Clallam Bay WWTP	WA0024431	S
Clallam Bay Corrections Center WWTP	WA0039845	S
Coupeville WWTP	WA0029378	S
Eastsound Orcas Village WWTP	WA0030911	S
Eastsound Sewer and Water District WWTP	WA0030571	S
Edmonds STP	WA0024058	M
Everett STP	WA0024490	D
Fisherman Bay STP	WA0030589	S
Friday Harbor STP	WA0023582	S
Gig Harbor WWTP	WA0023957	S
Hartstene Pointe STP	WA0038377	S
King County, Brightwater WWTP	WA0032247	D

Wastewater Treatment Plant	Individual NPDES Permit Number	Category
King County, South WWTP	WA0029581	D
King County, Vashon WWTP	WA0022527	S
King County, West Point WWTP	WA0029181	D
Kitsap County, Central Kitsap WWTP	WA0030520	M
Kitsap County, Kingston WWTP	WA0032077	S
Kitsap County, Manchester WWTP	WA0023701	S
Kitsap County Sewer District #7 Water Reclamation Facility (WRF)	WA0030317	S
La Conner STP	WA0022446	S
Lake Stevens Sewer District WWTP	WA0020893	M
Lakota WWTP	WA0022624	M
Langley WWTP	WA0020702	S
Lighthouse Point WRF/Blaine STP	WA0022641	M
LOTT Budd Inlet WRF	WA0037061	M
Lynnwood STP	WA0024031	M
Marysville STP	WA0022497	M
McNeil Island Special Commitment Center WWTP	WA0040002	S
Midway Sewer District WWTP	WA0020958	M
Miller Creek WWTP	WA0022764	M
Mt Vernon WWTP	WA0024074	M
Mukilteo Water and Wastewater District WWTP	WA0023396	S
Oak Harbor STP	WA0020567	S
Penn Cove WWTP	WA0029386	S
Pierce County Chambers Creek Regional WWTP	WA0039624	D
Port Angeles WWTP	WA0023973	M
Port Orchard WWTP (South Kitsap WRF)	WA0020346	M
Port Townsend STP	WA0037052	S
Post Point WWTP (Bellingham STP)	WA0023744	D
Redondo WWTP	WA0023451	M
Rustlewood WWTP	WA0038075	S
Salmon Creek WWTP	WA0022772	M

Wastewater Treatment Plant	Individual NPDES Permit Number	Category
Sekiu WWTP	WA0024449	S
Sequim WRF	WA0022349	S
Shelton WWTP	WA0023345	S
Skagit County Sewer District 2 Big Lake WWTP	WA0030597	S
Snohomish STP	WA0029548	M
Stanwood STP	WA0020290	S
Tacoma Central No. 1 WWTP	WA0037087	D
Tacoma North No. 3 WWTP	WA0037214	M
Tamoshan STP	WA0037290	S
WA Parks Larrabee WWTP	WA0023787	S

B. LIMITS ON COVERAGE

Coverage under this General Permit does not include discharges from WWTPs not listed in Table 3. Coverage under this General Permit also excludes all discharges from non-WWTP outfalls.

This permit does not cover the following discharges:

1. Discharges from facilities located on "Indian Country" as defined in 18 U.S.C. §1151, except portions of the Puyallup Reservation as noted below. Indian Country includes:
   a. All land within any Indian Reservation, notwithstanding the issuance of any patent, and including rights-of-way running through the reservation. This includes all federal, tribal, and Indian and non-Indian privately owned land within the reservation.
   b. All off-reservation Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same.
   c. All off-reservation federal trust lands held for Native American Tribes.

   Puyallup Exception: Following the *Puyallup Tribes of Indians Land Settlement Act of 1989*, 25 U.S.C. §1773,the permit does apply to land within the Puyallup Reservation except for discharges to surface water on land held in trust by the federal government.
2. Discharges from activities operated by any department, agency, or instrumentality of the executive, legislative, and judicial branches of the Federal Government of the United States, or another entity, such as a private contractor, performing industrial activity for any such department, agency, or instrumentality.

3. Discharges from any industrial or privately owned domestic wastewater treatment plant into Washington waters of the Salish Sea.
4. Discharges from domestic WWTPs entering tributary watersheds to Washington waters of the Salish Sea, upstream of Ecology ambient monitoring stations.

S2. APPLICATION FOR COVERAGE

A. OBTAINING PERMIT COVERAGE

1. The ***owner***/***operator*** seeking coverage under this permit must apply for permit coverage within the following time limits.
   a. Existing facilities are WWTPs in operation prior to the effective date of this permit, January 1, 2022 and are identified in Table 3.
   b. The owner/operator of an existing domestic wastewater treatment plant must submit a complete application for coverage no later than ninety (90) ***days*** after the issuance date of this permit. Upon submittal of a complete application for coverage (also called a ***Notice of Intent*** or NOI) ***Ecology*** will issue a decision on permit coverage pursuant to Special Condition S2.C.

B. HOW TO APPLY FOR PERMIT COVERAGE

The owner/operator seeking coverage under this permit must do the following:

1. Submit to Ecology, a complete application for coverage using the permit specific Notice of Intent through Ecology's Water Quality Permitting Portal: https://secureaccess.wa.gov/ecy/wqwebportal. The ***applicant*** must submit this application for coverage electronically. For more information about the WQWebPortal, visit Ecology's WQWebPortal guidance webpage[2].
2. A responsible person, as defined in General Condition G2, must sign the signature page of the NOI and submit it to Ecology.
3. Public Notice
   a. Public notice of the application for coverage is not required for the facilities subject to this general permit because they are all existing facilities.
   b. The owner/operator of an existing facility with coverage under the Puget Sound Nutrient General Permit (***Permittee***) wanting to modify their permit coverage must comply with public notice requirements specified in Special Condition S2.D.2.

C. PERMIT COVERAGE EFFECTIVE DATE

Permit coverage begins on the day Ecology issues the coverage letter to the applicant.

[2] https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Water-quality-permits-guidance/WQWebPortal-guidance

D. MODIFICATION OF PERMIT COVERAGE

A permittee requesting a reduction in monitoring, or a change in action level, or otherwise requesting a modification of permit coverage, must submit a complete Modification of Coverage Form to Ecology. The Permittee must:

1. Apply for modification of coverage at least 60 days prior to the change necessitating the coverage modification.
2. Complete the public notice requirements in WAC 173-226-130(5) as part of a complete application for modification of coverage.
3. Comply with ***SEPA*** as part of a complete application for modification of coverage if undergoing a significant process change driven by a corrective action.

S3. COMPLIANCE WITH STANDARDS

A. Discharges must not cause or contribute to a violation of surface water quality standards (Chapter 173-201A WAC), sediment management standards (Chapter 173-204 WAC), or human health-based criteria in the Federal water quality criteria applicable to Washington (40 CFR Part 135.45). This permit does not authorize discharge in violation of water quality standards.

B. Ecology presumes that a Permittee complies with water quality standards unless discharge monitoring data or other ***site***-specific information demonstrates that a discharge causes or contributes to a violation of water quality standards, when the Permittee complies with the following conditions. The Permittee must fully comply with all permit conditions, including planning, ***optimization***, corrective actions (as necessary), sampling, monitoring, reporting, waste management, and recordkeeping conditions.

S4. NARRATIVE EFFLUENT LIMITS FOR WWTPS WITH DOMINANT TIN LOADS

A. APPLICABILITY AND NARRATIVE EFFLUENT LIMITS

Beginning on the effective date, each of the Permittees with dominant TIN loads listed in Table 5 may discharge TIN from the WWTP through the designated ***outfall(s)*** described in its individual NPDES permit. See Table 3 in Section S1.A for the load category assignment.

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. Each Permittee listed in Table 5 must comply with the facility specific or bubbled ***action levels*** and narrative effluent limits listed in Table 4, which constitute the suite of ***best management practices*** (BMPs) required for a water quality based effluent limit under 40 CFR 122.44(k).

Table 4. Narrative Effluent Limits for Dominant TIN Loaders

Parameter	Narrative Effluent Limit
Monitoring	Monitor and report per the requirements in S7.A.
Nitrogen Optimization Plan	Optimize treatment performance to stay below the action level. Submit Optimization Report annually per the requirements in S4.C
Nutrient Reduction Evaluation	Submit Nutrient Reduction Evaluation per the requirements in S4.E

B. TIN ACTION LEVELS

If the action level listed in Table 5 for individual WWTPs or the bubbled action levels listed for single jurisdictions in Table 6 are exceeded, the Permittee must employ corrective actions identified in S4.D.

The annual Action Level is the sum of monthly nutrient loads measured over one year. Ecology will assess this total once per year based on the Permittee's Annual Report.

Table 5. Dominant WWTPs and Total Inorganic Nitrogen Action Levels

Wastewater Treatment Plant	Individual NPDES Permit Number	Action Level, TIN lbs/year	Outfall Number
Everett STP	WA0024490	1,530,000	100/015
King County Brightwater WWTP [1]	WA0032247	1,810,000	001
King County South WWTP [1]	WA0029581	7,340,000	001
King County West Point WWTP [1]	WA0029181	6,670,000	001
Pierce County Chambers Creek Regional WWTP	WA0039624	1,880,000	001
Post Point WWTP (Bellingham STP)	WA0023744	993,000	001
Tacoma Central No. 1 WWTP [4]	WA0037087	2,410,000	001

Table 6. Bubbled Action Levels for Corrective Action Assessment

Jurisdiction	Bubbled Action Level, TIN lbs/year
King County	15,820,000

C. NITROGEN OPTIMIZATION PLAN AND REPORT

Each Permittee listed in Table 5 must develop, implement and maintain a Nitrogen Optimization Plan to evaluate operational strategies for maximizing nitrogen removal from the existing treatment plant to stay below the calculated action level. Each Permittee must document their actions taken, any action level exceedances, and apply an adaptive management approach at the WWTP. Permittees will quantify results with required monitoring under this Permit.

The Permittee must begin the actions described in this section immediately upon permit coverage. Documentation of Nitrogen Optimization Plan implementation must be submitted annually through the Annual Report (S9- Reporting Requirements). See Appendix C for Annual Report questions that satisfy the Nitrogen Optimization Plan requirements.

The Nitrogen Optimization Plan submitted by each Permittee in Table 5 must include the following components:

1. Treatment Process Performance Assessment

   Assess the nitrogen removal potential of the current treatment process and identify viable optimization strategies prior to implementation.

   a. *Treatment Assessment* Develop a method to evaluate potential optimization approaches for the existing treatment process. Use the evaluation to:

      i. Determine current (pre-optimization) process performance to determine the existing TIN removal performance for the WWTP.

      ii. Create a list of potential optimization strategies capable of meeting the action level at the WWTP prior to starting optimization. Update the assessment and list of options as necessary with each Annual Report.

   b. *Identify and evaluate optimization strategies.* From the list developed in S4.C.1.a.ii, identify viable optimization strategies for each WWTP owned and operated by the Permittee. Prioritize and update this list as necessary to continuously maintain a working set of strategies for meeting the action level with the existing treatment processes.

      The Permittee may exclude any optimization strategy from the initial list created in S4.C.a.ii that was considered but found to exceed a reasonable implementation cost or timeframe. Documentation must include an explanation of the rationale and financial criteria used in the exclusion determination. If the Permittee finds no viable optimization strategies exist for their current treatment processes, they must immediately proceed to the identification of a corrective action under S4.D.

c. *Initial Selection.* **As soon as possible and no later than July 1, 2022**, select at least one optimization strategy for implementation.

   Document the expected performance (i.e., % TIN removal or a calculated reduction in effluent load or concentration) for the initial optimization strategy prior to implementation.

2. Optimization Implementation

   All Permittees in Table 5 must document implementation of the selected optimization strategy (from S4.C.1.c) during the first reporting period in the first Annual Report due March 31, 2023. Permittees must document implementation during every reporting period thereafter. The documentation must include:

   a. *Strategy Implementation.* Describe how the permittee implemented the selected strategy during each reporting period, following permit coverage. Including:

      i. Initial implementation costs

      ii. Length of time for full implementation, including start date.

      iii. Any adaptive management applied to refine implementation during the reporting period.

      iv. Anticipated and unanticipated challenges.

      v. Any impacts to the overall treatment performance as a result of process changes.

   b. *Discharge Evaluation.* By March 31 each year beginning in 2023, each Permittee in Table 5 must review effluent data collected during the previous calendar year to determine whether TIN loads are increasing.

      i. Using all accredited monitoring data, determine facility's annual average TIN concentration and load from the reporting period. **If the annual TIN load exceeds the Action Level in Table 5 (or the applicable bubbled Action Level in Table 6) take the corrective actions in S4.D.**

      ii. Determine the treatment plant's TIN removal rate observed during the reporting period.

3. Influent Nitrogen Reduction Measures/Source Control

   Permittees in Table 5 must investigate opportunities to reduce influent TIN loads from septage handling practices, commercial, dense residential and industrial sources and submit documentation with the Annual Report. The investigation must:

a. Review non-residential sources of nitrogen and identify any possible pretreatment opportunities.

b. Identify potential strategies for reducing TIN from new multi-family/dense residential developments and commercial buildings.

D. ACTION LEVEL EXCEEDANCE CORRECTIVE ACTIONS

Permittees in Table 5 must evaluate whether or not they exceeded the facility specific action level or the bubbled action level (as applicable) and, if they did, implement corrective actions while continuing optimization.

1. If the Permittee determines in the Annual Report that they have exceeded their action level, they must:

   a. Identify possible factors that caused the action level exceedance.

   b. Identify whether modifications to the optimization strategy can improve performance.

   c. Assess whether a different strategy or combination of strategies may provide better overall process improvements.

   d. Document changes made to the optimization strategy, if any, while completing corrective action requirements.

      i. Provide a detailed description of the modified or new optimization strategy selected from the list developed in S4.C.1.b. Include an implementation schedule for any changes and, as necessary, use the treatment process assessment developed to evaluate anticipated results.

      ii. If the Permittee proposes no changes to the optimization strategy, they must provide reasons for not making changes.

2. With the next Annual Report, submit for review a proposed approach to reduce the annual effluent load by at least 10% below the action level listed in Table 5 for individual plants or Table 6 for multiple plants under a bubbled action level. This must be an abbreviated engineering report or technical memo, unless Ecology has previously approved a design document with the proposed solution. The proposed approach must utilize solutions that can be implemented as soon as possible. This may include influent load reduction strategies identified in S4.C.3.

   The engineering document must include:

      i. Brief summary of the treatment alternatives considered and why the proposed approach was selected. Include cost estimates for operation and maintenance;

      ii. The basic design information, including influent characterization;

      iii. A description of the proposed treatment approach and operation, including updates to the WWTP's process flow diagram;

   iv. Anticipated results from the proposed approach including expected effluent quality;

   v. Certification by a licensed professional engineer.

a. If a Permittee exceeds an action level two years in a row, or for a third year during the permit term, the Permittee must begin to reduce nitrogen loads by implementing the proposed approach submitted per S4.D.2 following Ecology's written approval of the proposed approach and implementation schedule.

b. Submit an update to the Permittee's Operation and Maintenance Manual no later than 6 months following implementation.

E. NUTRIENT REDUCTION EVALUATION

1. All permittees in Table 5, except for those who meet the exclusions listed in this paragraph, must prepare and submit an approvable Nutrient Reduction Evaluation (NRE) to Ecology for review by December 31, 2025. Permittees with multiple plants may submit a combined report. This combined report must include an evaluation for all plants owned and operated by the jurisdiction. Permittees that maintain an annual TIN average of < 10 mg/L and meet their action level throughout the permit term must submit a truncated NRE that satisfies S4.E.3-S4.E.5. Permittees that meet their action level throughout the permit term, maintain an annual average of < 10 mg/L TIN and a seasonal average of < 3 mg/L do not have to submit the NRE.

2. The NRE must include an all known, available and reasonable treatment (***AKART***) analysis for purposes of evaluating reasonable treatment alternatives capable of reducing total inorganic nitrogen (TIN). It must present an alternative representing the greatest TIN reduction that is reasonably feasible on an annual basis.

3. In addition, the NRE must assess other site-specific main stream treatment plant upgrades, the applicability of side stream treatment opportunities, alternative effluent management options (e.g., disposal to ground, reclaimed water beneficial uses), the viability of satellite treatment, and other nutrient reduction opportunities that could achieve a final effluent concentration of 3 mg/L TIN (or equivalent load reduction) on seasonal average (April – October) basis.

4. The analysis must be sufficiently complete that an engineering report may be developed for the preferred AKART alternative as well as the preferred alternatives to reach 3 mg/L TIN seasonally, without substantial alterations of concept or basic considerations. The final report must contain appropriate requirements as described in the following guidance (or most recent version):
   a. The Criteria for Sewage Works Design (ECY Publication No. 98-37, 2019)[3]
   b. Reclaimed Water Facilities Manual: The Purple Book (ECY Publication No. 15-10-024, 2019)[4]
5. The analysis conducted for the NRE must include the following elements:
   a. Wastewater Characterization
      i. Current flowrates and growth trends within the sewer service area.
      ii. Current influent and effluent quality.
   b. Treatment Technology Analysis
      i. Description of current treatment processes, including any modifications made for optimization or due to corrective actions.
      ii. Description of site limitations, constraints, or other treatment implementation challenges that exist.
      iii. Identification and screening of potential treatment technologies for meeting two different levels of treatment:
         1. AKART for nitrogen removal (annual basis), and
         2. 3 mg/L TIN (or equivalent load), as a seasonal average April - October
   c. Economic Evaluation
      i. Develop capital, operation and maintenance costs and 20 year net present value using the real discount rate in the most current Appendix C to Office of Management and Budget Circular No. A-94[5] for each technology alternative evaluated.
      ii. Provide cost per pound of nitrogen removed.
      iii. Provide details on basis for current wastewater utility rate structure, including:
         1. How utilities allocate and recover costs from customers.

[3] https://apps.ecology.wa.gov/publications/summarypages/9837.html
[4] https://apps.ecology.wa.gov/publications/SummaryPages/1510024.html
[5] https://www.whitehouse.gov/wp-content/uploads/2020/12/2020_Appendix-C.pdf

2. How frequently rate structures are reviewed.

3. The last time rates were adjusted and the reason for that adjustment.

iv. Provide impact to current rate structure for each alternative assessed.

d. Environmental Justice (EJ) Review

i. Evaluate the demographics within the sewer service area to identify communities of color, Tribes, indigenous communities, and low income populations.

ii. Identify areas within service area that exceed the median household income.

iii. Include an affordability assessment to identify how much overburdened communities identified in S4.E.5.d.i can afford to pay for the wastewater utility.

iv. Propose alternative rate structures or measures that can be taken to prevent adverse effects of rate increases on populations with economic hardship identified in S4.E.5.d.i.

v. Provide information on how recreational and commercial opportunities may be improved for communities identified in S4.E.5.d.i as a result of the treatment improvements identified.

e. Selection of the most reasonable treatment alternative based on the AKART assessment; and the selected alternative for achieving an effluent concentration of 3 mg/L TIN (or equivalent load reduction) based on an April – October seasonal average.

f. Viable implementation timelines that include funding, design, and construction for meeting both the AKART and seasonal average 3 mg/L TIN preferred alternatives.

S5. NARRATIVE EFFLUENT LIMITS FOR WWTPS WITH MODERATE TIN LOADS

A. APPLICABILITY AND NARRATIVE EFFLUENT LIMITS

Beginning on the effective date, each of the Permittees with moderate TIN loads listed in Table 8 may discharge TIN from the WWTP through the designated ***outfall(s)*** described in its individual NPDES permit. See Table 3 in Section S1.A for the load category assignment.

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. Each Permittee listed in Table 8 must comply with the facility specific or bubbled ***action levels*** and narrative effluent limits listed in Table 7, which constitute the suite of ***best management practices*** (BMPs) required for a water quality based effluent limit under 40 CFR 122.44(k).

Table 7. Narrative Effluent Limits for Moderate TIN Loaders

Parameter	Narrative Effluent Limit
Monitoring	Monitor and report per the requirements in S7.B.
Nitrogen Optimization Plan	Optimize treatment performance to stay below the action level. Submit Optimization Report annually per the requirements in S5.C
Nutrient Reduction Evaluation	Submit Nutrient Reduction Evaluation per the requirements in S5.E

B. TIN ACTION LEVELS

If the action level listed in Table 8 for individual WWTPs or the bubbled action levels listed for single jurisdictions in Table 9 are exceeded, the Permittee must employ corrective actions identified in S5.D.

The annual Action Level is the sum of monthly nutrient loads measured over one year. Ecology will assess this total once per year based on the Permittee's Annual Report.

Table 8. Moderate WWTPs and Total Inorganic Nitrogen Action Levels

Wastewater Treatment Plant	Individual NPDES Permit Number	Action Level, TIN lbs/year	Outfall Number
Anacortes WWTP	WA0020257	167,000	001
Birch Bay Sewage Treatment Plant (STP)	WA0029556	66,400	001
Blaine STP (Lighthouse Point WRF)	WA0022641	18,200	001
Bremerton WWTP	WA0029289	602,000	001
Kitsap County Central Kitsap WWTP	WA0030520	306,000	001
Edmonds STP	WA0024058	432,000	001
Lake Stevens Sewer District WWTP	WA0020893	127,000	002
Lakota WWTP [1]	WA0022624	597,000	001

Wastewater Treatment Plant	Individual NPDES Permit Number	Action Level, TIN lbs/year	Outfall Number
LOTT Budd Inlet WWTF	WA0037061	338,000	001
Lynnwood STP	WA0024031	340,000	001
Marysville STP	WA0022497	592,000	100/001
Midway Sewer District WWTP	WA0020958	625,500	001
Miller Creek WWTP [2]	WA0022764	297,000	001
Mt Vernon WWTP	WA0024074	396,000	004
Port Angeles WWTP	WA0023973	177,000	001/002
Port Orchard WWTP (South Kitsap WRF)	WA0020346	215,000	001
Redondo WWTP [1]	WA0023451	249,000	001
Salmon Creek WWTP [2]	WA0022772	199,000	001
Snohomish STP	WA0029548	83,600	001
Tacoma North No. 3 WWTP	WA0037214	339,000	001

Table 9. Bubbled Action Levels for Corrective Action Assessment

Jurisdiction	Bubbled Action Level, TIN lbs/year
Lakehaven Water and Sewer District [1]	846,000
Southwest Suburban Sewer District [2]	496,000

C. NITROGEN OPTIMIZATION PLAN AND REPORT

Each Permittee listed in Table 8 must develop, implement and maintain a Nitrogen Optimization Plan to evaluate operational strategies for maximizing nitrogen removal from the existing treatment plant to stay below the calculated action level. Each Permittee must document their actions taken, any action level exceedances, and apply an adaptive management approach at the WWTP. Permittees will quantify results with required monitoring under this Permit.

The Permittee must begin the actions described in this section immediately upon permit coverage. Documentation of Nitrogen Optimization Plan implementation must be submitted annually through the Annual Report (S9- Reporting Requirements). See Appendix D for annual report questions that satisfy the Nitrogen Optimization Plan requirements.

The Nitrogen Optimization Plan submitted by each Permittee in Table 8 must include the following components:

1. Treatment Process Performance Assessment

   Assess the nitrogen removal potential of the current treatment process and identify viable optimization strategies prior to implementation.

   a. *Treatment Assessment.* Develop a method to evaluate potential optimization approaches for the existing treatment process. Use the evaluation to:

      i. Evaluate current (pre-optimization) process performance to determine the existing TIN removal performance for the WWTP.

      ii. Create a list of potential optimization strategies capable of meeting the action level at the WWTP prior to starting optimization. Update the assessment and list of options as necessary with each Annual Report.

   b. *Identify and evaluate optimization strategies.* From the list developed in S5.C.1.a.ii, identify viable optimization strategies for each WWTP owned and operated by the Permittee. Prioritize and update this list as necessary to continuously maintain a working set of strategies for meeting the action level with the existing treatment processes.

      The Permittee may exclude any optimization strategy from the initial list created in S5.C.a.ii that was considered but found to exceed a reasonable implementation cost or timeframe. Documentation must include an explanation of the rationale and financial criteria used in the exclusion determination. If the Permittee finds no viable optimization strategies exist for their current treatment processes, they must immediately proceed to the identification of a corrective action under S5.D.

   c. *Initial Selection.* **As soon as possible and no later than July 1, 2022** select at least one optimization strategy for implementation.

      Document the expected performance (i.e., % TIN removal or a calculated reduction in effluent load or concentration) for the initial optimization strategy prior to implementation.

2. Optimization Implementation

   All Permittees in Table 8 must document implementation of the selected optimization strategy (from S5.C.1.c) during the first reporting period in the first Annual Report due March 31, 2023. Permittees must document implementation during every reporting period thereafter. The documentation must include:

   a. *Strategy Implementation.* Describe how the permittee implemented the selected strategy during each reporting period, following permit coverage. Including:

      i. Initial implementation costs

      ii. Length of time for full implementation, including start date.

iii. Any adaptive management applied to refine implementation during the reporting period.

iv. Anticipated and unanticipated challenges.

v. Any impacts to the overall treatment performance as a result of process changes.

b. *Discharge Evaluation.* By March 31 each year beginning in 2023, each Permittee in Table 8 must review effluent data collected during the previous calendar year to determine whether TIN loads are increasing.

i. Using all accredited monitoring data, determine facility's annual average TIN concentration and load from the reporting period. **If the annual TIN load exceeds the Action Level in Table 8 (or the applicable bubbled Action Level in Table 9) take the corrective actions in S5.D.**

ii. Determine the treatment plant's TIN removal rate observed during the reporting period.

3. Influent Nitrogen Reduction Measures/Source Control

Permittees in Table 8 must investigate opportunities to reduce influent TIN loads from septage handling practices, commercial, dense residential and industrial sources and submit documentation with the Annual Report. The investigation must:

a. Review non-residential sources of nitrogen and identify any possible pretreatment opportunities.

b. Identify potential strategies for reducing TIN from new multi-family/dense residential developments and commercial buildings.

D. ACTION LEVEL EXCEEDANCE CORRECTIVE ACTIONS

Permittees in Table 8 must evaluate whether or not they exceeded the facility specific action level or the bubbled action level (as applicable) and, if they did, implement corrective actions while continuing optimization.

1. If the Permittee determines in the Annual Report that they have exceeded their action level, they must:

a. Identify possible factors that caused the action level exceedance.

b. Identify whether modifications to the optimization strategy can improve performance.

c. Assess whether a different strategy or combination of strategies may provide better overall process improvements.

d. Document changes made to the optimization strategy, if any, while completing corrective action requirements.

i. Provide a detailed description of the modified or new optimization strategy selected from the list developed in S5.C.1.b. Include an implementation schedule for any changes and, as necessary, use the treatment process assessment developed to evaluate anticipated results.

ii. If the Permittee proposes no changes to the optimization strategy, they must provide reasons for not making changes.

2. With the next Annual Report, submit for review a proposed approach to reduce the annual effluent load below the action level listed in either Table 8 or Table 9 (as applicable for those jurisdictions) for the duration of the permit term. This must be an abbreviated engineering report or technical memo, unless Ecology has previously approved a design document with the proposed solution. The proposed approach must utilize solutions that can be implemented as soon as possible. This may include influent load reduction strategies identified in S5.C.3.

   The engineering document must include:

   i. Brief summary of the treatment alternatives considered and why the proposed approach was selected. Include cost estimates for operation and maintenance;

   ii. The basic design information, including influent characterization;

   iii. A description of the proposed treatment approach and operation, including updates to the WWTP's process flow diagram;

   iv. Anticipated results from the proposed approach including expected effluent quality;

   v. Certification by a licensed professional engineer.

b. If a Permittee exceeds an action level two years in a row, or for a third year during the permit term, the Permittee must begin to reduce nitrogen loads by implementing the proposed approach submitted per S5.D.2 following Ecology's written approval of the proposed approach and implementation schedule.

c. Submit an update to the Permittee's Operation and Maintenance Manual no later than 6 months following implementation.

E. NUTRIENT REDUCTION EVALUATION

1. Permittees in Table 8, except for those who meet the exclusions listed in this paragraph, must prepare and submit an approvable Nutrient Reduction Evaluation (NRE) to Ecology for review by December 31, 2025. Permittees with multiple plants may submit a combined report. This combined report must include an evaluation for all plants owned and operated by the jurisdiction. Permittees that maintain an annual TIN average of < 10 mg/L and meet their action level throughout the permit term must submit a truncated NRE that satisfies S5.E.3-S5.E.5. Permittees that meet their action level throughout the permit term, maintain an annual average of < 10 mg/L TIN and a seasonal average of < 3 mg/L do not have to submit the NRE.
2. The NRE must include an all known, available and reasonable treatment (***AKART***) analysis for purposes of evaluating reasonable treatment alternatives capable of reducing total inorganic nitrogen (TIN). It must present an alternative representing the greatest TIN reduction that is reasonably feasible on an annual basis.
3. In addition, the NRE must assess other site- specific main stream treatment plant upgrades, the applicability of side stream treatment opportunities, alternative effluent management options (e.g., disposal to ground, reclaimed water beneficial uses), the viability of satellite treatment, and other nutrient reduction opportunities that could achieve a final effluent concentration of 3 mg/L TIN (or equivalent load reduction) on seasonal average (April – October) basis.
4. The analysis must be sufficiently complete that an engineering report may be developed for the preferred AKART alternative as well as the preferred alternatives to reach 3 mg/L TIN seasonally, without substantial alterations of concept or basic considerations. The final report must contain appropriate requirements as described in the following guidance (or most recent version):
    a. The Criteria for Sewage Works Design (ECY Publication No. 98-37, 2019)[6]
    b. Reclaimed Water Facilities Manual: The Purple Book (ECY Publication No. 15-10-024, 2019)[7]
5. The analysis conducted for the NRE must include the following elements:
    a. Wastewater Characterization
        i. Current flowrates and growth trends within the sewer service area.
        ii. Current influent and effluent quality.
    b. Treatment Technology Analysis

[6] https://apps.ecology.wa.gov/publications/summarypages/9837.html
[7] https://apps.ecology.wa.gov/publications/SummaryPages/1510024.html

i. Description of current treatment processes, including any modifications made for optimization or due to corrective actions.

ii. Description of site limitations, constraints, or other treatment implementation challenges that exist.

iii. Identification and screening of potential treatment technologies for meeting two different levels of treatment:

1. AKART for nitrogen removal (annual basis), and

2. 3 mg/L TIN (or equivalent load), as a seasonal average (April through October)

c. Economic Evaluation

i. Develop capital, operation and maintenance costs and 20 year net present value using the real discount rate in the most current Appendix C to Office of Management and Budget Circular No. A-94[8] for each technology alternative evaluated.

ii. Provide cost per pound of nitrogen removed.

iii. Provide details on basis for current wastewater utility rate structure, including:

1. How utilities allocate and recover costs from customers.

2. How frequently rate structures are reviewed.

3. The last time rates were adjusted and the reason for that adjustment.

iv. Provide impact to current rate structure for each alternative assessed.

d. Environmental Justice (EJ) Review

i. Evaluate the demographics within the sewer service area to identify communities of color, Tribes, indigenous communities, and low income populations.

ii. Identify areas within service area that exceed the median household income.

iii. Include an affordability assessment to identify how much overburdened communities identified in S5.E.5.d.i can afford to pay for the wastewater utility.

iv. Propose alternative rate structures or measures that can be taken to prevent adverse effects of rate increases on populations with economic hardship identified in S5.E.5.d.i.

[8] https://www.whitehouse.gov/wp-content/uploads/2020/12/2020_Appendix-C.pdf

v. Provide information on how recreational and commercial opportunities may be improved for communities identified in S5.E.5.d.i as a result of the treatment improvements identified.

e. Selection of the most reasonable treatment alternative based on the AKART assessment; and the selected alternative for achieving an effluent concentration of 3 mg/L TIN (or equivalent load reduction) based on an April through October seasonal average.

f. Viable implementation timelines that include funding, design, and construction for meeting both the AKART and seasonal average 3 mg/L TIN preferred alternatives.

S6. NARRATIVE EFFLUENT LIMITS FOR WWTPS WITH SMALL TIN LOADS

A. APPLICABILITY AND NARRATIVE EFFLUENT LIMITS

Beginning on the effective date, each of the Permittees with small TIN loads listed in Table 11 may discharge total inorganic nitrogen from the WWTP through each facility's designated outfall. See Table 3 in Section S1.A for the load category assignment.

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. Each Permittee listed in Table 11 must comply with the narrative effluent limits listed in Table 10 which constitute the suite of BMPs required for a narrative water quality based effluent limit under 40 CFR 122.44(k).

Table 10.Narrative Effluent Limits for WWTPs with Small TIN Loads

Parameter	Narrative Effluent Limit
Monitoring	Monitor and report per the requirements in S7.C.
Nitrogen Optimization Plan	Submit one Optimization Report per the requirements in S6.B
AKART Analysis	Submit an AKART Analysis per the requirements in S6.C

Table 11.Permittees with Small TIN Loads

Wastewater Treatment Plant	Individual NPDES Permit Number	Outfall Number
Alderwood STP	WA0020826	001
Bainbridge Island WWTP	WA0020907	001
Boston Harbor STP	WA0040291	001
Clallam Bay STP	WA0024431	001
Clallam Bay Corrections Center STP	WA0039845	001
Coupeville STP	WA0029378	001
Eastsound Orcas Village WWTP	WA0030911	001
Eastsound Sewer and Water District WWTP	WA0030571	001
Fisherman Bay STP	WA0030589	001
Friday Harbor STP	WA0023582	001
Gig Harbor WWTP	WA0023957	001
Hartstene Pointe STP	WA0038377	001
King County Vashon WWTP	WA0022527	001
Kitsap County Kingston WWTP	WA0032077	001
Kitsap County Manchester WWTP	WA0023701	001
Kitsap County Sewer District #7 Water Reclamation Facility (WRF)	WA0030317	001
La Conner STP	WA0022446	001
Langley WWTP	WA0020702	001
McNeil Island Special Commitment Center WWTP	WA0040002	001
Mukilteo Water and Wastewater District WWTP	WA0023396	001
Oak Harbor STP	WA0020567	003
Penn Cove WWTP	WA0029386	001
Port Townsend STP	WA0037052	001
Rustlewood STP	WA0038075	001
Sekiu WWTP	WA0024449	001
Sequim WRF	WA0022349	001
Shelton WWTP	WA0023345	001

Wastewater Treatment Plant	Individual NPDES Permit Number	Outfall Number
Skagit County Sewer District 2 Big Lake WWTP	WA0030597	001
Stanwood STP	WA0020290	001
Tamoshan STP	WA0037290	001
WA Parks Larrabee WWTP	WA0023787	001

B. NITROGEN OPTIMIZATION PLAN AND REPORT

Each Permittee listed in Table 11 must develop, implement, and maintain a Nitrogen Optimization Plan to evaluate and implement operational strategies for maximizing nitrogen removal from the existing treatment plant during the permit term. Permittees must document their actions taken and apply an adaptive management approach at the WWTP. Permittees will quantify results with required monitoring under this Permit.

The Permittee must begin the actions described in this section immediately upon permit coverage. Documentation of Nitrogen Optimization Plan implementation must be submitted through the Single Report (S9- Reporting Requirements). See Appendix E for report questions that satisfy the Nitrogen Optimization Plan requirements. This report must be submitted by March 31, 2026.

The Nitrogen Optimization Plan submitted by each Permittee in Table 11 must include the following components:

1. Treatment Process Performance Assessment

   Each Permittee listed in Table 11 must assess the nitrogen removal potential of the current treatment process and have the ability to evaluate optimization strategies prior to implementation.

   a. *Evaluation.* Each Permittee in Table 11 must develop a treatment process assessment method for purposes of evaluating optimization approaches during the permit term.

      i. Evaluate current (pre-optimization) process performance. Determine the empirical TIN removal rate for the WWTP.

      ii. Develop an initial assessment approach to evaluate possible optimization strategies at the WWTP prior to and after implementation.

      iii. Determine the optimization goal for the WWTP. Develop and document a prioritized list of optimization strategies capable of achieving the optimization goal for each WWTP owned and operated by the Permittee. Update this list as necessary to continuously maintain a selection of strategies for achieving each optimization goal identified.

iv. The Permittee may exclude from the initial selection any optimization strategy considered but found to exceed a reasonable implementation cost or timeframe. Documentation must include an explanation of the rationale and financial criteria used for the exclusion determination.

b. *Initial Selection.* **By December 31, 2022** identify the optimization strategy selected for implementation.

   Document the expected % TIN removal (or the expected reduction in effluent load) for the optimization strategy prior to implementation.

2. Optimization Implementation

   Permittees in Table 11 must document implementation of the selected optimization strategy (from S6.B.1.b) as it is applied to the existing treatment process during the reporting period. Permittees must document adaptive management applied to optimization strategies following initial implementation through the permit term.

   a. *Strategy Implementation.* Describe how the selected strategy was implemented during the reporting period, following permit coverage. Including:

      i. Initial implementation costs.

      ii. Length of time for full implementation, including start date.

      iii. Anticipated and unanticipated challenges.

      iv. Any impacts to the overall treatment performance as a result of process changes.

   b. *Load Evaluation.* Each Permittee listed in Table 11 must review effluent data collected during the reporting period to determine whether TIN loads are increasing.

      i. Using all accredited monitoring data, determine the facility's annual average TIN concentration and load for each year during the reporting period.

      ii. Determine the treatment plant's TIN removal rate at the end of each year. Compare the removal rate with the pre-optimization rate identified in S6.B.1.a.i.

   c. *Strategy Assessment.* Quantify the results of the implemented strategy and compare to the performance metric identified in S6.B.1.b.

      If the TIN loading increased, apply adaptive management, re-evaluate the optimization strategies and the resulting performance to identify the reason. Select a new optimization strategy for implementation and/or revise implementation for better performance. Document any updates to the implementation schedule and overall plan.

3. Influent Nitrogen Reduction Measures/Source Control

   Permittees in Table 11 must investigate opportunities to reduce influent TIN loads from septage handling practices, commercial, dense residential and industrial sources and submit documentation with the Annual Report. The investigation must:

   a. Review non-residential sources of nitrogen and identify any possible pretreatment opportunities.

   b. Identify strategies for reducing TIN from new multi-family/dense residential developments and commercial buildings.

C. AKART ANALYSIS

1. Permittees in Table 11, except for those who meet the exclusions listed in this paragraph, must prepare and submit an approvable all known, available and reasonable treatment (AKART) analysis to Ecology for purposes of evaluating reasonable treatment alternatives capable of reducing total inorganic nitrogen (TIN). Permittees must submit this report by December 31, 2025. Permittees that maintain an annual TIN average of < 10 mg/L and do not document an increase in load through their DMRs do not have to submit this analysis.

2. The analysis must contain appropriate requirements as described in the following guidance (or the most recent version):

   a. The Criteria for Sewage Works Design (ECY Publication No. 98-37, 2019)[9]

   b. Reclaimed Water Facilities Manual: The Purple Book (ECY Publication No. 15-10-024, 2019)[10]

3. The AKART analysis must include the following elements:

   a. Wastewater Characterization

      i. Current volumes, flowrates and growth trends

      ii. Current influent and effluent quality

   b. Treatment Technology Analysis

      i. Description of current treatment processes

      ii. Identification and screening of potential treatment technologies for TIN reduction that achieves AKART for nitrogen removal

   c. Economic Evaluation

[9] https://apps.ecology.wa.gov/publications/documents/9837.pdf

[10] https://apps.ecology.wa.gov/publications/SummaryPages/1510024.html

i. Develop capital, operation and maintenance costs and 20 year net present value using the real discount rate in the most current Appendix C to Office of Management and Budget Circular No. A-94[11] for each technology alternative evaluated.

ii. Provide cost per pound of nitrogen removed

iii. Provide details on basis for current wastewater utility rate structure, including:

1. How utilities allocate and recover costs from customers.

2. How frequently rate structures are reviewed.

3. The last time rates were adjusted and the reason for that adjustment.

iv. Provide impact to current rate structure for each alternative assessed.

d. Environmental Justice (EJ) Review

i. Evaluate the demographics within the sewer service area to identify communities of color, Tribes, indigenous communities, and low income populations.

ii. Identify areas within the service area that exceed the median household income.

iii. Include an affordability assessment to identify how much overburdened communities identified in S6.C.3.d.i can afford to pay for the wastewater utility.

iv. Propose alternative rate structures or measures that can be taken to prevent adverse effects of rate increases on populations with economic hardship identified in S6.C.3.d.i.

v. Provide information on how recreation and commercial opportunities may be improved for communities identified in S6.C.3.d.i as a result of the treatment improvements identified.

e. Selection of most reasonable treatment alternative.

f. Attainable implementation schedule that includes funding, design and construction of infrastructure improvement capable of achieving and maintaining AKART.

[11] https://www.whitehouse.gov/wp-content/uploads/2020/12/2020_Appendix-C.pdf

S7. MONTORING SCHEDULES AND SAMPLING REQUIREMENTS

A. MONITORING REQUIREMENTS FOR DOMINANT LOADERS

Each permittee listed in Table 5 must monitor influent and effluent in accordance with the following schedule and requirements specified in Table 12 and 13, respectively. Influent and effluent monitoring locations must be representative. Permittees may use the monitoring locations identified in their individual NPDES permit. If a Permittee conducts additional sampling of required parameters during the month, they must report all results on the monthly DMR.

Table 12. Influent Sampling Requirements for Dominant Loaders

Wastewater influent means the raw sewage flow from the collection system into the treatment facility. Sample the wastewater entering the headworks of the treatment plant excluding any side-stream returns from inside the plant, if possible.

The Permittee must collect total ammonia, nitrate plus nitrite, and TKN samples during the same sampling event.

Parameter	Units & Specifications	Minimum Sampling or Calculation Frequency	Analytical Method [k]	Laboratory Quantitation Level [l]	Sample Type
$CBOD_5$	mg/L	2/week [b]	SM5210-B	2 mg/L	24-hour composite [e]
Total Ammonia	mg/L as N	2/week [b]	SM4500-NH_3-B/C/D/E/F/G/H	0.02 mg/L	24-hour composite [e]
Nitrate plus Nitrite Nitrogen	mg/L as N	1/month [c]	SM4500-NO_3-E/F/H	0.1 mg/L	24-hour composite [e]
Total Kjeldahl Nitrogen (TKN)	mg/L as N	1/month [c]	SM4500-N_{org}-B/C and SM4500-NH_3-B/C/D/E/F/G/H	0.3 mg/L	24-hour composite [e]

Table 13. Effluent Sampling Requirements for Dominant Loaders

Final wastewater effluent means wastewater exiting the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process. The total ammonia, TKN, and nitrate plus nitrite samples must be taken during the same sampling event.

Parameter	Units & Specifications	Minimum Sampling or Calculation Frequency	Analytical Method [k]	Laboratory Quantitation Level [l]	Sample Type
Flow [f]	MGD	2/week [b]	--	--	Metered/ recorded
$CBOD_5$ [a]	mg/L	2/week [b]	SM5210-B	2 mg/L	24-hour composite [e]
Total Organic Carbon	mg/L	1/quarter [d]	SM5310-B/C/D	1 mg/L	24-hour composite [e]
Total Ammonia	mg/L as N	2/week [b]	SM4500-NH_3-B/C/D/E/F/G/H	0.02 mg/L	24-hour composite [e]
Nitrate plus Nitrite Nitrogen	mg/L as N	2/week [b]	SM4500-NO_3-E/F/H	0.1 mg/L	24-hour composite [e]
TKN	mg/L as N	1/month [c]	SM4500-N_{org}-B/C and SM4500-NH_3-B/C/D/E/F/G/H	0.3 mg/L	24-hour composite [e]
Total Inorganic Nitrogen	mg/L as N	2/week [b]	--	--	Calculated [g]
Total Inorganic Nitrogen	Lbs/day	2/week [b]	--	--	Calculated [h]
Average Monthly Total Inorganic Nitrogen	Lbs	1/month [c]	--	--	Calculated [i]
Annual Total Inorganic Nitrogen, year to date	Lbs	1/month [c]	--	--	Calculated [j]

Table 14. Footnotes for Influent and Effluent Monitoring Tables 12 and 13

Footnote	Information
a	Take effluent samples for the $CBOD_5$ analysis before or after the disinfection process. If taken after disinfection and chlorine is used, dechlorinate and reseed the sample.
b	2/*week* means two (2) times during each week
c	1/month means one (1) time during each month
d	Quarterly sampling periods are January through March, April through June, July through September, and October through December. The Permittee must begin quarterly monitoring for the quarter beginning on 1/1/22 4/1/22 7/1/22 10/1/22 and submit results by 4/15/22, 7/15/22, 10/15/22, 1/15/22.
e	24-hour *composite* means a series of individual samples collected over a 24-hour period into a single container, and analyzed as one sample.
f	Report daily flows only on days when collecting total ammonia and nitrate plus nitrite samples.
g	TIN (mg/L) as N = Total Ammonia (mg/L as N) + Nitrate plus Nitrite (mg/L as N)
h	Calculate mass concurrently with the respective concentration of a sample, using the following formula: Concentration (in mg/L) X daily flow (in MGD) X Conversion Factor (8.34) = lbs/day
i	Calculate the monthly average total inorganic nitrogen load (lbs as N) using the following equation: $\text{Monthly average TIN load (lbs as N)} = ((\sum \text{Calculated TIN loads } (\frac{\text{lbs}}{\text{day}} as\ N)) / number\ of\ samples) \text{ x number of days in the calendar month}$
j	Calculate the annual total inorganic nitrogen, year to date using the following calculation: $\text{Annual TIN load (lbs as N)} = \sum \text{Monthly average TIN loads, to date}$
k	Or other equivalent EPA-approved method with the same or lower quantitation level
l	The Permittee must ensure laboratory results comply with the quantitation level (QL) specified in the table. However, if an alternative method from 40 CFR Part 136 is sufficient to produce measurable results in the sample, the Permittee may use that method for analysis. If the Permittee uses an alternative method it must report the test method and QL on the discharge monitoring report. If the permittee is unable to obtain the required QL due to matrix effects, the Permittee must report the matrix-specific method detection level (MDL) and QL on the DMR. The permittee must also upload the QA/QC documentation from the lab on the QL development.

B. MONITORING REQUIREMENTS FOR MODERATE LOADERS

Each permittee listed in Table 8 must monitor influent and effluent in accordance with the following schedule and requirements specified in Table 15 and 16, respectively. Influent and effluent monitoring locations must be representative. Permittees may use the monitoring locations identified in their individual NPDES permit. If a Permittee conducts additional sampling of required parameters during the month, they must report all results on the monthly DMR.

Table 15. Influent Sampling Requirements for Moderate Loaders

Wastewater influent means the raw sewage flow from the collection system into the treatment facility. Sample the wastewater entering the headworks of the treatment plant excluding any side-stream returns from inside the plant, if possible.

The Permittee must collect total ammonia, nitrate plus nitrite, and TKN samples during the same sampling event.

Parameter	Units & Specifications	Minimum Sampling or Calculation Frequency	Analytical Method [k]	Laboratory Quantitation Level [l]	Sample Type
$CBOD_5$	mg/L	1/week [b]	SM5210-B	2 mg/L	24-hour composite [e]
Total Ammonia	mg/L as N	1/week [b]	SM4500-NH_3-B/C/D/E/F/G/H	0.02 mg/L	24-hour composite [e]
Nitrate plus Nitrite Nitrogen	mg/L as N	1/month [c]	SM4500-NO_3-E/F/H	0.1 mg/L	24-hour composite [e]
Total Kjeldahl Nitrogen (TKN)	mg/L as N	1/month [c]	SM4500-N_{org}-B/C and SM4500-NH_3-B/C/D/E/F/G/H	0.3 mg/L	24-hour composite [e]

Table 16. Effluent Sampling Requirements for Moderate Loaders

Final wastewater effluent means wastewater exiting the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process. The total ammonia, TKN, and nitrate plus nitrite samples must be taken during the same sampling event.

Parameter	Units & Specifications	Minimum Sampling or Calculation Frequency	Analytical Method [k]	Laboratory Quantitation Level [l]	Sample Type
Flow [f]	MGD	1/week [b]	--	--	Metered/ recorded
$CBOD_5$ [a]	mg/L	1/week [b]	SM5210-B	2 mg/L	24-hour composite [e]
Total Organic Carbon	mg/L	1/quarter [c]	SM5310-B/C/D	1 mg/L	24-hour composite [e]
Total Ammonia	mg/L as N	1/week [b]	SM4500-NH_3-B/C/D/E/F/G/H	0.02 mg/L	24-hour composite [e]
Nitrate plus Nitrite Nitrogen	mg/L as N	1/week [b]	SM4500-NO_3-E/F/H	0.1 mg/L	24-hour composite [e]
TKN	mg/L as N	1/month [c]	SM4500-N_{org}-B/C and SM4500-NH_3-B/C/D/E/F/G/H	0.3 mg/L	24-hour composite [e]
Total Inorganic Nitrogen	mg/L as N	1/week [b]	--	--	Calculated [g]
Total Inorganic Nitrogen	Lbs/day	1/week [b]	--	--	Calculated [h]
Average Monthly Total Inorganic Nitrogen	Lbs	1/month [c]	--	--	Calculated [i]
Annual Total Inorganic Nitrogen, year to date	Lbs	1/month [c]	--	--	Calculated [j]

Table 17. Footnotes for Influent and Effluent Monitoring Tables 15 and 16

Footnote	Information
a	Take effluent samples for the $CBOD_5$ analysis before or after the disinfection process. If taken after disinfection and chlorine is used, dechlorinate and reseed the sample.
b	1/*week* means one (1) times during each week
c	1/month means one (1) time during each month
d	Quarterly sampling periods are January through March, April through June, July through September, and October through December. The Permittee must begin quarterly monitoring for the quarter beginning on 1/1/22 4/1/22 7/1/22 10/1/22 and submit results by 4/15/22, 7/15/22, 10/15/22, 1/15/22.
e	24-hour *composite* means a series of individual samples collected over a 24-hour period into a single container, and analyzed as one sample.
f	Report daily flows only on days when collecting total ammonia and nitrate plus nitrite samples.
g	TIN (mg/L) as N = Total Ammonia (mg/L as N) + Nitrate plus Nitrite (mg/L as N)
h	Calculate mass concurrently with the respective concentration of a sample, using the following formula: Concentration (in mg/L) X daily flow (in MGD) X Conversion Factor (8.34) = lbs/day
i	Calculate the monthly average total inorganic nitrogen load (lbs as N) using the following equation: $\text{Monthly average TIN load (lbs as N)} = ((\sum \text{Calculated TIN loads } (\frac{\text{lbs}}{\text{day}} as\ N)) / number\ of\ samples) \text{ x number of days in the calendar month}$
j	Calculate the annual total inorganic nitrogen, year to date using the following calculation: $\text{Annual TIN load (lbs as N)} = \sum \text{Monthly average TIN loads, to date}$
k	Or other equivalent EPA-approved method with the same or lower quantitation level
l	The Permittee must ensure laboratory results comply with the quantitation level (QL) specified in the table. However, if an alternative method from 40 CFR Part 136 is sufficient to produce measurable results in the sample, the Permittee may use that method for analysis. If the Permittee uses an alternative method it must report the test method and QL on the discharge monitoring report. If the permittee is unable to obtain the required QL due to matrix effects, the Permittee must report the matrix-specific method detection level (MDL) and QL on the DMR. The permittee must also upload the QA/QC documentation from the lab on the QL development.

C. MONITORING REQUIREMENTS FOR SMALL LOADERS

Each permittee listed in Table 11 must monitor influent and effluent in accordance with the following schedule and requirements specified in Table 18 and 19, respectively. Influent and effluent monitoring locations must be representative. Permittees may use the monitoring locations identified in their individual NPDES permit. If a Permittee conducts additional sampling of required parameters during the month, they must report all results on the monthly DMR.

Table 18. Influent Sampling Requirements for Small Loaders

Wastewater influent means the raw sewage flow from the collection system into the treatment facility. Sample the wastewater entering the headworks of the treatment plant excluding any side-stream returns from inside the plant, if possible.

The Permittee must collect total ammonia, nitrate plus nitrite, and TKN samples during the same sampling event.

Parameter	Units & Specifications	Minimum Sampling or Calculation Frequency	Analytical Method [j]	Laboratory Quantitation Level [k]	Sample Type
$CBOD_5$	mg/L	2/month [c]	SM5210-B	2 mg/L	24-hour composite [e]
Total Ammonia	mg/L as N	2/month [c]	SM4500-NH_3-B/C/D/E/F/G/H	0.02 mg/L	24-hour composite [e]
Nitrate plus Nitrite Nitrogen	mg/L as N	1/month [b]	SM4500-NO_3-E/F/H	0.1 mg/L	24-hour composite [e]
Total Kjeldahl Nitrogen (TKN)	mg/L as N	1/month [b]	SM4500-N_{org}-B/C and SM4500-NH_3-B/C/D/E/F/G/H	0.3 mg/L	24-hour composite [e]

Table 19. Effluent Sampling Requirements for Small Loaders

Final wastewater effluent means wastewater exiting the last treatment process or operation. Typically, this is after or at the exit from the chlorine contact chamber or other disinfection process. The total ammonia, TKN, and nitrate plus nitrite samples must be taken during the same sampling event.

Parameter	Units & Specifications	Minimum Sampling or Calculation Frequency	Analytical Method [k]	Laboratory Quantitation Level [l]	Sample Type
Flow [f]	MGD	2/month [c]	--	--	Metered/ recorded
$CBOD_5$ [a]	mg/L	2/month [c]	SM5210-B	2 mg/L	24-hour composite [e]
Total Organic Carbon	mg/L	1/quarter [d]	SM5310-B/C/D	1 mg/L	24-hour composite [e]
Total Ammonia	mg/L as N	2/month [c]	SM4500-NH_3-B/C/D/E/F/G/H	0.02 mg/L	24-hour composite [e]
Nitrate plus Nitrite Nitrogen	mg/L as N	2/month [c]	SM4500-NO_3-E/F/H	0.1 mg/L	24-hour composite [e]
TKN	mg/L as N	1/month [b]	SM4500-N_{org}-B/C and SM4500-NH_3-B/C/D/E/F/G/H	0.3 mg/L	24-hour composite [e]
Total Inorganic Nitrogen	mg/L as N	2/month [c]	--	--	Calculated [g]
Total Inorganic Nitrogen	Lbs/day	2/month [c]	--	--	Calculated [h]
Average Monthly Total Inorganic Nitrogen	Lbs	1/month [b]	--	--	Calculated [i]
Annual Total Inorganic Nitrogen, year to date	Lbs	1/month [b]	--	--	Calculated [j]

Table 20. Footnotes for Influent and Effluent Monitoring Tables 18 and 19

Footnote	Information
a	Take effluent samples for the $CBOD_5$ analysis before or after the disinfection process. If taken after disinfection and chlorine is used, dechlorinate and reseed the sample.
b	1/month means one (1) time during each month
c	2/month means two (2) times during each month and on a rotational basis throughout the days of the week, except weekends and holidays.
d	Quarterly sampling periods are January through March, April through June, July through September, and October through December. The Permittee must begin quarterly monitoring for the quarter beginning on 1/1/22 4/1/22 7/1/22 10/1/22 and submit results by 4/15/22, 7/15/22, 10/15/22, 1/15/22.
e	24-hour composite means a series of individual samples collected over a 24-hour period into a single container, and analyzed as one sample.
f	Report daily flows only on days when collecting total ammonia and nitrate plus nitrite samples.
g	TIN (mg/L) as N = Total Ammonia (mg/L as N) + Nitrate plus Nitrite (mg/L as N)
h	Calculate mass concurrently with the respective concentration of a sample, using the following formula: Concentration (in mg/L) X daily flow (in MGD) X Conversion Factor (8.34) = lbs/day
i	Calculate the monthly average total inorganic nitrogen load (lbs as N) using the following equation: $\text{Monthly average TIN load (lbs as N)} = ((\sum \text{Calculated TIN loads } (\frac{\text{lbs}}{\text{day}} as\ N)) / number\ of\ samples) \text{ x number of days in the calendar month}$
j	Calculate the annual total inorganic nitrogen, year to date using the following calculation: $\text{Annual TIN load (lbs as N)} = \sum \text{Monthly average TIN loads, to date}$
k	Or other equivalent EPA-approved method with the same or lower quantitation level
l	The Permittee must ensure laboratory results comply with the quantitation level (QL) specified in the table. However, if an alternative method from 40 CFR Part 136 is sufficient to produce measurable results in the sample, the Permittee may use that method for analysis. If the Permittee uses an alternative method it must report the test method and QL on the discharge monitoring report. If the permittee is unable to obtain the required QL due to matrix effects, the Permittee must report the matrix-specific method detection level (MDL) and QL on the DMR. The permittee must also upload the QA/QC documentation from the lab on the QL development.

D. SAMPLING AND ANALYTICAL PROCEDURES

Samples and measurements taken to meet the requirements of this permit must represent the volume and nature of the monitored parameters, including ***representative sampling*** of any unusual discharge or discharge condition, including authorized ***bypasses***, upsets, and maintenance-related conditions affecting effluent quality.

Sampling and analytical methods used to meet the monitoring requirements specified in this permit must conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants*[12] contained in 40 CFR 136[13] (or as applicable in 40 CFR subchapter N[14] [Parts 400-471] or 40 CFR subchapter O[15] [Parts 501-503]) unless otherwise specified in this permit.

E. FLOW MEASUREMENT

The Permittee must:

1. Select and use appropriate flow measurement and method consistent with accepted scientific practices.
2. Install, calibrate, and maintain these devices to ensure the accuracy of the measurements is consistent with the accepted industry standard, the manufacture's recommendation, and approved O&M manual procedures for the device and the wastestream.
3. Establish a calibration frequency for each device or instrument in the Permittee's O&M Manual that conforms to the frequency recommended by the manufacturer.
4. Maintain calibration records for at least three years.

F. LABORATORY ACCREDITATION

1. The Permittee must ensure that all monitoring data required by Ecology for permit specified parameters is prepared by a laboratory registered or accredited under the provisions of chapter 173-50 WAC, *Accreditation of Environmental Laboratories.* Flow and internal process control parameters are exempt from this requirement.

G. REQUEST FOR REDUCTION IN MONITORING

1. The Permittee may request a reduction of the sampling frequency after twelve (12) months of monitoring by demonstrating that the distribution of

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[12] https://www.ecfr.gov/cgi-bin/text-idx?SID=0e534d17f9783994a26ffee684d260c2&mc=true&node=pt40.25.136&rgn=div5

[13] https://www.ecfr.gov/cgi-bin/text-idx?SID=0e534d17f9783994a26ffee684d260c2&mc=true&node=pt40.25.136&rgn=div5

[14] https://www.ecfr.gov/cgi-bin/text-idx?SID=0e534d17f9783994a26ffee684d260c2&mc=true&tpl=/ecfrbrowse/Title40/40CIsubchapN.tpl

[15] https://www.ecfr.gov/cgi-bin/text-idx?SID=0e534d17f9783994a26ffee684d260c2&mc=true&tpl=/ecfrbrowse/Title40/40CIsubchapO.tpl

concentrations can be accurately represented with a lower sampling frequency. Ecology will review each request and at its discretion grant the request in writing when it reissues the permit coverage or by a permit coverage modification.

2. The Permittee must:

   a. Provide a written request.

   b. Clearly state the parameters for which it is requesting reduced monitoring.

   c. Clearly state the justification for the reduction.

S8. DISCHARGES TO 303(D) OR TMDL WATER BODIES

If EPA approves an applicable ***Total Maximum Daily Load*** (TMDL) that includes wasteload allocations for WWTPs owned and operated by the Permittee Ecology will address any permit requirements related to the approved TMDL in the Permittee's individual permit or through a modification of this permit.

S9. REPORTING AND RECORDKEEPING REQUIREMENTS

A. DISCHARGE MONITORING REPORTS

Permittees required to conduct ***water quality*** sampling in accordance with Special Conditions S7, and/or G12 (Additional Monitoring) must submit the results to Ecology. Permittees must submit the monthly DMR by the 15th day of the following month.

Permittees must submit monitoring data using Ecology's WQWebDMR program.

B. MONITORING REQUIREMENTS

1. Wastewater Sampling Frequency
    a. The Permittee must sample both the influent and effluent discharge location at the frequencies listed in Condition S7.A, S7.B and S7.C.
    b. Samples must be representative of the flow and characteristics of the discharge.
    c. Sampling is not required outside of normal working hours or during unsafe conditions.
2. Wastewater Sampling Locations

    Influent and effluent sampling locations must be representative. Permittees may use the compliance monitoring locations in their individual NPDES permit, prior to entry into waters of the state.
3. Wastewater Sampling Documentation

    For each sample taken, the Permittee must record and retain the following information:
    a. Sample date and time
    b. Sample location
    c. Method of sampling, and method of sample preservation, if applicable
    d. Individual who performed the sampling
4. Where wastewater monitoring requirements under this Permit mirror requirements in a Permittee's individual permit, the same result may be applied to both permits.
5. Additional Monitoring by the Permittee

    If the Permittee monitors any ***pollutant*** more frequently than required by this permit using test procedures specified by Condition S7, the Permittee must include the results of the extra monitoring in the calculation and reporting of the data submitted in the Permittee's DMR.

C. ANNUAL REPORT FOR DOMINANT LOADERS

1. No later than March 31 of each year, each Permittee listed in Table 5 must submit an Annual Report documenting optimization and the adaptive management used at their WWTP. The Permittee must submit their first annual report by March 31, 2023 for the reporting period that begins on January 1, 2022 and lasts through December 31, 2022. All subsequent Annual Reports must use the reporting period of the previous calendar year unless otherwise specified.
2. Permittees must submit Annual reports electronically using Ecology's Water Quality Permitting Portal (WQWebPortal) available on Ecology's website, unless otherwise directed by Ecology.
3. The Annual Report documenting the Nutrient Optimization Plan for Permittees listed in Table 5 must include the following:
    a. Submittal of the Annual Report form as provided by Ecology pursuant to S4.C, describing the status of the requirements of this Permit during the reporting period.
    b. Attachments to the Annual Report including summaries, descriptions, reports and other information as required, or as applicable, to meet the requirements of this Permit during the reporting period, or as a required submittal. Refer to Appendix C for Annual Report questions.
    c. Certification and signature pursuant to G2.D and notification of any changes to authorization pursuant to G2.C.

D. ANNUAL REPORT FOR MODERATE LOADERS

1. No later than March 31 of each year, each Permittee listed in Table 8 must submit an Annual Report documenting optimization and the adaptive management used at their WWTP. The Permittee must submit their first annual report by March 31, 2023 for the reporting period that begins on January 1, 2022 and lasts through December 31, 2022. All subsequent Annual Reports must use the reporting period of the previous calendar year unless otherwise specified.
2. Permittees must submit Annual reports electronically using Ecology's Water Quality Permitting Portal (WQWebPortal) available on Ecology's website, unless otherwise directed by Ecology.
3. The Annual Report documenting the Nutrient Optimization Plan for Permittees listed in Table 8 must include the following:
    a. Submittal of the Annual Report form as provided by Ecology pursuant to S5.C, describing the status of the requirements of this Permit during the reporting period.
    b. Attachments to the Annual Report including summaries, descriptions, reports and other information as required, or as applicable, to meet the requirements of this Permit during the reporting period, or as a required submittal. Refer to Appendix D for Annual Report questions.

c. Certification and signature pursuant to G2.D and notification of any changes to authorization pursuant to G2.C.

E. REPORTING FOR SMALL LOADERS

1. No later than March 31, 2026 each Permittee listed in Table 11 must submit an Optimization Report documenting optimization and the adaptive management used at their WWTP. The reporting period for this report will be from January 1, 2022 through December 31, 2025.
2. Permittees must submit the Nitrogen Optimization Report electronically using Ecology's Water Quality Permitting Portal (WQWebPortal) available on Ecology's website, unless otherwise directed by Ecology.
3. The electronic report documenting the optimization for Permittees listed in Table 11 must include the following:
   a. Submittal of the Optimization Report form as provided by Ecology pursuant to S6.B, describing the status of the requirements of this Permit during the reporting period.
   b. Attachments to the Optimization Report including summaries, descriptions, reports and other information as required, or as applicable, to meet the requirements of this Permit during the reporting period, or as a required submittal. Refer to Appendix E for Optimization Report questions.
   c. Certification and signature pursuant to G2.D and notification of any changes to authorization pursuant to G2.C.

F. RECORDS RETENTION

The Permittee must retain records of all monitoring information (field notes, sampling results, etc.), optimization documents submitted with the annual or one-time report, and any other documentation of compliance with permit requirements for a minimum of five years following the termination of permit coverage. Such information must include all calibration and maintenance records, and records of all data used to complete the application for this permit. This period of retention must be extended during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

G. NONCOMPLIANCE NOTIFICATION

In the event the Permittee is unable to comply with any of the terms and conditions of this permit which may cause a threat to human health or the environment, including threats resulting from unanticipated ***bypass*** or upset, or does not comply with the narrative effluent requirements, the Permittee must:

1. Immediately, in no case more than 24 hours of becoming aware of the circumstances, notify Ecology of the failure to comply by calling the applicable regional office phone number (find at Ecology' Report a Spill webpage[16]).
2. Immediately take action to prevent the discharge/***pollution***, or otherwise stop or correct the noncompliance.
3. Submit a written report to Ecology using the WQWebPortal within five (5) days of the time the Permittee becomes aware of a reportable event. The report must contain:
   a. A description of the noncompliance and its cause
   b. The period of noncompliance including exact dates and times
   c. If the noncompliance has not been corrected, the anticipated time it is expected to continue
   d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance

Ecology may waive the written report on a case-by-case basis upon request if the Permittee has submitted a timely oral report.

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply. Refer to Section G13 of this permit for specific information regarding non-compliance.

H. ACCESS TO PLANS AND RECORDS

1. The Permittee must retain the following permit documentation (reports and monitoring records) on site, or within reasonable access to the site, for use by the operator or for on-site review by Ecology:
   a. Permit Coverage Letter
   b. Puget Sound Nutrient General Permit
   c. Discharge Monitoring Reports
   d. Attachments to the Annual or Single Report as required in the Nitrogen Optimization Plan (NOP)
   e. Nutrient Reduction Evaluation for Permittees listed in Tables 5 and 8 or AKART Analysis for Permittees listed in Table 11

S10. PERMIT FEES

The Permittee must pay permit fees assessed by Ecology. Fees for wastewater discharges covered under this permit are established by Chapter 173-224 WAC.

[16] https://ecology.wa.gov/About-us/Get-involved/Report-an-environmental-issue/Report-a-spill

GENERAL CONDITIONS

G1. DISCHARGE VIOLATIONS

All discharges and activities authorized by this general permit must be consistent with the terms and conditions of this general permit. Failure to follow the corrective action requirement after discharge of TIN at a level that exceeds the action level identified and authorized by the general permit constitutes a violation of the terms and conditions of this permit.

G2. SIGNATORY REQUIREMENTS

A. All permit applications must bear a certification of correctness to be signed:

1. In the case of corporations, by a responsible corporate officer;
2. In the case of a partnership, by a general partner of a partnership;
3. In the case of sole proprietorship, by the proprietor; or
4. In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official.

B. All reports required by this permit and other information requested by Ecology must be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

1. The authorization is made in writing by a person described above and submitted to Ecology.
2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters.

C. Changes to authorization. If an authorization under paragraph G2.B.2 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph G2.B.2 above must be submitted to Ecology prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section must make the following certification:

E. “I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.”

G3. RIGHT OF INSPECTION AND ENTRY

The Permittee must allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records are kept under the terms and conditions of this permit.

B. To have access to and copy – at reasonable times and at reasonable cost -- any records required to be kept under the terms and conditions of this permit.

C. To inspect – at reasonable times – any facilities, equipment (including monitoring and control equipment), practices, methods, or operations regulated or required under this permit.

D. To sample or monitor – at reasonable times – any substances or parameters at any location for purposes of assuring permit compliance or as otherwise authorized by the ***Clean Water Act***.

G4. GENERAL PERMIT MODIFICATION AND REVOCATION

This permit may be modified, revoked and reissued, or terminated in accordance with the provisions of Chapter 173-226 WAC. Grounds for modification, revocation and reissuance, or termination include, but are not limited to, the following:

A. When a change occurs in the technology or practices for control or abatement of pollutants applicable to the category of dischargers covered under this permit.

B. When effluent limitation guidelines or standards are promulgated pursuant to the CWA or Chapter 90.48 RCW, for the category of dischargers covered under this permit.

C. When a water quality management plan containing requirements applicable to the category of dischargers covered under this permit is approved, or

D. When information is obtained that indicates cumulative effects on the environment from dischargers covered under this permit are unacceptable.

G5. REVOCATION OF COVERAGE UNDER THE PERMIT

Pursuant to Chapter 43.21B RCW and Chapter 173-226 WAC, the ***Director*** may terminate coverage for any discharger under this permit for cause. Cases where coverage may be terminated include, but are not limited to, the following:

A. Violation of any term or condition of this permit.

B. Obtaining coverage under this permit by misrepresentation or failure to disclose fully all relevant facts.

C. A change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge.

D. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090.

E. A determination that the permitted activity endangers human health or the environment, or contributes to water quality standards violations.

F. Nonpayment of permit fees or penalties assessed pursuant to RCW 90.48.465 and Chapter 173-224 WAC.

G. Failure of the Permittee to satisfy the public notice requirements of WAC 173-226-130(5), when applicable.

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in this permit will be construed as excusing the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. DUTY TO REAPPLY

The Permittee must apply for permit renewal at least 180 days prior to the specified expiration date of this permit.

G8. TRANSFER OF GENERAL PERMIT COVERAGE

In the event of any change in control or ownership of facilities from which the authorized discharge emanate, the Permittee must follow the procedures listed in their individual NPDES permit when notifying Ecology.

G9. REMOVED SUBSTANCES

The Permittee must not re-suspend or reintroduce collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewater to the final effluent stream for discharge to state waters.

G10. DUTY TO PROVIDE INFORMATION

The Permittee must submit to Ecology, within a reasonable time, all information that Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also submit to Ecology, upon request, copies of records required to be kept by this permit [40 CFR 122.41(h)].

G11. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G12. ADDITIONAL MONITORING

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G13. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars ($10,000) and costs of prosecution, and/or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit shall incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars ($10,000) for every such violation. Each and every such violation shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance shall be deemed to be a separate and distinct violation.

G14. PROPERTY RIGHTS

This permit does not convey any property rights of any sort, or any exclusive privilege.

G15. DUTY TO COMPLY

The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

G16. TOXIC POLLUTANTS

The Permittee must comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G17. PENALTIES FOR TAMPERING

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this condition, punishment shall be a fine of not more than $20,000 per day of violation, or imprisonment of not more than four (4) years, or both.

G18. REPORTING PLANNED CHANGES

Report planned changes in a manner consistent with the individual permit.

G19. REPORTING OTHER INFORMATION

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to Ecology, it must promptly submit such facts or information.

G20. REPORTING ANTICIPATED NON-COMPLIANCE

The Permittee must give advance notice to Ecology by submission of a new application or supplement thereto at least one hundred and eighty (180) days prior to commencement of such discharges, of any facility expansions, or other planned changes, such as process modifications, in the permitted facility which may result in noncompliance with permit limits or conditions. Any maintenance of facilities, which might necessitate unavoidable interruption of operation and degradation of effluent quality, must be scheduled during non-critical water quality periods and carried out in a manner approved by Ecology.

G21. APPEALS

A. The terms and conditions of this general permit, as they apply to the appropriate class of dischargers, are subject to appeal by any person within 30 days of issuance of this general permit, in accordance with Chapter 43.21B RCW, and Chapter 173-226 WAC.

B. The terms and conditions of this general permit, as they apply to an individual discharger, are appealable in accordance with Chapter 43.21B RCW within 30 days of the effective date of coverage of that discharger. Consideration of an appeal of general permit coverage of an individual discharger is limited to the general permit's applicability or nonapplicability to that individual discharger.

C. The appeal of general permit coverage of an individual discharger does not affect any other dischargers covered under this general permit. If the terms and conditions of this general permit are found to be inapplicable to any individual discharger(s), the matter shall be remanded to Ecology for consideration of issuance of an individual permit or permits.

G22. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit, or application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

G23. BYPASS PROHIBITED

This permit prohibits a bypass, which is the intentional diversion of waste streams from any portion of a treatment facility.

See bypass prohibitions included in each jurisdiction's individual NPDES permit.

APPENDIX A – DEFINITIONS

303(d) Listed Waters means waterbodies listed as Category 5 on Washington State's Water Quality Assessment.

Action Level means an indicator value used to determine the effectiveness of best management practices at a WWTPs. Action levels are not water quality criteria or effluent limits by themselves but indicators of treatment optimization.

Adaptive Management means the process of incorporating new information into optimization implementation to ensure effective attainment of documented goals or the facility specific action level.

AKART means acronym for "all known, available, and reasonable methods of prevention, control, and treatment." AKART represents the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants and controlling pollution associated with a discharge.

Alternative Restoration Plan means a near-term plan, or description of actions, with a schedule and milestones, that is more immediately beneficial or practicable to achieving water quality standards.

Applicant means an owner or **operator in responsible charge** seeking coverage under this permit**.**

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the State.

Bubbled action level means the sum of individual action levels for all WWTPs in the same discharger category under a single jurisdiction's ownership.

Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

Day means a period of 24 consecutive hours.

Clean Water Act (CWA) means the Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; USC 1251 et seq.

Composite (also **Composite Sample)** means a mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increases while maintaining a constant time interval between the aliquots.

Director means the Director of the Washington Department of Ecology or his/her authorized representative.

Discharger means an owner or operator of any facility or activity subject to regulation under Chapter 90.48 RCW or the Federal Clean Water Act.

Domestic Wastewater means water carrying human wastes, including kitchen, bath, and laundry wastes from residences, buildings, industrial establishments, or other places, together with such ground water infiltration or surface waters as may be present.

Dominant loader means domestic WWTPs discharging more than 2,000 lbs/day TIN. Cumulatively, dominant loaders constitute > 80% of the domestic point source TIN load.

Ecology means the Washington State Department of Ecology.

Ground Water means water in a saturated zone or stratum beneath the land surface or a surface water body.

Greater Puget Sound Region means the marine area where human nutrient loads, from Washington Waters of the Salish Sea, contribute to waters not meeting marine DO standards. The GPS region include the Northern Bays (Bellingham, Samish, and Padilla Bays) as well as Puget Sound Proper, which are the marine waters south of the entrance of Admiralty Inlet (Whidbey Basin, Main Basin, South Sound, and Hood Canal).

Moderate loader means a domestic WWTP discharging between 100 and 2,000 lbs/day TIN. Cumulatively, moderate loaders constitute roughly 19 % of the domestic point source TIN load.

National Pollutant Discharge Elimination System (NPDES) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the State from point sources. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington Department of Ecology.

Notice of Intent (NOI) means the application for, or a request for coverage under this general permit pursuant to WAC 173-226-200.

Operator means any individual who performs routine duties, onsite at a wastewater treatment plant that affect plant performance or effluent quality.

Operator in Responsible Charge means the individual who is designated by the owner as the person routinely onsite and in direct charge of the overall operation and maintenance of a wastewater treatment plant.

Optimization (also treatment optimization) means a best management practice (BMP) resulting in the refinement of WWTP operations that lead to improved effluent water quality and/or treatment efficiencies.

Outfall means the location where the site's wastewater discharges to surface water.

Overburdened community means a geographic area where vulnerable populations face combined, multiple environmental harms and health impacts, and includes, but is not limited to, highly impacted communities as defined in RCW 19.405.020.

Owner means a town or city, a county, a sewer district, board of public utilities, association, municipality or other public body.

Permittee means an entity that receives notice of coverage under this general permit.

Point source means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, and container from which pollutants are or may be discharged to surface waters of the State. This term does not include return flows from irrigated agriculture.

Pollutant means dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, domestic sewage sludge (biosolids), munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste.

Pollution means contamination or other alteration of the physical, chemical, or biological properties of waters of the State; including change in temperature, taste, color, turbidity, or odor of the waters; or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the State as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare; or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses; or to livestock, wild animals, birds, fish or other aquatic life.

Receiving water means the water body at the point of discharge. If the discharge is to a storm sewer system, either surface or subsurface, the receiving water is the water body to which the storm system discharges. Systems designed primarily for other purposes such as for ground water drainage, redirecting stream natural flows, or for conveyance of irrigation water/return flows that coincidentally convey stormwater are considered the receiving water.

Representative sample (also **representative sampling**) means a wastewater sample which represents the flow and characteristics of the discharge. Representative samples may be a grab sample, a time-proportionate **composite sample**, or a flow proportionate sample.

Salish Sea means Puget Sound, Strait of Georgia, and Strait of Juan de Fuca, including their connecting channels and adjoining waters.

SEPA (State Environmental Policy Act) means the Washington State Law, RCW 43.21C.020, intended to prevent or eliminate damage to the environment.

Septage means, for the purposes of this permit, any liquid or semisolid removed from a septic tank, cesspool, vault toilet or similar source which concentrates wastes or to which chemicals have been added.

Site means the land where any "facility" is physically located.

Small Loader means a domestic WWTP discharging less than 100 lbs/day TIN. Cumulatively, small loaders constitute < 1% of the domestic point source TIN load.

Surface Waters of the State includes lakes, rivers, ponds, streams, inland waters, salt waters, and all other surface waters and water courses within the jurisdiction of the state of Washington.

Total Inorganic Nitrogen (TIN) means the sum of ammonia, nitrate, and nitrite. It includes dissolved and particulate fractions.

Total Maximum Daily Load (TMDL) means a calculation of the maximum amount of a pollutant that a water body can receive and still meet state water quality standards. Percentages of the total maximum daily load are allocated to the various pollutant sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The TMDL calculations must include a "margin of safety" to ensure that the water body can be protected in case there are unforeseen events or unknown sources of the pollutant. The calculation must also account for seasonable variation in water quality.

Washington Waters of the Salish Sea means areas of the Salish Sea subject to Washington State’s Water Pollution Control Act (Chapter 90.48 RCW)

Wasteload Allocation (WLA) means the portion of a receiving water’s loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality based effluent limitation (40 CFR 130.2[h]).

Water quality means the chemical, physical, and biological characteristics of water, usually with respect to its suitability for a particular purpose.

Waters of the State includes those waters as defined as "waters of the United States" in 40 CFR Subpart 122.2 within the geographic boundaries of Washington State and "waters of the State" as defined in Chapter 90.48 RCW, which include lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and water courses within the jurisdiction of the state of Washington.

Week (same as **Calendar Week**) means a period of seven consecutive days starting at 12:01 a.m. (0:01 hours) on Sunday.

APPENDIX B – ACRONYMS

AKART	All Known, Available, and Reasonable Methods of Prevention, Control, and Treatment
BMP	Best Management Practice
CFR	Code of Federal Regulations
CWA	Clean Water Act
DIN	Dissolved Inorganic Nitrogen
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
FR	Federal Register
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NRP	Nutrient Reduction Plan
PSNF	Puget Sound Nutrient Forum
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
TBEL	Technology Based Effluent Limit
TIN	Total Inorganic Nitrogen
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
WAC	Washington Administrative Code
WQ	Water Quality
WQBEL	Water Quality Based Effluent Limit
WWTP	Wastewater Treatment Plant

APPENDIX C – ANNUAL REPORT QUESTIONS FOR DOMINANT LOADERS

Permittees are required to submit annual reports online, pursuant to Special Condition S9.C.

1. Did your facility stay below the Action Level in S4.b, Table 5 or Table 6 for the jurisdiction with a bubbled action level? (S4.C.2.b.i)
   a. Attach a document listing the contribution of each of your individual facilities to the total bubble allocation for the reporting period. (S4.C.2.b.i)
2. Did your facility stay below a 10 mg/L annual average TIN concentration? (S4.C.2.b.i) (**If Q1 =Y and Q2 = Y, then no further questions).**
3. **Attach** a document describing the assessment method applied to evaluate the existing treatment process. (S4.C.1.a)
4. What is your pre-optimization TIN removal rate, expressed as a percentage? (S4.c.1.a.i)
5. **Attach** a document explaining your initial approach for optimization. (S4.C.1.a)
6. Did you maintain and/or update your assessment approach after year 1?(S4.C.1.a.ii)
7. Do viable optimization strategies exist for your current treatment process? (S4.C.1.b)
8. Did all of the potential optimization strategies you identified and evaluated for S4.C.1.b have a reasonable implementation cost and timeframe? (S4.C.1.b)
9. ATTACH a document describing your preferred optimization strategy for implementation in 2022 (due July 1) (S4.C.1.c)
10. What is the expected performance for the selected optimization strategy? (S4.C.1.c**)**
11. **Attach** a document describing optimization plan implementation including start date, schedule for full implementation, initial costs, and challenges including impacts to other measures of treatment plant performance. (S4.C.2.a)
12. What TIN removal rate was observed during the reporting period? (S4.C.2.b.ii)
13. **Attach** a document describing your ongoing investigations to reduce influent TIN loads from septage handling practices, commercial, dense residential and industrial sources. (S4.C.3.a, S4.C.3.b)
14. **(If Q1=N and Q7 = Y) Attach** document including: factors causing the WWTP to not meet the optimization goal, whether modifications to the strategy could improve performance, and whether a different strategy or combination of strategies may be more appropriate. Also, document changes to the optimization strategy either through the selection of the new optimization strategy and new performance metric or existing implementation refinement. Revise the expected performance if electing to keep the existing strategy. Provide rationale for no changes if Permittee proposes no changes to the optimization strategy (S4.D.1.a and S4.D.1.b)
15. **(If Q1 = No and Q7 = No) Attach** abbreviated engineering report or technical memo (due 12 months after documenting action level exceedance or determination that no optimization strategies exist). (S4.D.2)

16. **(If Q1 = No in two prior years)** Did you implement the Engineering Report as planned, starting after Ecology's approval? (S4.D.2.a)
17. Did you submit the required Nutrient Reduction Evaluation on or before 12/31/2026? If no, **date** the document was or will be provided. (S4.E)
18. Did you submit discharge monitoring reports according to the required schedule? If no, **attach** a document describing/listing the missing records and corrective actions taken/or planned. (S7, S9.A)
19. Are you retaining all applicable records? If no, **attach** a document describing/listing the missing records and corrective actions taken and/or planned. (S9.F)
20. Did you follow non-compliance notification requirements? If no, **attach** a document describing the non-compliance and the corrective actions taken and/or planned. (S9.G)

APPENDIX D – ANNUAL REPORT QUESTIONS FOR MODERATE LOADERS

Permittees are required to submit annual reports online, pursuant to Special Condition S9.D.

1. Did your facility stay below the Action Level in S5.b, Table 8 or Table 9 for the jurisdiction with a bubbled action level? (S5.C.2.b.i)
    a. Attach a document listing the contribution of each of your individual facilities to the total bubble allocation for the reporting period. (S5.C.2.b.i)
2. Did your facility stay below a 10 mg/L annual average TIN concentration? (S5.C.2.b.i) (**If Q1 =Y and Q2 = Y, then no further questions).**
3. **Attach** a document describing the assessment method applied to evaluate the existing treatment process. (S5.C.1.a)
4. What is your pre-optimization TIN removal rate, expressed as a percentage? (S5.c.1.a.i)
5. **Attach** a document explaining your initial approach for optimization. (S5.C.1.a)
6. Did you maintain and/or update your assessment approach after year 1?(S5.C.1.a.ii)
7. Do viable optimization strategies exist for your current treatment process? (S5.C.1.b)
8. Did all of the potential optimization strategies you identified and evaluated for S5.C.1.b have a reasonable implementation cost and timeframe? (S5.C.1.b)
9. ATTACH a document describing your preferred optimization strategy for implementation in 2022 (selection due July 1) (S5.C.1.c)
10. What is the expected performance for the selected optimization strategy? (S5.C.1.c**)**
11. **Attach** a document describing optimization plan implementation including start date, schedule for full implementation, initial costs, and challenges including impacts to other measures of treatment plant performance. (S5.C.2.a)
12. What TIN removal rate was observed during the reporting period? (S5.C.2.b.ii)
13. **Attach** a document describing your ongoing investigations to reduce influent TIN loads from septage handling practices, commercial, dense residential and industrial sources. (S5.C.3.a, S5.C.3.b)
14. **(If Q1=N and Q7 = Y) Attach** document including: factors causing the WWTP to not meet the optimization goal, whether modifications to the strategy could improve performance, and whether a different strategy or combination of strategies may be more appropriate. Also, document changes to the optimization strategy either thorough the selection of the new optimization strategy and new performance metric or existing implementation refinement. Revise the expected performance if electing to keep the existing strategy. Provide rationale for no changes if Permittee proposes no changes to the optimization strategy (S5.D.1.a and S5.D.1.b)
15. **(If Q1 = No and Q7 = No) Attach** abbreviated engineering report or technical memo (due 12 months after documenting action level exceedance or determination that no optimization strategies exist). (S5.D.2)

16. **(If Q1 = No in two prior years)** Did you implement the Engineering Report as planned, starting after Ecology's approval? (S5.D.2.a)
17. Did you submit the required Nutrient Reduction Evaluation on or before 12/31/2026? If no, **date** the document was or will be provided. (S5.E)
18. Did you submit discharge monitoring reports according to the required schedule? If no, **attach** a document describing/listing the missing records and corrective actions taken/or planned. (S7, S9.A)
19. Are you retaining all applicable records? If no, **attach** a document describing/listing the missing records and corrective actions taken and/or planned. (S9.F)
20. Did you follow non-compliance notification requirements? If no, **attach** a document describing the non-compliance and the corrective actions taken and/or planned. (S9.G)

APPENDIX E – ONE TIME REPORT QUESTIONS FOR SMALL LOADERS

Permittees are required to submit the single report online, pursuant to Special Condition S9.E.

1. **Attach** a document describing your initial assessment process, your optimization goal, the list of prioritized optimization strategies identified, and the strategy implemented in 2022 (S6.B.1.b). If any optimization strategies were found to not have a reasonable implementation cost or timeframe (S6.B.2.a.iv), include description of the feasibility and cost analysis that led to exclusion of any approach(es). (S6.B.1.a, S6.B.1.b)
2. Did your plant meet or exceed the pre-optimization empirical TIN removal rate in each year of this permit and also maintain or reduce TIN loads? If no, **attach** a document describing how you revised your optimization strategy in response to the evaluation in each of the prior permit years, and document your adaptive management steps, your assessment process, and the new optimization strategy or strategies you identified, and your updated optimization goal(s) and performance metric(s). (S6.B.2.b.ii, S6.B.2.c)
3. Did your facility stay below a 10 mg/L annual average TIN concentration? (S6.B.2.b.i) (**If Q2 =Y and Q3 = Y, then no further questions)**
4. What is your pre-optimization empirical TIN removal rate? (S6.B.1.a.i)
5. Did you maintain you reassessment approach after year 1? If no, **attach** a document describing assessment revisions that occurred each year over the permit term. (S6.B.1.a.ii)
6. What is your expected TIN removal with the preferred optimization strategy? (S6.B.1.b)
7. **Attach** a document describing optimization implementation including costs, time for full implementation, start date, challenges, and impacts to treatment performance. (S6.B.2.a)
8. What was the TIN removal rate observed each year during the reporting period? (S6.B.2.b.ii)
9. **Attach** a document describing your ongoing investigations to reduce influent TIN loads from septage handling practices, commercial, dense residential and industrial sources. (S6.B.3)
10. Did you submit the required AKART analysis on or before 12/31/2025? If no, **date** document was or will be provided. (S6.C)
11. Did you submit discharge monitoring reports according to the required schedule? If no, **attach** a document describing the missed monitoring activities and the corrective action taken. (S7, S9.A)
12. Are you retaining all applicable records? If no, **attach** a document descripting the missing records and the corrective action taken and/or planned. (S9.F)
13. Did you follow non-compliance notification requirements? If no, **attach** a document describing the non-compliance and the corrective actions taken and/or planned. (S9.G)

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Appendix E

State Waste Discharge Permit

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Issuance Date: May 28, 2019
Effective Date: July 1, 2019
Expiration Date: June 30, 2024

DEPARTMENT OF
ECOLOGY
State of Washington

STATE WASTE DISCHARGE PERMIT NUMBER ST 6127

State of Washington
DEPARTMENT OF ECOLOGY
Southwest Regional Office
PO Box 47775
Olympia, WA 98504-7775

In compliance with the provisions of the
State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington, as amended,

City of Port Townsend Compost Facility
250 Madison Street, Suite 2R
Port Townsend, WA 98368

is authorized to discharge wastewater in accordance with the special and general conditions which follow.

Plant Location:	Discharge Location:
603 County Landfill Road Port Townsend, WA 98368	Legal Description : SE ¼ SW ¼ Section 8, Range 1W, Township 30N

Treatment Type
Sequencing Batch Reactor (SBR) with Wetlands and Rapid Infiltration

Originally-Signed Permit is in Public Files

Richard Doenges
Southwest Region Manager
Water Quality Program
Washington State Department of Ecology

TABLE OF CONTENTS

SUMMARY OF PERMIT REPORT SUBMITTALS 4

SPECIAL CONDITIONS 5

S1. DISCHARGE LIMITS 5
- A. Effluent Limits 5
- B. Best Management Practices/Pollution Prevention 6

S2. MONITORING REQUIREMENTS 6
- A. Wastewater Monitoring 6
- B. Groundwater Monitoring 7
- C. Sampling and Analytical Procedures 8
- D. Flow Measurement and Field Measurement Devices 9
- E. Laboratory Accreditation 9

S3. REPORTING AND RECORDING REQUIREMENTS 9
- A. Discharge Monitoring Reports 10
- B. Permit Submittals and Schedules 11
- C. Records Retention 12
- D. Recording of Results 12
- E. Additional Monitoring by the Permittee 12
- F. Reporting Permit Violations 12
- G. Other Reporting 14
- H. MAINTAINING A COPY OF THIS PERMIT 15

S4. FACILITY LOADING 15
- A. Design Criteria 15
- B. Plans for Maintaining Adequate Capacity 15
- C. Duty to Mitigate 16
- D. Notification of New or Altered Sources 16
- E. Wasteload Assessment 16

S5. OPERATION AND MAINTENANCE 17
- A. Certified Operator 17
- B. Operation and Maintenance Program 17
- C. Short-Term Reduction 17
- D. Electrical Power Failure 18
- E. Bypass Procedures 18
- F. Operations and Maintenance Manual 20
- G. Infiltration Land Application Best Management Practices 21

S6. PRETREATMENT 22
- A. General Requirements 22
- B. Duty to Enforce Discharge Prohibitions 22

S7. SOLID WASTES 23
- A. Solid Waste Handling 23
- B. Leachate 24

S8. APPLICATION FOR PERMIT RENEWAL OR MODIFICATION FOR FACILITY CHANGES 24

GENERAL CONDITIONS 25
G1. SIGNATORY REQUIREMENTS 25
G2. RIGHT OF ENTRY 25
G3. PERMIT ACTIONS 26
G4. REPORTING A CAUSE FOR MODIFICATION 26
G5. PLAN REVIEW REQUIRED 26
G6. COMPLIANCE WITH OTHER LAWS AND STATUTES 26
G7. TRANSFER OF THIS PERMIT 26
G8. PAYMENT OF FEES 27
G9. PENALTIES FOR VIOLATING PERMIT CONDITIONS 27
G10. DUTY TO PROVIDE INFORMATION 27
G11. DUTY TO COMPLY 27
G12. SERVICE AGREEMENT REVIEW 27
APPENDIX A 28

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S3.A	Discharge Monitoring Report (DMR)	Monthly	August 15, 2019
S3.A	Discharge Monitoring Report (DMR)	Quarterly	October 15, 2019
S3.A	Discharge Monitoring Report (DMR)	Annual	January 15, 2021
S3.F	Reporting Permit Violations	As necessary	
S4.B	Plans for Maintaining Adequate Capacity	As necessary	
S4.D	Notification of New or Altered Sources	As necessary	
S4.E	Wasteload Assessment	1/permit cycle	June 1, 2022
S5.F	Reporting Bypasses	As necessary	
S5.G	Operations and Maintenance Manual Update	As necessary	
S8.	Application for Permit Renewal	1/permit cycle	February 1, 2024
G1	Notice of Change in Authorization	As necessary	
G4	Permit Application for Substantive Changes to the Discharge	As necessary	
G5	Engineering Report for Construction or Modification Activities	As necessary	
G7	Notice of Permit Transfer	As necessary	
G10	Duty to Provide Information	As necessary	
G12	Contract Submittal	As necessary	

SPECIAL CONDITIONS

S1. DISCHARGE LIMITS

A. Effluent Limits

All discharges and activities authorized by this permit must comply with the terms and conditions of this permit. The discharge of any of the following pollutants more frequently than, or at a concentration in excess of, that authorized by this permit violates the terms and conditions of this permit. Wastewater flows and loadings must not exceed the Design Criteria specified in Section S4.

Beginning on the effective date, the Permittee is authorized to discharge treated domestic wastewater to infiltration basins at the permitted location subject to the following limits:

Effluent Limits: SBR Effluent Latitude 48.10117 Longitude -122.83416		
Parameter	**Average Monthly [a]**	**Average Weekly [b]**
Biochemical Oxygen Demand (BOD_5)	30 milligrams/liter (mg/L) 1 pound/day (lbs/day) 85% removal of influent BOD_5	45 mg/L 1.5 lbs/day
Total Suspended Solids (TSS)	30 mg/L 1 lbs/day 85% removal of influent TSS	45 mg/L 1.5 lbs/day
Parameter	**Minimum**	**Maximum [d]**
pH [e]	6.0 Standard Units (SU)	9.0 SU
Effluent Limits: Wetland Influent		
Parameter	**Monthly Geometric Mean**	**7- day Geometric Mean**
Fecal Coliform [c]	200 col./100 mL	400 col./10 mL
Parameter	**Average Monthly [a]**	**Average Weekly [b]**
Total Residual Chlorine	0.5 mg/L	0.75 mg/L
Effluent Limit: Wetland Effluent		
Parameter	**Average Monthly [a]**	**Average Weekly [b]**
Nitrate	10 mg/L as N	-----
a	Average monthly effluent limit means the highest allowable average of daily discharges over a calendar month. To calculate the discharge value to compare to the limit, you add the value of each daily discharge measured during a calendar month and divide this sum by the total number of daily discharges measured.	
b	Average weekly discharge limit means the highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week. See footnote c for fecal coliform calculations.	

Effluent Limits: SBR Effluent Latitude 48.10117 Longitude -122.83416	
c	The Department of Ecology (Ecology) provides directions to calculate the monthly and the 7-day geometric mean in publication No. 04-10-020, Information Manual for Treatment Plant Operators available at: https://fortress.wa.gov/ecy/publications/SummaryPages/0410020.html
d	Maximum daily effluent limit means the highest allowable daily discharge. The daily discharge means the maximum discharge of a pollutant measured during a calendar day. For pollutants with limits expressed in units of mass, calculate the daily discharge as the total mass of the pollutant discharged over the day. For other units of measurement, the daily discharge is the average measurement of the pollutant over the day. This does not apply to pH or temperature.
e	The Permittee must report the instantaneous maximum and minimum pH monthly. Do not average pH.

B. Best Management Practices/Pollution Prevention

The Permittee must comply with the following Best Management Practices to prevent pollution to waters of the State:

1. Do not discharge in excess of the hydraulic capacity of the infiltration basins so that the pond overflows.

2. Do not discharge priority pollutants, dangerous wastes, or toxics in toxic amounts.

S2. MONITORING REQUIREMENTS

A. Wastewater Monitoring

The Permittee must monitor the wastewater prior to discharging into the infiltration basins.

The Permittee must monitor in accordance with the following schedule and the requirements specified in **Appendix A**.

Parameter	Units	Minimum Sampling Frequency	Sample Type
(1) Wastewater Influent			
Wastewater Influent means flow from into the SBR, excluding any side-stream returns from inside the plant.			
BOD_5	mg/L	2/month [a]	Grab [b]
BOD_5	lbs/day	2/month [a]	Calculated [c]
TSS	mg/L	2/month [a]	Grab [b]
TSS	lbs/day	2/month [a]	Calculated [c]

Parameter	Units	Minimum Sampling Frequency	Sample Type
(2) SBR Effluent			
SBR Effluent means wastewater which is exiting, or has exited, the SBR.			
Flow	gallons/day (gpd)	Daily or Per Batch	Measurement
BOD_5	mg/L	2/month [a]	Grab [b]
BOD_5	lbs/day	2/month [a]	Calculated [c]
BOD_5	% Removal	2/month [a]	Calculated [d]
TSS	mg/L	2/month [a]	Grab [b]
TSS	lbs/day	2/month [a]	Calculated [c]
TSS	% Removal	2/month [a]	Calculated [d]
pH	SU	2/month [a]	Grab [b]
(3) Wetland Influent			
Chlorine (Total Residual)	mg/L	2/month [a]	Grab [b]
Fecal Coliform	#Organisms /100 ml	2/month [a]	Grab [b]
(4) Wetland Effluent – Final Wastewater Effluent			
Nitrate (as N)	mg/L as N	2/month [a]	Grab [b]
pH	Standard Units	2/month [a]	Grab [b]
a	Two (2)/month is defined as two times during each calendar month.		
b	Grab means an individual sample collected over a 15 minute, or less, period.		
c	Calculation means figured concurrently with the respective sample, using the following formula: Concentration (in mg/L) X Flow (in MGD) X Conversion Factor (8.34) = lbs/day		
d	Percent (%) removal = (Influent concentration (mg/L) – Effluent concentration (mg/L) x 100 Influent BOD_5 (mg/L) Calculate the percent (%) removal of BOD_5 and TSS using the above equation.		

B. Groundwater Monitoring

The Permittee must monitor groundwater at monitoring well MW-1-93 in accordance with the following schedule and the requirements specified in Appendix A.

Parameter	Units & Speciation	Sampling Frequency	Sample Type
pH	SU	Quarterly [b]	Grab [a]
Conductivity	Micromho/cm	Quarterly [b]	Grab [a]
Total Coliform [c]	#/100 mL	Quarterly [b]	Grab [a]
Measured Depth to Groundwater	Feet (nearest 0.1 ft)	Quarterly [b]	Grab [a]
Temperature	Degrees C	Quarterly [b]	Field Measurement
Nitrate (as N)	mg/L as N	Quarterly [b]	Field Measurement
Chloride	mg/L	Annually [d]	Grab [a]
Sulfate	mg/L	Annually [d]	Grab [a]
Total Dissolved Solids	mg/L	Annually [d]	Grab [a]
Iron (Total)	mg/L	Annually [d]	Grab [a]
Manganese	mg/L	Annually [d]	Grab [a]
Lead	mg/L	Annually [d]	Grab [a]
Chromium	mg/L	Annually [d]	Grab [a]
Arsenic	mg/L	Annually [d]	Grab [a]
a	Grab means an individual sample collected over a 15 minute, or less, period.		
b	Quarterly is defined as January – March, April – June, July – September, and October – December, **starting July 1, 2019**.		
c	Report a numerical value for Total Coliforms following the procedures in Ecology's Information Manual for Wastewater Treatment Plant Operators, Publication Number 04-10-020 available at: https://fortress.wa.gov/ecy/publications/SummaryPages/0410020.html. Do not report a result as Too Numerous To Count (TNTC).		
d	Annually is defined as January – December, **starting January 1, 2020**.		

C. Sampling and Analytical Procedures

Samples and measurements taken to meet the requirements of this permit must represent the volume and nature of the monitored parameters, including representative sampling of any unusual discharge or discharge condition, including bypasses, upsets and maintenance-related conditions affecting effluent quality.

Groundwater sampling must conform to the latest protocols in the *Implementation Guidance for the Ground Water Quality Standards*, (Ecology 1996).

Sampling and analytical methods used to meet the water and wastewater monitoring requirements specified in this permit must conform to the latest revision of the following rules and documents unless otherwise specified in this permit or approved in writing by the Department of Ecology (Ecology).

- Guidelines Establishing Test Procedures for the Analysis of Pollutants contained in 40 Code of Federal Regulation (CFR) Part 136
- Standard Methods for the Examination of Water and Wastewater (APHA)

The Permittee must conduct and report all soil analysis in accordance with the Western States Laboratory Plant, Soil and Water Analysis Manual, *Soil, Plant And Water Reference Methods for The Western Region, 4th Edition,* 2013. You can find more information at: http://www.naptprogram.org/files/napt/publications/method-papers/western-states-methods-manual-2013.pdf.

D. Flow Measurement and Field Measurement Devices

The Permittee must:

1. Select and use appropriate flow measurement and field measurement devices and methods consistent with accepted scientific practices.

2. Install, calibrate, and maintain these devices to ensure the accuracy of the measurements is consistent with the accepted industry standard, the manufacturer's recommendation, and approved Operation and Maintenance (O&M) Manual procedures for the device and the wastestream.

3. Use field measurement devices as directed by the manufacturer and do not use reagents beyond their expiration dates.

4. Establish a calibration frequency for each device or instrument in the O&M manual that conforms to the frequency recommended by the manufacturer.

5. Calibrate flow monitoring devices at a minimum frequency of at least one calibration per year.

6. Maintain calibration records for at least three years.

E. Laboratory Accreditation

The Permittee must ensure that all monitoring data required by Ecology for permit specified parameters is prepared by a laboratory registered or accredited under the provisions of chapter 173-50 Washington Administrative Code (WAC), *Accreditation of Environmental Laboratories*. Flow, temperature, Settleable Solids, conductivity, pH, and internal process control parameters are exempt from this requirement. The Permittee must obtain accreditation for conductivity and pH if it must receive accreditation or registration for other parameters.

S3. REPORTING AND RECORDING REQUIREMENTS

The Permittee must monitor and report in accordance with the following conditions. Falsification of information submitted to Ecology is a violation of the terms and conditions of this permit.

A. Discharge Monitoring Reports

The first monitoring period begins on the effective date of the permit (unless otherwise specified). The Permittee must:

1. Summarize, report, and submit monitoring data obtained during each monitoring period on the electronic Discharge Monitoring Report (DMR) form provided by Ecology within the Water Quality Permitting Portal. Include data for each of the parameters tabulated in Special Condition S2 and as required by the form. Report a value for each day sampling occurred (unless specifically exempted in the permit) and for the summary values (when applicable) included on the electronic form.

   To find out more information and to sign up for the Water Quality Permitting Portal go to: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Water-quality-permits-guidance/WQWebPortal-guidance.

2. Enter the "No Discharge" reporting code for an entire DMR, for a specific monitoring point, or for a specific parameter as appropriate, if the Permittee did not discharge wastewater or a specific pollutant during a given monitoring period.

3. Report single analytical values below detection as "less than the Detection Level (DL)" by entering < followed by the numeric value of the detection level (e.g. < 2.0) on the DMR. If the method used did not meet the minimum DL and Quantitation Level (QL) identified in the permit, report the actual QL and DL in the comments or in the location provided.

4. **Do not** report zero for bacteria monitoring. Report as required by the laboratory method.

5. Calculate and report an arithmetic average value for each day for bacteria if multiple samples were taken in one day.

6. Calculate the geometric mean values for bacteria (unless otherwise specified in the permit) using:

   a. The reported numeric value for all bacteria samples measured above the detection value except when it took multiple samples in one day. If the Permittee takes multiple samples in one day it must use the arithmetic average for the day in the geometric mean calculation.

   b. The detection value for those samples measured below detection.

7. Report the test method used for analysis in the comments if the laboratory used an alternative method not specified in the permit and as allowed in Appendix A.

8. Calculate average values and calculated total values (unless otherwise specified in the permit) using:

a. The reported numeric value for all parameters measured between the agency-required detection value and the agency-required quantitation value.

b. One-half the detection value (for values reported below detection) if the lab detected the parameter in another sample from the same monitoring point for the reporting period.

c. Zero (for values reported below detection) if the lab did not detect the parameter in another sample for the reporting period.

9. Report single-sample grouped parameters (for example: priority pollutants, PAHs, pulp and paper chlorophenolics, TTOs) on the WQWebDMR form and include: sample date, concentration detected, DL (as necessary), and laboratory QL (as necessary).

The Permittee must also submit an electronic copy of the laboratory report as an attachment using WQWebDMR. The contract laboratory reports must also include information on the chain of custody, QA/QC results, and documentation of accreditation for the parameter.

10. Ensure that DMRs are electronically submitted no later than the dates specified below, unless otherwise specified in this permit.

11. Submit DMRs for parameters with the monitoring frequencies specified in S2 (monthly, quarterly, annual, etc.) at the reporting schedule identified below. The Permittee must:

a. Submit **monthly** DMRs by the 15th day of the following month.

b. Submit **quarterly** DMRs, unless otherwise specified in the permit, by the 15th day of the month following the monitoring period.

c. Submit **annual** DMRs, unless otherwise specified in the permit, by January 15th for the previous calendar year.

B. Permit Submittals and Schedules

The Permittee may use the Water Quality Permitting Portal – Permit Submittals application (unless otherwise specified in the permit) to submit all other written permit-required reports by the date specified in the permit.

When another permit condition requires submittal of a paper (hard-copy) report, the Permittee must ensure that it is postmarked or received by Ecology no later than the dates specified by this permit. Send these paper reports to Ecology at:

Water Quality Permit Coordinator
Department of Ecology
Southwest Regional Office
PO Box 47775
Olympia, WA 98504-7775

C. Records Retention

The Permittee must retain records of all monitoring information for a minimum of three years. Such information must include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. The Permittee must extend this period of retention during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

The Permittee must retain all records pertaining to the monitoring of sludge for a minimum of five years.

D. Recording of Results

For each measurement or sample taken, the Permittee must record the following information:

1. The date, exact place and time of sampling.
2. The individual who performed the sampling or measurement.
3. The dates the analyses were performed.
4. The individual who performed the analyses.
5. The analytical techniques or methods used.
6. The results of all analyses.

E. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by Special Condition S2 of this permit, then the Permittee must include the results of such monitoring in the calculation and reporting of the data submitted in the Permittee's DMR unless otherwise specified by Special Condition S2.

F. Reporting Permit Violations

The Permittee must take the following actions when it violates or is unable to comply with any permit condition:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the noncompliance and correct the problem.
2. If applicable, immediately repeat sampling and analysis. Submit the results of any repeat sampling to Ecology within 30 days of sampling.

a. Immediate Reporting

The Permittee must immediately report to Ecology (at the number listed below), all:

- Failures of the disinfection system
- Collection system overflows
- Plant bypasses resulting in a discharge
- Any other failures of the sewage system (pipe breaks, etc)
- Overflows or leaks of transmission or irrigation pipelines that discharge to a waterbody used as a source of drinking or irrigation water.

Southwest Regional Office	360-407-6300

b. Twenty-Four-Hour Reporting

The Permittee must report the following occurrences of noncompliance by telephone, to Ecology at the telephone number listed above, within 24 hours from the time the Permittee becomes aware of any of the following circumstances:

i. Any noncompliance that may endanger health or the environment, unless previously reported under immediate reporting requirements.

ii. Any unanticipated bypass that causes an exceedance of an effluent limit in the permit (See Part S5.F., "Bypass Procedures").

iii. Any upset that causes an exceedance of an effluent limit in the permit. Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

iv. Any violation of a maximum daily or instantaneous maximum discharge limit for any of the pollutants in Section S1.A of this permit.

v. Any overflow prior to the treatment works, whether or not such overflow endangers health or the environment or exceeds any effluent limit in the permit.

c. Report Within Five Days

The Permittee must also submit a written report within five days of the time that the Permittee becomes aware of any reportable event under subparts a or b, above. The report must contain:

i. A description of the noncompliance and its cause.

ii. Maps, drawings, aerial photographs, or pictures to show the location and cause(s) of the non-compliance.

iii. The period of noncompliance, including exact dates and times.

iv. The estimated time the Permittee expects the noncompliance to continue if not yet corrected.

v. Steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

vi. If the noncompliance involves an overflow prior to the treatment works, an estimate of the quantity (in gallons) of untreated overflow.

d. Waiver of Written Reports

Ecology may waive the written report required in subpart c, above, on a case-by-case basis upon request if the Permittee has submitted a timely oral report.

e. All Other Permit Violation Reporting

The Permittee must report all permit violations, which do not require immediate or within 24 hours reporting, when it submits monitoring reports for S3.A ("Reporting"). The reports must contain the information listed in subpart c, above. Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

G. Other Reporting

1. Spills of Oil or Hazardous Materials

The Permittee must report a spill of oil or hazardous materials in accordance with the requirements of Revised Code of Washington (RCW) 90.56.280 and chapter 173-303-145. You can obtain further instructions at the following website: https://ecology.wa.gov/About-us/Get-involved/Report-an-environmental-issue/Report-a-spill.

2. Failure to Submit Relevant or Correct Facts

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application, or in any report to Ecology, it must submit such facts or information promptly.

H. Maintaining a Copy of this Permit

The Permittee must keep a copy of this permit at the facility and make it available upon request to Ecology inspectors.

S4. FACILITY LOADING

A. Design Criteria

The flows or waste loads for the permitted facility must not exceed the following design criteria:

Maximum Month Design Flow (MMDF)	4,000 gpd
Daily Maximum Flow	6,200 gpd

B. Plans for Maintaining Adequate Capacity

1. Conditions Triggering Plan Submittal

The Permittee must submit a plan and a schedule for continuing to maintain capacity to Ecology when:

a. The actual flow or waste load reaches 85 percent of any one of the design criteria in S4.A for three consecutive months.

b. The projected plant flow or loading would reach design capacity within five years.

2. Plan and Schedule Content

The plan and schedule must identify the actions necessary to maintain adequate capacity for the expected population growth and to meet the limits and requirements of the permit. The Permittee must consider the following topics and actions in its plan.

a. Analysis of the present design and proposed process modifications.

b. Reduction or elimination of excessive infiltration and inflow of uncontaminated ground and surface water into the sewer system.

c. Limits on future sewer extensions or connections or additional waste loads

d. Modification or expansion of facilities.

e. Reduction of industrial or commercial flows or waste loads.

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.

C. Duty to Mitigate

The Permittee must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

D. Notification of New or Altered Sources

1. The Permittee must submit written notice to Ecology whenever any new discharge or a substantial change in volume or character of an existing discharge into the wastewater treatment plant is proposed which:

   a. Would interfere with the operation of, or exceed the design capacity of, any portion of the wastewater treatment plant.

   b. Is not part of an approved general sewer plan or approved plans and specifications.

   c. Is subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act.

2. This notice must include an evaluation of the wastewater treatment plant's ability to adequately transport and treat the added flow and/or wasteload, the quality and volume of effluent to be discharged to the treatment plant, and the anticipated impact on the Permittee's effluent [40 CFR 122.42(b)].

E. Wasteload Assessment

The Permittee must conduct an assessment of its influent flow and wasteload and submit a report to Ecology by **June 1, 2022**.

The report must contain:

1. A description of compliance or noncompliance with the permit effluent limits.

2. A comparison between the existing and design:

   a. Monthly Average Dry Weather and Wet Weather Flows

   b. Peak Flows

   c. BOD_5 Loading

   d. Total Suspended Solids Loadings

3. The percent change in the above parameters since the previous report (except for the first report).

4. The present and design population or population equivalent.

5. The projected population growth rate.

6. The estimated date upon which the Permittee expects the wastewater treatment plant to reach design capacity, according to the most restrictive of the parameters above.

Ecology may modify the interval for review and reporting if it determines that a different frequency is sufficient.

S5. OPERATION AND MAINTENANCE

The Permittee must, at all times, properly operate and maintain all facilities or systems of treatment and control (and related appurtenances), which are installed to achieve compliance with the terms and conditions of this permit. Proper Operation and Maintenance (O&M) also includes keeping a daily operation logbook (paper or electronic), adequate laboratory controls, and appropriate quality assurance procedures. This provision of the permit requires the Permittee to operate backup or auxiliary facilities or similar systems only when the operation is necessary to achieve compliance with the conditions of this permit.

A. Certified Operator

An operator certified for at least a Class II plant by the State of Washington must be in responsible charge of the day-to-day operation of the wastewater treatment plant. An operator certified for at least a Class II plant must be in charge during all regularly scheduled shifts.

B. O&M Program

The Permittee must:

1. Institute an adequate operation and maintenance program for the entire sewage system.

2. 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.

3. Make maintenance records available for inspection at all times.

C. Short-Term Reduction

The Permittee must schedule any facility maintenance, which might require interruption of wastewater treatment and degrade effluent quality, during non-critical water quality periods and carry this maintenance out according to the approved O&M Manual or as otherwise approved by Ecology.

If a Permittee contemplates a reduction in the level of treatment that would cause a violation of permit discharge limits on a short-term basis for any reason, and such reduction cannot be avoided, the Permittee must:

1. Give written notification to Ecology, if possible, 30 days prior to such activities.

2. Detail the reasons for, length of time of, and the potential effects of the reduced level of treatment.

This notification does not relieve the Permittee of its obligations under this permit.

D. Electrical Power Failure

The Permittee must ensure that adequate safeguards prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of this permit 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 must maintain Reliability Class II (EPA 430-99-74-001) at the wastewater treatment plant, which requires primary sedimentation and disinfection.

E. Bypass Procedures

This permit prohibits a bypass, which is the intentional diversion of waste streams from any portion of a treatment facility. Ecology may take enforcement action against a Permittee for a bypass unless one of the following circumstances (1, 2, or 3) applies.

1. Bypass for essential maintenance without the potential to cause violation of permit limits or conditions.

   This permit authorizes a bypass if it allows for essential maintenance and does not have the potential to cause violations of limits or other conditions of this permit, or adversely impact public health as determined by Ecology prior to the bypass. The Permittee must submit prior notice, if possible, at least 10 days before the date of the bypass.

2. Bypass which is unavoidable, unanticipated, and results in noncompliance of this permit.

   This permit authorizes such a bypass only if:

   a. Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

b. No feasible alternatives to the bypass exist, such as:

- The use of auxiliary treatment facilities
- Retention of untreated wastes
- Maintenance during normal periods of equipment downtime, but not if the Permittee should have installed adequate backup equipment in the exercise of reasonable engineering judgment to prevent a bypass.
- Transport of untreated wastes to another treatment facility

c. Ecology is properly notified of the bypass as required in Special Condition S3.F of this permit.

3. If bypass is anticipated and has the potential to result in noncompliance of this permit.

a. The Permittee must notify Ecology at least 30 days before the planned date of bypass. The notice must contain:

- A description of the bypass and its cause
- An analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing
- A cost-effectiveness analysis of alternatives including comparative resource damage assessment
- The minimum and maximum duration of bypass under each alternative
- A recommendation as to the preferred alternative for conducting the bypass
- The projected date of bypass initiation
- A statement of compliance with State Environmental Policy Act (SEPA)
- A request for modification of Water Quality Standards as provided for in WAC 173-201A-410, if an exceedance of any water quality standard is anticipated.
- Details of the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

b. For probable construction bypasses, the Permittee must notify Ecology of the need to bypass as early in the planning process as possible. The Permittee must consider the analysis required above during the project planning and design process. The project-specific engineering report or facilities plan as well as the plans and specifications must include details of probable construction bypasses to the extent practical. In cases where the Permittee determines the probable need to bypass early, the Permittee must continue to analyze conditions up to and including the construction period in an effort to minimize or eliminate the bypass.

c. Ecology will consider the following prior to issuing an administrative order for this type of bypass:

- If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of this permit.
- If feasible alternatives to bypass exist, such as the use of auxiliary treatment facilities, retention of untreated wastes, stopping production, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.
- If the Permittee planned and scheduled the bypass to minimize adverse effects on the public and the environment.

After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, Ecology will approve or deny the request. Ecology will give the public an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Ecology will approve a request to bypass by issuing an administrative order under RCW 90.48.120.

G. Operations and Maintenance (O&M) Manual

1. O&M Manual Submittal and Requirements

The Permittee must:

a. As needed, update O&M Manual that meets the requirements of WAC 173-240-080.

b. Review the O&M Manual at least annually.

c. Submit to Ecology for review and approval substantial changes or updates to the O&M Manual whenever it incorporates them into the manual.

d. Keep the approved O&M Manual at the permitted facility.

e. Follow the instructions and procedures of this Manual.

2. O&M Manual Components

In addition to the requirements of WAC 173-240-080(1) through (5), the O&M Manual must be consistent with the guidance in Table G1-3 in the *Criteria for Sewage Works Design* (Orange Book), 2008. The O&M Manual must include:

a. Emergency procedures for plant shutdown and cleanup in event of wastewater system upset or failure, or infiltration system leak.

b. Infiltration basin system operational controls and procedures.

c. Wastewater system maintenance procedures that contribute to the generation of wastewater.

d. Reporting protocols for submitting reports to Ecology to comply with the reporting requirements in the discharge permit.

e. 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 drains before beginning the overhaul of a stationary engine.)

f. Treatment plant process control monitoring schedule.

g. Wastewater sampling protocols and procedures for compliance with the sampling and reporting requirements in the wastewater discharge permit.

h. Minimum staffing adequate to operate and maintain the treatment processes and carry out compliance monitoring required by the permit.

i. Protocols and procedures for groundwater monitoring network, vadose zone, and soil sampling and testing.

j. Protocols and procedures for double-lined evaporation pond leak system, sampling and testing.

G. Infiltration Land Application Best Management Practices

The Permittee must:

1. Operate the infiltration basins to protect the existing and future beneficial uses of the groundwater, and not cause a violation of the groundwater standards.

2. Not allow practices to result in runoff of wastewater to any surface waters of the state or to any land not owned by or under its control.

3. Use recognized good practices, and all available and reasonable procedures to control odors from the infiltration basin system.

4. Implement measures to reduce odors to a reasonable minimum when notified by Ecology.

5. Not apply wastewater to the infiltration basins in quantities that:

a. Significantly reduce or destroy the long-term infiltration rate of the soil.

b. Would cause long-term anaerobic conditions in the soil.

c. Would cause ponding of wastewater and produce objectionable odors or support insects or vectors.

d. Would cause leaching losses of constituents of concern beyond the treatment zone or in excess of the approved design. Constituents of concern are constituents in the wastewater, partial decomposition products, or soil constituents that would alter groundwater quality in amounts that would affect current and future beneficial uses.

6. Maintain all agreements for lands not owned for the duration of the permit cycle. Any reduction in infiltration lands by termination of any irrigation agreements may result in permit modification or revocation.

7. Immediately inform Ecology in writing of any proposed changes to existing irrigation agreements.

8. Discontinue operation during periods of heavy or prolonged rainfall to prevent ground saturation and runoff.

S6. PRETREATMENT

A. General Requirements

The Permittee must work with Ecology to ensure that all commercial and industrial users of the Publicly Owned Treatment Works (POTW) comply with the pretreatment regulations in 40 CFR Part 403 and any additional regulations that the Environmental Protection Agency (U.S. EPA) may promulgate under Section 307(b) (pretreatment) and 308 (reporting) of the Federal Clean Water Act.

B. Duty to Enforce Discharge Prohibitions

1. Under federal regulations [40 CFR 403.5(a) and (b)], the Permittee must not authorize or knowingly allow the discharge of any pollutants into its POTW which may be reasonably expected to cause pass through or interference, or which otherwise violate general or specific discharge prohibitions contained in 40 CFR Part 403.5 or WAC 173-216-060.

2. The Permittee must not authorize or knowingly allow the introduction of any of the following into their treatment works:

a. Pollutants which create a fire or explosion hazard in the POTW (including, but not limited to waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21).

b. Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, or greater than 11.0 Standard Units, unless the works are specifically designed to accommodate such discharges.

c. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the POTW.

d. Any pollutant, including oxygen-demanding pollutants, (BOD_5, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW.

e. Petroleum oil, non-biodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through.

f. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity which may cause acute worker health and safety problems.

g. Heat in amounts that will inhibit biological activity in the POTW resulting in interference but in no case heat in such quantities such that the temperature at the POTW headworks exceeds 40 degrees Centigrade (104 degrees Fahrenheit) unless Ecology, upon request of the Permittee, approves, in writing, alternate temperature limits.

h. Any trucked or hauled pollutants, except at discharge points designated by the Permittee.

i. Wastewaters prohibited to be discharged to the POTW by the Dangerous Waste Regulations (chapter 173-303 WAC), unless authorized under the Domestic Sewage Exclusion (WAC 173-303-071).

3. The Permittee must also not allow the following discharges to the POTW unless approved in writing by Ecology:

a. Noncontact cooling water in significant volumes

b. Stormwater and other direct inflow sources

c. Wastewaters significantly affecting system hydraulic loading, which do not require treatment, or would not be afforded a significant degree of treatment by the system.

4. The Permittee must notify Ecology if any industrial user violates the prohibitions listed in this section (S6.B), and initiate enforcement action to promptly curtail any such discharge.

S7. SOLID WASTES

A. <u>Solid Waste Handling</u>

The Permittee must handle and dispose of all solid waste material in such a manner as to prevent its entry into state ground or surface water.

B. Leachate

The Permittee must not allow leachate from its solid waste material to enter state waters without providing all known, available, and reasonable methods of treatment, nor allow such leachate to cause violations of the State Surface Water Quality Standards, Chapter 173-201A WAC, or the State Ground Water Quality Standards, Chapter 173-200 WAC.

S8. APPLICATION FOR PERMIT RENEWAL OR MODIFICATION FOR FACILITY CHANGES

The Permittee must submit an application for renewal of this permit by **February 1, 2024**.

The Permittee must also submit a new application or addendum at least 180 days prior to commencement of discharges, resulting from the activities listed below, which may result in permit violations. These activities include any facility expansions, production increases, or other planned changes, such as process modifications, in the permitted facility.

GENERAL CONDITIONS

G1. SIGNATORY REQUIREMENTS

All applications, reports, or information submitted to Ecology must be signed as follows:

A. All permit applications must be signed by either a principal executive officer or ranking elected official.

B. All reports required by this permit and other information requested by Ecology must be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

1. The authorization is made in writing by the person described above and is submitted to Ecology at the time of authorization, and

2. The authorization specifies either a named individual or any individual occupying a named position.

C. Changes to authorization. If an authorization under paragraph G1.B above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization must be submitted to Ecology prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section must make the following certification:

> "I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G2. RIGHT OF ENTRY

Representatives of Ecology have the right to enter at all reasonable times in or upon any property, public or private for the purpose of inspecting and investigating conditions relating to the pollution or the possible pollution of any waters of the state. Reasonable times include normal business hours; hours during which production, treatment, or discharge occurs; or times when Ecology suspects a violation requiring immediate inspection. Representatives of Ecology must be allowed to have access to, and copy at reasonable cost, any records required to be kept under terms and conditions of the permit; to inspect any monitoring equipment or method required in the permit; and to sample the discharge, waste treatment processes, or internal waste streams.

G3. PERMIT ACTIONS

This permit is subject to modification, suspension, or termination, in whole or in part by Ecology for any of the following causes:

A. Violation of any permit term or condition;

B. Obtaining a permit by misrepresentation or failure to disclose all relevant facts;

C. A material change in quantity or type of waste disposal;

D. A material change in the condition of the waters of the state; or

E. Nonpayment of fees assessed pursuant to RCW 90.48.465.

Ecology may also modify this permit, including the schedule of compliance or other conditions, if it determines good and valid cause exists, including promulgation or revisions of regulations or new information.

G4. REPORTING A CAUSE FOR MODIFICATION

The Permittee must submit a new application at least 180 days before it wants to discharge more of any pollutant, a new pollutant, or more flow than allowed under this permit. The Permittee should use the State Waste Discharge Permit application, and submit required plans at the same time. Required plans include an Engineering Report, Plans and Specifications, and O&M Manual, (see Chapter 173-240 WAC). Ecology may waive these plan requirements for small changes, so contact Ecology if they do not appear necessary. The Permittee must obtain the written concurrence of the receiving POTW on the application before submitting it to Ecology. The Permittee must continue to comply with the existing permit until it is modified or reissued. Submitting a notice of dangerous waste discharge (to comply with Pretreatment or Dangerous Waste rules) triggers this requirement as well.

G5. PLAN REVIEW REQUIRED

Prior to constructing or modifying any wastewater control facilities, an Engineering Report and detailed Plans and Specifications must be submitted to Ecology for approval in accordance with Chapter 173-240 WAC. Engineering Reports, Plans, and Specifications should be submitted at least 180 days prior to the planned start of construction. Facilities must be constructed and operated in accordance with the approved plans.

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in this permit excuses the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. TRANSFER OF THIS PERMIT

This permit is automatically transferred to a new owner or operator if:

A. A written agreement between the old and new owner or operator containing a specific date for transfer of permit responsibility, coverage, and liability is submitted to Ecology;

B. A copy of the permit is provided to the new owner and;

C. Ecology does not notify the Permittee of the need to modify the permit.

Unless this permit is automatically transferred according to Section 1 above, this permit may be transferred only if it is modified to identify the new Permittee and to incorporate such other requirements as determined necessary by Ecology.

G8. PAYMENT OF FEES

The Permittee must submit payment of fees associated with this permit as assessed by Ecology. Ecology may revoke this permit if the permit fees established under Chapter 173-224 WAC are not paid.

G9. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit is guilty of a crime, and upon conviction thereof shall be punished by a fine of up to $10,000 and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit incurs, in addition to any other penalty as provided by law, a civil penalty in the amount of up to $10,000 for every such violation. Each and every such violation is a separate and distinct offense, and in case of a continuing violation, every day's continuance is considered a separate and distinct violation.

G10. DUTY TO PROVIDE INFORMATION

The Permittee must submit to Ecology, within a reasonable time, all information which Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also submit to Ecology upon request, copies of records required to be kept by this permit.

G11. DUTY TO COMPLY

The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of chapter 90.48 RCW and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

G12. SERVICE AGREEMENT REVIEW

The Permittee must submit to Ecology any proposed service agreements and proposed revisions or updates to existing agreements for the operation of any wastewater treatment facility covered by this permit. The review is to ensure consistency with chapters 90.46 and 90.48 RCW as required by RCW 70.150.040(9). In the event that Ecology does not comment within a 30-day period, the Permittee may assume consistency and proceed with the service agreement or the revised/updated service agreement.

APPENDIX A

LIST OF POLLUTANTS WITH ANALYTICAL METHODS, DETECTION LIMITS AND QUANTITATION LEVELS

The Permittee must use the specified analytical methods, detection limits (DLs) and quantitation levels (QLs) in the following table for permit and application required monitoring unless:

- Another permit condition specifies other methods, detection levels, or quantitation levels.
- The method used produces measurable results in the sample and EPA has listed it as an EPA-approved method in 40 CFR Part 136.

If the Permittee uses an alternative method, not specified in the permit and as allowed above, it must report the test method, DL, and QL on the discharge monitoring report or in the required report.

If the Permittee is unable to obtain the required DL and QL in its effluent due to matrix effects, the Permittee must submit a matrix-specific detection limit (MDL) and a QL to Ecology with appropriate laboratory documentation.

When the permit requires the Permittee to measure the base neutral compounds in the list of priority pollutants, it must measure all of the base neutral pollutants listed in the table below. The list includes EPA required base neutral priority pollutants and several additional polynuclear aromatic hydrocarbons (PAHs). The Water Quality Program added several PAHs to the list of base neutrals below from Ecology's Persistent Bioaccumulative Toxics (PBT) List. It only added those PBT parameters of interest to Appendix A that did not increase the overall cost of analysis unreasonably.

Ecology added this appendix to the permit in order to reduce the number of analytical "non-detects" in permit-required monitoring and to measure effluent concentrations near or below criteria values where possible at a reasonable cost.

The lists below include conventional pollutants (as defined in CWA section 502(6) and 40 CFR Part 122.), toxic or priority pollutants as defined in CWA section 307(a)(1) and listed in 40 CFR Part 122 Appendix D, 40 CFR Part 401.15 and 40 CFR Part 423 Appendix A), and nonconventionals. 40 CFR Part 122 Appendix D (Table V) also identifies toxic pollutants and hazardous substances which are required to be reported by dischargers if expected to be present. This permit appendix A list does not include those parameters.

CONVENTIONAL POLLUTANTS				
Pollutant	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] *µg/L unless specified***	**Quantitation Level (QL)[2] *µg/L unless specified***
Biochemical Oxygen Demand		SM5210-B		2 mg/L
Biochemical Oxygen Demand, Soluble		SM5210-B [3]		2 mg/L
Fecal Coliform		SM 9221E,9222	N/A	Specified in method - sample aliquot dependent
Oil and Grease (HEM) (Hexane Extractable Material)		1664 A or B	1,400	5,000
pH		SM4500-H^+ B	N/A	N/A
Total Suspended Solids		SM2540-D		5 mg/L

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Alkalinity, Total		SM2320-B		5 mg/L as CaCO3
Aluminum, Total	7429-90-5	200.8	2.0	10

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Ammonia, Total (as N)		SM4500-NH3-B and C/D/E/G/H		20
Barium Total	7440-39-3	200.8	0.5	2.0
BTEX (benzene +toluene + ethylbenzene + m,o,p xylenes)		EPA SW 846 8021/8260	1	2
Boron, Total	7440-42-8	200.8	2.0	10.0
Chemical Oxygen Demand		SM5220-D		10 mg/L
Chloride		SM4500-Cl B/C/D/E and SM4110 B		Sample and limit dependent
Chlorine, Total Residual		SM4500 Cl G		50.0
Cobalt, Total	7440-48-4	200.8	0.05	0.25
Color		SM2120 B/C/E		10 color units
Dissolved oxygen		SM4500-OC/OG		0.2 mg/L
Flow		Calibrated device		
Fluoride	16984-48-8	SM4500-F E	25	100
Hardness, Total		SM2340B		200 as CaCO3
Iron, Total	7439-89-6	200.7	12.5	50

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Magnesium, Total	7439-95-4	200.7	10	50
Manganese, Total	7439-96-5	200.8	0.1	0.5
Molybdenum, Total	7439-98-7	200.8	0.1	0.5
Nitrate + Nitrite Nitrogen (as N)		SM4500-NO3- E/F/H		100
Nitrogen, Total Kjeldahl (as N)		SM4500-N_{org}B/C and SM4500NH_3-B/C/D/EF/G/H		300
NWTPH Dx [4]		Ecology NWTPH Dx	250	250
NWTPH Gx [5]		Ecology NWTPH Gx	250	250
Phosphorus, Total (as P)		SM 4500 PB followed by SM4500-PE/PF	3	10
Salinity		SM2520-B		3 practical salinity units or scale (PSU or PSS)
Settleable Solids		SM2540 -F		Sample and limit dependent
Soluble Reactive Phosphorus (as P)		SM4500-P E/F/G	3	10
Sulfate (as mg/L SO_4)		SM4110-B		0.2 mg/L

NONCONVENTIONAL POLLUTANTS				
Pollutant & CAS No. (if available)	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1] µg/L unless specified**	**Quantitation Level (QL)[2] µg/L unless specified**
Sulfide (as mg/L S)		SM4500-S^2F/D/E/G		0.2 mg/L
Sulfite (as mg/L SO_3)		SM4500-SO3B		2 mg/L
Temperature (max. 7-day avg.)		Analog recorder or Use micro-recording devices known as thermistors		0.2º C
Tin, Total	7440-31-5	200.8	0.3	1.5
Titanium, Total	7440-32-6	200.8	0.5	2.5
Total Coliform		SM 9221B, 9222B, 9223B	N/A	Specified in method - sample aliquot dependent
Total Organic Carbon		SM5310-B/C/D		1 mg/L
Total dissolved solids		SM2540 C		20 mg/L

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
METALS, CYANIDE & TOTAL PHENOLS					
Antimony, Total	114	7440-36-0	200.8	0.3	1.0
Arsenic, Total	115	7440-38-2	200.8	0.1	0.5
Beryllium, Total	117	7440-41-7	200.8	0.1	0.5
Cadmium, Total	118	7440-43-9	200.8	0.05	0.25
Chromium (hex) dissolved	119	18540-29-9	SM3500-Cr C	0.3	1.2
Chromium, Total	119	7440-47-3	200.8	0.2	1.0
Copper, Total	120	7440-50-8	200.8	0.4	2.0
Lead, Total	122	7439-92-1	200.8	0.1	0.5
Mercury, Total	123	7439-97-6	1631E	0.0002	0.0005
Nickel, Total	124	7440-02-0	200.8	0.1	0.5
Selenium, Total	125	7782-49-2	200.8	1.0	1.0
Silver, Total	126	7440-22-4	200.8	0.04	0.2
Thallium, Total	127	7440-28-0	200.8	0.09	0.36
Zinc, Total	128	7440-66-6	200.8	0.5	2.5

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
METALS, CYANIDE & TOTAL PHENOLS					
Cyanide, Total	121	57-12-5	335.4	5	10
Cyanide, Weak Acid Dissociable	121		SM4500-CN I	5	10
Cyanide, Free Amenable to Chlorination (Available Cyanide)	121		SM4500-CN G	5	10
Phenols, Total	65		EPA 420.1		50

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
ACID COMPOUNDS					
2-Chlorophenol	24	95-57-8	625.1	3.3	9.9
2,4-Dichlorophenol	31	120-83-2	625.1	2.7	8.1
2,4-Dimethylphenol	34	105-67-9	625.1	2.7	8.1
4,6-dinitro-o-cresol (2-methyl-4,6,-dinitrophenol)	60	534-52-1	625.1/1625B	24	72
2,4 dinitrophenol	59	51-28-5	625.1	42	126

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
ACID COMPOUNDS					
2-Nitrophenol	57	88-75-5	625.1	3.6	10.8
4-Nitrophenol	58	100-02-7	625.1	2.4	7.2
Parachlorometa cresol (4-chloro-3-methylphenol)	22	59-50-7	625.1	3.0	9.0
Pentachlorophenol	64	87-86-5	625.1	3.6	10.8
Phenol	65	108-95-2	625.1	1.5	4.5
2,4,6-Trichlorophenol	21	88-06-2	625.1	2.7	8.1

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
VOLATILE COMPOUNDS					
Acrolein	2	107-02-8	624	5	10
Acrylonitrile	3	107-13-1	624	1.0	2.0
Benzene	4	71-43-2	624.1	4.4	13.2

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
VOLATILE COMPOUNDS					
Bromoform	47	75-25-2	624.1	4.7	14.1
Carbon tetrachloride	6	56-23-5	624.1/601 or SM6230B	2.8	8.4
Chlorobenzene	7	108-90-7	624.1	6.0	18.0
Chloroethane	16	75-00-3	624/601	1.0	2.0
2-Chloroethylvinyl Ether	19	110-75-8	624	1.0	2.0
Chloroform	23	67-66-3	624.1 or SM6210B	1.6	4.8
Dibromochloromethane (chlordibromomethane)	51	124-48-1	624.1	3.1	9.3
1,2-Dichlorobenzene	25	95-50-1	624	1.9	7.6
1,3-Dichlorobenzene	26	541-73-1	624	1.9	7.6
1,4-Dichlorobenzene	27	106-46-7	624	4.4	17.6
Dichlorobromomethane	48	75-27-4	624.1	2.2	6.6
1,1-Dichloroethane	13	75-34-3	624.1	4.7	14.1
1,2-Dichloroethane	10	107-06-2	624.1	2.8	8.4
1,1-Dichloroethylene	29	75-35-4	624.1	2.8	8.4

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL)[2] *µg/L unless specified*
VOLATILE COMPOUNDS					
1,2-Dichloropropane	32	78-87-5	624.1	6.0	18.0
1,3-dichloropropene (mixed isomers) (1,2-dichloropropylene)[6]	33	542-75-6	624.1	5.0	15.0
Ethylbenzene	38	100-41-4	624.1	7.2	21.6
Methyl bromide (Bromomethane)	46	74-83-9	624/601	5.0	10.0
Methyl chloride (Chloromethane)	45	74-87-3	624	1.0	2.0
Methylene chloride	44	75-09-2	624.1	2.8	8.4
1,1,2,2-Tetrachloroethane	15	79-34-5	624.1	6.9	20.7
Tetrachloroethylene	85	127-18-4	624.1	4.1	12.3
Toluene	86	108-88-3	624.1	6.0	18.0
1,2-Trans-Dichloroethylene (Ethylene dichloride)	30	156-60-5	624.1	1.6	4.8
1,1,1-Trichloroethane	11	71-55-6	624.1	3.8	11.4
1,1,2-Trichloroethane	14	79-00-5	624.1	5.0	15.0
Trichloroethylene	87	79-01-6	624.1	1.9	5.7
Vinyl chloride	88	75-01-4	624/SM6200B	1.0	2.0

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL)[2] *µg/L unless specified*
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Acenaphthene	1	83-32-9	625.1	1.9	5.7
Acenaphthylene	77	208-96-8	625.1	3.5	10.5
Anthracene	78	120-12-7	625.1	1.9	5.7
Benzidine	5	92-87-5	625.1	44	132
Benzyl butyl phthalate	67	85-68-7	625.1	2.5	7.5
Benzo(*a*)anthracene	72	56-55-3	625.1	7.8	23.4
Benzo(b)fluoranthene (3,4-benzofluoranthene) [7]	74	205-99-2	610/625.1	4.8	14.4
Benzo(j)fluoranthene [7]		**205-82-3**	625	0.5	1.0
Benzo(k)fluoranthene (11,12-benzofluoranthene) [7]	75	207-08-9	610/625.1	2.5	7.5
Benzo(r,s,t)pentaphene		**189-55-9**	625	1.3	5.0
Benzo(*a*)pyrene	73	50-32-8	610/625.1	2.5	7.5
Benzo(*ghi*)Perylene	79	191-24-2	610/625.1	4.1	12.3
Bis(*2-chloroethoxy)*methane	43	111-91-1	625.1	5.3	15.9

PRIORITY POLLUTANTS	**PP #**	**CAS Number (if available)**	**Recommended Analytical Protocol**	**Detection (DL)[1]** ***µg/L unless specified***	**Quantitation Level (QL) [2]** ***µg/L unless specified***
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Bis(*2-chloroethyl*)ether	18	111-44-4	611/625.1	5.7	17.1
Bis(*2-chloroisopropyl*)ether	42	39638-32-9	625	0.5	1.0
Bis(*2-ethylhexyl*)phthalate	66	117-81-7	625.1	2.5	7.5
4-Bromophenyl phenyl ether	41	101-55-3	625.1	1.9	5.7
2-Chloronaphthalene	20	91-58-7	625.1	1.9	5.7
4-Chlorophenyl phenyl ether	40	7005-72-3	625.1	4.2	12.6
Chrysene	76	218-01-9	610/625.1	2.5	7.5
Dibenzo (a,h)acridine		**226-36-8**	610M/625M	2.5	10.0
Dibenzo (a,j)acridine		**224-42-0**	610M/625M	2.5	10.0
Dibenzo(a-*h*)anthracene (1,2,5,6-dibenzanthracene)	82	53-70-3	625.1	2.5	7.5
Dibenzo(a,e)pyrene		192-65-4	610M/625M	2.5	10.0
Dibenzo(a,h)pyrene		189-64-0	625M	2.5	10.0
3,3-Dichlorobenzidine	28	91-94-1	605/625.1	16.5	49.5
Diethyl phthalate	70	84-66-2	625.1	1.9	5.7

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Dimethyl phthalate	71	131-11-3	625.1	1.6	4.8
Di-n-butyl phthalate	68	84-74-2	625.1	2.5	7.5
2,4-dinitrotoluene	35	121-14-2	609/625.1	5.7	17.1
2,6-dinitrotoluene	36	606-20-2	609/625.1	1.9	5.7
Di-n-octyl phthalate	69	117-84-0	625.1	2.5	7.5
1,2-Diphenylhydrazine (*as Azobenzene*)	37	122-66-7	1625B	5.0	20
Fluoranthene	39	206-44-0	625.1	2.2	6.6
Fluorene	80	86-73-7	625.1	1.9	5.7
Hexachlorobenzene	9	118-74-1	612/625.1	1.9	5.7
Hexachlorobutadiene	52	87-68-3	625.1	0.9	2.7
Hexachlorocyclopentadiene	53	77-47-4	1625B/625	2.0	4.0
Hexachloroethane	12	67-72-1	625.1	1.6	4.8
Indeno(*1,2,3-cd*)Pyrene	83	193-39-5	610/625.1	3.7	11.1
Isophorone	54	78-59-1	625.1	2.2	6.6
3-Methyl cholanthrene		**56-49-5**	625	2.0	8.0

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
BASE/NEUTRAL COMPOUNDS (compounds in bold are Ecology PBTs)					
Naphthalene	55	91-20-3	625.1	1.6	4.8
Nitrobenzene	56	98-95-3	625.1	1.9	5.7
N-Nitrosodimethylamine	61	62-75-9	607/625	2.0	4.0
N-Nitrosodi-n-propylamine	63	621-64-7	607/625	0.5	1.0
N-Nitrosodiphenylamine	62	86-30-6	625	1.0	2.0
Perylene		**198-55-0**	625	1.9	7.6
Phenanthrene	81	85-01-8	625.1	5.4	16.2
Pyrene	84	129-00-0	625.1	1.9	5.7
1,2,4-Trichlorobenzene	8	120-82-1	625.1	1.9	5.7

PRIORITY POLLUTANT	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
DIOXIN					
2,3,7,8-Tetra-Chlorodibenzo-P-Dioxin (2,3,7,8 TCDD)	129	1746-01-6	1613B	1.3 pg/L	5 pg/L

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
PESTICIDES/PCBs					
Aldrin	89	309-00-2	608.3	4.0 ng/L	12 ng/L
alpha-BHC	102	319-84-6	608.3	3.0 ng/L	9.0 ng/L
beta-BHC	103	319-85-7	608.3	6.0 ng/L	18 ng/L
gamma-BHC (Lindane)	104	58-89-9	608.3	4.0 ng/L	12 ng/L
delta-BHC	105	319-86-8	608.3	9.0 ng/L	27 ng/L
Chlordane [8]	91	57-74-9	608.3	14 ng/L	42 ng/L
4,4'-DDT	92	50-29-3	608.3	12 ng/L	36 ng/L
4,4'-DDE	93	72-55-9	608.3	4.0 ng/L	12 ng/L
4,4' DDD	94	72-54-8	608.3	11ng/L	33 ng/L
Dieldrin	90	60-57-1	608.3	2.0 ng/L	6.0 ng/L
alpha-Endosulfan	95	959-98-8	608.3	14 ng/L	42 ng/L
beta-Endosulfan	96	33213-65-9	608.3	4.0 ng/L	12 ng/L
Endosulfan Sulfate	97	1031-07-8	608.3	66 ng/L	198 ng/L
Endrin	98	72-20-8	608.3	6.0 ng/L	18 ng/L

PRIORITY POLLUTANTS	PP #	CAS Number (if available)	Recommended Analytical Protocol	Detection (DL)[1] *µg/L unless specified*	Quantitation Level (QL) [2] *µg/L unless specified*
PESTICIDES/PCBs					
Endrin Aldehyde	99	7421-93-4	608.3	23 ng/L	70 ng/L
Heptachlor	100	76-44-8	608.3	3.0 ng/L	9.0 ng/L
Heptachlor Epoxide	101	1024-57-3	608.3	83 ng/L	249 ng/L
PCB-1242 [9]	106	53469-21-9	608.3	0.065	0.195
PCB-1254	107	11097-69-1	608.3	0.065	0.195
PCB-1221	108	11104-28-2	608.3	0.065	0.195
PCB-1232	109	11141-16-5	608.3	0.065	0.195
PCB-1248	110	12672-29-6	608.3	0.065	0.195
PCB-1260	111	11096-82-5	608.3	0.065	0.195
PCB-1016 [9]	112	12674-11-2	608.3	0.065	0.195
Toxaphene	113	8001-35-2	608.3	240 ng/L	720 ng/L

1. Detection level (DL) or detection limit means the minimum concentration of an analyte (substance) that can be measured and reported with a 99 percent confidence that the analyte concentration is greater than zero as determined by the procedure given in 40 CFR part 136, Appendix B.

2. Quantitation Level (QL) also known as Minimum Level of Quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the lab has used all method-specified sample weights, volumes, and cleanup procedures. The QL is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1, 2, or 5) x 10^n, where n is an integer. (64 FR 30417).

ALSO GIVEN AS:

The smallest detectable concentration of analyte greater than the Detection Limit (DL) where the accuracy (precision & bias) achieves the objectives of the intended purpose. (Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs Submitted to the US Environmental Protection Agency December 2007).

3. Soluble Biochemical Oxygen Demand method note: First, filter the sample through a Millipore Nylon filter (or equivalent) - pore size of 0.45-0.50 um (prep all filters by filtering 250 ml of laboratory grade deionized water through the filter and discard). Then, analyze sample as per method 5210-B.

4. NWTPH Dx - Northwest Total Petroleum Hydrocarbons Diesel Extended Range – see https://fortress.wa.gov/ecy/publications/documents/97602.pdf

5. NWTPH Gx - Northwest Total Petroleum Hydrocarbons Gasoline Extended Range – see https://fortress.wa.gov/ecy/publications/documents/97602.pdf

6. 1, 3-dichloroproylene (mixed isomers) You may report this parameter as two separate parameters: cis-1, 3-dichlorpropropene (10061-01-5) and trans-1, 3-dichloropropene (10061-02-6).

7. Total Benzofluoranthenes - Because Benzo(b)fluoranthene, Benzo(j)fluoranthene and Benzo(k)fluoranthene co-elute you may report these three isomers as total benzofluoranthenes.

8. Chlordane – You may report alpha-chlordane (5103-71-9) and gamma-chlordane (5103-74-2) in place of chlordane (57-74-9). If you report alpha and gamma-chlordane, the DL/PQLs that apply are 14/42 ng/L.

9. PCB 1016 & PCB 1242 – You may report these two PCB compounds as one parameter called PCB 1016/1242.

ADDENDUM TO THE FACT SHEET FOR CITY OF PORT TOWNSEND COMPOST FACILITY STATE WASTE DISCHARGE PERMIT ST0006127

1. GENERAL INFORMATION

Facility: City of Port Townsend Compost Facility
603 County Landfill Road
Port Townsend, WA 98368

2. APPLICATION AND COMPLIANCE REVIEW

The city of Port Townsend submitted an application to the Department of Ecology (Ecology) on November 6, 2017, for permit reissuance, and Ecology accepted it on December 7, 2017. Ecology reviewed inspections and assessed compliance of the facility's discharge with the terms and conditions in the previous permit. Ecology has sufficiently reviewed the application, discharge monitoring reports, and other facility information in enough detail to ensure that:

- The city of Port Townsend Compost Facility has complied with all of the terms, conditions, requirements and schedules of compliance of the expired permit.
- Ecology has up-to date information on the city of Port Townsend Compost Facility's waste treatment practices; and the nature, content, volume, and frequency of its discharge.
- The discharge meets applicable effluent standards and limits, ground water quality standards, and other legally applicable requirements (see more information in Section 4).

Since the issuance of the current permit, Ecology has not received any additional information, which indicates that environmental impacts from the discharge warrant a complete renewal of the permit. Therefore, Ecology chose to reauthorize this permit.

3. PERMIT REAUTHORIZATION

When Ecology reauthorizes a discharge permit it essentially reissues the permit with the existing limits, terms and conditions. Alternatively, when Ecology renews a permit it re-evaluates the impact of the discharge on the ground water, which may lead to changes in the limits, terms and conditions of the permit.

The permit reauthorization process, along with the renewal of high priority permits, allows Ecology to reissue permits in a timely manner and minimize the number of active permits that have passed their expiration dates. Ecology assesses each permit that is expiring and due for reissuance and compares it with other permits due for reissuance when it plans its workload for the upcoming year.

This fact sheet addendum accompanies the permit, which Ecology proposes to reauthorize for the discharge of wastewater to groundwater. The previous fact sheet explains the basis for the discharge limits and conditions of the reauthorized permit and remains as part of the administrative record.

4. PERMIT LIMITS AND CONDITIONS

The reauthorized permit is virtually identical to the previous permit issued on June 10, 2013, with a few exceptions identified below. Ecology removed the completed report requirements that do not require additional or continued assessment. The proposed reauthorized permit includes:

- The discharge limits and conditions in effect at the time of expiration of the previous permit.
- Changes to the submittal dates for reports from those in the previous permit.
- Adjusted dates for the other necessary compliance and submittal requirements carried over from the past permit.
- Appendix A, which identifies the required test methods, detection levels and quantitation levels for the monitoring required in the proposed permit.

5. PUBLIC PROCESS

Ecology public notices the availability of the draft reauthorized permit at least 30 days before it reissues the permit. Ecology invites you to review and comment on its decision to reauthorize the permit (see **Appendix A-Public Involvement Information** for more detail on the Public Notice procedures).

After the public comment period has closed, Ecology will prepare a *Response to Comments* document and attach it to this fact sheet addendum. Ecology will respond to each comment and describe the resultant changes to the permit in this document. Ecology sends a copy of the *Response to Comments* to all parties that submitted comments.

6. PERMIT APPEAL PROCESS

Appendix B describes the permit appeal process.

7. RECOMMENDATION FOR PERMIT ISSUANCE

Ecology proposes to reissue this permit for five years.

APPENDIX A--PUBLIC INVOLVEMENT INFORMATION

Ecology proposes to reissue a permit to the city of Port Townsend Compost Facility. The permit includes wastewater discharge limits and other conditions. This fact sheet describes the facility and Ecology's reasons for requiring permit conditions.

Ecology will place a Public Notice of Draft on April 10, 2019 in *Port Townsend Leader* to inform the public and to invite comment on the proposed draft state waste discharge permit and fact sheet.

The notice:

- Tells where copies of the draft permit and fact sheet are available for public evaluation (a local public library, the closest regional or field office, posted on our website).
- Offers to provide the documents in an alternate format to accommodate special needs.
- Asks people to tell us how well the proposed permit would protect the receiving water.
- Invites people to suggest fairer conditions, limits, and requirements for the permit.
- Invites comments on Ecology's determination of compliance with antidegradation rules.
- Urges people to submit their comments, in writing, before the end of the comment period.
- Tells how to request a public hearing about the proposed State Waste Discharge permit.
- Explains the next step(s) in the permitting process.

Ecology has published a document entitled *Frequently Asked Questions about Effective Public Commenting,* which is available on our website.

You may obtain further information from Ecology by telephone, 360-407-6278, or by writing to the address listed below.

Water Quality Permit Coordinator
Department of Ecology
Southwest Regional Office
PO Box 47775
Olympia, WA 98504-7775

The primary authors of the permit and fact sheet addendum are Carey Cholski and Dave Dougherty.

APPENDIX B --YOUR RIGHT TO APPEAL

You have a right to appeal this permit to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of the final permit. The appeal process is governed by chapter 43.21B RCW and chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2) (see glossary).

To appeal you must do the following within 30 days of the date of receipt of this permit:

- File your appeal and a copy of this permit with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this permit on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in chapter 43.21B RCW and chapter 371-08 WAC.

ADDRESS AND LOCATION INFORMATION

Street Addresses	Mailing Addresses
Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive Southeast Lacey, WA 98503 **Pollution Control Hearings Board** 1111 Israel Road Southwest, Suite 301 Tumwater, WA 98501	**Department of Ecology** Attn: Appeals Processing Desk PO Box 47608 Olympia, WA 98504-7608 **Pollution Control Hearings Board** PO Box 40903 Olympia, WA 98504-0903

APPENDIX C – RESPONSE TO COMMENTS

No comments were received.

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Appendix F

SEPA Checklist/DNS and SERP/Affirmed Determination

To be Provided Later

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Appendix G

City Wastewater Engineering Standards

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CITY OF PORT TOWNSEND

DEPARTMENT OF PUBLIC WORKS

ENGINEERING
DESIGN STANDARDS
MANUAL

April 1997

Robert L. Wheeler, P. E., Director of Public Works
David L. Peterson, P.E., City Engineer
Colette Kostelec, P.E. Development Review Engineer

Chapter 3
WASTEWATER

1. General Requirements

a. Wastewater systems refer to the facilities that transport, treat, and discharge water-carried waste materials from domestic, commercial, and industrial sources. This chapter of the Standards addresses service connections to the existing mains as well as extensions, repairs, lift stations, and other system improvements.

b. Any extension, replacement, or other improvement of the Port Townsend Wastewater System must be approved by the Department of Public Works and all extensions must conform to the current standards of the City of Port Townsend and to Department of Ecology regulations. The material contained in these Standards shall be used in conjunction with the Washington State Department of Ecology regulations to develop all plans and specification for construction of wastewater facilities. Where there are conflicts or differences between these standards, DOH regulations and city ordinances, the DOH regulations shall apply followed in order of precedence by city ordinances and these Standards.

c. City sewer service shall not be extended outside the city limits.

d. In designing and planning for any development, it is the developer's responsibility to see that adequate wastewater systems are provided. The developer must show, in the proposed plans, how the development will be served by sewers and whether the existing system can adequately handle the flows and loads. Improvements necessary to assure that the existing system will not be adversely impacted are the responsibility of the developer. A detailed analysis of the system may be required to evaluate the capacity of the existing hydraulic system to handle the new loads.

e. Anyone that wishes to extend or connect to the city's wastewater system should contact the Department of Public Works for preliminary information and discussion of the extension proposed. The design of wastewater system improvements is the responsibility of the Developer proposing the construction and upgrading of the public wastewater system.

f. Prior to acceptance by the city and the discharge of any wastewater, all improvements must be completed and approved, as-builts submitted, all rights-of-way or easements filed, and all applicable fees as set forth in Chapter 3.36 PTMC must be paid.

g. Issuance of building permits for new construction of single family residences within new subdivisions shall not occur until final Public Works approval of all improvements is given unless otherwise allowed through an approved improvement methods report and/or construction bond. For commercial projects, building permits may be issued upon completion and approval by the Public Works Director of a Wastewater Discharge Plan (including pretreatment when necessary). Certificates of occupancy will not be granted until final Public Works approval and acceptance of all wastewater system improvements is given.

h. All requests for inspections and for witnessing tests shall be scheduled with the

Public Works Department 24 hours in advance. Failure to give adequate advance notice may result in delays to the contractor for required inspections.

i. Warranty: The developer shall warranty sewer mains and other wastewater system improvements for one year after installation, approval and acceptance by the City and shall be responsible for one year for any unanticipated settling of excavations or repairs to restored street surfaces. All necessary repairs shall be performed immediately or the city shall perform the repairs at the developer's expense.

j. Traffic Control: For work in opened streets and rights-of-way, the contractor shall follow procedures described in Chapter 1 of these standards.

k. Approval for Construction Outside of Business Hours: Any work performed in any street right of way at any time other than Monday through Friday 7 am to 6 pm must have the approval of the Public Works Department.

l. Noncompliance Penalty: Utility development permits may be revoked from any contractor not complying with these specifications.

m. Survey: See Chapter 1 of these standards.

n. Standard Details: All construction shall comply with city Standard Details.

2. Design Standards

a. The design, construction, and maintenance and operation of wastewater systems shall be in compliance with the city engineering design standards, the sewer code, the wastewater system master plan, the requirements of Jefferson County Environmental Health Department, Washington State Departments of Health and Ecology, any applicable federal regulations, and the WSDOT/APWA Standard Specifications.

b. The layout and sizing of extensions shall provide for the future continuation of the existing system as determined by the Director. All sewers shall be designed as a gravity sewer whenever physically and/or economically feasible or as outlined in the Wastewater System Master Plan.

c. The following GENERAL CONDITIONS shall apply to all work on the wastewater system, and, together with those in Chapter 1, Section 2a, shall be included on any plans dealing with the wastewater system construction:

   i. All work and materials shall conform to the City of Port Townsend Standards and WSDOT/APWA Standard Specifications.

   ii. The city shall be given 72 hours notice prior to scheduling a diversion of flows in the wastewater system.

   iii. During the construction of mains and services, the contractor shall cap, plug, or secure the ends of such lines whenever the project is shut down at the end of the day so that contaminates will not enter the lines.

   iv. All lines shall be tested in conformance with the standard specifications. Prior to final acceptance of all installations, the city reserves the right to conduct an inspection of all main lines by the use of television equipment.

   v. The city construction inspector shall be notified a minimum of 24 hours in advance of the time that a service connection to an existing main is needed so that city inspection may be scheduled for the work. The inspector shall be present at the time of the tap.

vi. Prior to backfilling, all sewer lines and appurtenances shall be inspected and approved by the city's inspector. Approval shall not relieve the contractor for correction of any deficiencies and/or failure as determined by subsequent testing and inspections. It shall be the contractor's responsibility to notify the city for the required inspections.

vii. Approximate locations of existing utilities have been obtained from available records and are shown for convenience. The contractor shall be responsible for verification of locations and to avoid damage to any additional utilities not shown. If conflicts with existing utilities arise during construction, the contractor shall notify the public works inspector and any changes required shall be approved by the Public Works Director prior to commencement of related construction on the project.

viii. All sewer main extensions within the public right-of-way or in easements must be staked by survey for line and grade prior to starting construction.

3. Sewer Service Connections

a. All new developments within the city limits are required to connect to the city's sewer system with the following exception:

i. New single-family residential development occurring on parcels equal to or greater than one acre in size: a) which is more than 500 feet from the nearest city sewer main, and b) which is not subject to review and threshold determination under the State Environmental Policy Act Implementing Ordinance, Chapter 19.04 PTMC, or c) which is not subject to the permit requirements of the Environmentally Sensitive Areas Ordinance, Chapter 19.05 PTMC.

b. Managed individual or group on-site septic systems are allowed for new development which meets the requirements of subsection a.i, provided the following conditions are met:

i. The soil conditions and parcel size will support the use of an on-site septic system until connection to the city's sewer system;

ii. The system is designed to be efficiently converted to the city's sewer system;

iii. The developer enters into a no protest agreement with the City (*i.e.*, requiring connection to the city's sewer system within two year(s) of when a sewer main is within 260 feet of the property line, and/or participation in a Local Improvement District ("LID") which may include installation of sewer mains, interceptors, pump stations and/or Latecomer Agreement paybacks), filed on record title, as a condition of any building or development permit; and

iv. The septic system is approved by the Jefferson County Environmental Health Department.

c. Existing parcels containing an on-site septic system are required to connect to the city's sewer system by July 2002.

d. After July 2002, any parcel containing an on-site septic system will be required to connect to the city's sewer system unless the nearest sewer main is greater than 260 feet (*i.e.*, one city block measured along public rights-of-way) from the nearest portion of the subject parcel (in which case connection is required within two years of when the sewer is within 260 feet).

e. Notwithstanding subsections, c and d above, if an on-site septic system fails connection is required unless the nearest portion of the subject parcel is greater than 500 feet from the nearest sewer main, in which case the septic system may be repaired to serve the subject property.

4. Sewer Main Extensions and other System Improvements

a. When Required. A main extension, main replacement, pump station, maintenance hole, force main or other system improvement may be required for any of the following reasons to mitigate the direct impacts of the proposed development:
   i. Whenever a customer requests service and the premises to be served does not abut a sewer main;
   ii. Whenever the existing sewer main(s) is not adequate to provide the necessary service;
   iii. Whenever the development cannot be served by a gravity system;
   iv. Where other components of the sewer system are inadequate to handle the increased wastewater discharges;
   v. Whenever necessary to handle wastewater from the development; or
   vi. Whenever necessary to protect public health and safety.

b. Right-of-way acquisition. When sufficient right-of-way does not exist, the customer shall provide sufficient right-of-way or utility easements where necessary to serve the needs of the development and for the maintenance and orderly growth of the system.

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5. Procedural Requirements

a. <u>Public Works Technical Conference</u>. Anyone wishing to connect to or extend the city's water system is encouraged to request a meeting with Public Works staff to obtain preliminary information of the location of existing facilities and to review water system extension requirements. A technical conference will generally be required for anyone proposing a main extension.

b. <u>Application for sewer service</u>. Any person seeking to connect to the City's water system shall submit an application to the Public Works Department on forms provided by the city.
   i. Information required for the sewer service application shall include:
      (1) The name of the owner or agent and his or her mailing address, the street address or name of the premises to be served, and the legal description of the premises to be served.
      (2) An estimate of wastewater volumes for all subdivisions, multi-family, mixed use, commercial and manufacturing proposals.

(3) A site plan and details showing the proposed location for the service connection.

(4) Upon request by the director, a hydraulic analysis and assessment of the ability of the collection system and treatment facilities to handle the wastewater discharges and proposed mitigations if required.

(5) Proposed pretreatment facilities and best management practices for commercial and manufacturing facilities.

(6) Any other information deemed reasonably necessary by the director to review the application for compliance with Title 13 PTMC and these Standards or required by other provisions of the City's code, Department of Health requirements, SEPA, permit conditions, or city ordinance.

(7) The design drawings and specifications for the water system improvements required under "item d" below.

ii. Complete Application Required. The city will not process any application unless and until the information required by this section is substantially complete. The public works director may reject an application as incomplete within a reasonable time of review, in which case the director shall return it to the applicant with an indication of the additional information needed to make the application complete.

c. Utility Development Permit. A Utility Development Permit is required for any sewer main extension, replacement, and other system improvements:

i. The Utility Development Permit shall contain all design drawings and information necessary for the Public Works Department to determine compliance with these Standards and the applicable codes and standards incorporated by reference into these Standards.

ii. When the City receives the application, the application will first be checked for completeness. Once it is determined to be complete the City will begin its review of the application.

iii. Utility Development Permits are reviewed and approved by the Public Works Department. Construction shall not commence until the permit is approved by the Director.

d. Construction Drawings and Engineered Plans. All applicants for sewer system connections and improvements shall furnish drawings and specifications necessary to describe and illustrate the proposed sewer system improvements. If base maps prepared by a licensed land surveyor are available, the design and construction plans shall be submitted on such maps. If base maps are unavailable, the public works director may require a survey to avoid conflicts with existing facilities, to determine elevations and contours, and to determine the limits of the right-of-way.

i. All plans for sewer main extensions and other sewer system improvements shall be prepared, signed and stamped by a civil engineer licensed in the State of Washington.

ii. For main extensions and replacements of 260 feet (one city block) or less in Tier 1 which do not require plans under another authority of the PTMC, the developer has the option of the city performing the engineering for the fee identified in Chapter 3.36 PTMC. Alternatively, the developer may pay for his or her own engineering with the full cost to be borne by the developer.

iii. All design and construction plans and specifications shall be prepared in accordance with current DOT/APWA standard specifications and the city's engineering design standards. If discrepancies exist in the standards and specifications, the city engineering design standards shall take precedence.

iv. The requirement for engineered plans may be waived in certain instances as defined by the PTMC and approved by the City Engineer for minor improvements to the sewer system that can be adequately inspected and certified by the City Engineer and that will still assure the long-term integrity of the system. As-builts must still be submitted.

v. All plans must be reviewed and approved by the Director prior to proceeding with construction.

vi. Plans should be prepared on plan/profile type sheets and show both plan and profile views. Other utilities are to be shown in profile view and in plan view.

vii. Plans shall include specific city standards for such items as maintenance holes, drop connections, side sewers, etc.

viii. Plans shall show invert elevations of the main at the outlet and all inlets of each maintenance hole, slope of the main, and surface elevations of the maintenance hole lid. In the profile view, the finish ground elevation over the pipe shall be shown as well as crossings of other existing or proposed utilities. Stationing of side sewers from the downhill maintenance hole is required. Drawings shall show mainline connection depth and distance from nearest maintenance hole, the street that mainline connection is made in and the nearest cross street shall be identified. Drawings will show and label all connections and pipe diameters.

ix. In all cases where a line is to be placed in an easement, the easement is to be shown with measurement information to accurately lay it out prior to constructing the pipe line.

e. <u>Inspection</u>: All sewer system installations shall be inspected and approved by the City. It is the responsibility of the developer or contractor to notify the city 24 hours in advance of necessary inspections at the proper point in construction. All excavations must be left open until inspection is complete.

f. <u>Approval, Acceptance, Conveyance and As-Builts</u>: Certificates of occupancy will not be granted until final Public Works approval and acceptance of all improvements is given easements filed, all applicable fees paid and as-built drawings are received.

6. Gravity Sewer Mains

a. Size

i. Sewer mains shall be sized for the ultimate development of the tributary area.

ii. New gravity systems shall be designed on the basis of an average daily per capita flow of not less than 100 gallons per capita per day. The table "Design Basis for Sewage Works" from the DOE Manual is assumed to cover normal infiltration, but additional allowances shall be made where conditions dictate. Generally, laterals and submain sewers should be designed to carry, when running full, not less than 400 gallons daily per capita contributions of sewage. When deviations from these per capita rates are used, a description of the procedure used shall be submitted to the City Engineer for review and approval. Nothing shall preclude the city from requiring the installation of larger mains if the city determines that a larger size is needed to meet requirements for future service. The developer may be eligible for a Utility Latecomer Agreement.

iii. The minimum pipe size for sanitary sewer mains shall be 8 inches in diameter, except that a 6-inch sewer may be approved in limited instances where the sewer has no potential to be extended to serve future customers.

iv. The minimum size service connection lateral in the street right-of-way shall be 6 inches and the minimum size for a service lateral on private property shall be 4 inches in accordance with the Standard Details. The depth at the property line shall be 5 feet, except as approved by the City Engineer. Sewer connections to the main shall be made with a wye connection. All new main connections to existing mains shall require the installation of a new maintenance hole if not made at an existing maintenance hole.

v. All nonferrous pipe shall be installed with metal wire and tracer tape as shown on the Standard Details and described in Chapter 1.

vi. Gravity sewer mains shall typically have a depth of 5 feet. Actual depth will be determined by the slope, flow, velocity, and elevation of the existing system as proposed by the applicant and approved by the City.

b. Slope

i. All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Mannings' formula using an "n" value of 0.013. The following are minimum slopes which should be provided; however slopes greater than these are desirable.

(1) 8-inch Mains: 0.40 feet per 100 feet.
(2) 10-inch Mains: 0.28 feet per 100 feet.
(3) 12-inch Mains: 0.22 feet per 100 feet.
(4) 15-inch mains: 0.15 feet per 100 feet.
(5) 18-inch mains: 0.12 feet per 100 feet.
(6) 21-inch mains: 0.10 feet per 100 feet.

(7) 24-inch mains: 0.08 feet per 100 feet.
(8) 30-inch mains: 0.06 feet per 100 feet.
(9) 36-inch mains: 0.05 feet per 100 feet.

ii. Under special conditions, slopes slightly less than those required for the 2.0 feet per second velocity requirement may be permitted by the City Engineer upon request by the applicant with engineering documentation.

iii. Sewers shall be laid with a uniform slope between maintenance holes.

iv. Sewers with slopes greater than 6.0 percent slope, or where groundwater may travel as a conduit, may require check dams. Such dams shall be noted on the drawings.

v. Sewer mains on slopes of 20% or greater shall be securely anchored per WSDOT/APWA standards.

c. <u>Materials</u>: Materials for sanitary sewer pipe shall meet the requirements of the following:

i. Sanitary Sewer Pipe - Preferred:

(1) PVC Ringtight ASTM D3034, SDR 35 or ASTM F789 with joints and gaskets conforming to ASTM D3212 and ASTM F477.
(2) Ductile Iron Pipe shall conform to ANSI A 21.51 or AWWA C151 and shall be cement mortar lined with push-on joint or mechanical joint. The ductile iron pipe shall be Class 52, unless otherwise approved.

ii. Sanitary Sewer Pipe - For repair only:

(1) Concrete Sewer Pipe shall meet the requirements of ASTM C14 Class 3, unless otherwise approved.
(2) Reinforced Concrete Sewer Pipe shall conform to ASTM Designation C76 and shall be of the class specified on the plans.

iii. Pipe Zone Material - see drawings

d. <u>Connections to Existing System</u>

i. All new sewer connections to the existing system shall be physically plugged until all tests have been completed and the city approves the removal of the plug.

ii. Connection of the new sewer mains to existing maintenance holes shall be core drilled for connection by the contractor. The base shall be rechanneled so as to provide smooth transitions into existing flows.

iii. Connection of a new sewer onto an existing sewer main where a maintenance hole is not available shall be accomplished by pouring a concrete base and setting maintenance hole sections around the existing pipe. For extending onto the end of a pipe, a precast base may be used.

iv. Straight grades between the invert out of the new maintenance hole and the invert out of the existing maintenance are preferred over drops.

v. An outside drop connection shall be constructed per the Drawings for a sewer entering a maintenance hole whenever the elevation of the entering sewer is 24 inches or more above the maintenance hole invert. Where the difference is less than 24 inches a fillet shall be poured below the entering pipe to prevent solids deposition.

vi. Connections when a building sewer is the same size as the existing sewer main shall be accomplished by installation of a new maintenance hole, unless otherwise approved in writing by the City.

e. Taps: Taps shall be a gasketed saddle wye or wye with a couplet. Taps shall not protrude into the existing sewer main. All taps shall be by the contractor. The contractor shall notify the city inspector at least 24 hours prior to the tap. All tap installation shall be witnessed by the city inspector.

f. Location: Parallel water and sewer lines shall be laid at least 10 feet apart horizontally. If this is impractical, the water line shall be at least three (3) feet above the top of the sewer line. Wherever it is necessary for sewer and water lines to cross each other, the crossings shall be made at an angle of approximately 90 degrees, and the sewer shall be located three or more feet below the water line if possible. See Chapter 2 "Water and Sewer Main Separation" for additional requirements.

g. Installation

i. General

(1) Installation of gravity mains shall be per WSDOT/APWA Standard Specifications Section 7-17 and 7-08.3.

(2) For typical trench details see Standard Details.

(3) Excavations shall be kept free of water.

(4) Safety is the responsibility of the contractor. Contractor(s) must conform to WISHA standards when working in excavations.

(5) All crossings and patches of city streets will be made to City standards and the contractor will be held responsible for the integrity of the patch for one full year.

(6) All new sewer services will be equipped with backflow preventer(s) when required by the City because of the floor elevation of the house relative to the sewer, or due to sewer main surcharging.

ii. Pipe Bedding and Pipe Zone

(1) The pipe bed shall be prepared per WSDOT/APWA 7-08.3(1)C.

(2) Pipe bedding and pipe zone material shall be per the WSDOT/APWA Standard Specifications Section 9-03.9(3).

(3) Bedding and pipe zones shall be as shown on the Standard Drawings.

(4) Bedding and pipe zone material shall be placed in more than one lift. The first lift, to provide at least 4 inches thickness under the pipe, shall be placed before the pipe is installed and shall be spread and compacted so that the pipe is uniformly supported. Subsequent lifts of not more than 6 inches thickness shall be installed to the crown of the pipe A further 12 inch lift of moderately compacted material shall be placed over the crown of the pipe prior to the start of backfilling the trench.

(5) Compact all pipe zone and bedding material to 95% density as determined by ASTM D698.

iii. <u>Backfill</u>

(1) Backfill material shall be per WSDOT/APWA 7-08(3) and as shown on the standard Drawings

(2) Backfill shall be compacted to 95% density under roadways and traveled ways. Controlled density backfill may be proposed as an alternate for road cuts. Compaction to 90% may be allowed where no roadways, driveways or vehicular travel will occur.

(3) Backfill to the elevation necessary to apply required surface treatment

iv. <u>Surface Treatment</u>

(1) Repair surface to original condition, including all driveways, culverts, curbs, gutters, sidewalks or other facilities damaged by the construction

(2) Street repair shall be per Chapter 6.

(3) Any drainage ditches damaged or disturbed during construction shall be pulled, dug, or otherwise repaired to restore storm drainage flow.

(4) Any disturbed vegetation shall be restored.

h. <u>Laying the Sewer Pipe</u>

i. Per WSDOT/APWA 7-083(2).

ii. All sewer main installations shall have line and grade stakes or hubs set prior to construction.

iii. The contractor may use any method such as "swede line and batter board" and "laser beam" etc., which would allow him to accurately transfer the control points provided by the surveyor in laying the pipe to the designated alignment and grade.

iv. When using the "swede line and batter board" method, the contractor shall transfer line and grade into the ditch where they shall be carried by means of a taut grade line supported on firmly set batter boards at intervals of not more than 30 feet. Not less than three batter boards shall be in use at one location. Grades shall be constantly checked and in event the batter boards do not line up, the work shall be immediately stopped and the cause remedied before proceeding with the work.

v. When using a "laser beam" to set pipe alignment and grade, the contractor shall constantly check the position of laser beam from surface hubs provided by the surveyor to ensure the laser beam is still on alignment and grade. In the event the laser beam is found out of position, the contractor shall stop work and make necessary corrections to the laser beam equipment and pipe installed.

i. <u>Inspections</u>

i. Pipe and connections shall remain exposed until inspected by the City.

ii. The contractor or his/her representative will be on-site at the time of the inspection.

j. Plugs and Connections

i. All fittings shall be capped or plugged with a plug of an approved material gasketed with the same gasket material as the pipe unit; or shall be fitted with an approved mechanical stopper; or shall have an integrally cast knock-out plug. The plug shall be able to withstand all test pressures without leaking, and when later removed, shall permit continuation of piping with jointing similar to joints in the installed line.

k. Jointing

i. Where it is necessary to break out or connect to an existing sewer during construction, only new pipe having the same inside diameter will be used in reconnecting the sewer. Where joints must be made between pipes with a mismatched wall thickness, the contractor shall use flexible gasketed coupling adaptor to make a watertight joint. Couplings shall be those manufactured by “Romac,” “Smith Blair,” or approved equal for reinforced pipes and “Fernco” or approved equal for non-reinforced pipes.

l. Cleaning and Testing

i. All sanitary sewer pipe installations shall be cleaned and tested in accordance with WSDOT/APWA Standard Specifications Section 7-17.3(2). A copy of this testing procedure is included at the end of this Section. Sewers and appurtenances shall be cleaned and tested after backfilling by either the exfiltration or low pressure air method at the option of the contractor, except where the groundwater table is such that the Public Works Director may require the infiltration test.

7. Alignment Tolerance

a. The maximum deviation from established line and grade shall not be greater than 1/32 inch per inch of pipe diameter and not to exceed 1/2 inch per pipe length.

b. No adverse grade in any pipe length will be permitted.

c. The difference in deviation from established line and grade between two successive joints shall not exceed 1/3 of the amounts specified above.

8. Maintenance holes

Maintenance holes shall be installed in accordance with these Standards, the Standard Details and WSDOT/APWA Standard Specifications Section 7-05. Where conflicts occur, these Standards shall have precedence over WSDOT/APWA Standard Specifications Section 7-05.

a. Materials:

i. Precast maintenance holes shall meet the requirements of ASTM C478 with either a precast base or a cast-in-place base made from 3,000 psi minimum structural concrete. Maintenance holes shall be as shown on the Standard Details and WSDOT drawing B-23a. Any deviations from the Standard Details will be subject to review of a shop drawing submitted by the contractor and approved by the Public Works Director.

ii. The minimum diameter of maintenance holes shall be 48 inches; larger diameters are preferable for large diameter sewers.

iii. Joints between maintenance hole elements shall be rubber gasketed conforming to ASTM C443.

iv. All pre-cast concrete shall be Class 4000. Maintenance hole channels shall be Class 3000 concrete. Concrete blocks or concrete (masonry) rings may be used for adjustment of the casting to final street grade.

v. Standard precast cones shall provide eccentric reduction from 48 inches to 24 inches with height of not less than 18 inches and 54 to 24 inches with height of not less than 24 inches. The eccentric cone shall be offset so as not to be located in the tire track or a traveled lane and shall be in line with the steps.

vi. Maintenance hole frames and covers shall be cast iron conforming to the requirements of ASTM A536, Grade 80-55-06, Olympic foundry Type MH 30D/T, or approved equal. The minimum clear opening in the frame shall be 24 inches. Grade rings and covers shall be machine-finished or ground-on seating surfaces so as to assure non-rocking fit in any position. The public works director may require that maintenance holes located in areas subject to inflow shall be equipped with a PRECO sewer guard watertight insert, or approved equal. All casting shall be coated with bituminous coating prior to delivery to the job site.

vii. Safety steps shall be fabricated of polypropylene conforming to ASTM D-4101, injection molded around a 1/2 inch ASTM A-615 grade steel bar with anti-slip tread. Steps shall project uniformly from the inside of the wall. Steps shall be installed per WSDOT/APWA Standard Plan B-24a.

b. <u>Spacing and location</u>:

i. Maintenance holes shall be provided at a maximum spacing of 300 feet. Intervals at distances greater than 300 feet require the approval of the Public Works Director.

ii. Maintenance holes shall be provided at intersections, and at all changes in direction, grade or pipe size.

iii. All maintenance holes are to be accessible to maintenance vehicles.

iv. Maintenance holes are not allowed in a fill section unless base is on a cut section.

v. A maintenance hole is required at the ends of all sewer mains, unless approved by the City.

c. <u>Construction Requirements</u>:

i. <u>Bedding</u>: Unless otherwise directed by the Public Works Director, maintenance holes shall be constructed with pre-cast base sections or cast-in-place to grade upon a 6 inch minimum depth of Crushed Surfacing Base Course meeting the requirements of WSDOT/APWA Standard Specifications Section 9.03.9(3). [verify ref.] The Crushed Surfacing Base Course shall be compacted to 95% maximum density.

ii. <u>Joints</u>: Shop drawings of the joint design shall be submitted to the Public

Works Director for approval, prior to manufacture. Completed joints shall show no visible leakage and shall conform to the dimensional requirements of ASTM 478. Joints shall be grouted from the inside.

iii. <u>Lift holes</u>: Shall be grouted from the outside and the inside of the maintenance hole.

iv. <u>Maintenance hole channels</u>: All maintenance holes shall be channeled unless otherwise approved in writing by the Public Works Director. Maintenance hole channels shall be made to conform accurately to the sewer grade and shall be brought together smoothly with well rounded junctions. Channel sides shall be carried up vertically to the crown elevation of the various pipes, and the concrete shelf between channels shall be smoothly finished and warped evenly with slope to drain.

v. <u>Maintenance hole pipe connections</u>:

(1) All pipes except PVC pipe entering or leaving the maintenance hole shall be provided with flexible joints within 1/2 of a pipe diameter or 12 inches, whichever is greater, from the outside face of the maintenance hole structure and shall be placed on firmly compacted bedding, particularly within the area of the maintenance hole excavation which normally is deeper than that of the sewer trench. Special care shall be taken to see that the openings through which pipes enter the maintenance hole are completely and firmly rammed full of non-shrink grout to ensure water tightness.

(2) PVC pipe connected to maintenance holes shall be provided with a maintenance hole adaptor complete with gasket and approved by the Public Works Director. No pipe joint in PVC shall be placed within 10 feet of the outside face of the maintenance hole.

vi. <u>Connections to existing maintenance holes</u>:

(1) The contractor shall verify invert elevations prior to construction. The crown elevation of laterals shall be the same as the crown elevation of the incoming pipe unless specified. The existing base shall be reshaped to provide a channel equivalent to that specified for a new maintenance hole.

(2) The maintenance hole shall be kept in operation at all times and the necessary precautions shall be taken to prevent debris or other material from entering the sewer, including a tight pipeline bypass through the exiting channel if required.

(3) The contractor shall core drill, line drill or wall saw an opening to match the size of pipe to be inserted. Where line drilling is the method used, the drilled holes must be interconnected. Line drilling shall be accomplished by the use of a small core drill or a rotary hammer. Jackhammer shall not be used. All openings must provide a minimum of 1 inch and a maximum of 2 inches clearance around the circumference of the pipe. Upstream pipes, except PVC pipe, penetrating the walls of maintenance holes shall

be placed with the bell facing out such that the bell is placed snug against the outside wall of the structure as the angle of penetration allows. Pipe, except PVC pipe, leaving or entering maintenance holes shall be provided with a flexible joint within 1/2 of a pipe diameter, or 12 inches, whichever is greater. After pipes have been placed to their final position, they shall be grouted tight with non-shrink grout in a workmanlike manner. PVC pipe connecting to existing maintenance hole shall be installed using gasketed inserts as approved by the Director.

(4) The contractor shall comply with all safety requirements for confined space entry.

9. Service Connection, Side Sewer, Building Sewer

A service connection for sewer (including the side sewer and building sewer) refers to the extension from the building plumbing at a point two feet from the outside of the outside of the outer foundation wall of the structure to the public sewer main. The service connection within the public right-of-way is considered the side sewer; the building sewer connects from the building to the side sewer.

a. <u>General</u>

i. Prior to construction a side sewer permit must be obtained from the City. During the permit process the City may request additional information about the type and amount of flows anticipated to the sewer system.

ii. Drawings for side sewers shall be required on forms provided by the city during the permit process. Information to be supplied is specified on the form. If the service connection does not involve extension of a main, design of the side sewer by a licensed engineer is not required.

iii. A separate and independent side sewer shall be constructed for every premises, except where multiple connections are approved by the Public Works Director.

iv. All side sewer service connections shall gravity flow into the City's wastewater system unless otherwise approved.

v. The construction of sewer service connections and side sewers shall conform to the latest edition of the Uniform Plumbing Code, WSDOT/APWA 7-18, and to the other Sections of these Standards. Where inconsistencies exist, these Standards for side sewers shall apply alike to all side sewers on public rights-of-way and private property.

vi. Maintenance of the sewer service connection is the sole responsibility of the owner of the premises served.

vii. Side sewer locations shown on the drawings shall be subject to relocation in the field after construction starts.

viii. If a side sewer is to serve two houses a six-inch clean out extending to within 12 inches of the ground surface will be required at the wye where the upper-grade connections are made.

ix. Side sewers are not permitted to cross a public right-of-way or run parallel to the right-of-way centerline. All lots must front on a public sanitary system in order to be served.

x. If a building sewer is to serve more than one property, by joint agreement of the owners, an approved document insuring that all properties involved shall have perpetual use of the side sewer, and having provisions for maintenance and for access for repair purposes, shall be signed by the recorded owner. This document shall be notarized and recorded with the county auditor and shall be referred to as an "easement."

b. Size

i. The minimum size for side sewers in the public right-of-way is 6-inches in diameter.

ii. The minimum size for a single family residential building sewer shall be 4-inch diameter.

iii. The minimum size of a dual residential, commercial/industrial and multi-family building sewer is 6-inches in diameter. A larger size may be required as determined by projected wastewater flows from the service.

c. Slope

i. The minimum slope on side sewers and building sewers shall be 2 percent.

d. Installation

i. Installation of service lines shall be the same as Water Main - Installation above.

ii. No side sewer connection shall be made to the public sewer until that section of sewer main has been approved by the city for side sewer connections.

iii. Connections to mainline will be sanitary tee or wye; 45 and 22 degree wyes may also be used depending on the situation. Connection to mainline will be either saddled, strapped and gasketed or installed with rubber repair coupler with stainless bands. Cutting in a ringtight sanitary tee or wye is also an option. No glue joints are allowed. No 90 degree bends are allowed. All right angle bends will be made with a combination of two 45 degree bends.

iv. In the event that there is no suitable tee or stub out, a tap to the main may be made by a licensed contractor, under the direct supervision of the Public Works Director. The tap shall be made with the approved rubber joint saddles on all types of sewer main. Grouting in a tee or wye is not permitted. Great care shall be taken in cutting a neat hole into the sewer main, and in the event of breakage of the sewer main, the broken section shall be removed and replaced at no cost to the city. [Alternate to iii]

v. The contractor shall prevent entrance of all foreign material into the pipe.

vi. The type of joint to be used for connecting the side sewer pipe to the tee or stub out shall be that for which the wye was designed. Rubber or plastic joint adapters shall be used as required to connect pipes and wyes of different materials or joint designs. Selected bedding material shall be hand-tamped in a moist condition under and around the wye and connection to the wye made so as to prevent any pressure on the wye. Care shall be taken to prevent the dislodging of this hand-tamped material during the balance of the backfill and water settling operation.

vii. A cleanout shall be provided within three (3) feet of the building or structure served. The cleanout shall be a wye from the service line with a branch installed upward. The wye connection shall be of the same size as the service run. A vertical riser shall be installed in the wye. This riser shall be brought to within 12 inches of the finish grade and capped with an approved cast iron plug or plastic plug with metal for detection. The plug shall be machined to fit the standard joint of the pipe being used, with the standard gasket.

viii. The connection to the building sewer shall be suitable rubber gasket sleeve or adapter. Grout joints will not be allowed. In exceptional cases, the Public Works Director may allow a connection using a hot pour jointing material JC 60 or approved equal.

ix. Where any property served by a side sewer carries industrial waste, the owner or occupant shall install a control maintenance hole in the side sewer to facilitate observation, sampling and measurement of the wastes when the same may be required by the Public Works Director. Such maintenance hole shall be accessibly and safely located and shall require plans approved prior to installation by the Public Works Director, and shall be maintained and installed by the owner or occupant at his/her sole expense.

e. Excavation, Bedding, Backfill and Compaction:

i. Follow procedures for sewer mains

ii. It shall be the responsibility of the licensed contractor to cut the road surface, dig a trench, lay the pipe, make the connection to the sewer or wye and backfill the trench within the limits of any public thoroughfare or right-of-way.

iii. The contractor shall restore all roadways, drainage features, culverts, and all other disturbed features to their original condition or as shown on the drawings.

iv. The contractor shall prevent any damage to the sewer main, tee or stub out, and shall so conduct his/her trenching operations as to prevent the possibility of damage occurring. Undercutting of sewer main and wye is prohibited.

v. The bottom of the trench must be smooth and free of large rocks which may injure the side sewer pipe. Where unsuitable bedding is found, as determined by the Public Works Director, the contractor shall over-excavate and prepare a bedding.

vi. Minimum cover for side sewers shall be five feet in the right-of-way unless otherwise approved.

f. Special discharge situations:

i. In any case where the house or building drain is too low to permit gravity flow to the public sewer, the same may be lifted by an individually-owned pumping facility that discharges to the side sewer or the sanitary sewer.

ii. A backwater valve may be prescribed by the Public Works Director where elevations of the sewer require it.

(1) The effective operation of any backwater valve shall be the responsibility of the owner of the side sewer.

g. Pipe Materials: the following pipe may be used between the sewer main and the property line and shall be used between the property line and the building drain:

i. Preferred: PVC

ii. Other: Cast Iron, Concrete Pipe

iii. The concrete pipe shall be rubber gasket pipe using "Tylox," "Flex-Tite," "Press Seal" or other approved units. The cast iron pipe shall have mechanical joints or "o" ring rubber gasket joints Tylon or equal.

h. Testing:

i. All side sewers shall be tested before backfill but after piping is suitably anchored. Side sewers that are reconstructed or repaired to a length of 10 feet or more shall be tested for water tightness. Testing of newly reconstructed sections of side sewers consisting of a single length of pipe will not be required. Testing shall be performed in the presence of the City Inspector in accordance with WSDOT Standard Specifications. A copy of this testing procedure is included at the end of this Section.

ii. When a new side sewer is installed, the entire length of new pipe shall be tested. In cases where a new tap is made on the main, the first joint of pipe off the main shall be installed with a test tee, so that an inflatable rubber ball can be inserted for sealing off the side sewer installation for testing. In cases where the side sewer stub is existing to the property line, the test ball may be inserted through the clean-out wye to test the new portion of the side sewer installation.

10. Grease Traps

Grease traps shall be required for all restaurants and other food processing facilities. Grease traps shall be cleaned at least once per year. All maintenance and cleaning costs are the responsibility of the property owner/operator.

11. Pump Stations

Any pump station which is intended to be conveyed to the City for operation and maintenance shall meet the following requirements.

a. Pump Station (General): Pump stations must be designed and installed to take into account pressure and hydraulics of distribution system, safety and aesthetics.

b. Noise Control: The following shall be provided for noise abatement and control:

i. All pump stations will be provided with adequate noise control to meet state noise guidelines.

ii. Pumps shall be housed in a concrete or equivalent structure with sound attenuation provided.

- iii. Pump stations shall be located away from residences where feasible.

c. Plans: The plans for lift stations shall include the following:
- i. An overall site drawing of the lift station showing the location of all components including elevations;
- ii. Service size, voltage and enclosure type and location in relation to the pump station;
- iii. A list of specific materials used including quantity description and manufacturer names;
- iv. A schematic and line diagram of the service and motor control center and lift station;
- v. All applicable telemetry installation with schematics;

d. Operations and Maintenance Manual: Three sets of the Operation and Maintenance manual from the lift station manufacturer shall be supplied.

e. Design Report: A design report shall be submitted with each lift station demonstrating its conformance with the standards and shall address the following items:
- i. Pump Data: size and type, horsepower, pump curves, head capacity, velocity
- ii. Motor: size and type, cycle length, type of motor
- iii. Controls: type
- iv. Telemetry: alarm system compatible with City system
- v. Housing: size and type, ventilation, humidity control, interior lighting, access
- vi. Well sizing: type, storage capacity
- vii. Maintenance: warranty, tools and equipment required
- viii. Electrical Service: size and type, source
- ix. Corrosion Protection: type of materials, coatings, linings, maintenance
- x. Site Layout: location of lift station on property
- xi. Testing: operational, pressure
- xii. Piping and Valves: size and type

f. Pumps are to be engineered and manufactured under a written Quality Assurance program. The Quality Assurance program is to be in effect for at least five (5) years, to include a written record of periodic internal and external audits to confirm compliance with UL Quality Assurance specifications.

g. Lift stations must be either a wet well/dry well type or submersible type.

h. Location:
- i. Lift station structures and electrical and mechanical equipment shall be protected from the 100 year flood.
- ii. Lift stations shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

i. Emergency Power:
- i. Lift stations must be provided with an emergency power source or auxiliary pumping equipment to ensure continuous operability unless

experience has shown the frequency and duration of outage to be low and the lift station and/or sewers provide storage sufficient for expected interruptions in power service.

ii. Provision of an emergency power supply may be accomplished by connection of the station to at least two independent public utility sources, or by provision of portable or in-place internal combustion engine equipment that will generate electrical or mechanical energy, or by the provision of portable pumping equipment.

iii. Emergency power shall be provided that, alone or combined with storage, will prevent overflows from occurring during any power outage that is equal to the maximum outage in the immediate area during the last 10 years. If available data are less than 10 years, an evaluation of a similar area served by the power utility for 10 years would be appropriate.

iv. <u>In-Place Equipment</u>:
Where in-place internal combustion equipment is utilized, the following will apply:

(1) The unit shall be bolted in place. Facilities shall be provided for unit removal for purposes of major repair or routine maintenance.

(2) Provision shall be made for automatic and manual startup and cut-in.

(3) Unit size shall be adequate to provide power for lighting and ventilating systems and such further systems that affect capability and safety as well as the pumps.

(4) The unit internal combustion engine should be located above grade, with suitable and adequate ventilation of exhaust gases.

(5) If diesel fuel is used there shall be a containment area for 125% of the diesel fuel tank capacity.

v. <u>Portable Equipment</u>:
Where portable equipment is utilized, the following apply:

(1) Pumping units shall have the capability to operate between the wet well and the discharge side of the station and the station shall be provided with permanent fixtures that will facilitate rapid and easy connection of lines.

(2) Electrical energy generating units should be protected against burnout when normal utility services are restored, and should have sufficient capacity to provide power for lighting and ventilating systems and any other station systems affecting capability and safety, in addition to the pumping units.

vi. <u>Storage</u>:
Where storage is provided in lieu of an emergency power supply, wet well and tributary main capacity above the high-level alarm should be sufficient to hold the peak flow expected during the maximum power outage duration during the last 10 years.

j. <u>Telemetry</u>:

A telemetry system shall be installed at the lift station which shall be connected to and compatible with the existing city alarm system for transferring alarm conditions from the lift station to the central alarm monitor.

k. Automated Controls:

A comprehensive automation system for the lift station shall be supplied. The equipment provided shall be a completely integrated control system consisting of the required power equipment (motor starters, circuit breakers, etc.), automation and monitoring equipment in a factory wired and tested assembly. The submersible level transducer and solid-state controller shall be standard catalogued products of the system supplier to assure one source responsibility, proper system interconnections and reliable, long term operation. The city will accept a Bulletin A1000/D152/F100 Control system as manufactured by Consolidated Electric Company, or equal. Float switches shall not be used.

l. Pump Features:

i. The following Submersible pumps are acceptable: Flight, Gorman-Rupp, Fairbanks & Morse, or equal.

ii. Heavy duty, nonclog submersible capable of passing a minimum of 3" spheres.

iii. Oil-filled, double mechanical shaft seals.

iv. Integral over temperature and moisture protection.

v. Rail mounted; stainless steel Schedule 40 pipe.

vi. Pump Sizing: Minimum two pumps. Sized to handle peak flow with one pump out of service.

vii. Pump Accessories: All accessories shall be constructed of Type 304 stainless steel.

viii. Pump safety chain: Able to lift pumps from wet well. Three-eight inch (3/8”) diameter 18” stainless steel chain, then stainless steel cable to top of rail. Safety chain clip; eye bolt for safety chain (304 SST)

ix. Intermediate guide bar bracket: Provide if guide bar exceeds 20’ in length

x. Lifting lugs: Provide if equipment exceeds 70 lbs.

xi. Anchor bolts: 316 stainless steel, at least 1” diameter

xii. Pump Installation: Pumps shall be automatically connected to the discharge connection elbow when lowered into place.

xiii. Spare Parts / Special Tools: Supply the following: 1 set special tools, 1 set upper and lower seal assembly per pump, 1 wear ring per pump, 1 complete O-ring set per pump, 1 set upper and lower bearings, 1 mechanical set seals.

xiv. Pump Painting

(1) Preparation: Abrasive Blast or centrifugal wheel blast (SP 5)

(2) Paint Material: Polyamide, anti-corrosive, epoxy primer.

(3) Min. Coats, cover: 1 coat, 2.5 MDFT

m. Instrumentation and Control: Provide heavy-duty waterproof control and power cable, motor temperature sensors for thermal overload detection. Stainless steel control panels required.

n. Special Construction: Equipment suitable for Class I, Division I, Group C and D hazardous location.

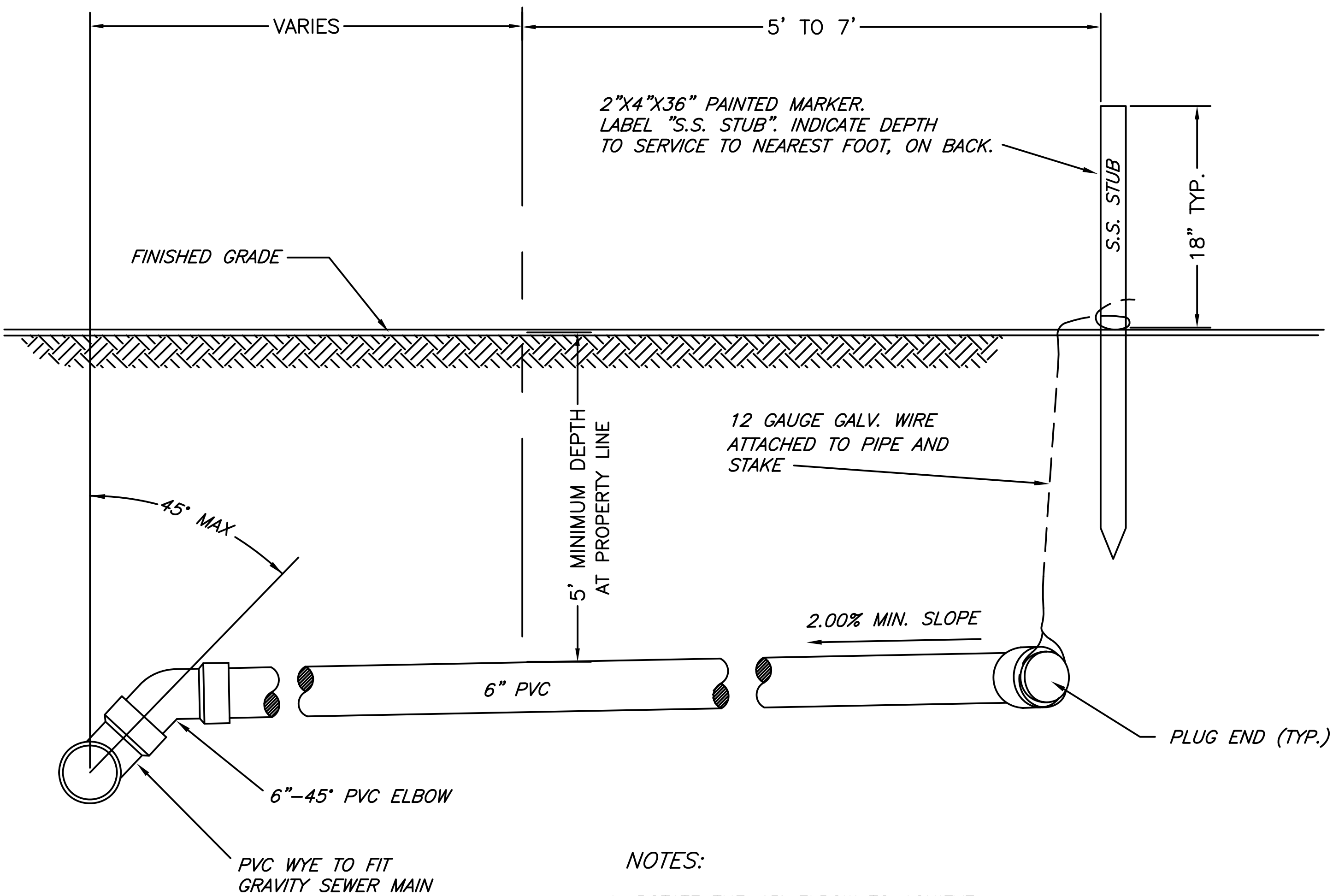
12. Individual Sewage Disposal Systems

The type, capacities, location and layout of a private sewage system shall comply with all Department of Public Health of the State of Washington, or other state regulatory agency, and to the regulations of the city. No septic tank or cesspool shall be permitted to discharge to any public sewer or natural outlet or to the ground surface. The owner shall operate and maintain the private sewage disposal facilities in a sanitary manner at all times at no expense to the city. All private septic tanks shall be thoroughly pumped a minimum of one time during any three-year period.

CHAPTER 3 - APPENDIX

Exhibit #	Standard Detail #	Title
1	SS- 1A	Single Sewer Service
2	SS - 1B	Dual Sewer Service
3	SS - 1C	Deep Trench Service Connection
4	SS - 2A	Trench Section Trenching Pavement Restoration
5	SS - 2B	Pipe Bedding
6	SS - 3	Standard Maintenance Hole/New Maintenance Hole on Existing Sewer
7	SS - 4	Sewer Cleanout Detail
8	SS - 5	24" Maintenance Hole Frame and Lid
9	SS - 6	Drop Connection for Sanitary Sewer
10	SS - 7	Pavement and Installation Underground Maintenance Hole
11	SS - 8	Typical Sewer Connection to Existing Sewer Mains
12	SS - 9	Pipe Anchor Detail For Slopes Greater Than 20%
13	SS - 10	Check Valve Assembly for Joint Use Side Sewer
14	SS - 11	Polypropylene Ladder and Maintenance Step
15		Cleaning and Testing (3 Pages)

City of Port Townsend - Public Works Department
Standard Detail



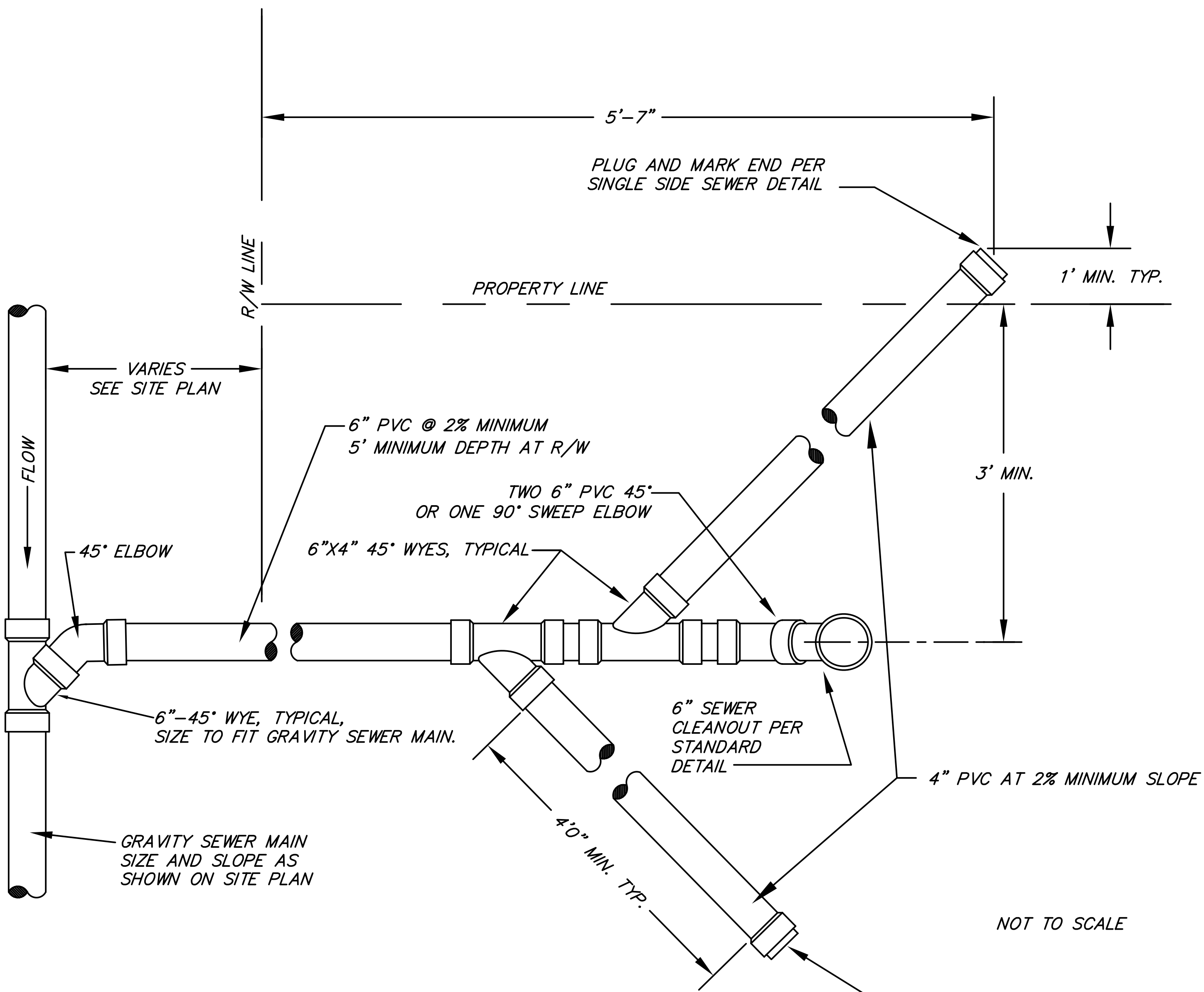
NOTES:

1. ROTATE THE 45° ELBOW TO ACHIEVE THE PROPER ANGLE TO REACH THE PROPERTY LINE WITH 5' OF COVER; THE MINIMUM ALLOWABLE SLOPE IS 2%.
2. 3' MINIMUM TO ADJOINING LOT LINE
3. SERVICE TO SINGLE RESIDENCE MAY BE REDUCED TO 4" BEYOND PLUG.

ALL WORK AND MATERIALS TO BE IN ACCORDANCE WITH CURRENT STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION", WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, AMERICAN PUBLIC WORKS ASSOCIATION.

	No.	Date	Revision	By	Apvd	
Date: April 1997						Single Sewer Service
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-1A

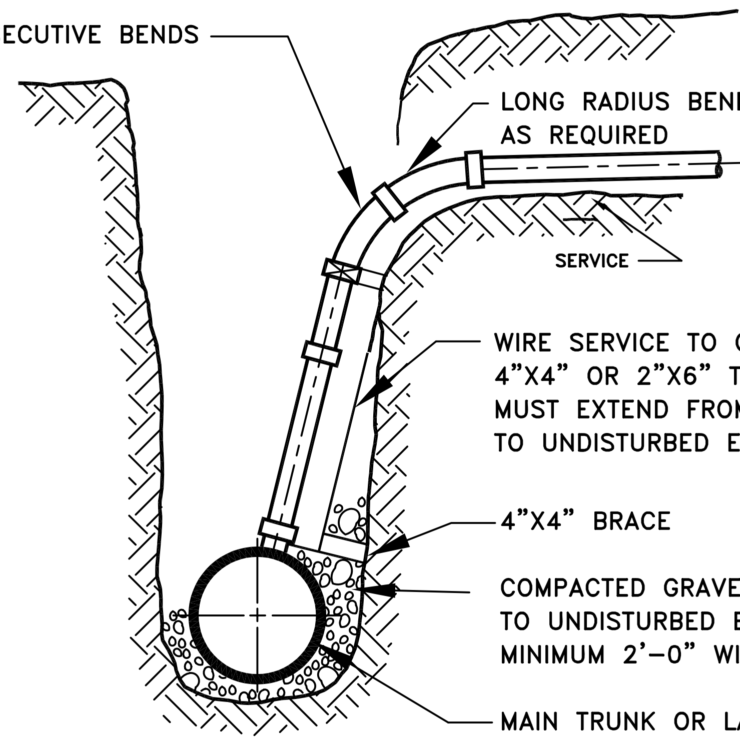
City of Port Townsend - Public Works Department
Standard Detail



ALL WORK AND MATERIALS TO BE IN ACCORDANCE WITH CURRENT STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION", WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, AMERICAN PUBLIC WORKS ASSOCIATION.

Date: April 1997	No.	Date	Revision	By	Apvd	Dual Sewer Service
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-1B

City of Port Townsend - Public Works Department
Standard Detail



INSPECTION REQUIRED UPON COMPLETION OF ROUGH GRADING AND DURING PLACEMENT OF STRUCTURAL SECTION.

CALL FOR FORM INSPECTION BY CITY PRIOR TO POURING CONCRETE AND PRIOR TO PAVING.

NOTE:

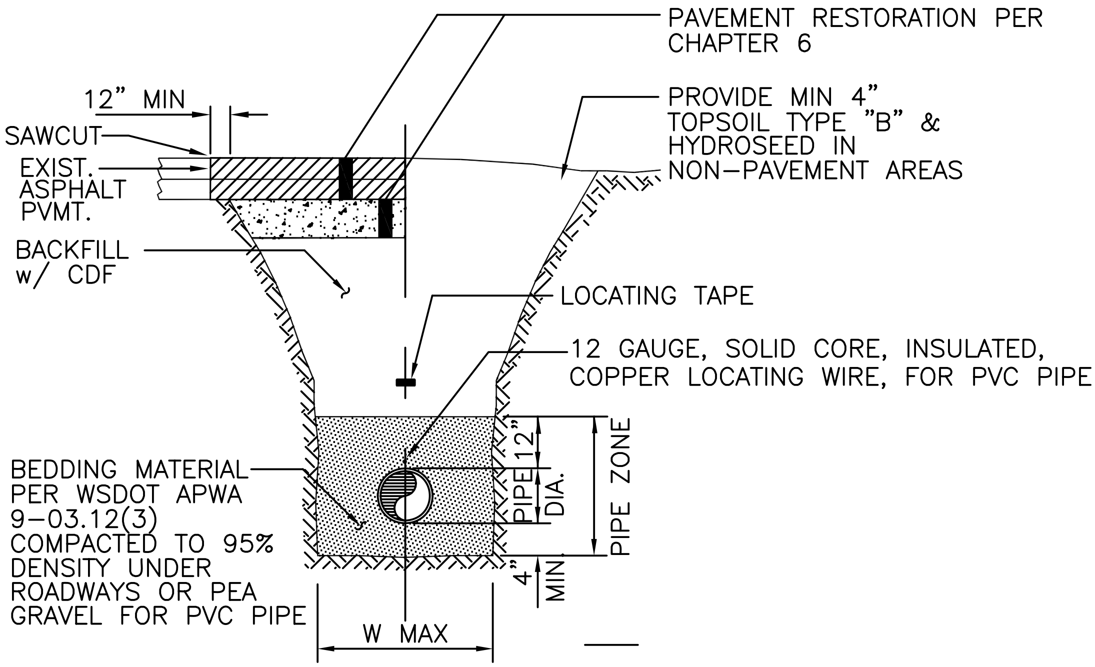
WOOD SUPPORT TO BE USED IN ALL CASES WHERE SERVICE CONNECTION CANNOT BE SUPPORTED FOR FULL LENGTH ON COMPACTED GRAVEL OR WHERE SEWER IS OVER 12'–0" DEEP TO FLOW LINE

ALL WORK AND MATERIALS TO BE IN ACCORDANCE WITH CURRENT STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION", WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, AMERICAN PUBLIC WORKS ASSOCIATION.

Date: April 1997	No.	Date	Revision	By	Apvd	Deep Trench Service Connection
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-1C

City of Port Townsend - Public Works Department
Standard Detail

TRENCH SECTION



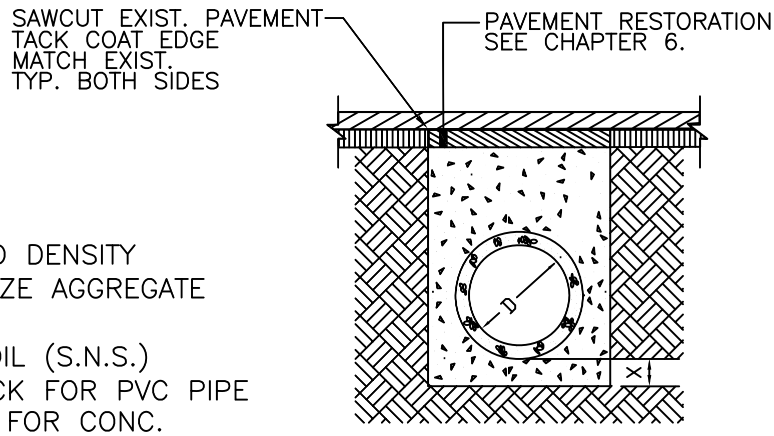
W=1.5 x PIPE DIA + 18"
FOR 6" W=27"
8" W=30"
12"W=36"

PEA GRAVEL SHALL BE FREE FROM ORGANIC MATTER MEET:

U.S. STD. SEIVE SIZE	%PASSING
3/4"	100
3/8"	95-100
#8	0-10
#200	0-3

Date: April 1997	No.	Date	Revision	By	Apvd	Trench Section and Pavement Restoration
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-2A

City of Port Townsend - Public Works Department
Standard Detail



LEGEND

C.D.F. (CONTROLLED DENSITY FILL) 1/4" MAX. SIZE AGGREGATE

SLECTED NATIVE SOIL (S.N.S.) MAX 3/4" DIA. ROCK FOR PVC PIPE MAX 2" DIA. ROCK FOR CONC. DI OR CI PIPE

NOTES :

C.D.F. SPEC. PER YARD

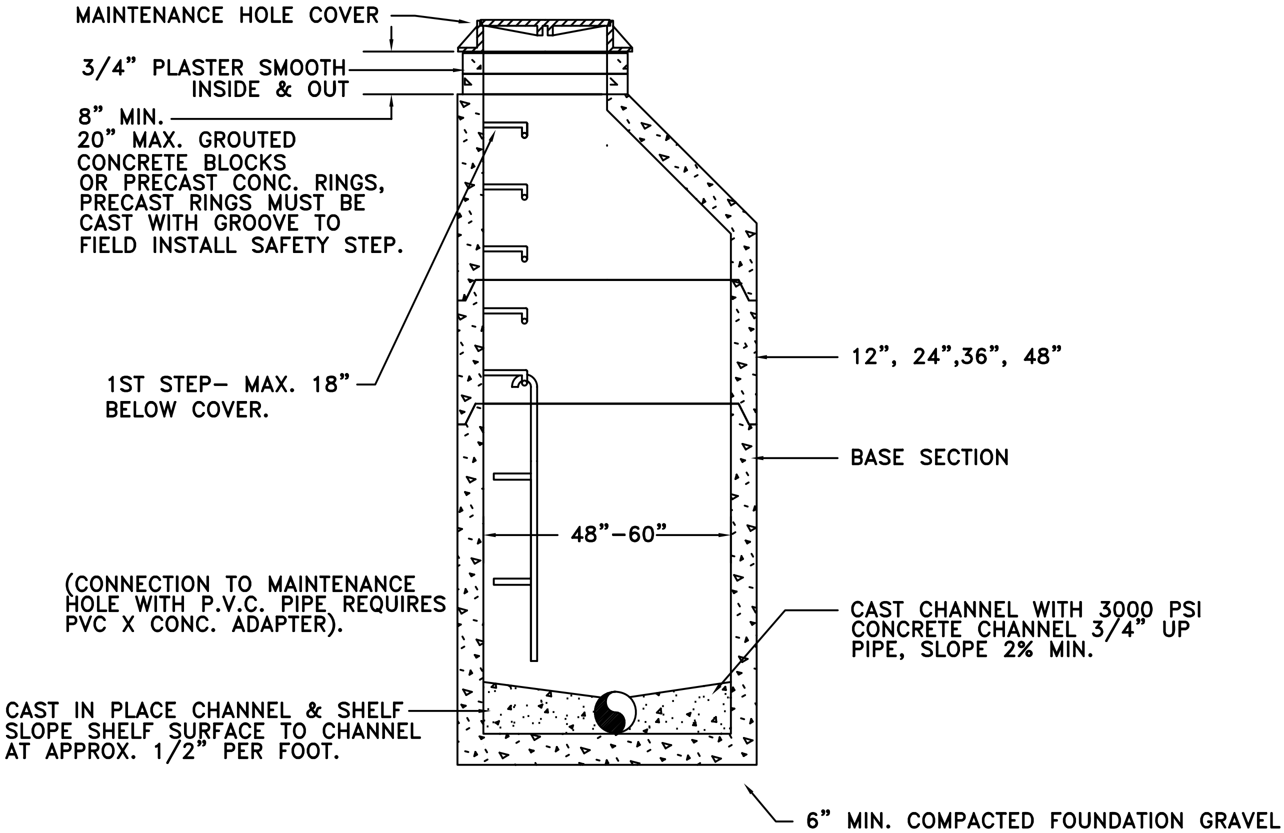
MATERIAL	POUNDS	ABS-VOLUME
CEMENT TYPE I	30	0.15
FLY ASH	300	2.19
SAND (SP.GR 2.68)	2550	15.25
WATER	300 (36 GAL)	4.81
AIR %	18.00	4.86

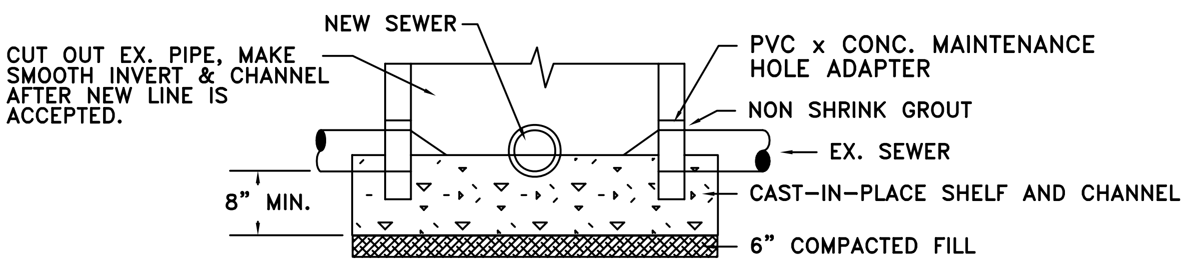
X = 2" FOR PIPE 6" & UNDER, 3" FOR PIPE 8" TO 18", 4" FOR PIPE 24" OR LARGER

C.D.F. PIPE BEDDING

Date: April 1997	No.	Date	Revision	By	Apvd	Pipe Bedding
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-2B

City of Port Townsend - Public Works Department
Standard Detail





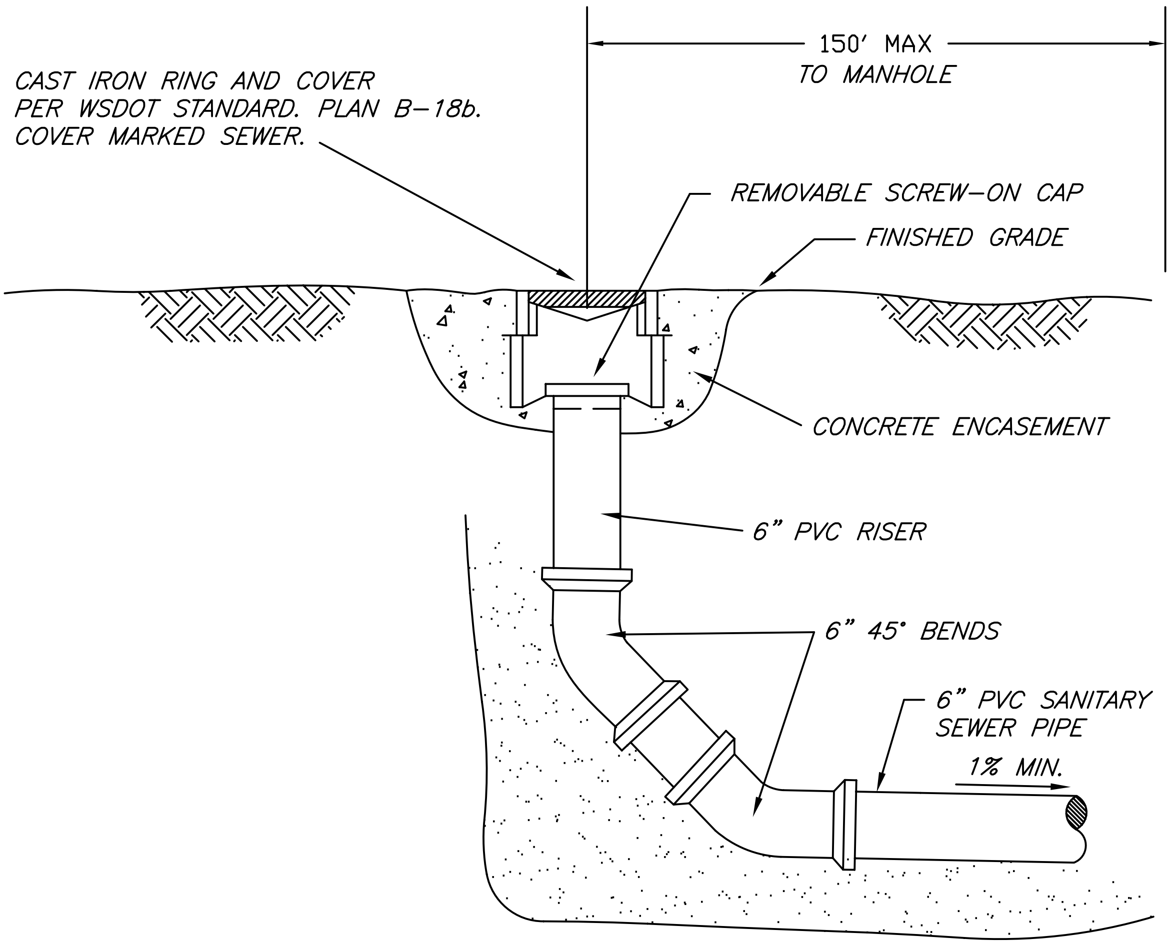
MAINTENANCE HOLE BASE - NEW MAINTENANCE HOLE ON EXISTING SEWER

GENERAL NOTES (APPLY TO ALL MAINTENANCE HOLES)

1. PRECAST SECTIONS SHALL BE REINFORCED PER ASTM SPECS FOR CORRESPONDING SEWER PIPE.
2. POLYPROPYLENE SAFETY STEPS WITH 12.0" SEPARATION BETWEEN RUNGS.
3. STEPS IN PRECAST BASE SECTION MAY BE CAST IN PLACE OR MOVABLE SAFETY LADDER GROUTED IN PLACE.
4. ALL HOLES FOR PIPE SHALL BE BLOCKED OUT AT THE TIME OF CASTING OF THE SECTION.
5 ALL RUBBER GASKETED MAINTENANCE HOLES SHALL BE FURNISHED WITH RUBBER GASKET JOINT CONFORMING TO ASTM C443.
6. MAINTENANCE HOLES OVER 10' HIGH SHALL BE FURNISHED WITH 5" MIN. WALL.
7. MINIMUM 3% SLOPE ACROSS MAINTENANCE HOLE CAHNNEL.
8. MAINTENANCE HOLES TO BE WATER TIGHT INCLUDING EXTENSIONS TO COVER CASTING

Date: April 1997	No.	Date	Revision	By	Apvd	Standard Maintenance Hole/New Maint. Hole on Existing Sewer
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-3

City of Port Townsend - Public Works Department
Standard Detail



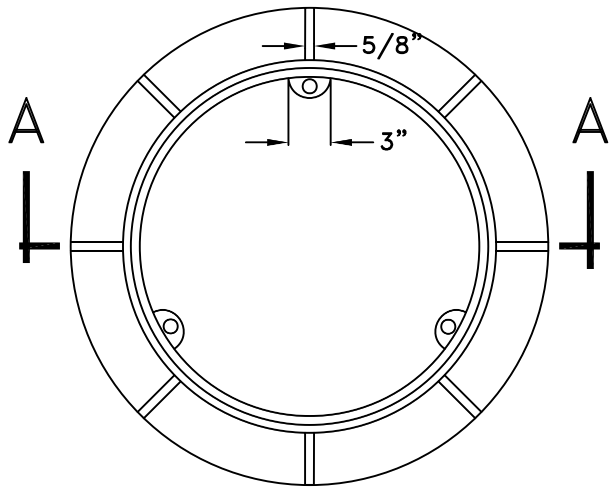
NOT TO SCALE

CALL FOR FORM INSPECTION BY CITY PRIOR TO POURING CONCRETE.

ALL WORK AND MATERIALS TO BE IN ACCORDANCE WITH CURRENT STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION", WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, AMERICAN PUBLIC WORKS ASSOCIATION.

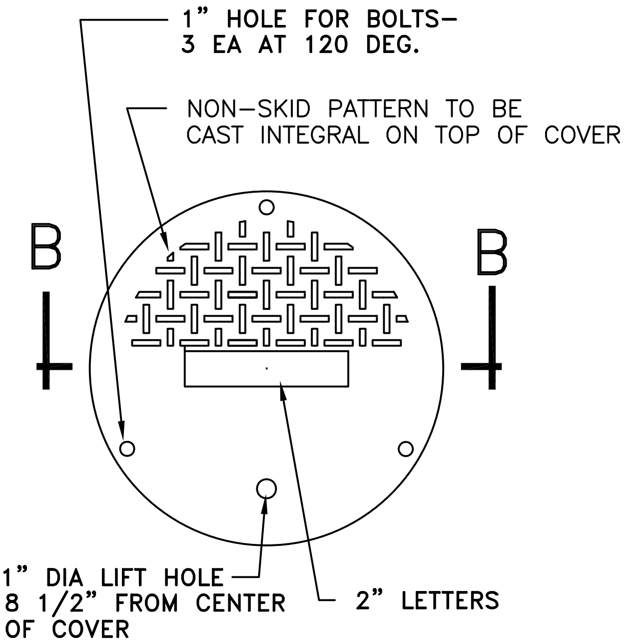
Date: April 1997	No.	Date	Revision	By	Apvd	Sewer Cleanout Detail
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-4

City of Port Townsend - Public Works Department
Standard Detail



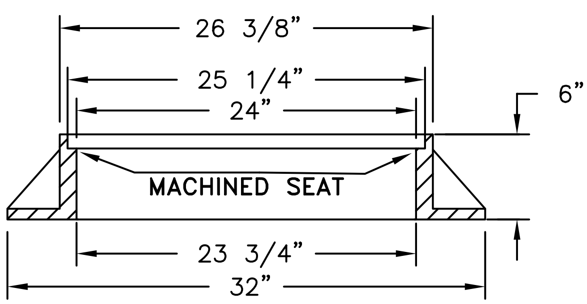
PLAN

MH RING



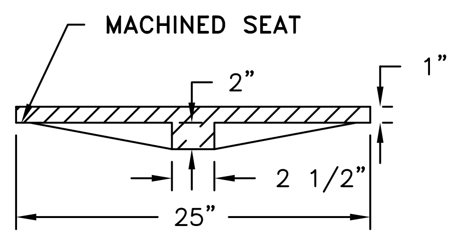
PLAN

MH COVER



SECTION A–A

DUCTILE OR CAST IRON FRAME
MINIMUM WEIGHT 210 LBS



SECTION B–B

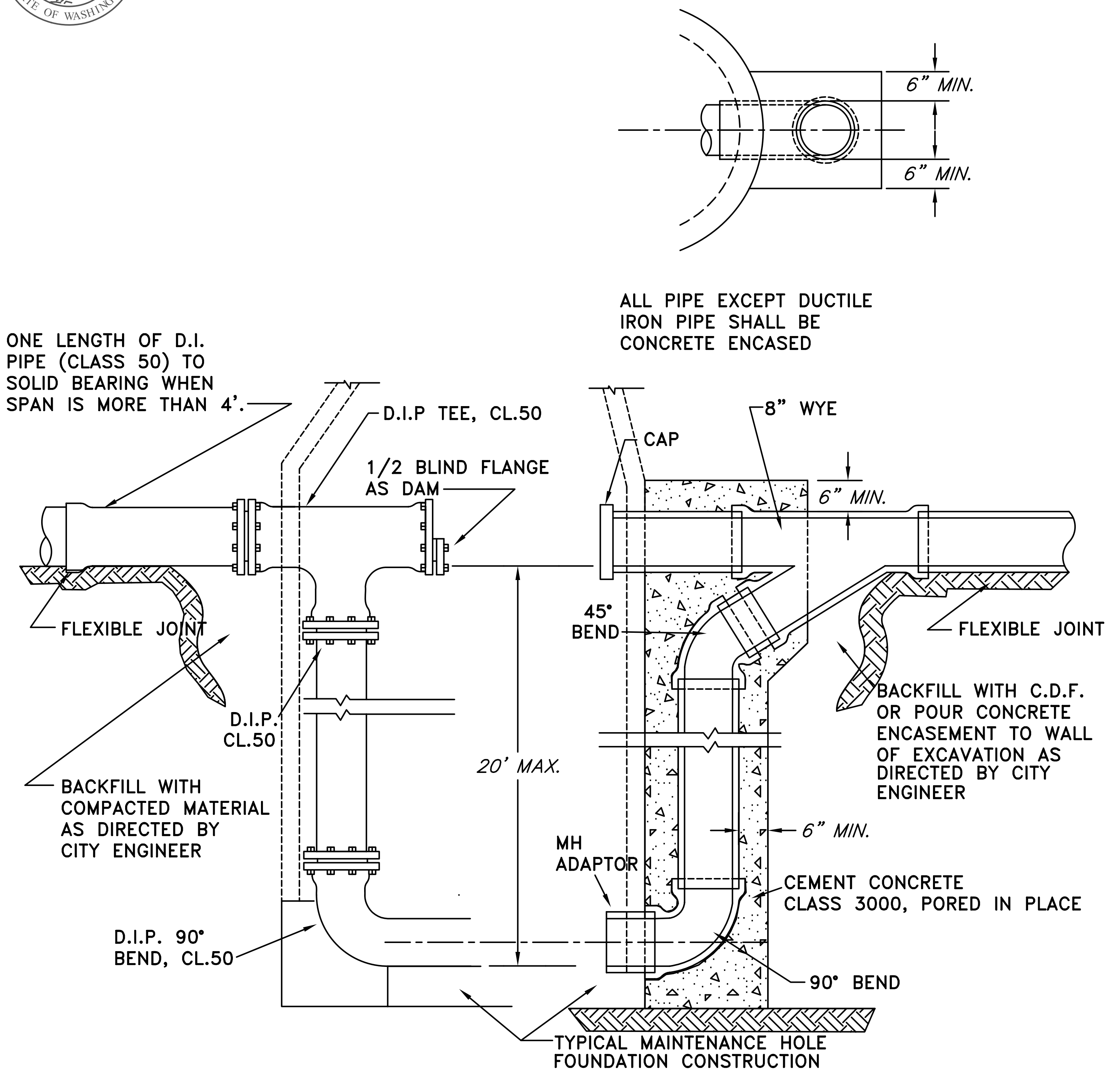
DUCTILE OR CAST IRON NON–LOCKING OR
LOCKING COVER, MINIMUM WEIGHT 150 LBS

NOTES:

1. 3 LOCKING BOLT LUGS TO BE PROVIDED FOR EACH MAINTENANCE HOLE
2. COVER SHALL HAVE THE WORD "SEWER" IN 2" RAISED LETTERS.

	No.	Date	Revision	By	Apvd	
Date: April 1997						24" Maintenance Hole Frame and Lid
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-5

City of Port Townsend - Public Works Department
Standard Detail



DUCTILE IRON INSIDE DROP CONNECTION

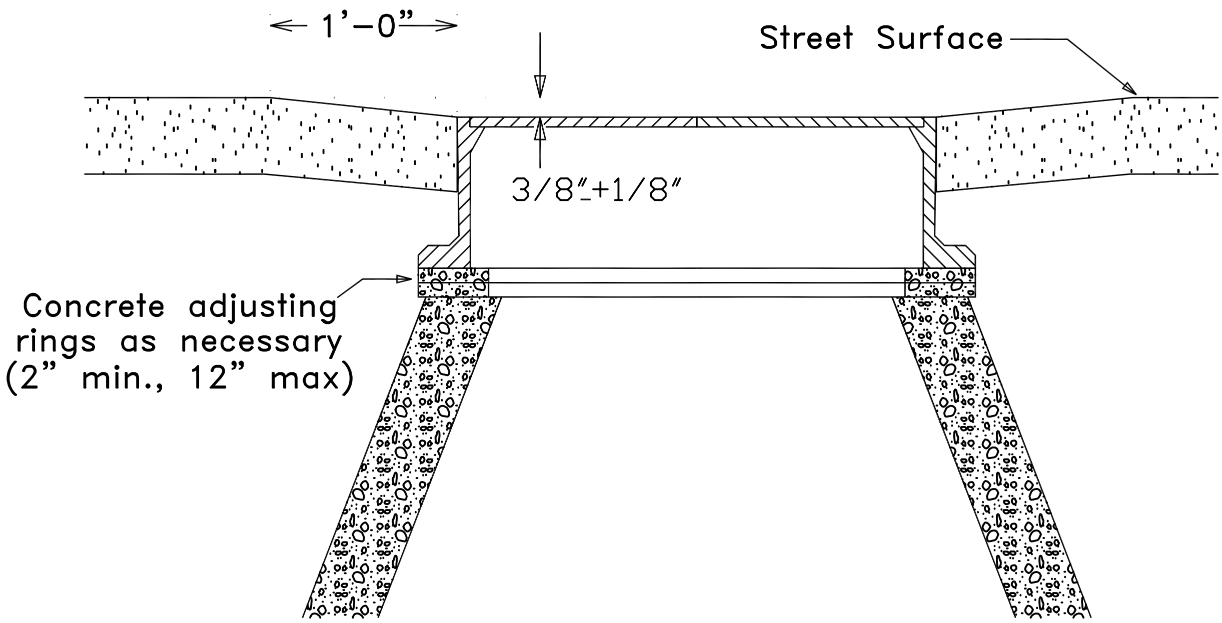
CONCRETE ENCASED PVC OUTSIDE DROP CONNECTION

NOTE: EXCAVATION TO BE CONDUCTED PER WISHA GUIDELINES

CALL FOR FORM INSPECTION BY CITY PRIOR TO POURING CONCRETE.

Date: April 1997	No.	Date	Revision	By	Apvd	Drop Connection For Sanitary Sewer
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-6

City of Port Townsend - Public Works Department
Standard Detail

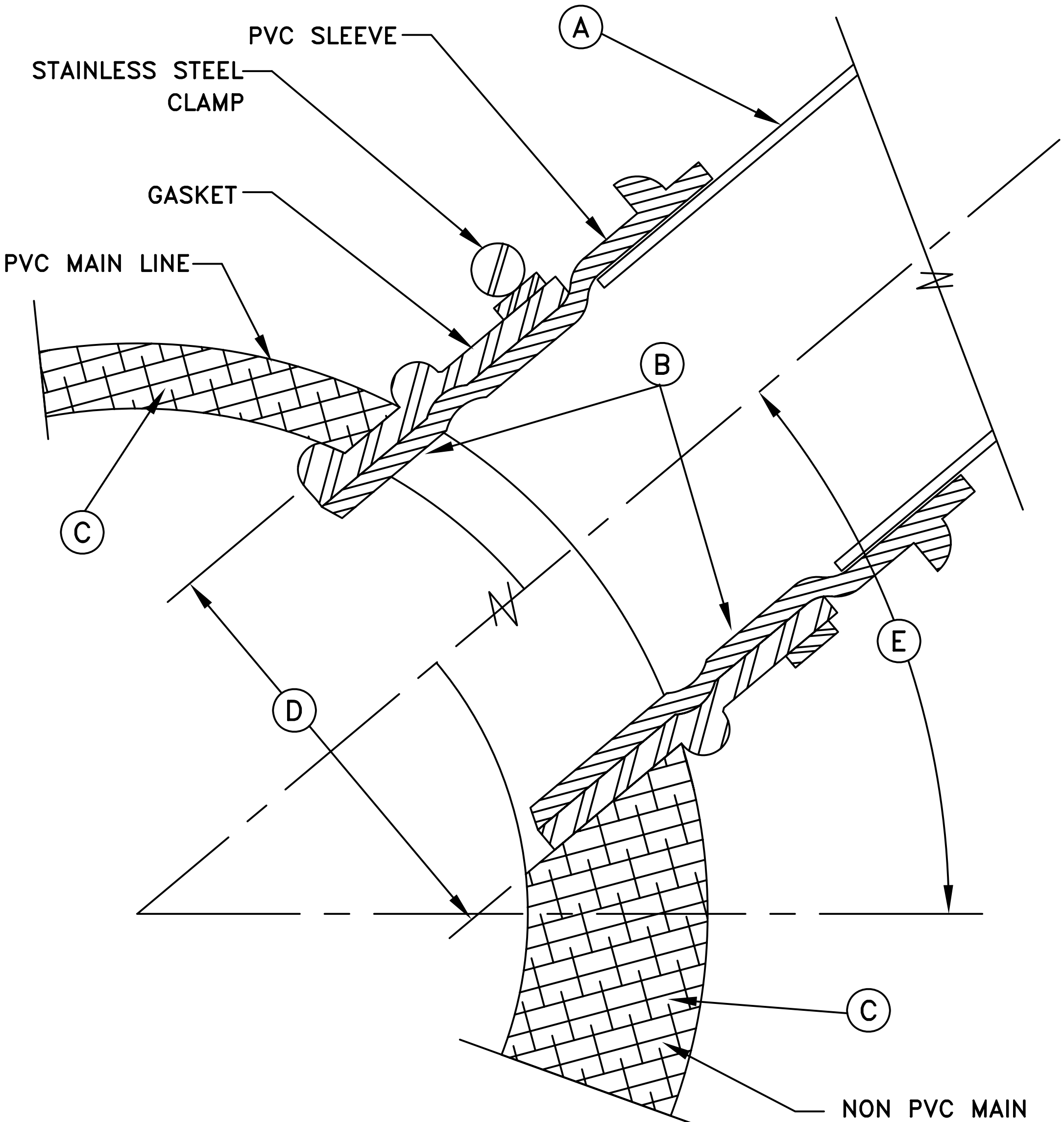


NOTES:

1.) Adjust manholes upward with adjusting rings under frame.
2.) Adjust maintenance holes downward by removing cone and barrel sections as necessary and replacing with sections of length required to match grade.
3.) Slope maint. hole frame as req'd to match slope of street.
4.) Final maint. hole adjustments shall be made before paving.

Date: April 1997	No.	Date	Revision	By	Apvd	Pavement and Intallation Underground Maintenance Hole
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-7

City of Port Townsend - Public Works Department
Standard Detail



NOTES

(A) PVC SIDE SEWER. FOR REMAINDER OF PVC SERVICE SEE DWG WW-1.

(B) FOWLER MFG, CO. "INSERTA TEE" OR APPROVED EQUAL.

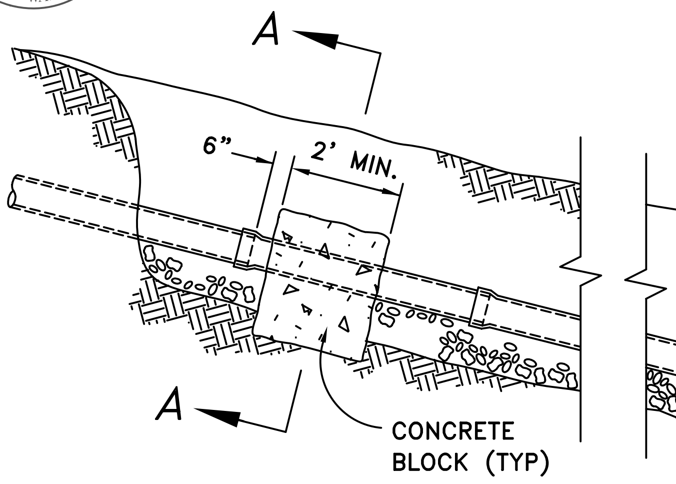
(C) EXISTING SANITARY SEWER MAIN.

(D) CORE DRILL EXISTING MAINLINE PIPE PER MFG'S SPECIFICATIONS.

(E) 35° MIN, 45° MAX

Date: April 1997	No.	Date	Revision	By	Apvd	Typical Sewer Connection to Existing Sewer Mains
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-8

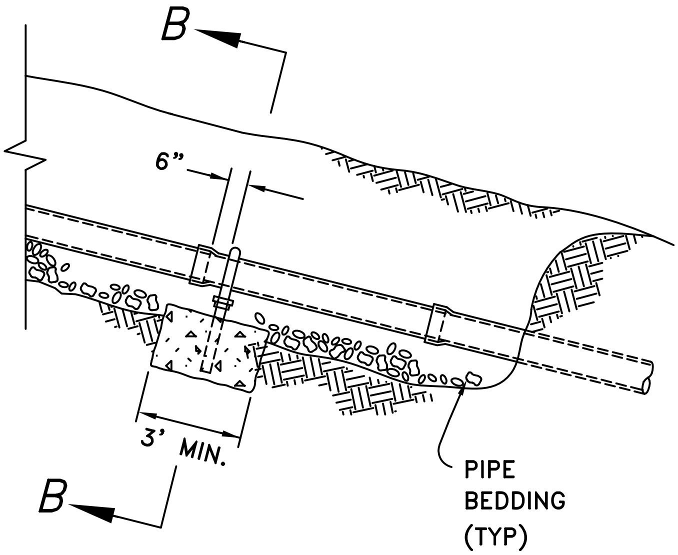
City of Port Townsend - Public Works Department
Standard Detail



CONCRETE BLOCK ANCHOR

N.T.S.

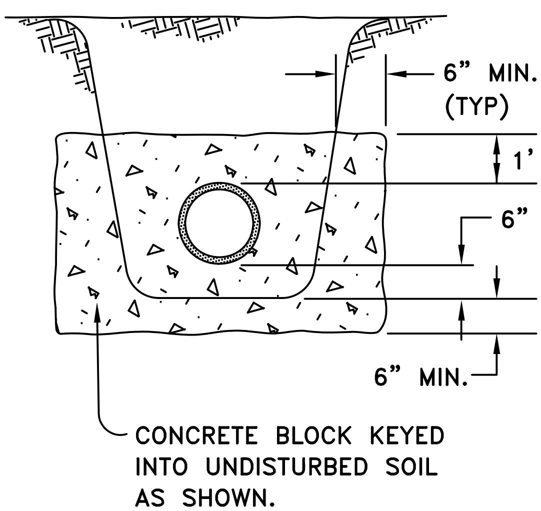
1 ANCHOR PER JOINT OF PIPE



STRAP – FOOTING ANCHOR

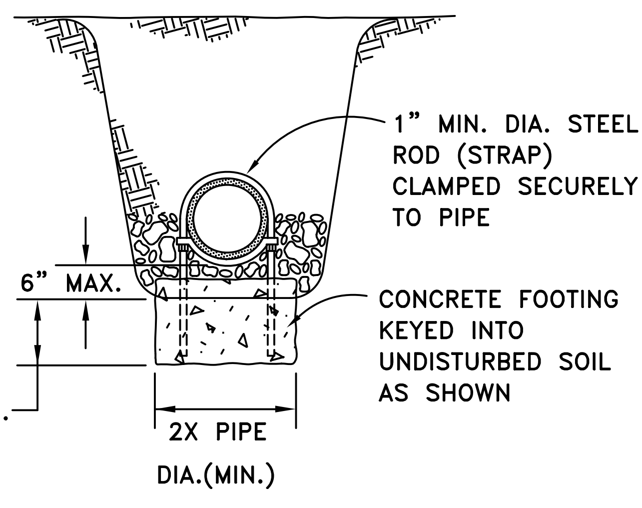
N.T.S.

1 ANCHOR PER JOINT OF PIPE



SECTION A–A

N.T.S.

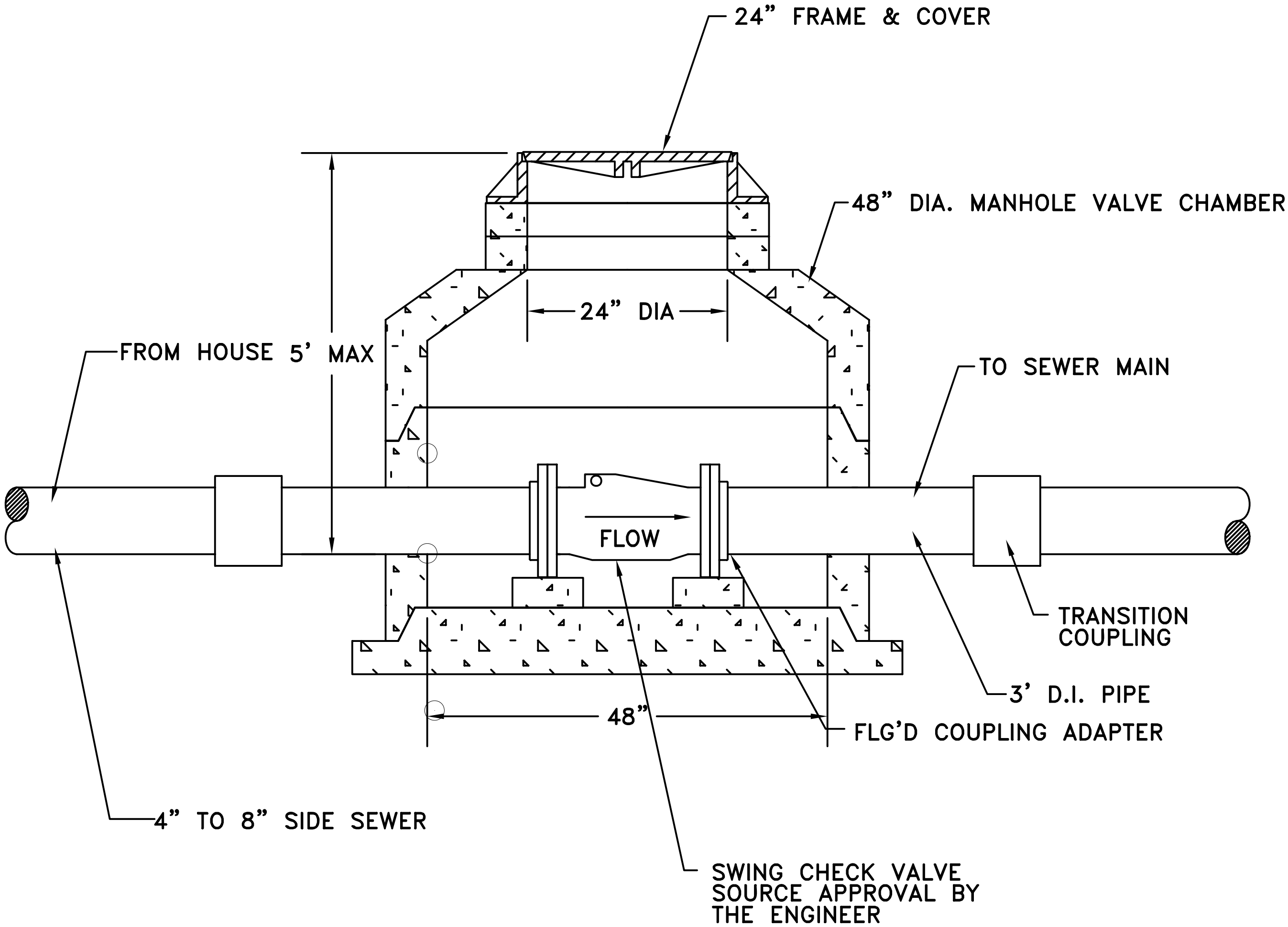


SECTION B–B

N.T.S.

Date: April 1997	No.	Date	Revision	By	Apvd	Pipe Anchor Detail For Slopes Greater Than 20%
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-9

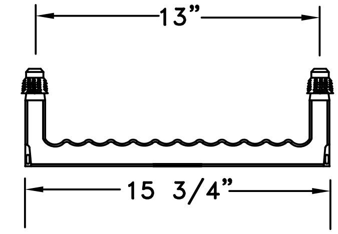
City of Port Townsend - Public Works Department
Standard Detail



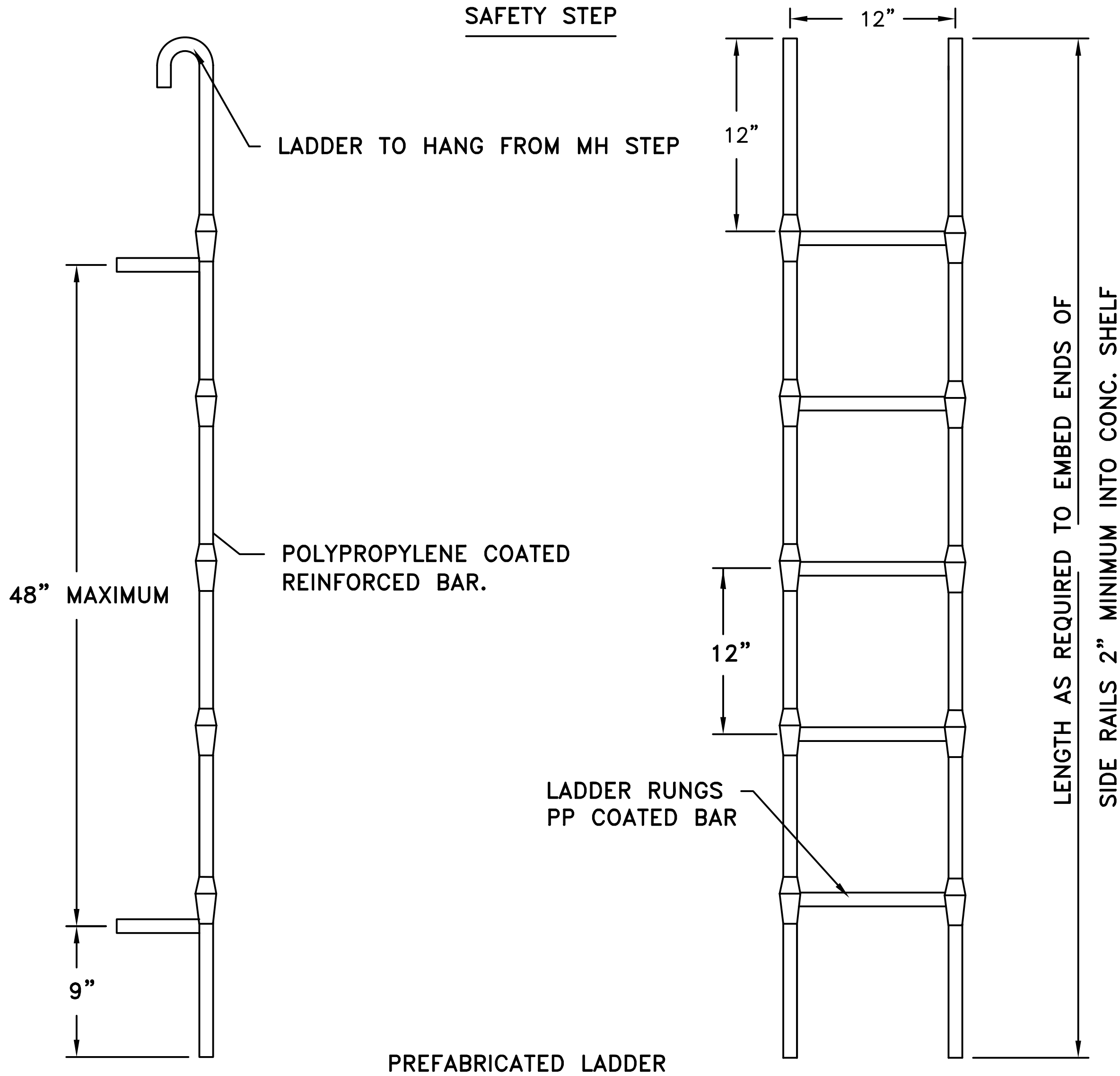
(4" to 8" Diameter)

Date: April 1997	No.	Date	Revision	By	Apvd	Check Valve Assembly for Joint Use Side Sewer
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-10

City of Port Townsend - Public Works Department
Standard Detail



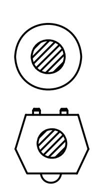
SAFETY STEP



PREFABRICATED LADDER

NOTES:

1. ALL STEP SHOULD MEET ASTM C-478 AND AASHTO M-199
2. POLYPROPYLENE SHALL CONORM TO ASTM D-4101.
3. 1/2" GRADE 60 RENINFORCING BAR SHALL CONFROM TO ASTM A-615.



Date: April 1997	No.	Date	Revision	By	Apvd	Polypropylene Ladder and Maintenance Step
Approved By:						
File: E:\eng_std\standard\san_sew						Detail: SS-11

7-17.3(4) CLEANING AND TESTING

7-17.3(4)A GENERAL

Sewers and appurtenances shall be cleaned and tested after backfilling by either the exfiltration or low pressure air method at the option of the Contractor, except where the ground water table is such that the Engineer may require the infiltration test.

All work involved in cleaning and testing sewer lines between manholes or rodding inlets as required herein shall be completed within 15 working days after backfilling of sewer lines and structures. Any further delay will require the written consent of the Engineer. The Contractor shall furnish all labor, materials, tools, and equipment necessary to make the test, clean the lines, and perform all work incidental thereto. The Contractor shall perform the tests under the direction and in the presence of the Engineer. Precautions shall be taken to prevent joints from drawing during tests, and any damage resulting from these tests shall be repaired by the Contractor. The manner and time of testing shall be subject to approval by the Engineer.

All wyes, tees, and stubs shall be plugged with flexible jointed caps, or acceptable alternate, securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.

If the Contractor elects to test large diameter pipe one joint at a time, leakage allowances shall be converted from GPM per 100 feet to GPM per joint by dividing by the number of joints occurring in 100 feet. If leakage exceeds the allowable amount, corrective measures shall be taken and the line then retested to the satisfaction of the Engineer.

Testing side sanitary sewers shall be for their entire length from the public sewer in the street to the connection with the building's plumbing. Their testing shall be as required by the local sanitary agency but in no case shall it be less thorough than that of filling the pipe with water before backfilling and visually inspecting the exterior for leakage. The decision of the Engineer as to acceptance of the side sanitary sewer shall be final.

If any sewer installation fails to meet the requirements of the test method used, the Contractor shall determine the source or sources of leakage and shall replace all defective pipe. The complete pipe installation shall meet the requirements of the test method used before being considered acceptable. Replacement of defective pipe shall not commence until the Contractor has received approval of his plan from the Engineer.

7-17.3(4)B EXFILTRATION TEST

Prior to making exfiltration leakage tests, the Contractor may fill the pipe with clear water to permit normal absorption into the pipe walls provided, however, that after so filling the pipe he shall complete the leakage test within twenty-four hours after filling. When under test, the allowable leakage shall be limited according to the provisions that follow. Specified allowances assume pre-wetted pipe.

Leakage shall be no more than 0.28 gph per inch diameter per 100 feet of sewer, with a hydrostatic head of 6 feet above the crown at the upper end of the test section, or above the natural groundwater table at the time of test, whichever is higher. The length of pipe tested shall be limited so that the pressure at the lower end of the section tested does not exceed 16 feet of head above the invert, and in no case shall be greater than 700 feet or the distance between manholes when greater than 700 feet.

Where the test head is other than 6 feet, the measured leakage shall not exceed 0.28 gph per inch diameter per 100 feet times the ratio of the square root of the test head to the square root of 6.

$$\text{Leakage maximum} = 0.28 \times \frac{\sqrt{H}}{\sqrt{6}} = 0.114\sqrt{H}\ \text{gph/inch dia./100ft.}$$

When the test is to be made one joint at a time, the leakage per joint shall not exceed the computed allowable leakage per length of pipe.

7-17.3(4)C INFILTRATION TEST

Infiltration test leakage shall not exceed 0.16 gph per inch diameter per 100 feet, when the natural groundwater head over the pipe is 2 feet or less above the crown of the pipe at the upper end of the test section. The length of pipe tested shall not exceed 700 feet or the distance between manholes when greater than 700 feet.

Where the natural groundwater head is more than 2 feet, the measured leakage shall not exceed 0.16 gph per inch diameter per 100 feet times the ratio of the square root of the natural groundwater head to the square root of 2.

$$\text{Leakage maximum} = 0.16 \times \frac{\sqrt{H}}{\sqrt{2}} = 0.114\sqrt{H}\ \text{gph/inch dia./100ft}$$

When a suitable head of groundwater exists above the crown of the pipe and when the pipe is large enough to work inside, acceptance may be based on the repair of visible leakage by means satisfactory to the Engineer.

7-17.3(4)D AIR PRESSURE TEST FOR SANITARY SEWERS CONSTRUCTED OF AIR PERMEABLE MATERIALS

(a) Pipelines may be tested with low pressure air by the pressure drop method, in lieu of water infiltration or exfiltration. The pressure drop shall be from 3-1/2 to 2-1/2 psig greater than the average back pressure of groundwater above the centerline of the pipe. At the Contractor's option, pipe may be tested without pre-wetting; however, the test allowances herein assume pre-wetted pipe.

(b) The allowable rate of air loss shall be .003 cfm per square foot of internal pipe surface, but the total air loss shall be not less than 2 cfm nor more than 3.50 cfm.

(c) The test equipment to be used shall be furnished by the Contractor and shall be inspected and approved by the Engineer prior to use. The Engineer may at any time require a calibration test of gauges or other instrumentation that is incorporated in the test equipment.

(d) Safety Provisions. Plugs used to close the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug which can become a high velocity projectile. Gauges, air piping manifolds, and valves shall be located at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure. (Four psig air pressure develops a force against the plug in a 12 inch diameter pipe of approximately 450 pounds.) Air testing apparatus shall be equipped with a pressure release device such as a rupture disk or a pressure relief valve designed to relieve pressure in the pipe under test at 6 psi.

(e) Pipe under 36 inches in diameter may be tested from manhole to manhole or such shorter lengths determined by the Contractor. Pipe 36 inches in diameter and over shall be tested one joint at a time. Each joint must show no appreciable loss of pressure when held for 30 seconds.

7-17.3(4)E AIR PRESSURE TEST FOR SANITARY SEWERS CONSTRUCTED OF NON AIR PERMEABLE MATERIALS

7-17.3(4)E1 GENERAL

When non air-permeable pipelines are subjected to the low pressure air test, all of the provisions of Section 7-17.3(4)D shall apply except that the pressure drop shall be from 3.5 to 3.0 psig greater than the average back pressure above the center of the pipe, and the minimum time shall be twice that computed as specified under Section 7-17.3(4)D.

7-17.3(4)E2 RECOMMENDED PROCEDURE FOR CONDUCTING ACCEPTANCE TEST BY PRESSURE DROP METHOD

(a) Plug all pipe outlets with suitable test plugs. Brace each plug securely.

(b) All gauge pressures in the test should be increased by the amount of groundwater pressure at the center of the pipe.

(c) Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

(d) After an internal pressure of 4.0 psig is obtained allow at least 2 minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

(e) After the 2 minute period, disconnect air supply.

(f) When pressure decreased to 3.5 psig, start stop watch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. This time interval should then be compared with the time required by specification as computed below.

(g) List size and length of all portions of pipe under test in table similar to the one that follows. The maximum reach to be tested in one operation shall be the reach between two consecutive manholes.

(h) By the use of Nomograph, compute K and C. Use scales d and L, read K and C, and enter these values in the table.

(i) Add all values of K and all values of C for pipe under test.

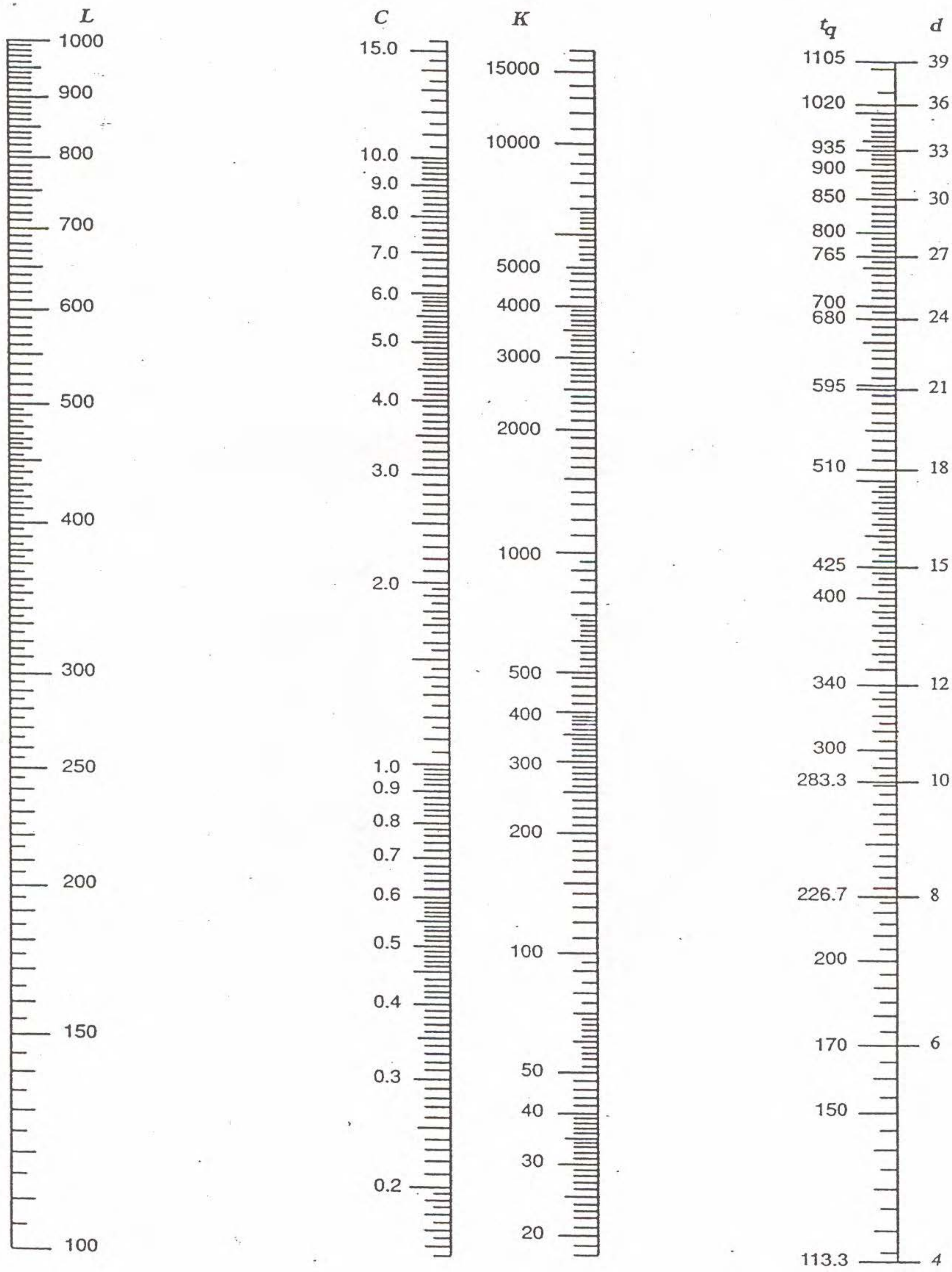
(j) If the total of all C values is less than one, enter the total of all K values into the space for "Time Required by Specification."

(k) If the total of all C values is greater than one, divide the total of all K values by the total of all C values to get t_q. To make this division with the nomograph, use scales C and D, and read t_q.

DIAMETER INCHES	LENGTH FEET	$K = .011\ d^2L$	$C = .0003882\ dL$

TOTAL K ______ TOTAL C ______

Time required by specification ______



NOMOGRAPH FOR THE SOLUTION OF K - .011d²L, C = .0003882dL, t_q = K/C

Appendix H

2016 to 2021 WWTF Influent Flow and Loading Summaries

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Flow

Annual Average, Maximum Month, and Maximum Week

Month	2016	2017	2018	2019	2020	2021	2022	Average
January	1.02	0.82	0.98	0.82	0.88	1.00	0.99	0.93
February	1.01	0.87	1.16	0.87	1.15	1.02	0.76	0.98
March	1.07	0.92	0.89	0.76	0.80	0.81	0.78	0.86
April	0.78	0.84	1.00	0.79	0.70	0.76	0.79	0.81
May	0.72	0.82	0.79	0.75	0.74	0.76	0.78	0.77
June	0.76	0.80	0.79	0.76	0.78	0.77	0.86	0.79
July	0.76	0.84	0.81	0.77	0.74	0.79	0.77	0.78
August	0.75	0.81	0.83	0.78	0.75	0.78	0.77	0.78
September	0.74	0.78	0.79	0.80	0.74	0.76	0.73	0.76
October	0.92	0.79	0.78	0.76	0.74	0.78	0.73	0.79
November	0.92	0.89	0.80	0.75	0.78	0.90	0.77	0.83
December	0.79	0.86	0.84	0.82	0.84	0.95	0.83	0.85
Annual Avg.	**0.85**	**0.84**	**0.87**	**0.78**	**0.80**	**0.84**	**0.80**	
Max. Month	**1.07**	**0.92**	**1.16**	**0.87**	**1.15**	**1.02**	**0.99**	
Max. 30-day	**1.19**	**0.93**	**1.16**	**0.87**	**1.15**	**1.05**	**1.00**	
Max. 7-day	**1.50**	**1.03**	**1.39**	**1.00**	**1.75**	**1.30**	**1.33**	

Maximum Day

Month	2016	2017	2018	2019	2020	2021	2022
January	1.35	1.15	1.29	1.02	0.97	2.18	1.56
February	1.78	1.01	1.82	1.08	2.37	1.55	0.91
March	1.99	1.15	1.08	0.86	0.95	0.95	0.87
April	1.22	0.98	1.59	0.94	0.91	1.00	1.10
May	0.81	1.01	0.88	0.93	0.83	0.85	0.93
June	1.10	0.89	0.95	0.84	1.10	0.89	1.68
July	0.82	0.92	0.88	0.84	0.83	0.94	0.88
August	0.84	0.88	1.05	0.88	0.83	0.86	0.85
September	0.82	0.88	0.90	0.96	0.84	0.96	0.81
October	1.13	1.03	0.98	1.12	0.86	1.09	0.99
November	1.46	1.35	1.01	0.93	1.14	1.25	0.98
December	1.07	1.39	1.06	1.07	1.83	1.25	1.26
Max. Day	**1.99**	**1.39**	**1.82**	**1.12**	**2.37**	**2.18**	**1.68**

BOD$_5$ (mg/L)

Annual Average, Maximum Month, and Maximum Week

Month	2016	2017	2018	2019	2020	2021	2022	Average
January	243	325	289	359	336	246	238	291
February	259	300	214	351	275	259	313	281
March	273	284	324	421	338	366	352	337
April	367	310	303	390	346	346	329	341
May	383	335	350	432	348	358	331	362
June	379	356	399	420	325	367	317	366
July	374	364	434	422	345	384	380	386
August	382	332	412	403	374	393	333	375
September	405	359	454	404	367	377	377	392
October	294	361	420	437	328	346	374	365
November	298	290	392	392	344	280	329	332
December	325	324	354	371	305	268	315	323
Annual Avg.	**332**	**329**	**363**	**400**	**336**	**334**	**333**	
Max. Month	**405**	**364**	**454**	**437**	**374**	**393**	**380**	

Maximum Day

Month	2016	2017	2018	2019	2020	2021	2022
January	262	350	334	398	366	330	286
February	335	326	258	390	312	277	324
March	312	324	352	476	366	438	402
April	424	341	341	430	355	360	392
May	432	383	410	562	360	376	396
June	410	404	422	442	354	406	370
July	392	380	523	440	372	400	398
August	424	356	448	426	387	414	358
September	471	368	486	424	388	400	398
October	324	388	497	473	361	369	393
November	367	347	438	416	456	350	382
December	340	419	376	396	366	288	364
Max. Day	**471**	**419**	**523**	**562**	**456**	**438**	**402**

BOD$_5$ (ppd)

Annual Average, Maximum Month, and Maximum Week

Month	2016	2017	2018	2019	2020	2021	2022	Average
January	2,124	2,225	2,327	2,468	2,422	1,955	1,869	2,198
February	2,062	2,196	2,021	2,603	2,353	2,274	1,961	2,210
March	2,210	2,158	2,340	2,700	2,203	2,377	2,369	2,337
April	2,384	2,119	2,302	2,524	1,954	2,099	2,259	2,234
May	2,189	2,339	2,369	2,628	2,178	2,182	2,103	2,284
June	2,296	2,303	2,517	2,635	1,978	2,270	2,230	2,318
July	2,368	2,538	2,968	2,718	2,048	2,442	2,474	2,508
August	2,370	2,251	2,807	2,557	2,243	2,500	2,034	2,395
September	2,442	2,364	2,949	2,630	2,146	2,360	2,312	2,458
October	2,107	2,382	2,585	2,628	1,940	2,100	2,164	2,272
November	2,224	2,170	2,464	2,531	2,287	2,057	2,117	2,264
December	2,117	2,405	2,411	2,503	2,066	1,959	2,128	2,227
Annual Avg.	**2,242**	**2,289**	**2,509**	**2,591**	**2,147**	**2,221**	**2,167**	
Max. Month	**2,442**	**2,538**	**2,968**	**2,718**	**2,422**	**2,500**	**2,474**	
Max. 30-day	**2,540**	**2,538**	**2,994**	**2,879**	**2,426**	**2,534**	**2,510**	
Max. 7-day	**3,026**	**3,063**	**3,531**	**3,602**	**3,117**	**2,841**	**2,763**	
MW/AA	1.35	1.34	1.41	1.39	1.45	1.28	1.27	

Maximum Day

Month	2016	2017	2018	2019	2020	2021	2022
January	2,253	2,526	2,436	3,100	2,440	2,118	2,177
February	2,128	2,508	2,451	3,058	2,415	2,422	2,139
March	2,466	2,276	2,568	3,138	2,242	2,811	2,724
April	2,926	2,373	2,510	2,763	2,035	2,188	2,650
May	2,462	2,622	2,717	3,602	2,240	2,460	2,442
June	2,436	2,515	2,616	2,778	2,099	2,504	2,464
July	2,686	2,688	3,531	2,808	2,220	2,505	2,763
August	2,694	2,605	2,942	2,640	2,358	2,733	2,129
September	3,026	2,496	3,270	2,958	2,307	2,841	2,524
October	2,270	3,063	3,094	2,809	2,094	2,294	2,397
November	2,381	2,347	2,676	2,680	3,117	2,337	2,259
December	2,328	2,577	2,638	2,805	2,373	1,990	2,460
Max. Day	**3,026**	**3,063**	**3,531**	**3,602**	**3,117**	**2,841**	**2,763**

TSS (mg/L)

Annual Average, Maximum Month, and Maximum Week

Month	2016	2017	2018	2019	2020	2021	2022	Average
January	248	312	303	343	305	252	261	289
February	268	294	205	314	310	240	351	283
March	269	285	328	408	359	327	347	332
April	361	326	326	376	348	341	370	350
May	376	334	393	392	369	354	365	369
June	370	356	396	391	337	343	340	362
July	388	367	405	417	359	350	381	381
August	376	343	393	398	386	390	366	379
September	384	357	431	397	378	352	369	381
October	299	359	390	391	317	325	376	351
November	307	282	379	348	318	287	331	321
December	325	327	352	342	298	288	339	325
Annual Avg.	**331**	**329**	**359**	**376**	**341**	**322**	**350**	
Max. Month	**388**	**367**	**431**	**417**	**386**	**390**	**381**	

Maximum Day

Month	2016	2017	2018	2019	2020	2021	2022
January	274	344	343	360	322	310	324
February	350	308	274	348	368	267	374
March	291	313	362	466	386	358	380
April	375	370	376	430	374	354	473
May	404	356	433	418	390	367	385
June	378	384	428	398	360	354	402
July	404	399	456	451	383	362	426
August	411	352	412	412	414	416	404
September	398	376	472	433	398	376	398
October	314	432	410	428	343	346	426
November	387	342	404	359	349	308	394
December	350	489	376	355	342	313	356
Max. Day	**411**	**489**	**472**	**466**	**414**	**416**	**473**

TSS (ppd)

Annual Average, Maximum Month, and Maximum Week

Month	2016	2017	2018	2019	2020	2021	2022	Average
January	2,166	2,137	2,440	2,345	2,198	2,026	2,042	2,193
February	2,138	2,149	1,970	2,333	2,725	2,095	2,192	2,229
March	2,191	2,173	2,370	2,616	2,354	2,125	2,334	2,309
April	2,341	2,231	2,474	2,439	1,966	2,073	2,540	2,295
May	2,151	2,341	2,651	2,373	2,311	2,160	2,326	2,330
June	2,244	2,306	2,503	2,448	2,056	2,119	2,392	2,295
July	2,458	2,564	2,768	2,686	2,125	2,231	2,482	2,473
August	2,339	2,321	2,684	2,530	2,313	2,481	2,236	2,415
September	2,304	2,352	2,799	2,591	2,209	2,190	2,260	2,386
October	2,145	2,385	2,406	2,351	1,876	1,971	2,169	2,186
November	2,285	2,122	2,382	2,250	2,116	2,116	2,130	2,200
December	2,121	2,412	2,396	2,297	2,032	2,107	2,414	2,254
Annual Avg.	**2,240**	**2,291**	**2,493**	**2,437**	**2,188**	**2,146**	**2,290**	
Max. Month	**2,458**	**2,564**	**2,799**	**2,686**	**2,725**	**2,481**	**2,540**	
Max. 30-day	**2,476**	**2,595**	**2,892**	**2,712**	**2,753**	**2,497**	**2,675**	
Max. 7-day	**2,768**	**3,410**	**3,079**	**3,072**	**3,734**	**2,746**	**3,743**	
MW/AA	1.24	1.49	1.24	1.26	1.71	1.28	1.63	

Maximum Day

Month	2016	2017	2018	2019	2020	2021	2022
January	2,370	2,483	2,668	2,744	2,272	2,060	2,181
February	2,205	2,354	2,415	2,777	3,734	2,194	2,264
March	2,337	2,418	2,643	3,072	2,551	2,297	2,480
April	2,588	2,575	2,767	2,763	2,031	2,272	3,197
May	2,417	2,561	2,869	2,679	2,639	2,329	2,474
June	2,316	2,426	2,618	2,473	2,112	2,228	2,677
July	2,768	2,837	3,079	2,857	2,220	2,483	2,958
August	2,547	2,554	2,745	2,761	2,474	2,746	2,458
September	2,506	2,410	3,074	3,050	2,282	2,308	2,377
October	2,329	3,410	2,540	2,525	1,995	2,014	2,414
November	2,451	2,390	2,647	2,313	2,385	2,376	2,492
December	2,284	3,007	2,566	2,538	2,089	2,226	3,743
Max. Day	**2,768**	**3,410**	**3,079**	**3,072**	**3,734**	**2,746**	**3,743**

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Appendix I

Hydraulic Model Data

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LABEL	DIA	ELEV_GND	ELEV_RIM	ELEV_INV	EX AAF + Mill (GPM)	NOTES
1	48	60.24	60.24	50.02	0.07	6' SOUTH CL SAPPHIRE AND CL MAGNOLIA
2	48	55.59	55.59	43.41	#N/A	
3	48	55.98	55.98	40.51	#N/A	
4	48	86.38	86.38	79.38	0.07	24' WEST OF CL DISCOVERY RD AND 50' SOUTH OF 29TH ST
6	48	37.38	37.38	0	#N/A	
9	48	14	14	0	#N/A	
28	54	25.09	25.09	17.31	#N/A	
29	54	24.86	24.86	17.57	4.62	
30	54	30.85	30.85	17.72	#N/A	
31	54	26.51	26.51	18.01	#N/A	
51	48	26	26	0	#N/A	
52	48	28.97	28.97	0	#N/A	
53	48	27.34	27.34	0	#N/A	
63	48	18.7	18.7	15.52	#N/A	was 11.7, updated to 15.52 per tyler. ground updated due to IE update.
64	48	26	26	16.22	0.05	ground updated due to IE update. Per Tyler, IE = 16.22'.
65	96	27.87	27.87	17.1	#N/A	Was 13.14, tyler says the invert is > 17. ground updated due to IE update. IE udpated per record drawings and slope from next downstream MH.
66	48	24.51	24.51	17	#N/A	was 14.2, updated to 17 per tyler. ground updated due to IE update.
67	48	24.57	24.57	16.7	#N/A	ground updated due to IE update. Per Tyler, IE = 16.7'.
68	48	23.48	23.48	16.7	#N/A	ground updated due to IE update. Per Tyler, IE = 16.7'.
69	48	22	22	16.38	0.31	ground updated due to IE update. Per Tyler, IE = 16.38'.
78	48	246.12	246.12	239.39	0.19	15' SOUTH OF INTERSECTION 14TH AND LOGAN
79	48	250.79	250.79	245.17	0.25	INTERSECTION OF MCPHERSON AND 14TH
88	48	230.07	230.07	218.26	#N/A	@ INTERSECTION OF ROSECRANS AND 9TH ST
94	48	216.25	216.25	203.24	0.03	8' WEST OF LOGAN AND 17.5' SOUTH OF SOUTH FOGLINE SIMS WAY
96	48	216.75	216.75	203.5	#N/A	2' NORTH OF NORTH FOGLINE SIMS WAY @ INTERSECTION OF LOGAN ST
99	48	207.23	207.23	200.73	#N/A	3' SOUTH OF SOUTH FOGLINE OF SIMS WAY @ INTERSECTION OF ROSECRANS ST
100	48	224.47	224.47	213.24	0.04	NORTH 45' INTERSECTION OF PARKSIDE AND MEMORY LANE
101	48	227.14	227.14	214.9	0.28	INTERSECTION PARKSIDE AND SUNRISE
102	48	222.04	222.04	210.86	0.31	SOUTH 180' OF INTERSECTION PARKSIDE AND MEMORY LANE
103	48	203.59	203.59	198.69	#N/A	2' SOUTH OF SOUTH FOGLINE OF SIMS WAY @ INTERSECTION OF MCCLELLAN
104	48	216.06	216.06	204.73	0.03	270' WEST OF INTERSECTION PARKSIDE AND HANCOCK
112	48	208.01	208.01	197.86	0.36	INTERSECTION HANCOCK AND PARKSIDE
114	48	203.42	203.42	194.7	#N/A	30' NORTH OF INTERSECTION OF SIMS AND HANCOCK
115	48	202.39	202.39	193.94	0.02	2' SOUTH OF SOUTH FOGLINE OF SIMS WAY AND 20' EAST OF INTERSECTION OF HANCOCK
120	48	23.3	23.3	13.71	#N/A	
122	48	188.47	188.47	177.84	0.34	INTERSECTION SHERMAN AND 3RD
123	48	199.25	199.25	190.85	1.78	2.5' NORTH OF SOUTH FOGLINE SIMS WAY AND 12.5' EAST OF INTERSECTION OF SHERMAN
124	48	199.47	199.47	191.96	1.16	35' NORTH OF INTERSECTION OF SIMS AND SHERMAN
127	48	187.05	187.05	176.8	0.09	INTERSECTION OF 3RD ST AND HENDRICKS
128	48	195.77	195.77	188.87	#N/A	13.5' NORTH OF NORTH FOGLINE SIMS WAY AND 8' EAST OF INTERSECTION OF HENDRICKS
134	48	188.13	188.13	167.93	0.77	INTERSECTION OF GRANT AND 3RD ST
135	48	188.93	188.93	181.83	1.51	14' NORTH OF NORTH FOGLINE OF SIMS WAY AND INTERSECTION OF GRANT
140	48	174.97	174.97	161.24	0.46	INTERSECTION OF 3RD ST AND SHERIDAN
142	48	173.77	173.77	167.92	#N/A	6' NORTH FOGLINE OF SIMS WAY AND 1.5' EAST OF INTERSECTION OF SHERIDAN ST
146	48	160.11	160.11	148.88	0.13	35' WEST OF INTERSECTION OF 3RD ST AND CLEVELAND
147	48	159.67	159.67	148.49	0.25	NORTH OF INTERSECTION OF 3RD ST AND CLEVELAND
150	48	159.24	159.24	153.74	#N/A	18' NORTH OF NORTH FOGLINE OF SIMS WAY AND 9' WEST OF INTERSECTION OF CLEVELAND
152	48	150.48	150.48	145.37	0.08	21' NORTH OF NORTH E-BT OF SIMS AVE AND 250' EAST OF CLEVELAND
155	48	138.66	138.66	130.39	#N/A	
156	48	132.67	132.67	124.8	0.14	
157	48	133.81	133.81	123.66	0.24	
158	48	124.96	124.96	118.13	0.28	
159	48	124.84	124.84	117.39	0.11	INTERSECTION OF GISE ANS SIMS WAY
160	48	127.41	127.41	116	0.41	INTERSECTION OF 6TH AND GISE
161	48	116.53	116.53	109.03	0.36	@ PC OF CURVE FOR INTERSECTION OF 7TH AND HOLCOMB
162	48	110.96	110.96	107.29	0.87	15' EAST OF INTERSECTION OF 8TH AND HOLCOMB
163	48	229.7	229.7	221.8	0.26	
164	48	232.76	232.76	223.38	0.15	100' NORTH OF INTERSECTION OF SIMS AND MCPHERSON
165	48	231.07	231.07	222.71	#N/A	12' NORTH OF SIMS WAY AND 18' EAST OF MCPHERSON INTERSECTION
170	48	226.79	226.79	213.9	#N/A	
171	48	227.61	227.61	212.59	0.18	15' WEST OF THOMAS AND 12' SOUTH OF SOUTH FOGLINE ON SIMS WAY
172	48	230.44	230.44	217.91	#N/A	INTERSECTION THOMAS ST AND SIMS WAY
173	48	237.31	237.31	229.4	0.18	INTERSECTION MCPHERSON AND 6TH
174	48	244.98	244.98	238.7	#N/A	INTERSECTION OF 9TH AND MCPHERSON
175	48	238.96	238.96	232.45	0.26	INTERSECTION OF THOMAS AND 9TH ST
176	48	230.28	230.28	219.28	0.37	INTERSECTION OF LOGAN AND 9TH
177	48	230.21	230.21	217.98	#N/A	INTERSECTION OF 9TH ST AND PARKSIDE
180	48	223.45	223.45	215.1	0.21	
181	48	218.18	218.18	207.93	0.14	10' NORTH OF CL 10TH ST AND 3' WEST OF CL HENDRICKS
182	48	216.06	216.06	209.5	0.10	

183	48	211.64	211.64	202.43	0.39	9' NORTH OF CL OF 10TH ST
185	48	206.2	206.2	197.59	#N/A	9' NORTH OF CL OF 10TH ST AND WEST 6' OF CL OF GRANT
186	48	199.2	199.2	193	1.65	11' NORTH OF CL 10TH AND 140' WEST OF CL OF SHERIDAN
187	48	192.89	192.89	186.1	0.62	13' NORTH OF CL OF 10TH AND 35' EAST OF CL OF SHERIDAN
190	48	179.18	179.18	171.7	0.42	3' SOUTH OF CL OF 10TH ST AND 20' EAST OF CL OF CLEVELAND
191	48	162.28	162.28	155.6	0.23	6.5' SOUTH OF CL 10TH ST AND 1' EAST CL GRAVEL DRIVE/WILSON ST
192	48	138.31	138.31	131.43	0.25	4' SOUTH OF CL 10TH ST AND 12' EAST OF CL OF ?
193	48	113.85	113.85	104.52	0.46	14' EAST OF INTERSECTION OF 10TH AND HOLCOMB
204	48	238.4	238.4	231.18	0.14	
207	48	240.89	240.89	235.69	0.19	INTERSECTION OF PARK AVE AND 6TH ST
208	48	239.5	239.5	235.01	0.22	100' EAST OF INTERSECTION OF PARK AVE AND 6TH
210	48	236.87	236.87	232.83	0.12	ENTRANCE TO STORAGE UNITS
211	48	238.62	238.62	233.2	#N/A	150' EAST OF INTERSECTION OF 6TH AND PARK
213	48	240.91	240.91	236.33	0.05	135' EAST OF INTERSECTION OF HOWARD AND 6TH AVE
215	48	247.32	247.32	240.77	#N/A	300' WEST OF INTERSECTION MCPHERSON AND 9TH
221	48	50.61	50.61	39.44	#N/A	
222	48	49.67	49.67	42.22	#N/A	
223	48	51.1	51.1	45.97	#N/A	
225	48	37.65	37.65	33.61	#N/A	
226	48	36.18	36.18	32.76	0.11	
227	48	37.74	37.74	21.99	#N/A	
231	48	44.57	44.57	38.29	#N/A	
246	48	30.73	30.73	22.6	0.16	
248	48	34.9	34.9	24.9	0.21	15' EAST OF KUHN ST AND 6' NORTH OF CL OF 19TH
252	48	25.7	25.7	19.72	0.11	
253	48	25.31	25.31	18.56	1.31	
254	48	24.78	24.78	19.21	#N/A	
257	48	34.96	34.96	30.09	#N/A	
262	48	28.33	28.33	23.71	0.44	
271	48	33.18	33.18	0	0.04	
273	48	32.62	32.62	0	0.19	
274	48	32.9	32.9	0	0.28	
275	48	31.97	31.97	0	#N/A	
318	48	22.89	22.89	13.94	1.31	
335	48	63.59	63.59	55.74	#N/A	CL CAINES
336	48	66.86	66.86	55	#N/A	INTERSECTION SAPPHIRE AND CAINES
339	48	70.39	70.39	54.34	#N/A	8' SOUTH CL SAPPHIRE GRAVEL AND 35' WEST CL WILLAMETTE
343	48	64.54	64.54	53.24	0.39	6' SOUTH CL SAPPHIRE AND 6' WEST CL BELL ST
347	48	63.13	63.13	56.18	#N/A	
354	48	56.43	56.43	46.76	0.15	6' SOUTH OF CL SAPPHIRE AND 12' EAST CL MASON
355	48	24.64	24.64	18.7	0.08	
356	48	36.81	36.81	31.83	#N/A	CL 49TH
357	48	37.53	37.53	32.63	0.20	22' SW CL COOK
358	48	38.76	38.76	33.4	#N/A	
362	48	37.46	37.46	20.86	#N/A	
363	48	35.2	35.2	21.95	#N/A	
365	48	56.71	56.71	45.5	0.60	5' WEST OF CL HAINES AND NORTH 32' FROM CL DISCOVERY
366	48	51.71	51.71	44.37	#N/A	
367	48	54.17	54.17	44.95	#N/A	
368	48	53.58	53.58	41.3	#N/A	
372	48	13.75	13.75	-0.06	#N/A	
383	48	18	18	0	0.92	
418	48	213.37	213.37	206.25	0.10	INTERSECTION SHERMAN AND 16TH
426	48	187	187	178.41	0.07	INTERSECTION OF HENDRICKS AND 16TH
436	48	167.34	167.34	159.78	0.04	INTERSECTION 16TH AND GRANT
447	48	153.14	153.14	144.4	#N/A	INTERSECTION SHERIDAN AND 16TH
454	48	143.31	143.31	135.91	0.26	INTERSECTION CLEVELAND AND 16TH
463	48	131.08	131.08	120.87	0.27	
471	48	109.46	109.46	105.31	0.30	
478	48	96.6	96.6	90.95	0.09	150' SOUTH OF INTERSECTION OF HOLCOMB AND 17TH ST
479	48	97.43	97.43	90.04	0.10	20' EAST OF INTERSECTION OF 17TH AND HOLCOMB ST
481	48	93.43	93.43	89.04	0.31	70' EAST OF INTERSECTION OF 17TH AND HOLCOMB
483	48	92.94	92.94	87.05	0.13	50' WEST OF INTERSECTION OF JACKMAN AND 18TH ST
487	48	93.2	93.2	84.9	0.38	30' EAST OF INTERSECTION OF 19TH AND JACKMAN
493	48	65.6	65.6	58.21	0.83	150' WEST OF INTERSECTION OF 19TH ST AND LANDES
522	48	28.84	28.84	23.41	0.19	
525	48	33.89	33.89	23.48	0.17	12' SOUTH OF CL UMATILLA @ INTERSECTION OF MCNEILL ST
529	48	33.62	33.62	22.09	0.29	15' WEST OF CL SAN JUAN @ NEW CURB AND CL ALBANY STREET
531	48	24.85	24.85	20.6	#N/A	CL ALBANY AND 320' EAST OF CL SAN JUAN
541	48	41.96	41.96	36.6	1.14	
561	48	43.1	43.1	39.6	#N/A	
648	48	17.69	17.69	0	0.03	
667	48	15.14	15.14	0	#N/A	
687	48	26.86	26.86	14.79	#N/A	was 11.24, updated to 14.79 per tyler

688	48	27.7	27.7	0	#N/A	
746	48	26.19	26.19	14.45	#N/A	was 10.99, updated to 14.45 per tyler
764	48	11.55	11.55	0	0.07	
765	48	246	246	235.35	0.76	
768	48	239.05	239.05	234	0.36	INTERSECTION HANCOCK AND 14TH ST
769	48	229.5	229.5	223.73	0.31	INTERSECTION OF SHERMAN AND 14TH
777	48	105.49	105.49	99.22	#N/A	25' EAST OF INTERSECTION OF 14TH AND HOLCOMB
781	48	10.23	10.23	0	0.59	
782	48	16.76	16.76	11.76	#N/A	Assumed invert based on depth
783	48	14	14	-0.67	#N/A	
784	48	14	14	0	#N/A	
786	48	14.98	14.98	1.72	#N/A	
787	48	18	18	0	2.74	
790	48	240.24	240.24	235.75	0.26	INTERSECTION MCCLELLAN AND 14TH
792	48	12.97	12.97	0	#N/A	
793	48	14	14	0	#N/A	
810	48	110.49	110.49	101.88	0.39	12.5' EAST OF INTERSECTION OF HOLCOMB AND 12TH ST
821	48	235.42	235.42	225.36	1.28	100' NORTH OF INTERSECTION OF LOGAN AND 10TH ST
830	48	13.62	13.62	0	1.64	
831	48	12	12	0	#N/A	
833	48	249.85	249.85	245.19	#N/A	130' WEST OF INTERSECTION OF CLIFF ST AND 10TH
834	48	249.13	249.13	244.54	#N/A	20' WEST OF INTERSECTION CLIFF AND 10TH
836	48	239.97	239.97	231.3	2.05	INTERSECTION 12TH AND LOGAN
843	48	10.42	10.42	0.72	0.76	
849	48	30	30	22.79	#N/A	
851	48	29.93	29.93	25.18	0.00	6' WEST OF MCNEILL (GRAVEL ROAD) AND 12' NORTH OF CL DISCOVERY ROAD
854	48	10	10	0	#N/A	
901	48	32.73	32.73	24.5	0.32	120' NORTH OF CL 19TH ST
902	48	25.7	25.7	19.59	0.59	
903	48	29.56	29.56	22.8	0.31	15' WEST OF CL SAN JUAN AVE AND 9' SOUTH OF CL UMATILLA
904	48	28.05	28.05	23.82	0.32	
905	48	22.81	22.81	20.22	#N/A	
906	48	24.19	24.19	20.32	0.21	
907	48	22	22	0	0.67	
908	48	17.64	17.64	9.54	0.19	
909	48	16.69	16.69	10.51	0.49	
910	48	17.96	17.96	10.89	#N/A	16' South of Center Line of 49th St. and 8' East of Center Line of Landes St.
911	48	20.5	20.5	11.92	#N/A	
913	48	35.32	35.32	30.43	0.27	11' SOUTH CL 49TH ST @ SHERIDAN
919	48	15.09	15.09	9.29	#N/A	ADJUSTED - invert was 9.29, updated because tyler said the slope is basically flat
920	48	27.82	27.82	0	#N/A	
922	48	47.91	47.91	0	#N/A	
923	48	54.06	54.06	0	#N/A	
940	48	35.98	35.98	31.03	0.50	12' SOUTH OF 49TH ST AND 9' EAST OF CL GRANT (GRAVEL)
942	48	36.47	36.47	30.16	#N/A	18' SOUTH OF 49TH ST AND 150' EAST OF SHERIDAN
947	48	28.31	28.31	22.22	0.53	22' SOUTH CL 49TH ST @ WILSON ST
952	48	28.15	28.15	20.38	#N/A	18' SOUTH CL 49TH ST
958	48	23.33	23.33	15.03	#N/A	18' SOUTH CL 49TH ST AND 300' WEST OF JACKMAN
964	48	19.18	19.18	13.74	0.18	16' SOUTH CL 49TH AND 16' WEST CL JACKMAN
971	48	15.79	15.79	12.63	#N/A	16' SOUTH CL 49TH @ HILL ST
984	48	21.76	21.76	8.31	#N/A	ADJUSTED - invert was 8.31, updated because tyler said the slope is basically flat
986	48	19.78	19.78	8.34	#N/A	
987	48	19.33	18.69	5.97	#N/A	
988	48	22.66	22.66	15.76	#N/A	
989	48	19.27	18.33	6.99	0.10	
995	48	28.05	28.05	0	0.11	
997	48	29.26	29.26	0	0.19	
998	48	31.93	31.93	0	0.44	
999	48	32.05	32.05	19.6	0.15	
1000	48	43.8	43.8	20.5	#N/A	
1001	48	27.82	27.82	21.3	#N/A	
1002	48	27.28	27.28	0	#N/A	
1009	48	39.47	39.47	0	#N/A	
1051	48	19.84	19.84	0	#N/A	
1060	48	256.03	256.03	248.38	0.21	130' WEST OF INTERSECTION 10TH ST AND HOWARD
1061	48	251.56	251.56	245.38	0.18	INTERSECTION OF 14TH ST AND KATHERINE
1062	48	250.62	250.62	244.61	0.28	INTERSECTION OF MCPHERSON AND 14TH ST
1063	48	251.29	251.29	246.71	0.45	150' EAST OF INTERSECTION OF HOWARED AND 10TH
1064	48	249.54	249.54	243.64	#N/A	15' SOUTH OF INTERSECTION OF 14TH AND THOMAS ST
1068	48	24.5	24.5	14.95	#N/A	was 11.49, updated to 14.95 per tyler
1069	48	24	24	15.16	#N/A	was 11.7, updated to 15.16 per tyler
1070	48	18.7	18.7	15.65	#N/A	was 11.75, updated to 15.65 per tyler. ground updated due to IE update.
1073	48	23.52	23.52	15.99	#N/A	ground updated due to IE update. Per Tyler, IE = 15.99'.
1074	48	23.01	23.01	15.9	#N/A	ground updated due to IE update. Per Tyler, IE = 15.9'.

1086	48	21.92	21.92	16.04	#N/A	ground updated due to IE update. Per Tyler, IE = 16.04'.
1087	48	21.99	21.99	16.07	#N/A	ground updated due to IE update. Per Tyler, IE = 16.07'.
1111	48	39.68	39.68	0	0.55	HENDRICKS AND 51ST STREET
1112	48	37.62	37.62	0	#N/A	49TH AND HENDRICKS STREET
1120	48	21.25	21.25	12.76	0.10	
1121	48	21.8	21.8	12.47	#N/A	
1135	48	25.25	25.25	6.12	0.12	
1136	48	15.25	15.25	6.48	0.03	
1137	48	12.2	12.2	6.74	0.12	
1138	48	13	13	7	0.17	
1139	48	20	20	8.22	#N/A	
1140	48	25.3	25.3	9.28	#N/A	
1141	48	22.6	22.6	10.23	#N/A	
1142	48	21.45	21.45	10.62	#N/A	
1143	48	19.4	19.4	11.26	#N/A	
1215	48	241.13	241.13	237.3	#N/A	
1266	48	248.49	248.49	240.91	#N/A	
1267	48	250.25	250.25	242.47	#N/A	
1268	48	249.22	249.22	243.32	#N/A	
1283	48	258.58	258.58	253.1	#N/A	
1285	48	16	16	0	#N/A	
1286	48	33.51	33.51	26.17	0.36	
1309	54	26.98	26.98	17.86	0.23	
1319	48	155.4	155.4	144.76	0.05	
1328	48	38.42	38.42	0	#N/A	
1339	48	237.74	237.74	225.77	0.39	
1348	48	273.86	273.86	263.2	#N/A	
1349	48	264.68	264.68	260.5	#N/A	
1350	48	264.9	264.9	260	#N/A	
1351	48	263.84	263.84	259.6	#N/A	
1352	48	266.2	266.2	256.2	#N/A	
1353	48	290.66	290.66	282.5	100.00	100 gpm WTP load
1354	48	276.06	276.06	270.4	#N/A	
1355	48	285.31	285.31	279.4	0.23	
1356	48	269.27	269.27	262.1	#N/A	
1357	48	263.82	263.82	258.8	#N/A	
1358	48	266.67	266.67	257.4	#N/A	
1359	48	265.83	265.83	256	#N/A	
1360	48	264.09	264.09	255.1	#N/A	
1361	48	262.59	262.59	254.2	#N/A	
1362	48	261.03	261.03	250.5	#N/A	
1363	48	261.68	261.68	249.9	#N/A	
1375	48	252.14	252.14	242.1	2.13	MillLS Connection 1D > used Buildout Flows as pointload
1376	48	250.39	250.39	240.2	#N/A	
1378	48	247.26	247.26	238.6	#N/A	
1384	48	105.52	105.52	99.1	0.17	
1385	48	37.76	37.76	0	#N/A	
1395	48	13	13	4.64	2.04	
1415	48	262.33	262.33	254.67	#N/A	
1418	48	247.24	247.24	240.14	#N/A	
MH-7268	48	119.63	119.63	0	0.18	
MH-7270	48	28.61	28.61	17.11	#N/A	
MH-7299	48	14	14	0	0.02	
MH-7315	48	18.39	18.39	5.95	#N/A	
MH-7328	48	30	30	22.77	#N/A	
MH-7349	48	16.26	16.26	0	#N/A	
MH-7359	48	24.42	24.42	19.58	#N/A	
MH-7466	48	259.92	259.92	255.71	0.38	MillLS Connection 1A > used Buildout Flows as pointload
MH-7469	48	21.57	21.57	0	1.29	
MH-7472	48	30.49	30.49	22.7	#N/A	
MH-7570	48	35.14	35.14	0	#N/A	
MH-7784	48	38.38	38.38	0	#N/A	
MH-7825	48	28	28	26.15	0.20	
MH-7869	48	29.8	29.8	22.88	#N/A	
MH-7870	48	13.2	13.2	0	#N/A	

#N/A means no allocation of flow at this MH

Port Townsend
Sewer Model - Pipe Data

LABEL	DIAMETER	LENGTH	MATERIAL	MANNING'S 'N'	US MH LABEL	US MH RIM	US MH IE	US MH DIAMETER	US MH AAF (GPM)	DS MH LABEL	DS MH RIM	DS IE	DS MH DIAMETER	DS MH AAF (GPM)	PIPE SLOPE
7767	12	9.6	Concrete	0.013	777	105.49	99.22	48	#N/A	1384	105.52	99.1	48	0.1744	1.251
909	30	12	PVC	0.013	MH-7270	28.61	17.11	48	#N/A	65	27.87	17.1	96	#N/A	0.047
118	15	17.5	PVC	0.013	9	14	0.85	48	#N/A	783	14	0.82	48	#N/A	0.15
117	18	17.9	PVC	0.013	783	14	0.82	48	#N/A	MH-7299	14	0.8	48	0.0201	0.112
2636	24	20.4	PVC	0.013	987	18.69	5.97	48	#N/A	MH-7315	18.39	5.95	48	#N/A	0.08
6639	10	22.6	Vitrified Clay	0.013	6	37.38	3.68	48	#N/A	1328	38.42	3.62	48	#N/A	0.28
6526	18	22.8	Concrete	0.013	849	30	22.79	48	#N/A	MH-7328	30	22.77	48	#N/A	0.088
4017	30	24.7	PVC	0.013	1087	21.99	16.07	48	#N/A	1086	21.92	16.04	48	#N/A	0.122
1157	8	27.1	Concrete	0.013	146	160.11	148.88	48	0.1316	147	159.67	148.49	48	0.2537	1.44
5452	10	29	Vitrified Clay	0.013	782	16.76	1.83	48	#N/A	MH-7349	16.26	1.75	48	#N/A	0.28
3963	8	30.1	PVC	0.013	79	250.79	245.17	48	0.2547	1062	250.62	244.61	48	0.282	1.863
6536	18	33.8	PVC	0.013	252	25.7	19.72	48	0.1133	MH-7359	24.42	19.58	48	#N/A	0.414
915	30	35.1	PVC	0.013	67	24.57	17	48	#N/A	68	23.48	16.7	48	#N/A	0.854
7582	8	35.4	PVC	0.013	1354	276.06	270.4	48	#N/A	1348	273.86	263.2	48	#N/A	20.321
7593	8	38.1	PVC	0.013	1352	266.2	256.2	48	#N/A	1359	265.83	256	48	#N/A	0.524
3685	18	39.5	PVC	0.013	984	21.76	8.31	48	#N/A	986	19.78	8.34	48	#N/A	-0.076
4018	30	44.2	PVC	0.013	1086	21.92	16.04	48	#N/A	1073	23.52	15.99	48	#N/A	0.113
2136	12	44.4	Concrete	0.013	479	97.43	90.04	48	0.0978	481	93.43	89.04	48	0.3113	2.252
3684	18	46.2	PVC	0.013	986	19.78	8.34	48	#N/A	987	18.69	5.97	48	#N/A	5.135
1129	8	46.2	Concrete	0.013	96	216.75	203.5	48	#N/A	94	216.25	203.24	48	0.0282	0.562
906	30	46.9	PVC	0.013	1070	18.7	15.65	48	#N/A	63	18.7	15.52	48	#N/A	0.277
213	12	49.7	PVC	0.013	356	36.81	31.83	48	#N/A	1112	37.62	31.62	48	#N/A	0.423
339	18	50	PVC	0.013	253	25.31	18.56	48	1.3148	31	26.51	18.01	54	#N/A	1.1
1150	30	58.1	PVC	0.013	318	22.89	13.94	48	1.3057	120	23.3	13.71	48	#N/A	0.396
5190	8	60	PVC	0.013	1266	248.49	240.91	48	#N/A	215	247.32	240.77	48	#N/A	0.233
341	30	61	PVC	0.013	31	26.51	18.01	54	#N/A	1309	26.98	17.86	54	0.2342	0.246
116	15	62.9	PVC	0.013	793	14	0.89	48	#N/A	MH-7299	14	0.8	48	0.0201	0.15
6112	10	66.6	PVC	0.013	971	15.79	12.63	48	#N/A	1285	16	12.17	48	#N/A	0.69
8062	8	67.9	Asbestos Cement	0.013	781	10.23	2.48	48	0.594	843	10.42	2.21	48	0.7551	0.397
1125	8	71.2	Concrete	0.013	164	232.76	223.38	48	0.1502	165	231.07	222.71	48	#N/A	0.942
8058	8	73.3	PVC	0.013	1415	262.33	254.57	48	#N/A	1361	262.59	254.2	48	#N/A	0.498
6471	8	73	Concrete	0.013	1319	155.4	148.44	48	0.053	447	153.14	144.4	48	#N/A	5.538
4218	30	73.3	PVC	0.013	1135	25.25	6.12	48	0.1156	987	18.69	5.97	48	#N/A	0.205
335	30	74.4	PVC	0.013	29	24.86	17.57	54	4.6202	28	25.09	17.31	54	#N/A	0.35
3138	18	75.8	Concrete	0.013	MH-7359	24.42	19.58	48	#N/A	254	24.78	19.21	48	#N/A	0.488
6025	8	76.4	PVC	0.013	MH-7466	259.92	253.41	48	0.3796	1283	258.58	253.1	48	#N/A	0.4
7578	8	76.6	PVC	0.013	1349	264.68	260.5	48	#N/A	1350	264.9	260	48	#N/A	0.653
33	30	78.1	PVC	0.013	1073	23.52	15.99	48	#N/A	1074	23.01	15.9	48	#N/A	0.115
508	10	78.2	Vitrified Clay	0.013	MH-7469	21.57	2.05	48	1.2886	782	16.76	1.83	48	#N/A	0.28
6525	18	80	PVC	0.013	MH-7328	30	22.77	48	#N/A	MH-7472	30.49	22.7	48	#N/A	0.087
8070	8	81.5	PVC	0.013	215	247.32	240.77	48	#N/A	1418	247.24	240.14	48	#N/A	0.773
918	30	84.4	PVC	0.013	65	27.87	17.1	96	#N/A	66	24.51	17	48	#N/A	0.12
3965	8	86.6	PVC	0.013	211	238.62	233.2	48	#N/A	210	236.87	232.83	48	0.1172	0.427
4229	12	87.9	PVC	0.013	988	22.66	15.76	48	#N/A	1141	22.6	10.23	48	#N/A	6.291
7845	8	89	Asbestos Cement	0.013	831	12	5	48	#N/A	1395	13	4.64	48	2.0437	0.4
2634	18	93.9	PVC	0.013	919	15.09	9.29	48	#N/A	984	21.76	8.31	48	#N/A	1.044
7579	8	95.4	PVC	0.013	1350	264.9	260	48	#N/A	1351	263.84	259.6	48	#N/A	0.419
1160	8	105.6	Concrete	0.013	157	133.81	123.66	48	0.2418	158	124.96	118.13	48	0.2792	5.237
3094	18	106.9	Concrete	0.013	MH-7472	30.49	22.7	48	#N/A	246	30.73	22.6	48	0.1611	0.094
3065	8	107.3	PVC	0.013	833	249.85	245.19	48	#N/A	834	249.13	244.54	48	#N/A	0.606
7591	8	107.4	PVC	0.013	1360	264.09	255.1	48	#N/A	1415	262.33	254.57	48	#N/A	0.498

3928	30	107.9	PVC	0.013	1120	21.25	12.76	48	0.1004	1121	21.8	12.47	48	#N/A	0.269
2489	18	116.5	PVC	0.01	784	14	1.09	48	#N/A	793	14	0.89	48	#N/A	0.17
2479	30	116.7	PVC	0.013	1069	24	15.16	48	#N/A	1068	24.5	14.95	48	#N/A	0.18
2635	18	118.1	PVC	0.013	1051	19.84	8.54	48	#N/A	919	15.09	9.29	48	#N/A	-0.635
441	8	119.5	Concrete	0.013	88	230.07	218.26	48	#N/A	177	230.21	217.98	48	#N/A	0.234
3657	12	119.5	Asbestos Cement	0.013	997	29.26	17.52	48	0.1868	995	28.05	16.65	48	0.1067	0.728
7770	10	131.5	Vitrified Clay	0.013	1385	37.76	3.22	48	#N/A	MH-7570	35.14	2.85	48	#N/A	0.28
911	30	122.6	PVC	0.013	64	26	16.22	48	0.045	1087	21.99	16.07	48	#N/A	0.122
2480	30	122.9	PVC	0.013	1068	24.5	14.95	48	#N/A	687	26.86	14.79	48	#N/A	0.13
3896	10	127.1	PVC	0.013	347	63.13	56.18	48	#N/A	335	63.59	55.74	48	#N/A	0.346
3149	18	128.6	Concrete	0.013	363	35.2	21.95	48	#N/A	227	37.74	21.99	48	#N/A	-0.031
3967	8	130.2	PVC	0.013	207	240.89	235.69	48	0.1894	208	239.5	235.01	48	0.2164	0.522
3968	8	131.8	PVC	0.013	213	240.91	236.33	48	0.0488	207	240.89	235.69	48	0.1894	0.486
3682	18	132.7	PVC	0.013	989	18.33	6.99	48	0.0978	987	18.69	5.97	48	#N/A	0.769
1258	8	133.4	Asbestos Cement	0.013	185	206.2	197.59	48	#N/A	186	199.2	193	48	1.646	3.44
1199	8	133.5	Asbestos Cement	0.013	183	211.64	202.43	48	0.3869	185	206.2	197.59	48	#N/A	3.624
2368	10	133.9	Asbestos Cement	0.013	903	29.56	22.8	48	0.3058	529	33.62	22.09	48	0.2887	0.53
3122	18	135.2	Concrete	0.013	904	28.05	23.82	48	0.3209	262	28.33	23.71	48	0.4371	0.081
912	30	136.3	Concrete	0.013	69	22	16.38	48	0.3063	64	26	16.22	48	0.045	0.117
1163	8	136.6	PVC	0.013	1339	237.74	227.86	48	0.3914	176	230.28	223.4	48	0.3748	3.264
6024	8	137.9	PVC	0.013	1283	258.58	253.1	48	#N/A	1060	256.03	248.38	48	0.2055	3.423
7121	8	140.6	PVC	0.013	175	238.96	232.45	48	0.2649	1339	237.74	227.86	48	0.3914	3.265
2057	10	141.8	Vitrified Clay	0.013	1328	38.42	3.62	48	#N/A	1385	37.76	3.22	48	#N/A	0.28
7589	8	146.3	PVC	0.013	1362	261.03	250.5	48	#N/A	1363	261.68	249.9	48	#N/A	0.41
1198	8	148.4	Asbestos Cement	0.013	181	218.18	207.93	48	0.1359	183	211.64	202.43	48	0.3869	3.705
509	12	148.6	Vitrified Clay	0.013	MH-7349	16.26	1.75	48	#N/A	792	12.97	1.42	48	#N/A	0.22
3551	10	149.5	Asbestos Cement	0.013	920	27.82	21.72	48	#N/A	1001	27.82	21.3	48	#N/A	0.281
4635	8	152	PVC	0.013	1215	241.13	237.3	48	#N/A	213	240.91	236.33	48	0.0488	0.638
3362	12	152.2	PVC	0.013	913	35.32	30.43	48	0.2715	942	36.47	30.16	48	#N/A	0.177
4225	30	152.7	PVC	0.013	1142	21.45	10.62	48	#N/A	1141	22.6	10.23	48	#N/A	0.255
7586	8	157.6	PVC	0.013	1351	263.84	259.6	48	#N/A	1357	263.82	258.8	48	#N/A	0.508
5192	8	159.2	PVC	0.013	1267	250.25	242.47	48	#N/A	1266	248.49	240.91	48	#N/A	0.98
3142	18	159.1	Concrete	0.013	906	24.19	20.32	48	0.2072	905	22.81	20.22	48	#N/A	0.063
3159	12	161.5	Asbestos Cement	0.013	225	37.65	33.31	48	#N/A	226	36.18	32.76	48	0.1088	0.34
917	30	164.1	PVC	0.013	66	24.51	17	48	#N/A	67	24.57	16.7	48	#N/A	0.183
7585	8	164.7	PVC	0.013	1348	273.86	263.2	48	#N/A	1356	269.27	262.1	48	#N/A	0.668
1180	8	164.8	Concrete	0.013	112	208.01	197.86	48	0.356	114	203.42	194.7	48	#N/A	1.917
1269	8	165.8	Concrete	0.013	186	199.2	193	48	1.646	187	192.89	186.1	48	0.6246	4.161
3121	18	165.9	Concrete	0.013	248	34.9	24.9	48	0.2077	901	32.73	24.5	48	0.3186	0.241
5191	8	166.6	PVC	0.013	1268	249.22	243.27	48	#N/A	1267	250.25	242.47	48	#N/A	0.48
6118	8	167.9	PVC	0.013	1286	33.51	26.17	48	0.3647	947	28.31	22.22	48	0.5337	2.352
1189	8	168.6	Concrete	0.013	155	138.66	130.39	48	#N/A	159	124.84	117.39	48	0.1104	7.712
3615	8	169.8	PVC	0.013	942	36.47	30.16	48	#N/A	1286	33.51	26.17	48	0.3647	2.349
1167	8	173	Concrete	0.013	101	227.14	214.9	48	0.277	100	224.47	213.24	48	0.0351	0.96
2135	12	174.8	Concrete	0.013	478	96.6	90.95	48	0.0862	479	97.43	90.04	48	0.0978	0.521
3611	12	175.4	PVC	0.013	357	37.53	32.63	48	0.2004	356	36.81	31.83	48	#N/A	0.456
3926	10	184	PVC	0.013	1285	16	12.17	48	#N/A	910	17.96	10.89	48	#N/A	0.696
3129	10	184	Concrete	0.013	541	41.96	20.24	48	1.1419	252	25.7	19.72	48	0.1133	0.283
3449	10	184.8	PVC	0.013	221	50.61	39.44	48	#N/A	231	44.57	38.29	48	#N/A	0.622
3051	8	185.5	Asbestos Cement	0.013	830	13.62	5.74	48	1.641	831	12	5	48	#N/A	0.4
1187	8	190.4	Concrete	0.013	150	159.24	153.74	48	#N/A	152	150.48	145.37	48	0.0849	4.397
1123	8	191.2	Concrete	0.013	170	226.79	213.9	48	#N/A	171	227.61	212.59	48	0.1836	0.685
7592	8	191.6	PVC	0.013	1359	265.83	256	48	#N/A	1360	264.09	255.1	48	#N/A	0.47

2734	10	192	Concrete	0.013	274	32.9	23.79	48	0.2827	273	32.62	23.25	48	0.1944	0.281
1188	8	194.4	Concrete	0.013	152	150.48	145.37	48	0.0849	155	138.66	130.39	48	#N/A	7.704
3150	18	194.6	Concrete	0.013	262	28.33	23.71	48	0.4371	522	28.84	23.41	48	0.1943	0.154
3897	10	199.4	PVC	0.013	335	63.59	55.74	48	#N/A	336	66.86	55	48	#N/A	0.371
1165	8	199.8	Concrete	0.013	177	230.21	217.98	48	#N/A	101	227.14	214.9	48	0.277	1.542
7685	8	201.5	PVC	0.013	1375	252.14	242.1	48	2.13	1376	250.39	240.2	48	#N/A	0.943
4224	30	202.8	PVC	0.013	1141	22.6	10.23	48	#N/A	1140	25.3	9.28	48	#N/A	0.468
3982	30	204.1	PVC	0.013	1074	23.01	15.9	48	#N/A	1070	18.7	15.65	48	#N/A	0.123
3609	10	204.2	PVC	0.013	231	44.57	38.29	48	#N/A	358	38.76	33.4	48	#N/A	2.394
2090	8	204.7	Concrete	0.013	436	167.34	159.78	48	0.0419	1319	155.4	148.44	48	0.053	5.539
3665	12	209.5	Asbestos Cement	0.013	998	31.93	17.87	48	0.4392	997	29.26	17.52	48	0.1868	0.167
89	12	210.5	PVC	0.013	52	28.97	16.61	48	#N/A	53	27.34	16.15	48	#N/A	0.219
7583	8	211.4	PVC	0.013	1353	290.66	282.5	48	100	1355	285.31	279.4	48	0.2297	1.467
88	12	211.5	PVC	0.013	51	26	17.08	48	#N/A	52	28.97	16.61	48	#N/A	0.222
4155	30	212.4	PVC	0.013	1121	21.8	12.47	48	#N/A	911	20.5	11.92	48	#N/A	0.259
1607	10	216.6	Asbestos Cement	0.013	372	13.75	1.43	48	#N/A	783	14	0.82	48	#N/A	0.282
2367	10	217.3	Asbestos Cement	0.013	525	33.89	23.48	48	0.1718	903	29.56	22.8	48	0.3058	0.313
340	30	217.7	PVC	0.013	1309	26.98	17.86	54	0.2342	30	30.85	17.72	54	#N/A	0.064
7576	8	219.8	PVC	0.013	1355	285.31	279.4	48	0.2297	1354	276.06	270.4	48	#N/A	4.095
1311	8	220.5	PVC	0.013	1418	247.24	240.14	48	#N/A	174	244.98	238.7	48	#N/A	0.653
3446	10	220.9	PVC	0.013	368	53.58	41.3	48	#N/A	3	55.98	40.51	48	#N/A	0.358
7577	8	223.8	PVC	0.013	1356	269.27	262.1	48	#N/A	1349	264.68	260.5	48	#N/A	0.715
8099	8	224.8	Concrete	0.013	192	138.31	131.43	48	0.2483	193	113.85	104.52	48	0.4609	11.97
2050	8	226	Asbestos Cement	0.013	764	11.55	3.39	48	0.0705	781	10.23	2.48	48	0.594	0.403
3610	10	228.5	PVC	0.013	358	38.76	33.4	48	#N/A	357	37.53	32.63	48	0.2004	0.337
1168	8	229.8	Concrete	0.013	100	224.47	213.24	48	0.0351	102	222.04	210.86	48	0.3071	1.036
7588	8	234.7	PVC	0.013	1363	261.68	249.9	48	#N/A	1060	256.03	248.38	48	0.2055	0.648
3603	10	234.3	PVC	0.013	223	51.1	45.97	48	#N/A	367	54.17	44.95	48	#N/A	0.435
2083	8	237.1	PVC	0.013	418	213.37	206.25	48	0.1012	426	187	178.41	48	0.0675	11.74
3141	18	236.4	Concrete	0.013	905	22.81	20.22	48	#N/A	902	25.7	19.59	48	0.5856	0.266
3110	8	237.9	PVC	0.013	1062	250.62	244.61	48	0.282	1064	249.54	243.64	48	#N/A	0.408
3607	10	238.9	PVC	0.013	222	49.67	42.22	48	#N/A	368	53.58	41.3	48	#N/A	0.385
442	8	239.8	Concrete	0.013	176	230.28	219.28	48	0.3748	88	230.07	218.26	48	#N/A	0.425
4223	30	239.1	PVC	0.013	1140	25.3	9.28	48	#N/A	1139	20	8.22	48	#N/A	0.443
214	12	240	PVC	0.013	1112	37.62	31.62	48	#N/A	940	35.98	31.03	48	0.4981	0.246
7587	8	240.5	PVC	0.013	1358	266.67	257.4	48	#N/A	1352	266.2	256.2	48	#N/A	0.499
1264	8	241.7	Concrete	0.013	173	237.31	229.4	48	0.1767	164	232.76	223.38	48	0.1502	2.491
3931	18	244.2	Concrete	0.013	908	17.64	9.54	48	0.1868	1051	19.84	8.54	48	#N/A	0.409
1147	8	244.8	Concrete	0.013	122	188.47	177.84	48	0.3436	127	187.05	176.8	48	0.0934	0.425
3108	8	246.4	PVC	0.013	1061	251.56	245.38	48	0.1766	79	250.79	245.17	48	0.2547	0.085
2482	12	246.1	PVC	0.013	688	27.7	15.49	48	#N/A	1068	24.5	14.95	48	#N/A	0.219
1301	8	247.7	PVC	0.013	210	236.87	232.83	48	0.1172	204	238.4	231.18	48	0.1443	0.666
1151	8	248.7	Concrete	0.013	134	188.13	167.93	48	0.7727	140	174.97	161.24	48	0.4563	2.69
1186	8	249.4	Concrete	0.013	142	173.77	167.92	48	#N/A	150	159.24	153.74	48	#N/A	5.686
1154	8	249.9	Concrete	0.013	140	174.97	161.24	48	0.4563	146	160.11	148.88	48	0.1316	4.947
2099	10	250	Concrete	0.013	471	109.46	105.31	48	0.2964	478	96.6	90.95	48	0.0862	5.744
1134	8	250.4	Concrete	0.013	99	207.23	200.73	48	#N/A	103	203.59	198.69	48	#N/A	0.815
1196	8	251.7	Asbestos Cement	0.013	180	223.45	215.1	48	0.2106	182	216.06	209.5	48	0.0965	2.225
1121	8	251.9	Concrete	0.013	163	229.7	221.8	48	0.2598	170	226.79	213.9	48	#N/A	3.136
1126	8	254.3	Concrete	0.013	165	231.07	222.71	48	#N/A	172	230.44	217.91	48	#N/A	1.888
2481	30	253.9	PVC	0.013	687	26.86	14.79	48	#N/A	746	26.19	14.45	48	#N/A	0.134
1161	8	254.2	Concrete	0.013	158	124.96	118.13	48	0.2792	159	124.84	117.39	48	0.1104	0.291
3604	10	255.5	PVC	0.013	367	54.17	44.95	48	#N/A	366	51.71	44.37	48	#N/A	0.227

4226	30	256.1	PVC	0.013	1143	19.4	11.26	48	#N/A	1142	21.45	10.62	48	#N/A	0.25
3549	10	256.9	Asbestos Cement	0.013	273	32.62	23.25	48	0.1944	271	33.18	22.53	48	0.0442	0.28
1203	8	258.3	Concrete	0.013	187	192.89	186.1	48	0.6246	190	179.18	171.7	48	0.4152	5.574
3555	10	241.7	Asbestos Cement	0.013	275	31.97	22.8	48	#N/A	1002	27.28	22.13	48	#N/A	0.277
1184	8	259.2	Concrete	0.013	135	188.93	181.83	48	1.5075	142	173.77	167.92	48	#N/A	5.367
512	8	259.4	PVC	0.013	790	240.24	235.75	48	0.2582	768	239.05	234	48	0.3612	0.675
1205	8	259.8	Concrete	0.013	190	179.18	171.7	48	0.4152	191	162.28	155.73	48	0.2297	6.147
1206	8	260.2	Concrete	0.013	191	162.28	155.6	48	0.2297	192	138.31	131.43	48	0.2483	9.289
2071	8	260.4	PVC	0.013	78	246.12	239.39	48	0.1911	765	246	235.35	48	0.7631	1.552
2073	8	260.8	PVC	0.013	765	246	235.35	48	0.7631	836	239.97	231.3	48	2.0492	1.553
1127	8	261.9	Concrete	0.013	172	230.44	217.91	48	#N/A	96	216.75	203.5	48	#N/A	5.503
3898	10	261.6	PVC	0.013	336	66.86	55	48	#N/A	339	70.39	54.34	48	#N/A	0.252
2097	8	262	Concrete	0.013	454	143.31	135.91	48	0.2638	463	131.08	120.87	48	0.2695	5.742
2731	10	257.3	Asbestos Cement	0.013	1009	39.47	23.53	48	#N/A	275	31.97	22.8	48	#N/A	0.284
916	30	262.5	Concrete	0.013	68	23.48	16.7	48	#N/A	69	22	16.38	48	0.3063	0.122
2729	10	263.7	Asbestos Cement	0.013	922	47.91	25.06	48	#N/A	MH-7784	38.38	24.33	48	#N/A	0.277
3363	12	264	PVC	0.013	940	35.98	31.03	48	0.4981	913	35.32	30.43	48	0.2715	0.227
1159	8	265.8	Concrete	0.013	156	132.67	124.8	48	0.1433	157	133.81	123.66	48	0.2418	0.429
1260	8	265.7	Concrete	0.013	159	124.84	117.39	48	0.1104	160	127.41	116	48	0.4076	0.523
2085	8	266.8	PVC	0.013	426	187	178.41	48	0.0675	436	167.34	159.78	48	0.0419	6.983
3605	10	267.3	PVC	0.013	366	51.71	44.37	48	#N/A	2	55.59	43.41	48	#N/A	0.359
3113	8	268.6	PVC	0.013	1064	249.54	243.64	48	#N/A	78	246.12	239.39	48	0.1911	1.582
4221	30	268.5	PVC	0.013	1138	13	7	48	0.1655	1137	12.2	6.74	48	0.1195	0.097
7580	8	268.9	PVC	0.013	1357	263.82	258.8	48	#N/A	1358	266.67	257.4	48	#N/A	0.521
3133	10	269.7	Asbestos Cement	0.013	531	24.85	20.6	48	#N/A	1309	26.98	19.58	54	0.2342	0.378
3922	10	270.3	PVC	0.013	343	64.54	53.24	48	0.3914	1	60.24	50.02	48	0.0712	1.191
3667	12	270.3	Asbestos Cement	0.013	999	32.05	19.6	48	0.1488	355	24.64	18.7	48	0.0801	0.333
4219	30	269.8	PVC	0.013	1136	15.25	6.48	48	0.0282	1135	25.25	6.12	48	0.1156	0.133
4220	30	270	PVC	0.013	1137	12.2	6.74	48	0.1195	1136	15.25	6.48	48	0.0282	0.096
3535	8	270.9	PVC	0.013	947	28.31	22.22	48	0.5337	952	28.15	20.38	48	#N/A	0.679
2098	10	271	Concrete	0.013	463	131.08	120.87	48	0.2695	471	109.46	105.31	48	0.2964	5.741
1182	8	271.1	Concrete	0.013	124	199.47	191.96	48	1.1604	128	195.77	188.87	48	#N/A	1.14
3153	12	271.4	Asbestos Cement	0.013	854	10	2.81	48	#N/A	843	10.42	2.21	48	0.7551	0.221
1194	8	273	Concrete	0.013	160	127.41	116	48	0.4076	161	116.53	109.03	48	0.3566	2.553
3602	10	273.6	PVC	0.013	354	56.43	46.76	48	0.1512	223	51.1	45.97	48	#N/A	0.289
2081	8	275.3	PVC	0.013	768	239.05	234	48	0.3612	769	229.5	223.73	48	0.3101	3.731
1315	8	275.7	PVC	0.013	204	238.4	231.18	48	0.1443	173	237.31	229.4	48	0.1767	0.646
1118	8	275.9	Concrete	0.013	115	202.39	193.94	48	0.0198	123	199.25	190.85	48	1.7758	1.12
1130	8	276.3	Concrete	0.013	171	227.61	212.59	48	0.1836	94	216.25	203.24	48	0.0282	3.384
3601	10	276.1	PVC	0.013	1	60.24	50.02	48	0.0712	354	56.43	46.76	48	0.1512	1.181
4222	30	275.5	PVC	0.013	1139	20	8.22	48	#N/A	1138	13	7	48	0.1655	0.443
3925	18	275.5	Concrete	0.013	910	17.96	10.89	48	#N/A	909	16.69	10.51	48	0.4892	0.138
2091	8	276.7	Concrete	0.013	447	153.14	144.4	48	#N/A	454	143.31	135.91	48	0.2638	3.069
967	8	276.2	PVC	0.013	834	249.13	244.54	48	#N/A	1268	249.22	243.37	48	#N/A	0.424
1133	8	278.4	Concrete	0.013	94	216.25	203.24	48	0.0282	99	207.23	200.73	48	#N/A	0.902
2730	10	285.7	Asbestos Cement	0.013	MH-7784	38.38	24.33	48	#N/A	1009	39.47	23.53	48	#N/A	0.28
1170	8	279.2	Concrete	0.013	104	216.06	204.73	48	0.0263	112	208.01	197.86	48	0.356	2.46
2324	10	279.7	Asbestos Cement	0.013	365	56.71	45.5	48	0.6028	851	29.93	25.18	48	0	7.265
3556	10	295.7	Asbestos Cement	0.013	1002	27.28	22.13	48	#N/A	1001	27.82	21.3	48	#N/A	0.281
1608	10	279.9	Asbestos Cement	0.013	843	10.42	2.21	48	0.7551	372	13.75	1.43	48	#N/A	0.279
1183	8	281.1	Concrete	0.013	128	195.77	188.87	48	#N/A	135	188.93	181.83	48	1.5075	2.505
3064	8	281.6	PVC	0.013	1063	251.29	246.71	48	0.4506	833	249.85	245.19	48	#N/A	0.54
1323	8	282.7	PVC	0.013	1060	256.03	248.38	48	0.2055	1063	251.29	246.71	48	0.4506	0.591

1197	8	282.8	Asbestos Cement	0.013	182	216.06	209.5	48	0.0965	181	218.18	207.93	48	0.1359	0.555
3627	8	283.6	PVC	0.013	964	19.18	13.74	48	0.1842	971	15.79	12.63	48	#N/A	0.391
336	30	283.7	PVC	0.013	30	30.85	17.72	54	#N/A	29	24.86	17.57	54	4.6202	0.053
1148	8	284.8	Concrete	0.013	127	187.05	176.8	48	0.0934	134	188.13	167.93	48	0.7727	3.115
4227	30	284.7	PVC	0.013	911	20.5	11.92	48	#N/A	1143	19.4	11.26	48	#N/A	0.232
1162	8	287.3	PVC	0.013	174	244.98	238.7	48	#N/A	175	238.96	232.45	48	0.2649	2.175
3970	18	287.9	Concrete	0.013	901	32.73	24.5	48	0.3186	904	28.05	23.82	48	0.3209	0.236
2137	12	290.6	Concrete	0.013	481	93.43	89.04	48	0.3113	483	92.94	87.05	48	0.1334	0.685
3550	10	290.2	Asbestos Cement	0.013	271	33.18	22.53	48	0.0442	920	27.82	21.72	48	#N/A	0.279
1181	8	291.4	Concrete	0.013	114	203.42	194.7	48	#N/A	124	199.47	191.96	48	1.1604	0.94
7683	8	291.9	PVC	0.013	1376	250.39	240.2	48	#N/A	1378	247.26	238.6	48	#N/A	0.548
2058	10	292	PVC	0.013	561	43.1	4.5	48	#N/A	6	37.38	3.68	48	#N/A	0.28
3908	10	293.7	PVC	0.013	339	70.39	54.34	48	#N/A	343	64.54	53.24	48	0.3914	0.375
3616	8	295.9	PVC	0.013	952	28.15	20.38	48	#N/A	958	23.33	15.03	48	#N/A	1.808
3537	12	296.3	CI	0.013	1000	43.8	20.5	48	#N/A	999	32.05	19.6	48	0.1488	0.304
2056	10	288.5	Vitrified Clay	0.013	MH-7570	35.14	2.85	48	#N/A	MH-7469	21.57	2.05	48	1.2886	0.28
90	12	299.6	PVC	0.013	53	27.34	16.15	48	#N/A	688	27.7	15.49	48	#N/A	0.22
1135	8	300.3	Concrete	0.013	103	203.59	198.69	48	#N/A	115	202.39	193.94	48	0.0198	1.582
2138	12	301.1	Concrete	0.013	483	92.94	87.05	48	0.1334	487	93.2	84.9	48	0.3771	0.714
3668	12	303.2	CI	0.013	1001	27.82	21.3	48	#N/A	1000	43.8	20.5	48	#N/A	0.264
3618	8	304.5	PVC	0.013	958	23.33	15.03	48	#N/A	964	19.18	13.74	48	0.1842	0.424
3666	12	311.1	Asbestos Cement	0.013	355	24.64	18.7	48	0.0801	998	31.93	17.87	48	0.4392	0.267
3074	8	311.4	Asbestos Cement	0.013	1395	13	4.64	48	2.0437	764	11.55	3.39	48	0.0705	0.4
3140	18	315.1	Concrete	0.013	902	25.7	19.59	48	0.5856	252	25.7	19.72	48	0.1133	-0.041
1169	8	315.8	Concrete	0.013	102	222.04	210.86	48	0.3071	104	216.06	204.73	48	0.0263	1.941
3955	12	317.7	Concrete	0.013	161	116.53	109.03	48	0.3566	162	110.96	107.29	48	0.8699	0.548
3674	10	326	Asbestos Cement	0.013	923	54.06	25.98	48	#N/A	922	47.91	25.06	48	#N/A	0.282
3664	12	330.5	Asbestos Cement	0.013	995	28.05	16.65	48	0.1067	988	22.66	15.76	48	#N/A	0.269
3093	18	330.4	Concrete	0.013	246	30.73	22.6	48	0.1611	363	35.2	21.95	48	#N/A	0.197
2369	10	335.7	Asbestos Cement	0.013	529	33.62	22.09	48	0.2887	531	24.85	20.6	48	#N/A	0.444
7684	8	336.7	PVC	0.013	1378	247.26	238.6	48	#N/A	1215	241.13	237.3	48	#N/A	0.386
1907	10	340.2	Concrete	0.013	MH-7268	119.63	85.85	48	0.1764	487	93.2	84.9	48	0.3771	0.28
3966	8	342.9	PVC	0.013	208	239.5	235.01	48	0.2164	211	238.62	233.2	48	#N/A	0.528
7590	8	349.2	PVC	0.013	1361	262.59	254.2	48	#N/A	1362	261.03	250.5	48	#N/A	1.06
2323	10	350.1	Asbestos Cement	0.013	4	86.38	79.38	48	0.0683	365	56.71	45.5	48	0.6028	9.678
3156	12	350.5	Asbestos Cement	0.013	226	36.18	32.76	48	0.1088	257	34.96	30.09	48	#N/A	0.762
3091	10	394.6	Asbestos Cement	0.013	MH-7825	28	26.15	48	0.2015	849	30	22.79	48	#N/A	0.851
332	30	352.8	PVC	0.013	28	25.09	17.31	54	#N/A	MH-7270	28.61	17.11	48	#N/A	0.058
2325	10	360.7	Asbestos Cement	0.013	851	29.93	25.18	48	0	525	33.89	23.48	48	0.1718	0.471
2178	14	364.3	Asbestos Cement	0.013	383	18	2.97	48	0.9161	787	18	2.35	48	2.7383	0.17
2054	14	366.5	Asbestos Cement	0.013	786	14.98	1.72	48	#N/A	784	14	1.09	48	#N/A	0.17
2177	14	367.3	Asbestos Cement	0.013	648	17.69	3.59	48	0.0302	383	18	2.97	48	0.9161	0.17
3608	10	368.7	PVC	0.013	3	55.98	40.51	48	#N/A	221	50.61	39.44	48	#N/A	0.29
2179	14	373.9	Asbestos Cement	0.013	787	18	2.35	48	2.7383	786	14.98	1.72	48	#N/A	0.17
2176	14	374.2	Asbestos Cement	0.013	667	15.14	4.23	48	#N/A	648	17.69	3.59	48	0.0302	0.17
2150	12	377.5	Concrete	0.013	487	93.2	84.9	48	0.3771	493	65.6	58.21	48	0.8315	7.07
1355	30	385.1	PVC	0.013	746	26.19	14.45	48	#N/A	318	22.89	13.94	48	1.3057	0.132
3606	10	390.5	PVC	0.013	2	55.59	43.41	48	#N/A	222	49.67	42.22	48	#N/A	0.305
3089	8	396.7	Concrete	0.013	836	239.97	231.3	48	2.0492	821	235.42	225.36	48	1.2792	1.497
1117	8	398.5	Concrete	0.013	147	159.67	148.49	48	0.2537	156	132.67	124.8	48	0.1433	5.945
962	8	397.7	Concrete	0.013	821	235.42	225.36	48	1.2792	176	230.28	219.28	48	0.3748	1.529
1146	8	408.3	Concrete	0.013	123	199.25	190.85	48	1.7758	122	188.47	177.84	48	0.3436	3.186
2478	30	409.5	PVC	0.013	63	18.7	15.52	48	#N/A	1069	24	15.16	48	#N/A	0.088

4112	30	423	PVC	0.013	120	23.3	13.71	48	#N/A	1120	21.25	12.76	48	0.1004	0.225
3157	18	459.7	Concrete	0.013	227	37.74	21.99	48	#N/A	362	37.46	20.86	48	#N/A	0.246
3158	12	462.6	Asbestos Cement	0.013	257	34.96	30.09	48	#N/A	MH-7825	28	26.15	48	0.2015	0.852
3927	18	466.1	Concrete	0.013	907	22	11.45	48	0.6722	910	17.96	10.89	48	#N/A	0.12
3137	18	467.9	Concrete	0.013	254	24.78	19.21	48	#N/A	253	25.31	18.56	48	1.3148	0.139
3120	12	471.7	Concrete	0.013	493	65.6	58.21	48	0.8315	248	34.9	24.9	48	0.2077	7.061
3143	18	483.2	Concrete	0.013	362	37.46	20.86	48	#N/A	906	24.19	20.32	48	0.2072	0.112
3932	18	489.8	Concrete	0.013	909	16.69	10.51	48	0.4892	908	17.64	9.54	48	0.1868	0.198
4147	12	500.6	PVC	0.013	1111	39.68	32.72	48	0.5515	1112	37.62	31.62	48	#N/A	0.22
1208	12	513.3	Concrete	0.013	162	110.96	107.29	48	0.8699	193	113.85	104.52	48	0.4609	0.54
966	12	530.6	Concrete	0.013	193	113.85	104.52	48	0.4609	810	110.49	101.88	48	0.3887	0.498
3075	12	532.7	Concrete	0.013	810	110.49	101.88	48	0.3887	777	105.49	99.22	48	#N/A	0.499
1528	8	542.4	PVC	0.013	769	229.5	223.73	48	0.3101	418	213.37	206.25	48	0.1012	3.223
1908	12	627	Concrete	0.013	1384	105.52	99.1	48	0.1744	478	96.6	91.31	48	0.0862	1.242
CO-20	15	20		0.013	MH-7299	14	0.8	48	0.0201	W-Gaines St	#N/A	0.77	#N/A	#N/A	0.15
CO-25	24	5.5	PVC	0.013	MH-7315	18.39	5.95	48	#N/A	O-2	#N/A	5.95	#N/A	#N/A	0.079
3092(1)	18	341	Concrete	0.013	522	28.84	23.41	48	0.1943	MH-7869	29.8	22.88	48	#N/A	0.155
3092(2)	18	59.1	Concrete	0.013	MH-7869	29.8	22.88	48	#N/A	849	30	22.79	48	#N/A	0.152
121(1)	12	48.7	Vitrified Clay	0.013	792	12.97	1.42	48	#N/A	MH-7870	13.2	1.31	48	#N/A	0.22
121(2)	12	211.3	Vitrified Clay	0.013	MH-7870	13.2	1.31	48	#N/A	9	14	0.85	48	#N/A	0.22

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
3541	MH-7233	0	977	35.66	4.2	Min. Slope	8	PVC	0.013	0.1212	0.001	
6295	MH-7237	0	1301	160.15	5	Min. Slope	8	PVC	0.013	1.4375	0.005	
6309	MH-7238	0	1304	227.84	5	Min. Slope	6	PVC	0.013	0.2798	0.002	
7697	MH-7236	0	1139	8.22	5	Min. Slope	8	PVC	0.013	0.0901	0.001	
6286	MH-7240	0	1296	0	4.7	0	8	PVC	0.013	3.1049	57.25	
4349	MH-7241	0	1160	31.2	5.6	Min. Slope	8	PVC	0.013	0.5357	0.004	
2661	MH-7242	0	709	238.29	6.1	Min. Slope	6	PVC	0.013	251.6143	1.597	
3941	MH-7246	0	375	232.16	7	Min. Slope	8	PVC	0.013	0.5409	0.002	
8050	1408	0.03	W-Point Hudson	0	7.5	0.402	8	PVC	0.013	3.3192	0.965	
4601	1075	5.28	1203	5.08	7.9	2.529	10	PVC	0.013	176.018	11.255	
6968	MH-7249	0	430	189.16	8	Min. Slope	6	PVC	0.013	3.3751	0.028	
2744	MH-7251	0	1098	0	8.1	0	8	PVC	0.013	2.1781	40.16	
5378	MH-7252	65.68	MH-7253	65.64	8.1	0.401	6	PVC	0.013	0.7696	0.483	
2568	MH-7254	0	MH-7255	0	8.3	0	6	PVC	0.013	1.2123	48.14	
7664	1371	0	MH-7251	0	8.4	0	8	PVC	0.013	1.802	33.225	
4682	MH-7256	0	423	229.23	8.4	Min. Slope	8	PVC	0.013	4.5168	0.016	
5243	MH-7257	7.41	1396	7.37	8.7	0.398	8	PVC	0.013	0.9333	0.273	
4277	MH-7258	0	379	0	8.9	0	6	PVC	0.013	0.6741	26.768	
7075	MH-7259	230.42	MH-7260	230.38	9	0.4	6	PVC	0.013	0.6466	0.406	
5083	MH-7261	0	1256	63.14	9.2	Min. Slope	8	PVC	0.013	0.4597	0.003	
5293	1276	106.39	576	106.35	9.4	0.401	6	Concrete	0.013	1.5549	0.975	
7767	777	99.22	1384	99.1	9.6	1.251	12	Concrete	0.013	962.1563	53.805	
5104	MH-7263	241.1	MH-7264	241.06	9.6	0.399	6	PVC	0.013	3.8832	2.441	
5618	263	102.77	MH-7267	102.73	10.1	0.399	6	PVC	0.013	10.043	6.316	
8090	1422	0	MH-7268	0	10.7	0	8	PVC	0.013	0.9404	17.34	
914	532	0	68	0	11.5	0	6	PVC	0.013	1.0062	39.957	
4437	125	0	W-Island Vista	0	10.7	0	8		0.013	15.4896	285.605	
4074	MH-7269	57.58	1096	57.53	11.8	0.425	8	PVC	0.013	0.1608	0.045	
6445	MH-7272	54.08	1188	31.43	12	188.75	10	Vitrified Clay	0.013	555.3964	4.111	
909	MH-7270	17.11	65	17.1	12	0.047	30	PVC	0.013	3,711.37	93.091	
7636	MH-7271	0	1367	49.42	12	Min. Slope	8	PVC	0.013	0.37	0.003	
4020	386	0	395	0	12.4	0	8	PVC	0.013	0	0	
4652	MH-7275	0	1216	118.6	12.9	Min. Slope	8	PVC	0.013	0.1608	0.001	
108	MH-7276	91.59	8	91.54	13	0.384	6	PVC	0.013	0.6481	0.415	
5627	MH-7277	95.28	MH-7278	95.28	13	0	6	PVC	0.013	3.6412	144.592	
4395	MH-7279	0	1175	47.1	13.3	Min. Slope	8	PVC	0.013	0.639	0.006	
2299	444	209.12	443	207.81	13.4	9.746	8	PVC	0.013	26.9661	1.593	
6265	MH-7280	0	1291	0	13.6	0	8	PVC	0.013	0.4262	7.859	
7637	MH-7284	0	1369	52.12	14	Min. Slope	8	PVC	0.013	0.6988	0.007	
6780	MH-7281	90.28	MH-7282	90.23	14	0.4	6	PVC	0.013	0.4114	0.258	
6655	1333	0	MH-7283	0	14	0	8	PVC	0.013	3.5705	65.834	
7663	1370	0	1371	0	14.1	0	8	PVC	0.013	0.7522	13.869	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4701	MH-7285	0	1222	245.52	14.7	Min. Slope	8	PVC	0.013	0	0	
4822	1235	244.06	MH-7286	244	14.8	0.401	6	PVC	0.013	1.1853	0.743	
4073	MH-7287	57.59	1096	57.53	14.8	0.4	8	PVC	0.013	0.945	0.276	
5025	MH-7288	0	1252	0	15	0	8	PVC	0.013	0.6871	12.67	
6544	MH-7289	0	624	0	15.2	0	6	Concrete	0.013	1.8935	75.191	
8082	1490	0	1420	237.45	15.3	Min. Slope	6	PVC	0.013	0.3871	0.004	
4330	MH-7290	0	1156	0	16	0	6	PVC	0.013	0.5706	22.66	
7457	MH-7291	0	MH-7292	0	16	0	8	PVC	0.013	24.0223	442.936	
5095	MH-7293	0	498	76.94	16.2	Min. Slope	6	Concrete	0.013	7.0501	0.129	
3170	857	1.61	W-Monroe	1.56	16.6	0.28	10		0.013	903.5155	173.698	
4658	MH-7294	0	1218	108.9	16.8	Min. Slope	8	PVC	0.013	0.8183	0.006	
6256	MH-7295	75.67	892	62.27	17	78.826	10	Asbestos Cement	0.013	134.1305	1.536	
8093	1424	115.86	579	107.1	17.1	51.303	8	PVC	0.013	0.8904	0.023	
4427	MH-7296	185.94	636	185.87	17.2	0.4	6	PVC	0.013	5.079	3.191	
5090	MH-7297	0	528	0	17.5	0	6	Asbestos Cement	0.013	25.0733	995.649	
118	9	0.85	783	0.82	17.5	0.15	15	PVC	0.013	79.9401	7.127	
4653	MH-7298	0	1216	118.6	17.6	Min. Slope	8	PVC	0.013	0.1608	0.001	
117	783	0.82	MH-7299	0.8	17.9	0.112	18	PVC	0.013	301.7063	19.16	
7339	MH-7300	145.64	MH-7301	134.11	18	64.056	6	PVC	0.013	2.0659	0.102	
3961	MH-7302	0	178	227.58	18.1	Min. Slope	8	PVC	0.013	17.2806	0.09	
6250	1148	0	538	0	18.3	0	8	PVC	0.013	2.7267	50.277	
3171	869	1.68	857	1.61	18.6	0.4	10		0.013	82.165	13.208	
6917	MH-7303	0	MH-7304	224.94	18.7	Min. Slope	6	PVC	0.013	0.3761	0.004	
8030	1458	0	1214	62.82	19.2	Min. Slope	8		0.013	0.1472	0.001	
1415	MH-7305	38.16	490	38.08	19	0.4	8	PVC	0.013	0.2786	0.081	
4784	MH-7306	0	1232	230.47	19.9	Min. Slope	8	PVC	0.013	0.4566	0.002	
6259	MH-7307	0	714	229.99	20	Min. Slope	8	PVC	0.013	0.3761	0.002	
6656	MH-7308	0	1333	0	20	0	6	PVC	0.013	0.7496	29.767	
6852	MH-7309	0	974	0	20	0	8	PVC	0.013	0.4896	9.027	
7644	850	12.04	1070	15.65	20.1	Min. Slope	8	PVC	0.013	2.2476	0.098	
8004	MH-7310	229.8	MH-7311	229.72	20.1	0.399	6	PVC	0.013	0.7975	0.501	
2636	987	5.97	MH-7315	5.95	20.4	0.08	24	PVC	0.013	4,210.08	146.452	
81	MH-7314	0	181	207.93	20.3	Min. Slope	6	PVC	0.013	0.5936	0.007	
3949	MH-7316	0	509	33.34	20.8	Min. Slope	6	PVC	0.013	0.6472	0.02	
6444	MH-7317	54.14	MH-7272	54.08	21	0.28	10	PVC	0.013	555.3534	106.731	
4628	1211	200.67	W-Hamilton Heights	0	21	954.232	8	PVC	0.013	9.0703	0.054	
7743	MH-7318	13.05	1382	12.97	21.1	0.399	6	Vitrified Clay	0.013	6.7865	4.264	
3804	MH-7319	0	MH-7320	0	21.3	0	6	PVC	0.013	0.7248	28.782	
7225	MH-7323	0	MH-7324	0	22	0	6	PVC	0.013	12.6842	503.684	
3948	MH-7321	0	1050	60.71	22	Min. Slope	8	PVC	0.013	1.9742	0.022	
4797	1233	165.9	MH-7322	0	22	754.961	8	PVC	0.013	2.5428	0.017	
7195	MH-7325	0	38	0	22	0	8	PVC	0.013	0.1608	2.965	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4793	MH-7326	0	457	0	22.2	0	6	PVC	0.013	0.2798	11.111	
1175	MH-7327	0	118	216.24	22.7	Min. Slope	8	PVC	0.013	0.6199	0.004	
6639	6	3.68	1328	3.62	22.6	0.28	10	Vitrified Clay	0.013	47.1055	9.06	
6526	849	22.79	MH-7328	22.77	22.8	0.088	18	Concrete	0.013	1,232.07	88.32	
6779	MH-7329	90.12	MH-7330	90.02	24	0.4	6	PVC	0.013	0.5576	0.35	
2002	377	0	586	0	24.4	0	6	Concrete	0.013	30.4524	1,209.25	
7192	41	0	MH-7331	0	24.6	0	8	PVC	0.013	2.8662	52.849	
4085	MH-7332	0	708	0	24.6	0	6	PVC	0.013	0.1124	4.463	
5290	MH-7333	2.89	887	2.79	24.7	0.401	6	PVC	0.013	3.6083	2.264	
4393	MH-7334	0	1174	37.1	24.7	Min. Slope	8	PVC	0.013	0.1608	0.002	
4017	1087	16.07	1086	16.04	24.7	0.122	30	PVC	0.013	3,786.81	59.009	
2791	MH-7335	0	618	182.45	25	Min. Slope	8	PVC	0.013	1.2182	0.008	
5611	MH-7336	38.69	MH-7337	38.59	25.5	0.4	6	PVC	0.013	8.6857	5.453	
5080	1255	55.28	1164	0	25.5	216.568	8	PVC	0.013	2.2368	0.028	
2811	726	210.79	725	210.4	25.6	1.523	8	PVC	0.013	5.9257	0.885	
5430	1088	6.2	1279	6.1	25.8	0.401	8	PVC	0.013	15.2417	4.44	
4164	1125	0	475	0	26	0	6	PVC	0.013	1.6153	64.144	
1104	MH-7338	0	129	0	26.2	0	8	PVC	0.013	9.6233	177.44	
3806	MH-7339	0	325	0	26.2	0	6	PVC	0.013	3.0393	120.69	
4905	MH-7340	0	1243	245.5	26.5	Min. Slope	8	PVC	0.013	0	0	
5432	MH-7341	13.16	MH-7318	13.05	26.8	0.4	6	PVC	0.013	6.7134	4.215	
848	MH-7342	0	MH-7343	0	26.9	0	8	PVC	0.013	0.7036	12.973	
4904	MH-7344	0	1241	244.91	26.9	Min. Slope	8	PVC	0.013	0	0	
6778	MH-7282	90.23	MH-7329	90.12	27	0.4	6	Concrete	0.013	0.4845	0.304	
3252	879	135.73	1197	63.45	292.7	24.692	8	Vitrified Clay	0.013	314.7145	11.678	SM 9
2335	630	142.13	631	129.09	27.3	47.673	8	PVC	0.013	8.7349	0.233	
4348	MH-7346	0	1159	34.13	27.7	Min. Slope	8	PVC	0.013	1.0737	0.018	
3798	MH-7320	0	326	0	27.7	0	8	PVC	0.013	0.8856	16.33	
6428	1310	150.56	396	144.34	28.2	22.047	6	Vitrified Clay	0.013	10.58	0.895	
3221	MH-7348	168.73	898	163.4	47.2	11.283	6	Vitrified Clay	0.013	34.2703	4.051	
4697	MH-7347	0	1225	256	28.4	Min. Slope	8	PVC	0.013	0	0	
2188	513	0	511	0	28.5	0	8	PVC	0.013	5.6505	104.187	
7602	819	90.93	818	79.5	29	39.369	6	PVC	0.013	1.5204	0.096	
5452	782	1.83	MH-7349	1.75	29	0.28	10	Vitrified Clay	0.013	72.9632	14.027	
3954	MH-7350	0	724	218.49	29.5	Min. Slope	6	PVC	0.013	0.3761	0.005	
3963	79	245.17	1062	244.61	30.1	1.863	8	PVC	0.013	8.8359	1.194	
7224	MH-7324	0	544	0	30.1	0	6	Concrete	0.013	12.8314	509.529	
2344	595	0	594	0	30.2	0	8	Concrete	0.013	9.3316	172.06	
6440	1423	0	MH-7351	0	30.4	0	8	PVC	0.013	0.5574	10.278	
3945	MH-7352	0	954	44.48	30.4	Min. Slope	8	PVC	0.013	0.1212	0.002	
4346	MH-7353	0	1158	43.3	31	Min. Slope	8	PVC	0.013	0.1472	0.002	
908	71	0	65	18.15	31.1	Min. Slope	8	PVC	0.013	19.0852	0.461	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
8029	MH-7354	56.81	1403	56.68	31.5	0.4	6	Vitrified Clay	0.013	27.8333	17.476	
6317	1307	226.73	49	226.02	32.3	2.198	8	PVC	0.013	3.2428	0.403	
7728	1380	153.85	MH-7355	119.88	32.7	104.037	6	Vitrified Clay	0.013	0.9184	0.036	
3172	858	1.7	857	1.61	32.8	0.28	10		0.013	821.3076	157.881	
6273	657	189.42	1293	187.63	33.1	5.41	8	PVC	0.013	3.3307	0.264	
6652	MH-7356	86.62	MH-7357	86.49	33.1	0.399	6	Vitrified Clay	0.013	0.3088	0.194	
3950	MH-7358	0	509	33.34	33.3	Min. Slope	4	PVC	0.013	1.9812	0.232	
34	259	0	1073	0	33.5	0	8	PVC	0.013	14.6726	270.541	
776	516	0	518	0	33.7	0	6	Asbestos Cement	0.013	21.0478	835.8	
6536	252	19.72	MH-7359	19.58	33.8	0.414	18	PVC	0.013	1,363.87	44.943	
3444	918	13.84	970	13.8	33.9	0.118	8	Asbestos Cement	0.013	33.9752	18.242	
3785	MH-7360	64.36	MH-7361	64.23	34	0.4	6	PVC	0.013	5.5857	3.507	
137	MH-7362	0	914	59.55	35	Min. Slope	6	PVC	0.013	1.1374	0.035	
915	67	17	68	16.7	35.1	0.854	30	PVC	0.013	3,759.87	22.098	
7582	1354	270.4	1348	263.2	35.4	20.321	8	PVC	0.013	102.7601	4.203	
4323	1152	23.88	MH-7363	0	35.6	67.086	8	PVC	0.013	6.4376	0.145	
140	MH-7365	0	10	0	36	0	8	PVC	0.013	1.075	19.822	
3957	MH-7364	0	142	167.92	35.9	Min. Slope	8	PVC	0.013	0.3871	0.003	
1695	MH-7366	0	610	0	36.8	0	6	PVC	0.013	0.9485	37.666	
4623	MH-7367	0	1209	233	37	Min. Slope	8	PVC	0.013	0.7979	0.006	
7691	1377	0	1215	237.3	37.1	Min. Slope	8	PVC	0.013	0.3871	0.003	
38	530	0	848	0	37.1	0	8	PVC	0.013	5.2756	97.275	
3811	MH-7368	0	324	0	37.5	0	8	PVC	0.013	5.2926	97.587	
24	MH-7369	0	44	224.41	37.6	Min. Slope	8	PVC	0.013	0.3761	0.003	
7821	1393	61.2	240	59.6	37.9	4.219	8	PVC	0.013	1.2864	0.115	
7338	651	145.79	MH-7300	145.64	38	0.4	6	Vitrified Clay	0.013	2.0229	1.27	
4737	1228	0	1200	42.99	38.1	Min. Slope	6	Concrete	0.013	14.0332	0.525	
8048	1406	41.07	MH-7370	40.92	38.3	0.4	8	Vitrified Clay	0.013	0.1462	0.043	
7593	1352	256.2	1359	256	38.1	0.524	8	PVC	0.013	105.7689	26.931	
107	MH-7371	91.74	MH-7276	91.59	37.1	0.4	6	PVC	0.013	0.4873	0.306	
7887	MH-7374	0	MH-7375	0	39	0	8	Ductile Iron	0.013	2.2912	42.246	
4773	MH-7376	0	1231	228.5	39.4	Min. Slope	6	PVC	0.013	1.0769	0.018	
3685	984	8.31	986	8.34	39.5	Min. Slope	18	PVC	0.013	130.8788	10.072	
8078	1487	242.62	1417	242.34	39.8	0.704	8		0.013	0.3871	0.085	
1993	MH-7377	0	598	0	39.8	0	6	Concrete	0.013	0.4715	18.721	
4052	1091	74.56	MH-7378	48.91	39.9	64.249	8	PVC	0.013	6.1054	0.14	
3080	MH-7379	0	809	0	40	0	8	PVC	0.013	1.8828	34.716	
58	MH-7380	0	519	0	40	0	8	PVC	0.013	0.4461	8.225	
813	249	0	250	24.49	40.4	Min. Slope	8	PVC	0.013	15.1443	0.358	
4774	MH-7382	0	1231	228.5	40.5	Min. Slope	6	PVC	0.013	0.367	0.006	
4098	411	68.14	MH-7383	68.3	40.7	Min. Slope	6	PVC	0.013	0.3995	0.251	
7597	MH-7384	0	136	0	41.6	0	8	PVC	0.013	30.5571	563.427	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4413	MH-7387	0	1173	35.4	42	Min. Slope	8	PVC	0.013	1.6552	0.033	
4507	MH-7388	0	1187	29.54	42.1	Min. Slope	8	PVC	0.013	0.0901	0.002	
3029	817	4.97	828	4.8	42.1	0.4	8	PVC	0.013	1.0948	0.319	
1204	189	0	190	171.7	42.7	Min. Slope	8	PVC	0.013	32.0063	0.294	
3996	867	5.72	1076	6.08	42.7	Min. Slope	8	Vitrified Clay	0.013	151.3932	30.603	
6742	MH-7389	0	1315	0	43	0	8	Ductile Iron	0.013	1.399	25.795	
7680	MH-7390	242.87	1373	242.7	43.1	0.4	8	PVC	0.013	0.3871	0.113	
4276	MH-7391	6	862	5.83	43.2	0.4	6		0.013	0.8181	0.514	
938	MH-7392	0	74	212.1	43.4	Min. Slope	8	PVC	0.013	0.3233	0.003	
4809	MH-7393	0	MH-7394	0	43.6	0	8	PVC	0.013	0.6217	11.463	
4345	MH-7395	0	1158	43.3	43.6	Min. Slope	8	PVC	0.013	0.1472	0.003	
4282	1151	10.62	908	9.54	44.1	2.447	8	PVC	0.013	1.2182	0.144	
4018	1086	16.04	1073	15.99	44.2	0.113	30	PVC	0.013	3,786.96	61.174	
2136	479	90.04	481	89.04	44.4	2.252	12	Concrete	0.013	1,016.17	42.35	
3953	MH-7396	0	409	221.44	44.6	Min. Slope	8	PVC	0.013	1.6927	0.014	
7744	1382	12.97	MH-7570	12.79	44.7	0.4	6	PVC	0.013	6.8596	4.307	
6281	1303	0	1294	0	45	0	4		0.013	0.3276	38.352	
5100	583	87.42	MH-7397	15.18	45.4	159.225	6	Vitrified Clay	0.013	4.058	0.128	
4130	24	0	1089	0	45.5	0	6	PVC	0.013	1.2641	50.195	
627	MH-7400	0	975	0	46.3	0	6	Concrete	0.013	2.0714	82.255	
3684	986	8.34	987	5.97	46.2	5.135	18	PVC	0.013	138.398	1.295	
7617	MH-7398	0	MH-7399	0	46.2	0	6	PVC	0.013	1.9223	76.332	
1161	158	118.13	159	117.39	254.2	0.291	18	PVC	0.013	538.4058	21.168	SM 1
5626	MH-7278	95.28	1189	95.28	46.7	0	6	Vitrified Clay	0.013	3.7143	147.495	
5252	MH-7401	0	MH-7402	0	46.9	0	6	PVC	0.013	0.3761	14.935	
4142	818	79.5	303	0	46.9	169.573	6	PVC	0.013	1.6105	0.049	
906	1070	15.65	63	15.52	46.9	0.277	30	PVC	0.013	3,821.90	39.441	
6285	1296	0	413	232.63	48.2	Min. Slope	8	PVC	0.013	3.481	0.029	
2417	405	234.19	406	233.93	48.2	0.539	8	PVC	0.013	5.2275	1.313	
3768	MH-7405	0	319	0	48.8	0	8	PVC	0.013	1.0801	19.916	
6662	1335	68.14	MH-7404	78.46	48.8	Min. Slope	6	PVC	0.013	0.5281	0.046	
213	356	31.83	1112	31.62	49.7	0.423	12	PVC	0.013	60.3195	5.803	
5103	MH-7264	241.06	1237	240.86	49.8	0.4	6	Vitrified Clay	0.013	3.9262	2.465	
339	253	18.56	31	18.01	50	1.1	18	PVC	0.013	1,369.32	27.7	
3946	MH-7406	0	951	23.84	50	Min. Slope	8	PVC	0.013	0.1212	0.003	
6436	1317	216.12	1320	215.13	50.4	1.966	6	Vitrified Clay	0.013	3.7005	1.048	
4381	MH-7407	0	1171	0	51	0	8	PVC	0.013	0.3871	7.138	
2291	535	0	534	0	51.3	0	8	PVC	0.013	19.7363	363.907	
6304	1264	0	1149	0	51.6	0	6	Concrete	0.013	16.2115	643.753	
3112	1071	0	841	0	51.7	0	8	PVC	0.013	2.4819	45.762	
7258	MH-7408	86.23	MH-7409	86.02	51.7	0.4	6	Vitrified Clay	0.013	1.3051	0.819	
7810	MH-7410	0	1387	0	52.6	0	8	PVC	0.013	0.6641	12.245	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
536	MH-7411	0	62	0	53	0	6	PVC	0.013	0.2579	10.24	
1523	MH-7412	0	424	230.12	53.1	Min. Slope	6	PVC	0.013	0.4611	0.009	
6434	1315	0	1314	207.55	53.3	Min. Slope	8	PVC	0.013	3.0596	0.029	
4331	1222	245.52	1156	0	53.2	461.678	8	PVC	0.013	1.3156	0.011	
5118	MH-7413	33.41	195	33.2	53.4	0.4	8	PVC	0.013	3.1794	0.927	
3085	762	9.04	811	8.83	53.6	0.4	8	PVC	0.013	10.4682	3.052	
752	MH-7414	0	592	0	53.9	0	8	PVC	0.013	1.2918	23.82	
8073	1486	0	1418	240.14	54	Min. Slope	8		0.013	0.5311	0.005	
6529	1323	0	1322	0	54.2	0	8	Concrete	0.013	24.1388	445.083	
247	15	0	18	109.67	54.5	Min. Slope	8	PVC	0.013	2.3336	0.03	
5465	682	97.34	MH-7415	86.06	55.1	20.487	8	Vitrified Clay	0.013	108.8388	4.434	
7824	MH-7416	123.42	1391	123.2	55.4	0.4	6	PVC	0.013	0.1608	0.101	
46	76	0	622	164.08	55.6	Min. Slope	8	PVC	0.013	1.3729	0.015	
4364	1166	247.99	1165	247.75	56	0.428	8	PVC	0.013	1.955	0.551	
2015	399	227.39	395	0	56.4	402.843	8	PVC	0.013	5.0064	0.046	
4853	1239	118.24	MH-7348	117.92	79.3	0.4	6	Vitrified Clay	0.013	4.3895	2.756	
4508	MH-7418	0	1187	29.54	57.1	Min. Slope	8	PVC	0.013	1.4259	0.037	
249	MH-7419	0	14	0	57.9	0	6	PVC	0.013	1.7762	70.533	
1784	MH-7420	0	723	216.42	58.2	Min. Slope	6	PVC	0.013	1.0283	0.021	
1150	318	13.94	120	13.71	58.1	0.396	30	PVC	0.013	3,827.76	33.055	
4178	1316	204.4	1130	204.6	58.2	Min. Slope	8	PVC	0.013	3.6192	1.138	
1265	167	230.66	173	229.42	58.4	2.123	8	Concrete	0.013	6.551	0.829	
3198	MH-7421	3.38	MH-7422	0	59	5.72	6	PVC	0.013	2.3682	0.393	
4626	1212	204	1206	202.4	59.4	2.694	8	PVC	0.013	4.6262	0.52	
7156	1340	0	188	0	59.8	0	8	PVC	0.013	30.6479	565.101	
5190	1266	240.91	215	240.77	60	0.233	8	PVC	0.013	122.5948	46.81	
4522	MH-7423	0	1190	25.25	60	Min. Slope	6	PVC	0.013	0.5695	0.035	
3380	MH-7424	0	914	59.55	60.3	Min. Slope	8	PVC	0.013	1.5574	0.029	
5377	640	65.92	MH-7252	65.68	60.4	0.4	6	Vitrified Clay	0.013	0.043	0.027	
4006	1078	0	1077	0	60.3	0	8	PVC	0.013	12.1259	223.584	
2322	508	0	4	79.38	60.3	Min. Slope	8	Asbestos Cement	0.013	14.642	0.235	
6003	1145	0	MH-7425	0	60.7	0	6	PVC	0.013	1.114	44.235	
3696	978	0	975	0	60.7	0	8	PVC	0.013	2.7878	51.402	
341	31	18.01	1309	17.86	61	0.246	30	PVC	0.013	3,110.12	34.076	
7598	650	65.03	1416	64.78	61.1	0.4	6	Vitrified Clay	0.013	3.3242	2.087	
4149	MH-7429	0	1114	0	62	0	8	PVC	0.013	0.6254	11.531	
6648	MH-7427	98.48	MH-7428	98.23	62	0.4	6	Ductile Iron	0.013	0.0731	0.046	
1173	MH-7426	0	118	216.24	62	Min. Slope	8	PVC	0.013	8.883	0.088	
254	MH-7431	0	232	168.8	62.3	Min. Slope	6	Concrete	0.013	1.8952	0.046	
26	45	0	MH-7432	0	62.8	0	8	PVC	0.013	2.0245	37.33	
116	793	0.89	MH-7299	0.8	62.9	0.15	15	PVC	0.013	889.3612	79.176	
5464	MH-7415	86.06	MH-7433	85.8	63.5	0.4	8	PVC	0.013	111.4567	32.498	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
6418	MH-7434	0	489	116.09	64	Min. Slope	8	PVC	0.013	1.8891	0.026	
7537	1342	0	1345	165.16	64.2	Min. Slope	8	PVC	0.013	0.6221	0.007	
3929	MH-7435	0	1121	12.47	64.5	Min. Slope	8	PVC	0.013	25.8475	1.084	
6315	1305	227.68	1306	227.09	64.7	0.912	8	PVC	0.013	0.9281	0.179	
7257	MH-7409	86.02	MH-7436	85.76	65	0.4	6	PVC	0.013	1.3481	0.846	
4614	MH-7437	0	1208	224.51	65.3	Min. Slope	8	PVC	0.013	0.9575	0.01	
4025	MH-7438	174.99	1262	174.73	66.1	0.4	6	Vitrified Clay	0.013	3.1516	1.979	
3971	591	0	1072	0	66.2	0	8	Asbestos Cement	0.013	3.9904	73.576	
6653	MH-7357	86.49	MH-7408	86.23	66.1	0.4	6	PVC	0.013	1.0734	0.674	
2093	438	0	440	0	66.4	0	8	PVC	0.013	0.2798	5.159	
5363	554	66.74	1278	66.48	66.3	0.4	8	Concrete	0.013	8.9027	2.595	
7984	1450	0	1401	74.5	66.4	Min. Slope	8		0.013	0.9282	0.016	
6112	971	12.63	1285	12.17	66.6	0.69	10	PVC	0.013	123.8442	15.16	
1705	MH-7439	0	738	0	66.6	0	6	PVC	0.013	0.0901	3.578	
2302	MH-7440	0	456	201.47	67	Min. Slope	6	PVC	0.013	2.3892	0.055	
5331	MH-7441	104.57	MH-7442	74.78	67.4	44.203	6	Vitrified Clay	0.013	4.7054	0.281	
8062	781	2.48	843	2.21	67.9	0.397	8	Asbestos Cement	0.013	218.6499	63.948	
6671	MH-7443	0	MH-7444	0	68.5	0	8	PVC	0.013	0.3847	7.093	
4394	1368	47.44	1175	47.1	68.7	0.495	8	PVC	0.013	2.3581	0.618	
1287	203	229.22	205	228.88	68.7	0.495	8	PVC	0.013	4.3888	1.151	
1011	200	77.26	89	76.98	69	0.4	8	PVC	0.013	1.8064	0.527	
2330	MH-7445	120.79	665	113.91	69.3	9.919	8	Vitrified Clay	0.013	59.5843	3.488	
2285	567	0	562	0	69.7	0	8	PVC	0.013	0.8021	14.789	
4768	MH-7447	0	1229	222.79	69.9	Min. Slope	8	PVC	0.013	0.5072	0.005	
959	86	1.41	824	1.13	70	0.4	8	Asbestos Cement	0.013	75.1601	21.906	
4488	MH-7448	0	1184	0	70.3	0	6	PVC	0.013	0.3761	14.935	
1291	MH-7449	0	217	0	70.4	0	8	PVC	0.013	0.7742	14.275	
4636	MH-7450	0	1215	237.3	70.9	Min. Slope	8	PVC	0.013	30.2034	0.304	
1159	156	124.8	157	123.66	265.8	0.429	18	PVC	0.013	534.8707	17.322	SM 1
2277	537	0	536	0	71.5	0	8	PVC	0.013	6.9329	127.832	
4132	17	242.87	MH-7451	242.59	71.7	0.4	6	PVC	0.013	1.7222	1.081	
1773	MH-7452	0	728	214.12	71.7	Min. Slope	6	Asbestos Cement	0.013	0.7626	0.018	
8058	1415	254.57	1361	254.2	73.3	0.498	8	PVC	0.013	106.9302	27.942	
6293	1300	0	191	155.6	72	Min. Slope	8	PVC	0.013	2.6205	0.033	
3683	981	19.17	986	8.34	72.1	15.015	8	PVC	0.013	7.3585	0.35	
6471	1319	148.44	447	144.4	73	5.538	8	Concrete	0.013	19.3312	1.515	
5061	MH-7454	0	MH-7455	0	72.8	0	6	PVC	0.013	0.3188	12.66	
4867	MH-7456	0	180	215.1	73	Min. Slope	8		0.013	0.2798	0.003	
4218	1135	6.12	987	5.97	73.3	0.205	30	PVC	0.013	4,024.01	48.307	
1001	MH-7457	0	168	232.2	73.3	Min. Slope	6	PVC	0.013	2.0348	0.045	
3160	540	0	225	33.71	74	Min. Slope	8	Asbestos Cement	0.013	8.8723	0.242	
5094	491	95.78	MH-7458	76.94	74.2	25.391	6	PVC	0.013	4.4085	0.347	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
335	29	17.57	28	17.31	74.4	0.35	30	PVC	0.013	3,711.08	34.092	
7626	MH-7459	79.05	1364	78.75	74.7	0.4	6	Vitrified Clay	0.013	3.8838	2.439	
1290	MH-7460	0	216	0	74.8	0	8	PVC	0.013	0.3871	7.138	
1668	MH-7461	124.66	575	124.36	74.9	0.4	6	Vitrified Clay	0.013	0.0731	0.046	
4627	MH-7462	0	1211	200.67	75.1	Min. Slope	8	PVC	0.013	9.0703	0.102	
3628	917	30.66	MH-7463	0	75.2	40.79	8	PVC	0.013	0.8596	0.025	
3138	MH-7359	19.58	254	19.21	75.8	0.488	18	Concrete	0.013	1,364.15	41.415	
619	MH-7464	113.51	659	113.21	76.1	0.4	6	Vitrified Clay	0.013	0.9165	0.576	
6025	MH-7466	253.41	1283	253.1	76.4	0.4	8	PVC	0.013	1.6626	0.485	
7578	1349	260.5	1350	260	76.6	0.653	8	PVC	0.013	103.8884	23.704	
6290	423	229.23	1297	227.99	76.8	1.614	8	PVC	0.013	18.2208	2.644	
3987	MH-7467	65.4	MH-7468	65.09	77.6	0.4	6	PVC	0.013	0.043	0.027	
3988	MH-7468	65.09	1416	64.78	77.8	0.4	6	PVC	0.013	2.1748	1.366	
33	1073	15.99	1074	15.9	78.1	0.115	30	PVC	0.013	3,801.78	60.845	
508	MH-7469	2.05	782	1.83	78.2	0.28	10	Vitrified Clay	0.013	72.8901	14.012	
2911	804	0	797	0	77.9	0	8	PVC	0.013	1.8151	33.468	
4119	1105	260.05	1104	259.37	79.1	0.86	8	PVC	0.013	0.1417	0.028	
6314	MH-7470	0	1305	227.68	79.9	Min. Slope	8	PVC	0.013	0.2798	0.003	
601	MH-7471	0	67	0	80	0	8	PVC	0.013	21.953	404.78	
1260	159	117.39	160	116	265.7	0.523	18	PVC	0.013	789.7912	23.16	SM 1
2256	612	0	1149	0	80.3	0	8	PVC	0.013	2.9783	54.915	
5093	1258	121.11	MH-7445	120.79	80.4	0.4	6	Vitrified Clay	0.013	8.7439	5.489	
2566	MH-7255	0	518	0	80.3	0	8	PVC	0.013	1.491	27.492	
3787	304	0	305	0	80.3	0	8	Concrete	0.013	8.9869	165.706	
1230	MH-7473	0	106	212.61	81	Min. Slope	8	Concrete	0.013	1.0699	0.012	
8070	215	240.77	1418	240.14	81.5	0.773	8	PVC	0.013	122.9818	25.799	
4823	MH-7474	244.39	1235	244.06	81.6	0.4	6	PVC	0.013	0.5712	0.359	
4613	1205	210.25	1206	202.4	81.7	9.605	8	PVC	0.013	4.2207	0.251	
4150	1114	0	1113	0	82.1	0	8	PVC	0.013	1.0117	18.654	
1598	553	66.01	551	65.68	82.4	0.4	6	Concrete	0.013	9.6916	6.084	
2113	402	235.19	401	234.64	84.3	0.653	8	PVC	0.013	9.8343	2.245	
7538	144	0	1345	165.16	84.2	Min. Slope	6	Concrete	0.013	14.8624	0.421	
918	65	17.1	66	17	84.4	0.12	30	PVC	0.013	3,730.75	58.493	
3673	993	7.64	989	6.99	84.5	0.77	8	Concrete	0.013	47.0183	9.882	
2112	1270	0	402	235.19	83.3	Min. Slope	8	PVC	0.013	6.9175	0.076	
354	33	0	MH-7478	0	84.7	0	8	PVC	0.013	1.1913	21.966	
4179	MH-7477	0	1131	218.5	84.7	Min. Slope	8	PVC	0.013	4.2993	0.049	
5487	MH-7479	0	MH-7480	0	85	0	4	Vitrified Clay	0.013	0.7316	85.655	
261	21	0	MH-7481	0	85.5	0	6	PVC	0.013	2.3371	92.805	
3783	MH-7361	64.23	785	63.88	86.5	0.4	6	Vitrified Clay	0.013	5.6588	3.554	
6284	MH-7508	32.22	873	12	98.5	20.537	8	Vitrified Clay	0.013	19.5008	0.793	SM 10
4143	MH-7483	0	323	0	87.1	0	6	PVC	0.013	0.517	20.531	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4494	1185	210.84	725	0	87.6	240.821	8	PVC	0.013	1.0765	0.013	
1656	MH-7330	90.02	560	89.67	87.8	0.4	6	Concrete	0.013	0.7998	0.502	
4229	988	15.76	1141	10.23	87.9	6.291	12	PVC	0.013	158.6752	3.956	
1015	MH-7485	77.61	200	77.26	88	0.4	8	PVC	0.013	1.4184	0.413	
1991	MH-7484	0	689	0	88	0	8	PVC	0.013	0.2009	3.704	
251	MH-7486	0	MH-7487	0	88.2	0	6	PVC	0.013	1.2115	48.108	
4000	1077	0	W-Hamilton Heights	0	88.6	0	8	PVC	0.013	24.1577	445.432	
2060	MH-7397	15.18	MH-7488	14.82	88.6	0.4	6	PVC	0.013	4.5371	2.849	
7845	831	5	1395	4.64	89	0.4	8	Asbestos Cement	0.013	207.4599	60.482	
5010	1250	223.56	712	222.88	89.2	0.762	8	PVC	0.013	2.8148	0.595	
44	74	0	75	192.04	89.2	Min. Slope	8	PVC	0.013	0.4357	0.005	
2266	606	0	602	0	90	0	8	PVC	0.013	2.1494	39.631	
946	MH-7489	0	185	197.59	89.7	Min. Slope	8	Asbestos Cement	0.013	0.8868	0.011	
4538	1195	34.7	1196	32.82	90.2	2.085	8	PVC	0.013	3.7839	0.483	
2110	394	237.31	402	235.19	88.3	2.401	8	PVC	0.013	2.6369	0.314	
6552	1326	41.17	MH-7490	0	90.8	45.317	8	PVC	0.013	0.3583	0.01	
3269	878	104.94	MH-7441	104.57	90.6	0.4	6	PVC	0.013	4.5998	2.888	
3773	317	0	316	0	90.6	0	8	Concrete	0.013	21.7016	400.144	
2238	MH-7260	230.38	668	230.02	91	0.4	6	Vitrified Clay	0.013	1.2072	0.758	
6528	1322	0	MH-7869	0	91.2	0	8	Concrete	0.013	24.4175	450.221	
355	MH-7492	0	33	0	91.5	0	8	PVC	0.013	0.5201	9.591	
1392	MH-7493	0	436	159.78	91.5	Min. Slope	6	Vitrified Clay	0.013	1.0735	0.032	
3820	320	0	321	15.46	92.1	Min. Slope	8	PVC	0.013	7.1508	0.322	
6614	1327	144.9	654	0	92.3	156.909	8	PVC	0.013	0.1802	0.003	
907	258	14.57	66	17	92.5	Min. Slope	8	PVC	0.013	1.9445	0.221	
2246	MH-7494	222.6	670	222.23	92.8	0.4	6	PVC	0.013	2.0048	1.259	
4125	1118	0	MH-7405	0	93.6	0	8	PVC	0.013	0.9193	16.951	
4539	1196	32.82	703	0	93.7	35.041	8	PVC	0.013	3.9311	0.122	
1201	136	0	MH-7495	0	93.5	0	8	PVC	0.013	30.8369	568.586	
8089	1494	0	1422	0	93.9	0	8	PVC	0.013	0.2798	5.159	
4290	1108	0	1080	0	93.7	0	8	PVC	0.013	5.1082	94.187	
2634	919	9.29	984	8.31	93.9	1.044	18	PVC	0.013	130.718	2.714	
7976	MH-7496	115.88	MH-7497	115.51	94.2	0.4	8		0.013	14.3255	4.177	
6334	MH-7498	72.91	382	72.53	94.2	0.4	6	PVC	0.013	0.6143	0.386	
2372	MH-7500	0	542	0	94.6	0	8	PVC	0.013	5.8743	108.314	
4612	MH-7499	0	1207	212.33	94.5	Min. Slope	8	PVC	0.013	0	0	
730	MH-7501	0	588	0	94.9	0	6	PVC	0.013	2.5214	100.124	
1896	MH-7502	37.42	360	37.04	95	0.4	8	PVC	0.013	0.8365	0.244	
2429	455	199.74	460	198.98	95	0.8	8	Asbestos Cement	0.013	174.8405	36.05	
2259	618	182.45	MH-7374	0	95.4	191.218	8	PVC	0.013	2.1788	0.029	
350	MH-7503	107.71	20	107.33	95.5	0.4	6	PVC	0.013	0.5467	0.343	
4625	MH-7504	0	1208	224.51	95.6	Min. Slope	8	PVC	0.013	0.3032	0.004	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
204	13	0	271	0	95.7	0	8	PVC	0.013	6.0345	111.267	
4362	1168	249.74	1167	249.1	95.9	0.667	8	PVC	0.013	0.7013	0.158	
7579	1350	260	1351	259.6	95.4	0.419	8	PVC	0.013	104.2645	29.697	
4802	MH-7505	0	MH-7449	0	96.7	0	8	PVC	0.013	0.3871	7.138	
2028	MH-7301	134.11	398	133.72	97	0.4	6	Vitrified Clay	0.013	2.6785	1.682	
5212	MH-7422	3.61	897	4	97	Min. Slope	6	Concrete	0.013	11.4794	7.208	
7601	1097	0	606	0	97.4	0	8	PVC	0.013	2.037	37.559	
2180	551	65.68	558	65.29	97.7	0.4	6	Concrete	0.013	9.7647	6.13	
1062	1341	4.53	196	4.14	97.9	0.4	8	Asbestos Cement	0.013	12.6511	3.689	
6316	1306	227.09	1307	226.73	98.1	0.367	8	PVC	0.013	2.0141	0.613	
2164	MH-7497	115.51	MH-7507	115.11	98	0.4	6	Vitrified Clay	0.013	17.8625	11.217	
2333	641	127.77	644	127.38	98.4	0.4	8	PVC	0.013	11.8413	3.452	
6527	873	12	1321	10.4	205	0.78	8	Vitrified Clay	0.013	19.5438	4.079	SM 10
2338	638	186.89	37	186.5	98.6	0.4	8	PVC	0.013	1.0563	0.308	
6263	1291	0	1290	0	99.1	0	8	PVC	0.013	0.706	13.018	
866	58	0	59	72.38	99.5	Min. Slope	8	PVC	0.013	0.9791	0.021	
2354	576	106.35	574	105.95	99.9	0.4	6	Concrete	0.013	5.1502	3.233	
2251	599	0	MH-7511	0	100.2	0	6	Concrete	0.013	21.3252	846.814	
426	MH-7509	0	87	142.64	100	Min. Slope	6	PVC	0.013	0.623	0.021	
3887	MH-7510	69.74	333	69.34	100	0.4	8	PVC	0.013	0.8591	0.25	
1929	1067	186.17	770	175	100.5	11.111	8	PVC	0.013	2.2329	0.124	
812	251	0	249	24.53	100.4	Min. Slope	8	PVC	0.013	14.9971	0.559	
6538	MH-7514	0	MH-7424	0	100.7	0	8	PVC	0.013	0.5097	9.399	
160	MH-7515	109.13	11	108.73	100.8	0.4	6	PVC	0.013	0.4114	0.258	
1882	MH-7513	0	414	206.6	100.6	Min. Slope	8	PVC	0.013	0.2798	0.004	
2280	MH-7512	0	627	0	100.6	0	8	PVC	0.013	3.7151	68.501	
7886	MH-7375	0	609	134.8	101	Min. Slope	8	PVC	0.013	2.7574	0.044	
5082	MH-7516	0	1256	63.14	100.9	Min. Slope	8	PVC	0.013	1.4556	0.034	
1683	MH-7520	0	622	0	101.5	0	8	PVC	0.013	0.1124	2.072	
5609	1101	55.5	MH-7336	38.69	102.2	16.441	6	Vitrified Clay	0.013	8.5788	0.84	
1296	212	0	206	0	102.6	0	6	Vitrified Clay	0.013	9.9212	393.969	
3997	MH-7522	6.49	1076	6.08	102.5	0.4	6	Vitrified Clay	0.013	24.197	15.193	
2255	MH-7521	171.84	632	128.73	102.4	42.106	6	PVC	0.013	12.1451	0.743	
775	511	0	516	0	102.9	0	8	PVC	0.013	20.3546	375.309	
5292	1275	0	380	148.98	103	Min. Slope	6	Concrete	0.013	2.8998	0.096	
4243	1146	0	MH-7527	0	102.9	0	8	PVC	0.013	0.3871	7.138	
2	MH-7528	0	477	147.39	103	Min. Slope	8	PVC	0.013	3.6919	0.057	
3111	841	0	80	0	103.4	0	8	PVC	0.013	3.2734	60.356	
3107	MH-7530	253.91	1065	253.49	104.1	0.4	8	PVC	0.013	2.6409	0.77	
2425	549	0	543	0	105.2	0	8	PVC	0.013	3.7741	69.588	
1160	157	123.66	158	118.13	105.6	5.237	8	Concrete	0.013	537.0804	43.273	
311	25	237.34	MH-7534	235.75	106	1.499	8	PVC	0.013	1.2682	0.191	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
768	MH-7533	0	521	0	106	0	8	PVC	0.013	1.2947	23.872	
3094	MH-7472	22.7	246	22.6	106.9	0.094	18	Concrete	0.013	1,232.63	85.487	
2742	385	0	384	0	107.2	0	8	PVC	0.013	5.4859	101.153	
3065	833	245.19	834	244.54	107.3	0.606	8	PVC	0.013	120.2721	28.498	
4053	MH-7535	97.17	1094	96.74	107	0.4	8	PVC	0.013	0.1608	0.047	
7591	1360	255.1	1415	254.57	107.4	0.498	8	PVC	0.013	106.5431	27.836	
8086	1493	0	1421	78.12	107.6	Min. Slope	8	PVC	0.013	0.0597	0.001	
2783	MH-7540	0	491	95.78	108.1	Min. Slope	8	Vitrified Clay	0.013	4.1298	0.081	
3928	1120	12.76	1121	12.47	107.9	0.269	30	PVC	0.013	3,836.68	40.195	
2349	MH-7539	135.6	614	135.17	108.1	0.4	6	Vitrified Clay	0.013	0.3088	0.194	
2103	MH-7541	0	387	247.06	108.7	Min. Slope	8	PVC	0.013	1.3627	0.017	
2027	398	133.72	655	133.28	108.8	0.4	6	Vitrified Clay	0.013	6.0697	3.812	
8052	1410	0.26	MH-7870	-0.18	109	0.4	6	Vitrified Clay	0.013	6.6845	4.197	
2626	708	0	707	0	109.2	0	8	PVC	0.013	2.873	52.974	
4605	MH-7542	0	MH-7543	0	109.4	0	6	PVC	0.013	0.1608	6.385	
1286	MH-7545	0	203	229.22	110.4	Min. Slope	8	PVC	0.013	0.4988	0.006	
2128	MH-7546	0	453	0	110.5	0	6	PVC	0.013	1.3321	52.897	
7596	MH-7547	0	1304	227.84	110.5	Min. Slope	8	PVC	0.013	1.3669	0.018	
6308	1304	227.84	MH-7548	0	110.5	206.19	8	PVC	0.013	2.1533	0.028	
3033	811	8.83	813	8.38	111.1	0.4	8	PVC	0.013	21.5325	6.276	
3470	926	11.48	990	11.09	111.1	0.351	8	Asbestos Cement	0.013	44.7524	13.93	
7599	636	185.87	637	172.86	110.8	11.738	8	PVC	0.013	9.0372	0.486	
2101	758	249.26	760	248.56	112	0.625	8	PVC	0.013	15.2132	3.549	
763	MH-7455	0	607	0	111.9	0	6	PVC	0.013	0.4312	17.123	
7841	MH-7549	0	327	0	111.9	0	8	PVC	0.013	1.7847	32.907	
4692	MH-7550	0	977	35.66	113	Min. Slope	8	PVC	0.013	1.496	0.049	
2627	MH-7551	0	708	0	113.2	0	8	PVC	0.013	2.6482	48.829	
4946	1246	72.64	1245	63.94	113.3	7.675	8	PVC	0.013	1.5278	0.102	
7595	416	231.45	MH-7552	230.12	113.5	1.172	8	PVC	0.013	8.8133	1.501	
5997	11	108.73	1282	107.78	114.3	0.83	6	Concrete	0.013	1.065	0.464	
516	753	250.23	756	249.53	114.5	0.611	8	PVC	0.013	14.1717	3.343	
3288	996	0	MH-7553	0	114.7	0	8	PVC	0.013	0.7775	14.336	
3780	MH-7554	0	306	0	115.1	0	6	PVC	0.013	1.5644	62.122	
5317	1277	116.83	1198	105.51	115.2	9.825	6	Vitrified Clay	0.013	1.3586	0.172	
2489	784	1.09	793	0.89	116.5	0.17	18	PVC	0.01	889.2881	35.192	
7370	652	162	MH-7555	161.53	116.3	0.4	6	Vitrified Clay	0.013	4.6455	2.917	
2182	1278	66.48	553	66.01	116.4	0.4	8	Concrete	0.013	9.6185	2.804	
54	46	0	546	0	116.9	0	6	PVC	0.013	0.68	27.001	
2479	1069	15.16	1068	14.95	116.7	0.18	30	PVC	0.013	3,822.19	48.936	
1176	118	216.24	117	216.39	116.8	Min. Slope	8	PVC	0.013	9.89	5.088	
3118	842	7.39	247	6.92	117.1	0.4	8	PVC	0.013	6.5823	1.919	
4610	1210	212.28	1207	212.33	117.2	Min. Slope	8	PVC	0.013	1.7152	1.531	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
6	MH-7556	0	838	207.93	117.2	Min. Slope	8	Asbestos Cement	0.013	0.6006	0.008	
72	MH-7557	109.2	11	108.73	117.3	0.4	6	PVC	0.013	0.5805	0.364	
1750	MH-7558	0	408	232.78	117.7	Min. Slope	6	PVC	0.013	2.2377	0.063	
4846	1238	149.74	MH-7438	149.27	117.6	0.4	6	Vitrified Clay	0.013	2.425	1.522	
1140	108	0	109	0	117.9	0	8	Concrete	0.013	0.8165	15.056	
2635	1051	8.54	919	9.29	118.1	Min. Slope	18	PVC	0.013	130.5572	3.475	
1964	27	0	MH-7552	0	118.5	0	8	PVC	0.013	0.8296	15.297	
7491	619	0	MH-7559	0	118.8	0	8	PVC	0.013	4.7324	87.258	
2066	563	65.25	566	41.54	119	19.927	8	Concrete	0.013	10.486	0.433	
441	88	218.26	177	217.98	119.5	0.234	8	Concrete	0.013	178.9597	68.17	
3657	997	17.52	995	16.65	119.5	0.728	12	Asbestos Cement	0.013	158.1364	11.59	
1413	MH-7560	29.26	780	28.78	119.4	0.4	8	PVC	0.013	0.3464	0.101	
7858	1398	59.2	MH-7562	0	120.1	49.289	8	PVC	0.013	1.7799	0.047	
2082	425	0	426	178.41	119.9	Min. Slope	8	PVC	0.013	3.0539	0.046	
1928	MH-7561	0	770	175	120	Min. Slope	8	PVC	0.013	1.1635	0.018	
6551	MH-7563	0	1326	41.17	119.7	Min. Slope	8	PVC	0.013	0.2682	0.008	
1802	MH-7564	0	450	0	120.3	0	8	PVC	0.013	1.2015	22.154	
4458	1181	27.15	1179	25.69	120.7	1.21	8	PVC	0.013	2.0333	0.341	
4156	1122	0	587	0	120.7	0	8	PVC	0.013	1.0504	19.368	
1262	126	137.95	125	0	120.9	114.073	8	PVC	0.013	14.8964	0.257	
3437	916	0	976	0	121.1	0	8	Asbestos Cement	0.013	1.2628	23.284	
668	338	61.59	339	61.11	120.9	0.4	8	PVC	0.013	4.4545	1.298	
2228	745	0	750	0	121.2	0	8	Concrete	0.013	0.7093	13.079	
4824	MH-7565	244.55	1235	244.06	121.2	0.4	6	PVC	0.013	0.5712	0.359	
2295	1297	0	428	227.99	121.7	Min. Slope	8	PVC	0.013	18.9338	0.255	
2063	696	75.81	MH-7566	75.32	121.7	0.4	6	Vitrified Clay	0.013	4.6385	2.913	
4043	1279	6.1	893	5.61	121.6	0.4	8	PVC	0.013	15.2847	4.456	
4361	MH-7567	0	1168	249.74	121.9	Min. Slope	8	PVC	0.013	0.4215	0.005	
4261	MH-7569	0	916	0	122.3	0	6	PVC	0.013	1.1416	45.332	
879	MH-7568	0	918	13.84	122	Min. Slope	6	PVC	0.013	0.6891	0.081	
4765	1231	228.5	1230	228.5	122.6	0	8	PVC	0.013	1.4439	26.623	
7770	1385	3.22	MH-7570	2.85	131.5	0.28	10	Vitrified Clay	0.013	47.2517	9.081	
2340	MH-7572	173.35	637	172.86	122.8	0.4	6	Vitrified Clay	0.013	0.8754	0.55	
3014	MH-7571	100.93	1119	100.44	122.5	0.4	6	PVC	0.013	0.6724	0.422	
911	64	16.22	1087	16.07	122.6	0.122	30	PVC	0.013	3,786.66	58.808	
6430	MH-7573	0	1311	214.57	123	Min. Slope	8	PVC	0.013	0.2798	0.004	
2480	1068	14.95	687	14.79	122.9	0.13	30	PVC	0.013	3,822.93	57.566	
6670	MH-7444	0	542	0	123.5	0	8	PVC	0.013	1.4224	26.228	
6261	419	200.5	1249	174.61	123.6	20.952	8	PVC	0.013	98.6829	3.975	
4607	1204	0	487	84.9	123.6	Min. Slope	8	PVC	0.013	139.7255	3.108	
4115	1106	244.91	1107	0	124.1	197.288	8	PVC	0.013	2.6927	0.035	
514	755	0	757	0	125	0	8	PVC	0.013	17.5626	323.827	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4766	1230	228.5	1229	222.79	126	4.534	8	PVC	0.013	3.9275	0.34	
1257	197	4.72	198	4.21	126	0.4	6	PVC	0.013	0.1194	0.075	
3703	956	25.36	955	20.78	125.7	3.643	8	Asbestos Cement	0.013	16.5389	1.598	
3888	333	69.34	334	62.6	126.3	5.338	8	PVC	0.013	1.5369	0.123	
748	602	0	MH-7577	0	126.5	0	8	PVC	0.013	2.2618	41.703	
3934	517	27.4	262	24.37	126.2	2.401	8	PVC	0.013	11.3772	1.354	
4971	1247	0	912	61.79	126.6	Min. Slope	8	PVC	0.013	0.2424	0.006	
202	MH-7578	0	12	0	126.7	0	8	PVC	0.013	0.0901	1.661	
4521	1190	25.25	MH-7569	0	127.2	19.852	6	PVC	0.013	0.6907	0.062	
1369	MH-7436	85.76	1334	85.25	127	0.4	6	Vitrified Clay	0.013	1.3911	0.873	
3896	347	56.18	335	55.74	127.1	0.346	10	PVC	0.013	28.2352	4.88	
4170	1127	0	806	235.67	127	Min. Slope	8	PVC	0.013	2.0596	0.028	
4503	MH-7579	0	MH-7580	0	127.1	0	8	PVC	0.013	0.0901	1.661	
1702	MH-7581	0	715	234.08	127.3	Min. Slope	8	PVC	0.013	0.3761	0.005	
3509	MH-7582	0	1056	0	127.9	0	8	PVC	0.013	2.4388	44.968	
624	MH-7583	0	552	0	128	0	8	Asbestos Cement	0.013	2.272	41.892	
2174	MH-7566	75.32	603	74.81	128.5	0.4	6	Vitrified Clay	0.013	6.5045	4.084	
1401	MH-7584	0	503	0	135.8	0	6	PVC	0.013	0.899	35.698	
1120	199	1.93	86	1.41	128.7	0.4	8	Asbestos Cement	0.013	15.2686	4.452	
5038	MH-7585	106.9	1276	106.39	128.9	0.4	6	PVC	0.013	0.2422	0.152	
3149	363	21.95	227	21.99	128.6	Min. Slope	18	Concrete	0.013	1,264.98	152.12	
2784	492	83.53	494	76.41	129.2	5.509	8	PVC	0.013	3.3919	0.266	
7560	1346	9.34	811	8.83	129.6	0.4	8	PVC	0.013	11.0046	3.209	
1289	MH-7586	0	204	231.18	129.7	Min. Slope	8	PVC	0.013	0.3871	0.005	
7817	1391	123.2	1390	121.8	129.7	1.08	8	PVC	0.013	0.3216	0.057	
4635	1215	237.3	213	236.33	152	0.638	8	PVC	0.013	279.1967	64.44	SM 2
4162	MH-7588	62.72	1124	62.2	130.3	0.4	6	PVC	0.013	0.3077	0.193	
6545	MH-7587	0	1325	0	130	0	6	PVC	0.013	1.9381	76.961	
2621	706	0	705	0	130.1	0	8	PVC	0.013	1.9705	36.333	
45	75	0	76	168.11	130.7	Min. Slope	8	PVC	0.013	0.5481	0.009	
2004	MH-7589	0	458	192.87	130.4	Min. Slope	6	Asbestos Cement	0.013	2.0568	0.067	
1172	107	0	116	0	131.5	0	8	Concrete	0.013	3.922	72.316	
2810	723	215.47	726	210.79	131.5	3.56	8	PVC	0.013	5.5496	0.542	
4972	MH-7590	0	1247	0	131.5	0	8	PVC	0.013	0.1212	2.235	
867	59	0	60	62.37	131.3	Min. Slope	8	PVC	0.013	3.3816	0.09	
1301	210	232.83	204	231.18	247.7	0.666	8	PVC	0.013	292.7056	66.126	SM 2
3439	967	32.63	966	29.62	131.4	2.29	8	PVC	0.013	2.1408	0.261	
8072	1419	0	1267	242.47	132	Min. Slope	6	PVC	0.013	0.3871	0.011	
4079	378	0	425	0	132.1	0	8	PVC	0.013	1.9238	35.472	
1329	236	90.87	237	90.34	132.6	0.4	8	PVC	0.013	4.5493	1.327	
3764	MH-7592	0	297	0	132.7	0	6	PVC	0.013	1.7822	70.769	
1635	MH-7591	208.51	669	207.98	132.6	0.4	6	PVC	0.013	0.9004	0.565	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
3682	989	6.99	987	5.97	132.7	0.769	18	PVC	0.013	47.5079	1.149	
4174	1128	203.1	415	205.41	133.1	Min. Slope	8	PVC	0.013	30.3798	4.253	
1258	185	197.59	186	193	133.4	3.44	8	Asbestos Cement	0.013	81.5246	8.104	
1199	183	202.43	185	197.59	133.5	3.624	8	Asbestos Cement	0.013	42.7582	4.141	
430	MH-7593	0	791	100	133.2	Min. Slope	8	PVC	0.013	1.0004	0.021	
2592	702	0	701	25.64	133.2	Min. Slope	8	PVC	0.013	6.6584	0.28	
1292	MH-7594	0	212	0	133.8	0	6	PVC	0.013	7.8033	309.866	
4004	1083	0	1082	0	133.6	0	8	PVC	0.013	11.7782	217.172	
4372	MH-7562	0	1169	56.98	134.1	Min. Slope	8	PVC	0.013	2.0889	0.059	
1332	243	91.4	236	90.87	134.3	0.395	8	PVC	0.013	2.4293	0.713	
2368	903	22.8	529	22.09	133.9	0.53	10	Asbestos Cement	0.013	580.2009	81.031	
4639	1220	96.8	1221	82.2	133.9	10.903	8	PVC	0.013	2.4634	0.138	
1436	MH-7595	0	721	205.4	134	Min. Slope	8	PVC	0.013	0.2798	0.004	
7661	1253	0	MH-7596	0	134.4	0	8	PVC	0.013	1.8108	33.388	
4097	1447	68.68	411	68.14	134.4	0.4	6	PVC	0.013	0.2801	0.176	
4044	893	5.61	871	5.07	134.5	0.4	6	Concrete	0.013	18.9612	11.905	
3797	322	0	321	15.36	134.4	Min. Slope	8	PVC	0.013	14.6634	0.8	
1336	MH-7597	91.95	243	91.4	135.6	0.406	6	PVC	0.013	1.7341	1.081	
3892	352	74.2	351	73.66	134.5	0.4	8	PVC	0.013	21.1733	6.174	
211	MH-7598	93.15	1093	92.61	135	0.4	8	PVC	0.013	2.0736	0.605	
3122	904	23.82	262	23.71	135.2	0.081	18	Concrete	0.013	1,182.29	87.919	
2127	486	98.91	1204	84.9	135.2	10.365	8	PVC	0.013	138.4991	7.932	
2553	692	0	691	116.38	135.5	Min. Slope	8	PVC	0.013	3.1706	0.063	
415	MH-7599	0	93	204.2	135.7	Min. Slope	6	Concrete	0.013	2.0904	0.068	
1711	374	0	654	0	135.7	0	8	PVC	0.013	5.3108	97.923	
6242	1287	0	211	233.2	135.6	Min. Slope	8		0.013	2.2328	0.031	
7806	1386	204.68	1067	186.17	136	13.61	8	PVC	0.013	0.7617	0.038	
2785	18	109.67	MH-7540	0	136	80.635	8	PVC	0.013	3.596	0.074	
912	69	16.38	64	16.22	136.3	0.117	30	Concrete	0.013	3,786.37	60.038	
3012	806	235.67	85	234.13	136.1	1.131	8	PVC	0.013	3.9578	0.686	
807	514	0	520	0	136.5	0	8	PVC	0.013	6.2179	114.649	
3784	382	72.53	MH-7360	64.36	136.4	5.987	6	Vitrified Clay	0.013	5.5126	0.895	
1163	1339	227.86	176	223.4	136.6	3.264	8	PVC	0.013	136.2466	13.906	
2809	724	218.49	723	215.47	136.2	2.217	8	PVC	0.013	4.1451	0.513	
517	417	202.86	419	200.5	136.9	1.724	8	PVC	0.013	98.4031	13.819	
2801	MH-7601	0	435	0	136.6	0	6	PVC	0.013	1.1214	44.529	
2371	228	0	529	22.09	136.9	Min. Slope	8	PVC	0.013	1.8265	0.084	
4076	1095	55.55	336	55	137.7	0.4	8	PVC	0.013	3.4086	0.994	
6024	1283	253.1	1060	248.38	137.9	3.423	8	PVC	0.013	2.0497	0.204	
1974	727	219.47	431	218.45	146.3	0.697	8	PVC	0.013	123.9409	27.365	
2151	503	0	248	24.9	137.7	Min. Slope	8	Asbestos Cement	0.013	1.9201	0.083	
6262	1292	0	441	174.03	137.8	Min. Slope	8	PVC	0.013	2.8434	0.047	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2032	80	0	81	0	138.2	0	8	PVC	0.013	4.5927	84.683	
6297	MH-7602	0	807	0	138	0	6	PVC	0.013	1.1585	46.003	
6433	1313	212.57	MH-7389	0	138.1	153.953	8	PVC	0.013	1.1192	0.017	
595	50	0	35	205.6	138.5	Min. Slope	8	PVC	0.013	4.1225	0.062	
3442	MH-7603	0	963	16.79	138.5	Min. Slope	6	PVC	0.013	0.7884	0.09	
5291	1274	43.5	364	33.4	138.6	7.29	6	Vitrified Clay	0.013	6.3124	0.928	
4336	MH-7604	0	1159	34.13	138.8	Min. Slope	8	PVC	0.013	0.1472	0.005	
902	62	0	617	254.05	138.6	Min. Slope	8	PVC	0.013	0.5158	0.007	
1977	375	232.16	371	231.48	139.1	0.489	8	PVC	0.013	1.2528	0.33	
4638	1221	82.2	941	61	139	15.247	8	PVC	0.013	2.6242	0.124	
7066	624	0	1325	0	139.4	0	6	Concrete	0.013	2.0059	79.654	
2191	528	0	363	0	140.1	0	6	Concrete	0.013	31.2493	1,240.90	
2625	707	0	689	0	140.2	0	8	PVC	0.013	3.3098	61.027	
7121	175	232.45	1339	227.86	140.6	3.265	8	PVC	0.013	134.5443	13.73	
3788	MH-7607	0	313	0	140.6	0	6	Concrete	0.013	1.3875	55.097	
4615	1206	202.4	MH-7462	0	140.6	143.905	8	PVC	0.013	8.8469	0.136	
809	520	0	524	0	140.6	0	8	PVC	0.013	8.0909	149.184	
3400	MH-7606	0	949	37.79	140.4	Min. Slope	8	PVC	0.013	0.7488	0.027	
2274	MH-7610	0	MH-7323	0	140.9	0	6	Concrete	0.013	11.8245	469.547	
1210	194	33.76	195	33.2	141	0.4	8	PVC	0.013	6.7753	1.975	
3260	877	162.38	882	71.71	141	64.326	6	Vitrified Clay	0.013	51.8626	2.568	
1433	MH-7608	51.18	778	50.62	140.7	0.4	8	PVC	0.013	0.8818	0.257	
1876	1123	52.04	496	37.5	141.2	10.298	6	PVC	0.013	0.9509	0.118	
2350	MH-7609	135.73	614	135.17	140.8	0.4	6	Vitrified Clay	0.013	0.9224	0.579	
1379	MH-7548	0	369	219.22	141.4	Min. Slope	8	PVC	0.013	3.5668	0.053	
4495	MH-7611	0	1185	210.84	141.4	Min. Slope	8	PVC	0.013	0.7004	0.011	
6613	MH-7612	0	1327	144.9	141.8	Min. Slope	8	PVC	0.013	0.0901	0.002	
8081	1420	237.45	1288	0	142	167.169	8	PVC	0.013	0.7742	0.011	
2057	1328	3.62	1385	3.22	141.8	0.28	10	Vitrified Clay	0.013	47.1786	9.067	
6435	1314	207.55	1316	204.4	141.7	2.223	8	PVC	0.013	3.3394	0.413	
6340	1308	0	584	0	142.1	0	8	PVC	0.013	1.2276	22.634	
2241	666	254.78	668	230.02	143.3	17.283	6	Vitrified Clay	0.013	3.6654	0.35	
751	MH-7613	0	572	0	143	0	6	PVC	0.013	1.2404	49.257	
2552	691	0	580	0	143.2	0	8	Concrete	0.013	5.1672	95.275	
2613	1213	50.37	704	28.34	143.6	15.344	8	PVC	0.013	3.2659	0.154	
4550	1198	105.51	878	104.94	143.7	0.4	6	Vitrified Clay	0.013	2.4397	1.532	
3614	939	0	940	31.03	143.9	Min. Slope	8	PVC	0.013	4.6123	0.183	
489	756	249.53	758	249.26	145	0.186	8	PVC	0.013	14.6361	6.254	
4502	MH-7580	0	12	0	144.5	0	8	PVC	0.013	0.1802	3.323	
4518	397	106.81	MH-7277	95.28	145	7.954	6	Vitrified Clay	0.013	2.8916	0.407	
2281	627	0	384	0	144.8	0	8	PVC	0.013	4.7356	87.317	
2119	434	0	441	174.03	145.5	Min. Slope	8	PVC	0.013	101.7636	1.716	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2184	560	89.67	555	83.23	145.6	4.424	6	Concrete	0.013	0.8729	0.165	
4999	MH-7615	0	1248	0	145.7	0	8	PVC	0.013	0.8735	16.106	
3119	360	29.36	361	28.78	145.8	0.4	8	PVC	0.013	3.0478	0.889	
6292	1299	0	840	201.29	145.6	Min. Slope	8	PVC	0.013	10.3386	0.162	
4700	1223	253.1	1222	245.52	146.1	5.189	8	PVC	0.013	1.3156	0.106	
1145	121	178.65	122	177.84	146	0.555	8	Concrete	0.013	1.1574	0.287	
2051	1381	2.49	764	1.9	148.4	0.4	6	Concrete	0.013	1.5953	1.002	
3438	966	29.62	968	27.14	146	1.699	8	PVC	0.013	4.0851	0.578	
749	MH-7577	0	591	0	146.6	0	4	Asbestos Cement	0.013	3.878	454.02	
2419	587	0	588	0	146.2	0	6	Concrete	0.013	1.9295	76.618	
3630	974	0	973	27.56	146.2	Min. Slope	8	PVC	0.013	0.6504	0.028	
7589	1362	250.5	1363	249.9	146.3	0.41	8	PVC	0.013	107.7044	31.007	
2279	539	0	538	0	146.3	0	8	PVC	0.013	7.7099	142.159	
2847	800	255.05	802	251.55	146.5	2.389	8	PVC	0.013	5.201	0.62	
6077	1248	0	1284	0	146.9	0	8	PVC	0.013	2.7266	50.275	
2230	749	0	748	0	146.9	0	8	Concrete	0.013	0.9102	16.783	
164	MH-7511	0	589	0	147	0	8	PVC	0.013	22.2744	410.707	
3139	543	20.59	905	20.22	147	0.252	8	Asbestos Cement	0.013	4.8478	1.782	
2293	412	232.96	410	232.39	146.7	0.388	8	PVC	0.013	7.0962	2.099	
2248	MH-7559	0	615	0	146.8	0	8	Concrete	0.013	5.3465	98.582	
260	MH-7487	0	21	0	146.9	0	8	PVC	0.013	2.1899	40.378	
7464	MH-7616	0	486	98.91	147	Min. Slope	8	PVC	0.013	0.7659	0.017	
1994	MH-7617	0	506	0	147	0	8	PVC	0.013	0.8757	16.148	
2448	MH-7555	161.53	658	160.95	147.2	0.4	6	Vitrified Clay	0.013	5.4039	3.392	
838	MH-7618	0	701	25.64	147.8	Min. Slope	6	PVC	0.013	1.1654	0.111	
5072	MH-7351	0	549	0	147.9	0	8	PVC	0.013	0.8361	15.416	
1350	743	0	311	0	147.5	0	8	Concrete	0.013	0.9747	17.972	
2306	433	0	432	219.23	147.6	Min. Slope	8	Asbestos Cement	0.013	0.3761	0.006	
2084	379	0	1275	148.98	148.3	Min. Slope	6	Concrete	0.013	0.9539	0.038	
2983	754	0	802	251.55	148.3	Min. Slope	8	PVC	0.013	1.4582	0.021	
1765	MH-7619	0	464	0	148	0	6	PVC	0.013	0.5543	22.012	
1198	181	207.93	183	202.43	148.4	3.705	8	Asbestos Cement	0.013	5.2306	0.501	
2146	361	28.78	842	14.96	148.9	9.284	8	PVC	0.013	3.3017	0.2	
1256	196	4.14	201	3.54	148.8	0.4	8	Asbestos Cement	0.013	12.7108	3.706	
509	MH-7349	1.75	792	1.42	148.6	0.22	12	Vitrified Clay	0.013	73.0363	9.737	
6953	788	0	1058	198.66	148.6	Min. Slope	8	Asbestos Cement	0.013	9.0627	0.145	
5424	1150	0	1333	0	149	0	6	Concrete	0.013	2.7085	107.552	
4118	MH-7620	0	1105	260.05	149.1	Min. Slope	8	PVC	0.013	0.1417	0.002	
1330	237	90.33	238	89.74	148.6	0.4	8	PVC	0.013	6.3205	1.843	
1138	133	165.9	132	0	149.1	111.233	8	Concrete	0.013	144.8836	2.533	
2474	MH-7622	0	789	209.04	149.6	Min. Slope	8	PVC	0.013	1.4606	0.023	
1367	MH-7624	118.84	1239	118.24	149.7	0.4	6	Vitrified Clay	0.013	2.9793	1.871	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
3551	920	21.72	1001	21.3	149.5	0.281	10	Asbestos Cement	0.013	73.3974	14.084	
5018	MH-7623	62.8	1124	62.2	149.7	0.4	6	PVC	0.013	0.1381	0.087	
2337	633	187.49	638	186.89	150.2	0.4	6	PVC	0.013	1.0133	0.636	
2250	MH-7625	0	589	0	150	0	6	Concrete	0.013	1.0623	42.185	
630	MH-7626	0	MH-7400	0	150.5	0	6	PVC	0.013	1.301	51.662	
7684	1378	238.6	1215	237.3	336.7	0.386	8	PVC	0.013	248.2191	73.653	SM 2
4444	MH-7337	38.59	MH-7469	11.98	152	17.505	6	Vitrified Clay	0.013	14.3028	1.357	
3829	327	0	294	0	152.2	0	8	PVC	0.013	8.2714	152.512	
3362	913	30.43	942	30.16	152.2	0.177	12	PVC	0.013	83.1805	12.35	
973	MH-7629	0	137	0	151.9	0	6	Asbestos Cement	0.013	1.5494	61.525	
798	MH-7534	235.75	790	235.75	152.4	0	8	PVC	0.013	3.8485	70.96	
3819	326	0	319	24.41	152	Min. Slope	8	PVC	0.013	1.2839	0.059	
1144	105	195.1	111	181.73	153.2	8.728	8	Concrete	0.013	1.1289	0.07	
4225	1142	10.62	1141	10.23	152.7	0.255	30	PVC	0.013	3,862.89	41.52	
5881	1281	0	124	191.96	153	Min. Slope	8	PVC	0.013	0.5824	0.01	
6341	MH-7630	0	1308	0	153.4	0	8	PVC	0.013	0.3188	5.878	
1010	89	76.98	194	76.37	153.6	0.4	8	PVC	0.013	3.4217	0.998	
4461	1179	25.69	1178	23.98	153.4	1.115	8	PVC	0.013	3.5436	0.619	
7	838	0	839	0	153.9	0	8	PVC	0.013	28.7696	530.468	
2249	610	0	615	0	154	0	6	Concrete	0.013	1.3578	53.917	
3542	957	35.19	956	25.36	153.7	6.394	8	Asbestos Cement	0.013	15.0429	1.097	
623	MH-7631	9.66	762	9.04	153.9	0.4	8	PVC	0.013	10.4085	3.034	
4451	MH-7632	0	1177	111.73	154.1	Min. Slope	8	PVC	0.013	1.0735	0.023	
2160	MH-7253	65.64	650	65.03	154.7	0.4	6	Vitrified Clay	0.013	1.1544	0.725	
2414	MH-7633	0	526	0	154.5	0	8	PVC	0.013	2.6577	49.005	
4099	MH-7634	68.76	411	68.14	154.7	0.4	6	PVC	0.013	0.0597	0.037	
4586	MH-7635	169.77	1201	169.15	155	0.4	6	PVC	0.013	0.2761	0.173	
203	12	0	13	0	155.4	0	8	PVC	0.013	1.4291	26.35	
805	550	0	545	0	155.3	0	8	PVC	0.013	4.1226	76.014	
3123	733	202.85	788	198.66	155.2	2.7	8	Asbestos Cement	0.013	5.9323	0.666	
7819	1389	120.3	1388	119.5	156.1	0.512	8	PVC	0.013	0.6432	0.166	
4443	MH-7636	0	MH-7419	0	156.2	0	6	PVC	0.013	1.2708	50.462	
439	145	150.77	146	148.88	156.3	1.209	8	Concrete	0.013	0.7999	0.134	
4236	700	164.16	1144	158.3	156.5	3.744	6	Vitrified Clay	0.013	1.3356	0.274	
1131	91	0	92	205.7	157.1	Min. Slope	8	Concrete	0.013	0.4855	0.008	
120	37	186.5	636	185.87	157.2	0.4	8	PVC	0.013	2.7103	0.79	
2286	562	0	557	0	157.8	0	8	PVC	0.013	0.9493	17.503	
3681	1050	60.71	946	60.11	157.3	0.381	8	PVC	0.013	3.8637	1.153	
7586	1351	259.6	1357	258.8	157.6	0.508	8	PVC	0.013	104.6406	27.081	
4767	1229	222.79	1212	204	158	11.896	8	PVC	0.013	4.4347	0.237	
2798	435	0	235	0	158.6	0	8	PVC	0.013	1.5712	28.971	
2215	MH-7637	61.09	1234	60.46	158.5	0.4	6	Vitrified Clay	0.013	17.453	10.958	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
5192	1267	242.47	1266	240.91	159.2	0.98	8	PVC	0.013	122.2076	22.762	
3227	871	5.07	900	4.44	159.1	0.4	6	Concrete	0.013	19.0042	11.932	
3966	208	235.01	211	233.2	342.9	0.528	8	PVC	0.013	289.3047	73.426	SM 2
518	415	205.41	417	202.86	160	1.594	8	PVC	0.013	98.1233	14.332	
2229	598	0	747	0	159.6	0	6	Concrete	0.013	0.5616	22.299	
25	MH-7402	0	44	224.58	160.4	Min. Slope	6	PVC	0.013	0.8962	0.03	
6240	1289	0	1288	0	160	0	8		0.013	0.6844	12.619	
1710	MH-7638	0	374	0	160	0	6	PVC	0.013	0.7683	30.508	
7081	801	0	753	250.23	160.9	Min. Slope	8	PVC	0.013	3.8151	0.056	
989	MH-7639	0	182	209.5	160.9	Min. Slope	8	PVC	0.013	1.1383	0.018	
3159	225	33.31	226	32.76	161.5	0.34	12	Asbestos Cement	0.013	9.151	0.981	
1202	MH-7495	0	184	0	161.4	0	8	PVC	0.013	35.5975	656.363	
360	MH-7641	0	34	248.19	161.6	Min. Slope	8	PVC	0.013	0.943	0.014	
3599	MH-7640	0	265	0	161.5	0	6	PVC	0.013	1.8141	72.035	
3471	980	11.89	926	11.48	162.3	0.253	8	Asbestos Cement	0.013	38.3059	14.051	
1721	MH-7643	0	420	204.32	162.4	Min. Slope	6	PVC	0.013	1.9404	0.069	
2827	714	229.99	715	229.22	162	0.475	8	PVC	0.013	117.9902	31.556	
3249	MH-7442	74.78	884	74.13	162.1	0.4	6	Vitrified Clay	0.013	5.4204	3.404	
2807	716	215.84	719	215.05	162.6	0.486	8	PVC	0.013	268.482	71.03	
27	44	0	45	222.17	162.4	Min. Slope	8	PVC	0.013	1.6484	0.026	
2362	MH-7644	0	MH-7871	0	169.1	0	6	PVC	0.013	1.549	61.509	
4001	1082	0	1077	0	164.5	0	8	PVC	0.013	12.0318	221.848	
917	66	17	67	16.7	164.1	0.183	30	PVC	0.013	3,737.77	47.495	
7585	1348	263.2	1356	262.1	164.7	0.668	8	PVC	0.013	103.1362	23.269	
1072	198	4.21	201	3.54	167.6	0.4	6	PVC	0.013	0.1791	0.112	
4460	MH-7648	0	1180	34.8	164.8	Min. Slope	1	PVC	0.013	0.1472	1.512	
2307	432	219.23	431	218.45	164.8	0.473	8	Asbestos Cement	0.013	10.5507	2.827	
1180	112	197.86	114	194.7	164.8	1.917	8	Concrete	0.013	236.925	31.551	
3195	865	0.69	1408	0.03	165.2	0.4	8	PVC	0.013	2.6723	0.78	
4157	MH-7650	0	1122	0	165.8	0	8	PVC	0.013	0.938	17.296	
1847	MH-7649	0	420	204.32	165.3	Min. Slope	6	PVC	0.013	0.3932	0.014	
1269	186	193	187	186.1	165.8	4.161	8	Concrete	0.013	89.5317	8.093	
2070	MH-7651	240.05	78	239.39	166	0.4	8	PVC	0.013	0.8366	0.244	
2292	534	0	533	0	165.5	0	8	PVC	0.013	20.774	383.042	
1158	149	156.42	147	148.49	165.6	4.789	8	Concrete	0.013	1.0653	0.09	
3121	248	24.9	901	24.5	165.9	0.241	18	Concrete	0.013	1,179.58	50.957	
2114	401	234.64	404	234.07	166.3	0.343	8	PVC	0.013	57.9457	18.252	
2620	705	0	549	0	165.8	0	8	PVC	0.013	2.6593	49.033	
2466	629	132.17	630	142.13	166.2	Min. Slope	6	Vitrified Clay	0.013	4.1973	0.681	
5191	1268	243.27	1267	242.47	166.6	0.48	8	PVC	0.013	121.4334	32.315	
4416	1284	0	1176	179	166.7	Min. Slope	8	PVC	0.013	4.4016	0.078	
2741	626	0	385	0	166.3	0	8	PVC	0.013	3.7086	68.381	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
7982	494	76.41	1400	48.54	166.9	16.703	8	PVC	0.013	5.0028	0.226	
513	791	100	779	49.54	166.9	30.226	8	PVC	0.013	3.889	0.13	
2297	445	210.15	444	209.12	166.7	0.618	8	PVC	0.013	23.5136	5.516	
2970	797	0	798	0	167.2	0	8	PVC	0.013	8.56	157.834	
6118	1286	26.17	947	22.22	167.9	2.352	8	PVC	0.013	84.7275	10.186	
2328	656	126.67	660	126	167.7	0.4	8	PVC	0.013	38.2057	11.138	
3019	MH-7652	77.74	822	77.07	168	0.4	6	PVC	0.013	1.7564	1.103	
4139	MH-7653	0	26	0	168.3	0	8	PVC	0.013	1.6041	29.576	
1189	155	130.39	159	117.39	168.6	7.712	8	Concrete	0.013	250.6274	16.641	
6887	711	230.34	1337	222.88	169	4.414	8	PVC	0.013	257.1786	22.57	
402	MH-7655	0	1115	0	169.2	0	8	PVC	0.013	1.2115	22.338	
4238	MH-7654	0	1145	0	168.8	0	6	PVC	0.013	0.7938	31.52	
2108	400	0	401	236.76	168.9	Min. Slope	8	PVC	0.013	23.7849	0.37	
5024	1252	0	1253	0	169.6	0	8	PVC	0.013	1.531	28.229	
4487	1184	0	713	231.68	169.2	Min. Slope	8	PVC	0.013	2.2938	0.036	
3615	942	30.16	1286	26.17	169.8	2.349	8	PVC	0.013	83.3413	10.026	
2278	542	0	539	0	169.4	0	8	PVC	0.013	7.444	137.255	
7998	MH-7311	229.72	1318	229.04	169.9	0.4	6	Vitrified Clay	0.013	0.8405	0.528	
4268	MH-7657	130.41	1425	129.73	170.2	0.4	6	PVC	0.013	0.4608	0.289	
2294	424	230.12	423	229.23	169.9	0.524	8	PVC	0.013	13.3278	3.395	
1550	MH-7343	0	844	193.76	170.2	Min. Slope	8	PVC	0.013	1.0797	0.019	
3648	MH-7463	0	973	27.56	170.6	Min. Slope	8	PVC	0.013	1.8871	0.087	
73	1282	107.78	579	107.1	170.2	0.4	6	Concrete	0.013	2.119	1.331	
3726	MH-7658	0	968	27.14	171.1	Min. Slope	6	PVC	0.013	2.0286	0.202	
4571	MH-7659	0	736	30.7	171.3	Min. Slope	8	PVC	0.013	0.9125	0.04	
7079	512	0	23	0	170.9	0	8	PVC	0.013	4.1523	76.563	
1686	MH-7660	0	613	0	171.5	0	8	PVC	0.013	1.3919	25.665	
3034	813	8.38	812	7.69	171.9	0.4	8	PVC	0.013	21.5922	6.294	
3776	305	0	306	0	171.3	0	8	Concrete	0.013	10.0796	185.852	
4459	1180	34.8	1179	25.69	171.6	5.309	8	PVC	0.013	0.6209	0.05	
2804	1337	0	712	222.88	172	Min. Slope	8	PVC	0.013	258.5128	4.187	
2263	MH-7662	0	584	0	172	0	6	Concrete	0.013	1.2624	50.128	
6530	MH-7661	126.21	1324	125.52	171.7	0.4	6	Vitrified Clay	0.013	0.3437	0.216	
440	MH-7663	0	88	224.56	172.6	Min. Slope	8	PVC	0.013	1.4014	0.023	
4902	1242	236.4	MH-7437	0	172.8	136.828	8	PVC	0.013	0.9575	0.015	
2143	779	49.54	780	28.78	173.3	11.977	8	PVC	0.013	5.3636	0.286	
1164	218	224.89	177	223.55	173.4	0.773	8	PVC	0.013	21.3289	4.474	
3749	MH-7664	0	307	0	177.6	0	6	PVC	0.013	1.2454	49.456	
1167	101	214.9	100	213.24	173	0.96	8	Concrete	0.013	203.1515	38.238	
4498	MH-7665	0	1186	136.12	174.7	Min. Slope	6	PVC	0.013	0.9864	0.044	
1147	122	177.84	127	176.8	244.8	0.425	8	Concrete	0.013	368.1441	104.138	SM 3
4690	MH-7666	0	1191	111.58	175.1	Min. Slope	6	PVC	0.013	1.0858	0.054	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2282	MH-7667	0	385	0	175.3	0	8	PVC	0.013	0.874	16.116	
1366	MH-7433	85.8	896	85.1	175.6	0.4	8	Vitrified Clay	0.013	111.877	32.613	
3611	357	32.63	356	31.83	175.4	0.456	12	PVC	0.013	60.1587	5.571	
804	559	0	550	0	175.9	0	8	PVC	0.013	3.5895	66.184	
6889	712	222.88	1338	215.84	176	4	8	PVC	0.013	263.3902	24.283	
3055	816	5.68	823	2.57	175.6	1.77	8	PVC	0.013	56.6741	7.855	
2332	644	127.38	656	126.67	176.5	0.4	8	PVC	0.013	27.4618	8.007	
963	822	77.07	194	76.37	176.1	0.4	8	PVC	0.013	2.5276	0.737	
4609	1208	224.51	1210	212.28	176.1	6.944	8	PVC	0.013	1.3163	0.092	
4008	1081	0	1080	0	176.9	0	8	PVC	0.013	4.5982	84.783	
1152	141	0	140	161.24	176.8	Min. Slope	8	Concrete	0.013	0.3871	0.007	
1934	MH-7668	0	80	0	176.9	0	8	PVC	0.013	0.9323	17.19	
4141	1102	112.27	819	90.93	177.4	12.027	6	PVC	0.013	0.8959	0.103	
4457	1182	35.04	1181	27.15	177.7	4.441	8	PVC	0.013	1.4111	0.123	
3289	MH-7553	0	997	0	177.2	0	8	Asbestos Cement	0.013	3.0793	56.777	
520	590	99	583	87.42	177.8	6.513	6	Vitrified Clay	0.013	3.7482	0.583	
1347	744	0	313	0	177.6	0	8	Concrete	0.013	1.0008	18.453	
2239	MH-7671	257.09	653	256.38	178	0.4	6	Vitrified Clay	0.013	0.043	0.027	
622	MH-7669	0	492	83.53	177.7	Min. Slope	8	PVC	0.013	1.4125	0.038	
427	87	142.64	157	123.66	178.3	10.646	8	PVC	0.013	1.0101	0.057	
3907	MH-7670	92.99	345	92.28	177.9	0.4	8	PVC	0.013	1.2069	0.352	
6272	MH-7672	188.34	1293	187.63	178	0.4	6	PVC	0.013	0.7822	0.491	
2932	805	260.23	795	260.37	178.5	Min. Slope	8	PVC	0.013	0.903	0.594	
1261	129	0	126	137.95	178.6	Min. Slope	8	PVC	0.013	13.1826	0.277	
6318	MH-7673	0	1306	227.09	178.5	Min. Slope	8	PVC	0.013	0.6989	0.011	
3777	311	0	309	0	179	0	8	Concrete	0.013	1.8019	33.225	
2476	1110	178.9	461	175.47	178.5	1.921	8	PVC	0.013	4.2153	0.561	
4002	1085	0	1084	0	178.8	0	8	PVC	0.013	1.6168	29.812	
7844	MH-7674	5.36	1395	4.64	179	0.4	8	PVC	0.013	0.2761	0.08	
2183	555	83.23	554	66.74	178.9	9.217	6	Concrete	0.013	8.8296	1.155	
803	568	0	559	0	179.7	0	8	PVC	0.013	2.5517	47.05	
2233	742	0	741	0	179.7	0	8	Concrete	0.013	1.1811	21.777	
4551	MH-7677	106.23	1198	105.51	179.8	0.4	6	PVC	0.013	0.2298	0.144	
2003	MH-7675	0	495	100.19	179.5	Min. Slope	8	PVC	0.013	1.6867	0.042	
1605	MH-7676	0	408	232.78	179.7	Min. Slope	8	PVC	0.013	2.2006	0.036	
1328	239	89.01	241	82.76	180.5	3.464	8	PVC	0.013	7.0874	0.702	
3969	168	232.2	166	233.24	180.4	Min. Slope	8	PVC	0.013	2.6464	0.643	
4391	MH-7543	0	1172	0	181.1	0	6	PVC	0.013	0.3216	12.771	
2284	MH-7678	0	567	0	181.8	0	8	PVC	0.013	0.1472	2.714	
3436	976	0	980	11.89	182	Min. Slope	6	Vitrified Clay	0.013	1.384	0.215	
4569	MH-7679	0	245	31.7	182.6	Min. Slope	8	PVC	0.013	0.4754	0.021	
2790	MH-7680	188.23	MH-7681	187.49	183.1	0.4	6	Concrete	0.013	1.9245	1.208	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1331	238	89.74	239	89.01	183.1	0.399	8	PVC	0.013	6.4813	1.893	
4428	MH-7682	1.47	870	0.73	183.2	0.4	8	PVC	0.013	1.5911	0.464	
3430	MH-7490	0	272	0	183.1	0	8	PVC	0.013	0.7156	13.194	
405	1117	0	1118	0	182.4	0	8	PVC	0.013	0.7585	13.986	
4785	MH-7683	0	1212	204	183.7	Min. Slope	8	PVC	0.013	0.1915	0.003	
433	MH-7684	0	137	0	184	0	6	PVC	0.013	0.4238	16.831	
3926	1285	12.17	910	10.89	184	0.696	10	PVC	0.013	124.005	15.12	
3129	541	20.24	252	19.72	184	0.283	10	Concrete	0.013	88.3963	16.911	
125	MH-7685	239.24	25	237.34	184.1	1.032	8	PVC	0.013	0.9884	0.179	
1023	188	0	189	0	184.2	0	8	PVC	0.013	30.9277	570.26	
3449	221	39.44	231	38.29	184.8	0.622	10	PVC	0.013	59.003	7.607	
5105	1263	0	483	87.05	185.2	Min. Slope	6	Concrete	0.013	7.6349	0.442	
1768	502	0	508	0	185.2	0	8	Asbestos Cement	0.013	13.8065	254.57	
625	552	0	546	0	185.5	0	8	Asbestos Cement	0.013	3.6956	68.142	
3051	830	5.74	831	5	185.5	0.4	8	Asbestos Cement	0.013	204.2016	59.53	
3598	266	0	267	0	185.3	0	6	Concrete	0.013	0.3591	14.259	
6264	1290	0	1292	0	186.2	0	8	PVC	0.013	1.8607	34.308	
4171	MH-7686	0	1127	0	186.4	0	6	PVC	0.013	1.1418	45.341	
1166	202	216.89	101	214.9	186.5	1.067	8	Concrete	0.013	1.1578	0.207	
2802	709	238.29	710	234.93	186.6	1.801	8	PVC	0.013	251.9904	34.626	
4116	1156	0	1106	244.91	186.6	Min. Slope	8	PVC	0.013	1.8863	0.03	
2288	547	0	1148	0	187	0	8	PVC	0.013	2.2233	40.994	
865	MH-7687	0	59	72.38	187.2	Min. Slope	8	PVC	0.013	0.8355	0.025	
2803	710	234.93	711	230.34	187.4	2.449	8	PVC	0.013	255.533	30.106	
4181	1133	227.8	1132	225.7	187.6	1.12	8	PVC	0.013	11.6834	2.036	
30	MH-7688	0	190	171.7	187.4	Min. Slope	6	PVC	0.013	0.4475	0.019	
7635	1367	49.42	1368	47.44	188.7	1.049	8	PVC	0.013	1.3904	0.25	
6982	MH-7690	41.83	1406	41.07	188.7	0.4	8	Vitrified Clay	0.013	0.0731	0.021	
1149	MH-7689	0	134	167.93	188.6	Min. Slope	6	PVC	0.013	2.0426	0.086	
4341	1160	31.2	MH-7500	0	189.2	16.492	8	PVC	0.013	5.1334	0.233	
3796	324	0	322	16.48	188.7	Min. Slope	8	PVC	0.013	8.8316	0.551	
4334	MH-7691	0	1158	43.3	189.3	Min. Slope	6	PVC	0.013	2.6408	0.219	
4161	1124	62.2	1123	52.04	189.8	5.354	6	PVC	0.013	0.8912	0.153	
8094	1496	116.62	1424	115.86	189.8	0.4	8	PVC	0.013	0.6143	0.179	
1187	150	153.74	152	145.37	190.4	4.397	8	Concrete	0.013	249.568	21.946	
4363	1167	249.1	1166	247.99	189.4	0.586	8	PVC	0.013	0.9811	0.236	
2467	MH-7692	132.99	629	132.17	204	0.4	6	Vitrified Clay	0.013	0.4228	0.265	
1426	MH-7693	29.54	780	28.78	190	0.4	8	PVC	0.013	1.5851	0.462	
3830	294	0	328	0	190.7	0	8	PVC	0.013	8.9702	165.396	
2210	681	105.09	263	102.77	191	1.215	6	PVC	0.013	10	3.603	
6431	1311	214.57	1312	213.62	191.5	0.496	8	PVC	0.013	0.5596	0.146	
1123	170	213.9	171	212.59	191.2	0.685	8	Concrete	0.013	24.3379	5.421	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1116	98	0	126	137.95	191.8	Min. Slope	8	PVC	0.013	1.4501	0.032	
7592	1359	256	1360	255.1	191.6	0.47	8	PVC	0.013	106.156	28.563	
2734	274	23.79	273	23.25	192	0.281	10	Concrete	0.013	58.8109	11.277	
5249	MH-7696	4.18	876	3.4	194.2	0.4	6	Vitrified Clay	0.013	0.1715	0.108	
1948	MH-7697	0	773	0	193	0	8	PVC	0.013	1.1057	20.387	
2253	622	0	612	0	192.9	0	8	PVC	0.013	2.2508	41.502	
7682	1374	240.8	1378	238.6	192.5	1.143	8	PVC	0.013	1.9012	0.328	
4289	1107	0	1108	0	192.7	0	8	PVC	0.013	4.4436	81.933	
7456	MH-7292	0	68	0	192.7	0	8	Asbestos Cement	0.013	24.1695	445.65	
2156	509	33.34	517	27.4	193.5	3.07	6	PVC	0.013	9.9411	2.253	
3972	1072	0	578	0	193.6	0	6	Concrete	0.013	4.545	180.482	
3520	977	35.66	978	0	193.2	18.455	8	PVC	0.013	2.2183	0.095	
2433	613	0	1264	0	193.4	0	6	Concrete	0.013	15.9551	633.569	
3382	915	37.3	967	32.63	193.7	2.411	8	PVC	0.013	0.7136	0.085	
1188	152	145.37	155	130.39	194.4	7.704	8	Concrete	0.013	250.2404	16.623	
3150	262	23.71	522	23.41	194.6	0.154	18	Concrete	0.013	1,195.41	64.575	
4122	1109	253.42	57	0	194.9	130.004	8	PVC	0.013	3.474	0.056	
3405	MH-7698	0	977	35.66	195.1	Min. Slope	8	PVC	0.013	0.4798	0.021	
6306	154	126.8	156	124.8	194.9	1.026	8	PVC	0.013	5.5407	1.009	
7681	1373	242.7	1374	240.8	195.2	0.974	8	PVC	0.013	1.5141	0.283	
3106	1065	253.49	1061	245.38	196	4.138	8	PVC	0.013	3.1991	0.29	
3270	889	2.38	891	1.6	196.1	0.4	8	Asbestos Cement	0.013	4.0572	1.183	
1171	106	212.61	107	0	196	108.498	8	Concrete	0.013	1.457	0.026	
4901	1240	236	MH-7367	0	195.9	120.476	8	PVC	0.013	0.7979	0.013	
2739	MH-7399	0	515	0	196	0	6	PVC	0.013	2.2984	91.267	
4796	MH-7699	0	1233	165.9	197	Min. Slope	6	PVC	0.013	1.6961	0.073	
3409	MH-7274	0	943	45.91	197.4	Min. Slope	6	PVC	0.013	0.3603	0.03	
1478	MH-7700	92.25	679	91.46	197.7	0.4	8	PVC	0.013	3.0452	0.888	
4329	MH-7701	0	730	199.65	198.2	Min. Slope	6	Concrete	0.013	1.3928	0.055	
4239	MH-7425	0	599	0	198.1	0	6	Concrete	0.013	1.2264	48.698	
6654	MH-7702	0	1330	146.72	198.3	Min. Slope	6	Vitrified Clay	0.013	0.5128	0.024	
2848	799	0	800	255.05	198.4	Min. Slope	8	PVC	0.013	0.903	0.015	
2357	MH-7480	0	564	0	198.9	0	6	Asbestos Cement	0.013	1.9105	75.866	
4180	1132	225.7	1131	218.5	199	3.617	8	PVC	0.013	15.8269	1.534	
3443	MH-7703	0	917	30.66	199.2	Min. Slope	8	PVC	0.013	0.3999	0.019	
2423	250	0	261	22.82	198.9	Min. Slope	8	PVC	0.013	15.2915	0.832	
3194	868	1.49	865	0.69	199.5	0.401	8	PVC	0.013	2.0832	0.607	
3889	334	62.6	349	61.8	199.4	0.4	8	PVC	0.013	2.232	0.651	
3897	335	55.74	336	55	199.4	0.371	10	PVC	0.013	28.396	4.74	
943	840	201.29	77	0	200.1	100.597	8	PVC	0.013	279.5728	5.14	
2100	759	0	760	248.56	199.8	Min. Slope	8	PVC	0.013	1.495	0.025	
1165	177	217.98	101	214.9	199.8	1.542	8	Concrete	0.013	200.6757	29.801	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1141	109	0	110	0	200	0	8	Concrete	0.013	2.4874	45.864	
429	MH-7705	0	1109	253.42	200.5	Min. Slope	8	PVC	0.013	2.545	0.042	
3001	MH-7704	0	807	0	200.2	0	6	PVC	0.013	2.3875	94.805	
3816	308	0	310	0	200.3	0	8	Concrete	0.013	0.5041	9.295	
3278	MH-7706	67.71	874	66.91	200.8	0.4	6	Vitrified Clay	0.013	1.0376	0.652	
4281	MH-7708	0	1151	10.62	201.4	Min. Slope	8	PVC	0.013	0.4298	0.035	
8071	1417	242.24	1418	240.14	200.9	1.045	8		0.013	0.7742	0.14	
1194	160	116	161	109.03	273	2.553	8	Concrete	0.013	792.8289	91.484	SM 3
617	585	70.46	MH-7341	13.16	201.5	28.441	6	PVC	0.013	6.6403	0.494	
3936	MH-7707	5.52	197	4.72	201.3	0.4	6	PVC	0.013	0.0597	0.037	
2287	557	0	547	0	201.9	0	8	PVC	0.013	1.4824	27.333	
4948	1244	62.89	349	61.8	202.1	0.539	8	PVC	0.013	1.8494	0.464	
820	485	132.79	488	117.9	202.6	7.348	8	PVC	0.013	326.6684	22.22	
7983	1401	74.5	1397	66.95	203	3.719	8		0.013	1.5375	0.147	
2065	558	65.29	563	65.25	203	0.02	6	Concrete	0.013	9.8378	27.83	
6668	MH-7428	98.23	1336	97.42	203	0.4	6	Vitrified Clay	0.013	0.2477	0.156	
4224	1141	10.23	1140	9.28	202.8	0.468	30	PVC	0.013	4,021.65	31.921	
3940	MH-7552	0	424	230.12	204	Min. Slope	8	PVC	0.013	11.6969	0.203	
3982	1074	15.9	1070	15.65	204.1	0.123	30	PVC	0.013	3,819.50	59.277	
1724	MH-7709	0	517	27.4	203.8	Min. Slope	4	PVC	0.013	0.6472	0.207	
3609	231	38.29	358	33.4	204.2	2.394	10	PVC	0.013	59.1638	3.888	
2090	436	159.78	1319	148.44	204.7	5.539	8	Concrete	0.013	18.8733	1.479	
41	533	0	MH-7291	0	204.2	0	8	Asbestos Cement	0.013	22.7605	419.669	
3440	MH-7710	0	967	32.63	205	Min. Slope	8	PVC	0.013	0.8983	0.042	
1133	94	203.24	99	200.73	278.4	0.902	8	Concrete	0.013	349.8638	67.937	SM 3
2104	387	247.06	390	241.4	206.3	2.743	8	PVC	0.013	19.9299	2.219	
3255	MH-7711	84.75	875	83.93	206	0.4	6	Vitrified Clay	0.013	1.2583	0.79	
3623	1057	0	1056	0	206	0	8	PVC	0.013	15.3337	282.729	
3237	880	7.5	885	6.67	206.6	0.4	6	Vitrified Clay	0.013	13.1827	8.278	
1200	130	0	MH-7384	0	207.1	0	8	PVC	0.013	29.7536	548.612	
7823	1394	145.2	1388	123.8	207.1	10.333	8	PVC	0.013	0.1608	0.009	
2265	611	0	1097	0	207.5	0	8	PVC	0.013	1.4852	27.385	
3236	1155	3.62	887	2.79	207.1	0.4	8	Asbestos Cement	0.013	9.4708	2.761	
2102	760	248.56	387	247.06	207.5	0.723	8	PVC	0.013	18.1018	3.926	
4947	1245	63.94	1244	62.89	209	0.502	8	PVC	0.013	1.6886	0.439	
3185	859	6.56	867	5.72	208.9	0.4	8	Asbestos Cement	0.013	0.172	0.05	
4738	MH-7714	0	1228	0	208.6	0	8	PVC	0.013	0.9501	17.519	
2321	501	91.32	5	82.87	209.4	4.035	8	Asbestos Cement	0.013	536.4777	49.247	
144	527	0	528	0	208.9	0	8	PVC	0.013	5.8973	108.738	
3665	998	17.87	997	17.52	209.5	0.167	12	Asbestos Cement	0.013	154.3394	23.613	
3678	MH-7378	48.91	292	48.07	209.7	0.4	8	PVC	0.013	6.6249	1.931	
89	52	16.61	53	16.15	210.5	0.219	12	PVC	0.013	0.2944	0.039	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2298	MH-7394	0	444	209.12	210.7	Min. Slope	8	PVC	0.013	2.8261	0.052	
7583	1353	282.5	1355	279.4	211.4	1.467	8	PVC	0.013	101.2361	15.413	
88	51	17.08	52	16.61	211.5	0.222	12	PVC	0.013	0.1472	0.02	
6288	MH-7715	144.44	623	143.41	258.6	0.4	6	Vitrified Clay	0.013	0.043	0.027	
4456	1183	43.48	1182	35.04	211.2	3.996	8	PVC	0.013	1.2639	0.117	
7662	MH-7717	0	1370	0	212	0	8	PVC	0.013	0.3761	6.935	
7620	MH-7716	227.17	1272	166.79	211.8	28.507	6	Vitrified Clay	0.013	9.9662	0.741	
5129	MH-7718	134.74	1265	133.89	212	0.4	6	PVC	0.013	1.3343	0.838	
3054	828	4.8	826	3.95	212.5	0.4	8	Asbestos Cement	0.013	2.2071	0.643	
4155	1121	12.47	911	11.92	212.4	0.259	30	PVC	0.013	3,862.62	41.23	
966	193	104.52	810	101.88	530.6	0.498	12	Concrete	0.013	946.7441	83.942	SM 4
330	MH-7719	22.85	227	21.99	214.4	0.401	6	Concrete	0.013	0.9318	0.584	
6294	1301	160.15	1300	0	213.9	74.871	8	PVC	0.013	1.7173	0.037	
6432	1312	213.62	1313	212.57	214.9	0.489	8	PVC	0.013	0.8394	0.221	
8092	1495	0	1423	0	214.8	0	8	PVC	0.013	0.2787	5.139	
2320	495	100.19	501	91.32	214.8	4.129	8	Asbestos Cement	0.013	534.5439	48.504	
5102	MH-7720	108.28	1261	107.42	214.5	0.4	6	Vitrified Clay	0.013	5.9676	3.747	
3241	MH-7721	80.03	881	79.17	214.9	0.4	6	Vitrified Clay	0.013	0.4775	0.3	
2329	655	133.28	1258	121.11	218	5.585	6	Vitrified Clay	0.013	7.2957	1.226	
3634	979	0	982	0	215.1	0	8	PVC	0.013	2.3345	43.045	
2147	MH-7722	38.36	496	37.5	215	0.4	8	PVC	0.013	0.5385	0.157	
3821	321	0	296	0	215.7	0	8	PVC	0.013	25.5966	471.963	
2342	669	207.98	MH-7723	190.32	215.9	8.179	6	Vitrified Clay	0.013	1.4715	0.204	
4585	MH-7724	170.02	1201	169.15	216	0.4	6	Vitrified Clay	0.013	2.6777	1.681	
425	MH-7725	0	174	238.7	216.5	Min. Slope	8	PVC	0.013	0.8123	0.014	
1607	372	1.43	783	0.82	216.6	0.282	10	Asbestos Cement	0.013	221.6931	42.485	
1125	164	223.38	165	222.71	71.2	0.942	8	Concrete	0.013	312.208	59.324	SM 5
2217	1320	215.13	677	171.71	217.5	19.959	6	Vitrified Clay	0.013	4.5735	0.407	
340	1309	17.86	30	17.72	217.7	0.064	30	PVC	0.013	3,695.03	79.148	
1953	MH-7596	0	771	0	218.5	0	8	PVC	0.013	2.0906	38.547	
2538	MH-7726	166.59	690	165.72	218.1	0.4	6	Vitrified Clay	0.013	0.7158	0.449	
4003	1084	0	1083	0	218.6	0	8	PVC	0.013	7.863	144.981	
98	57	0	1081	0	218.7	0	8	PVC	0.013	4.1689	76.868	
2370	MH-7727	0	228	0	219.2	0	6	PVC	0.013	1.2129	48.166	
3600	291	90.91	290	84.11	218.7	3.109	8	PVC	0.013	4.6145	0.483	
7576	1355	279.4	1354	270.4	219.8	4.095	8	PVC	0.013	102.384	9.329	
815	461	175.47	470	165.46	220.2	4.546	8	PVC	0.013	309.9687	26.805	
4689	MH-7728	58.47	MH-7287	57.59	219.7	0.4	8	PVC	0.013	0.7842	0.229	
1311	1418	240.14	174	238.7	220.5	0.653	8	PVC	0.013	124.6743	28.449	
3693	951	23.84	955	20.78	220.6	1.387	8	PVC	0.013	3.2772	0.513	
3446	368	41.3	3	40.51	220.9	0.358	10	PVC	0.013	58.6814	9.98	
1441	MH-7730	0	769	223.73	220.5	Min. Slope	8	PVC	0.013	0.2798	0.005	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) 1	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2235	738	0	737	0	221.2	0	6	PVC	0.013	0.1802	7.156	
822	406	233.93	412	232.96	221.8	0.437	8	PVC	0.013	5.6036	1.562	
4168	MH-7731	0	18	109.67	221.5	Min. Slope	6	PVC	0.013	0.2787	0.016	
1192	1345	165.16	153	0	222.2	74.314	6	Concrete	0.013	15.7644	0.726	
2221	MH-7732	154.74	1380	153.85	222.8	0.4	6	Vitrified Clay	0.013	0.2298	0.144	
1335	240	59.6	244	58.33	222.8	0.57	8	PVC	0.013	27.7528	6.778	
2424	628	0	619	0	223.7	0	8	PVC	0.013	0.6137	11.315	
7577	1356	262.1	1349	260.5	223.8	0.715	8	PVC	0.013	103.5123	22.572	
7633	MH-7733	99.37	1366	98.48	223.7	0.4	6	Vitrified Clay	0.013	3.3402	2.097	
3641	954	44.48	957	35.19	223.8	4.151	8	PVC	0.013	10.0766	0.912	
4903	1243	245.5	1242	236.4	224	4.063	8	PVC	0.013	0.6862	0.063	
786	430	189.16	437	183.54	224.7	2.501	6	Concrete	0.013	7.5131	1.886	
2662	1089	0	691	116.55	224	Min. Slope	8	PVC	0.013	1.8494	0.047	
8099	192	131.43	193	104.52	224.8	11.97	8	Concrete	0.013	130.8252	6.972	
4900	1241	244.91	1240	236	224.4	3.971	8	PVC	0.013	0.2234	0.021	
3762	310	0	299	0	225.2	0	8	Concrete	0.013	7.1474	131.786	
1136	131	166.8	133	165.9	224.7	0.4	8	Concrete	0.013	137.7226	40.155	
2209	MH-7734	162.9	652	162	225	0.4	6	Vitrified Clay	0.013	0.7646	0.48	
3251	MH-7735	64.35	1197	63.45	225.1	0.4	6	Vitrified Clay	0.013	1.3722	0.861	
2426	MH-7723	190.32	657	189.42	225.5	0.4	6	Vitrified Clay	0.013	2.2691	1.425	
3250	MH-7736	136.63	879	135.73	225.6	0.4	6	Vitrified Clay	0.013	2.3289	1.462	
2050	764	3.39	781	2.48	226	0.403	8	Asbestos Cement	0.013	216.581	62.928	
3254	MH-7737	86	896	85.1	226.1	0.4	6	Vitrified Clay	0.013	1.1444	0.718	
32	MH-7738	0	329	34.13	227	Min. Slope	8	PVC	0.013	1.2456	0.059	
2427	1293	187.63	686	175.77	227	5.225	8	PVC	0.013	4.5356	0.366	
3366	MH-7739	0	939	0	227.1	0	8	PVC	0.013	0.1608	2.965	
1646	60	0	515	0	227.5	0	8	PVC	0.013	4.9612	91.476	
1965	MH-7740	0	405	234.19	227.7	Min. Slope	8	PVC	0.013	4.5878	0.083	
818	476	148.35	477	147.39	227.2	0.423	8	PVC	0.013	315.8597	89.586	
2910	796	0	794	0	227.3	0	8	PVC	0.013	2.8308	52.195	
2080	767	0	768	234	227.6	Min. Slope	8	PVC	0.013	0.6996	0.013	
709	370	100.91	791	100	227.7	0.4	8	PVC	0.013	2.7539	0.803	
2059	573	40.51	561	39.6	228.3	0.4	8	Vitrified Clay	0.013	42.1299	12.284	
3431	MH-7741	0	270	0	228.2	0	8	PVC	0.013	0.4369	8.057	
3885	353	80.97	348	81.38	228.7	Min. Slope	8	PVC	0.013	11.9489	5.204	
2094	440	0	448	156.38	229	Min. Slope	8	PVC	0.013	1.0158	0.023	
7603	504	0	60	0	228.9	0	8	PVC	0.013	0.3761	6.935	
3610	358	33.4	357	32.63	228.5	0.337	10	PVC	0.013	59.3246	10.394	
2035	MH-7745	150.66	1238	149.74	228.8	0.4	6	Vitrified Clay	0.013	1.8161	1.14	
3225	MH-7744	1.66	870	0.73	230.5	0.4	8	Vitrified Clay	0.013	2.0194	0.589	
3613	941	61	939	0	228.5	26.696	8	PVC	0.013	3.2034	0.114	
130	MH-7527	0	393	0	228.8	0	8	PVC	0.013	1.0277	18.949	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
3774	316	0	315	0	229.5	0	8	Concrete	0.013	23.2365	428.446	
3640	948	50.41	954	44.48	229.9	2.579	8	PVC	0.013	8.9675	1.03	
262	MH-7481	0	692	0	229.9	0	8	PVC	0.013	2.8108	51.827	
1168	100	213.24	102	210.86	229.8	1.036	8	Concrete	0.013	203.6565	36.896	
1999	MH-7747	0	586	0	230.4	0	6	Concrete	0.013	0.9602	38.127	
93	56	0	790	235.75	230	Min. Slope	8	PVC	0.013	0.5619	0.01	
2072	766	239.24	765	235.35	230.7	1.686	8	PVC	0.013	0.7556	0.107	
1764	MH-7746	0	1062	244.61	232.7	Min. Slope	8	PVC	0.013	0.5824	0.01	
2223	642	0	645	0	230.6	0	8	Concrete	0.013	3.1397	57.892	
1785	1273	0	485	132.79	231.4	Min. Slope	8	PVC	0.013	2.6923	0.066	
5053	MH-7748	102.75	625	101.82	231.5	0.4	6	PVC	0.013	0.5467	0.343	
3531	330	0	279	0	231.3	0	8	Concrete	0.013	16.9356	312.267	
6327	MH-7750	0	533	0	232	0	6	Concrete	0.013	1.2159	48.282	
4335	1158	43.3	1159	34.13	231.4	3.962	8	PVC	0.013	3.0824	0.286	
819	477	147.39	484	134.98	232.6	5.335	8	PVC	0.013	320.9809	25.625	
2107	391	0	400	0	232.9	0	8	PVC	0.013	21.1112	389.259	
36	MH-7751	0	524	0	232.3	0	6	PVC	0.013	0.1472	5.845	
3629	973	27.56	981	19.17	233.3	3.597	8	PVC	0.013	2.6983	0.262	
2267	MH-7754	0	581	0	233.4	0	6	Concrete	0.013	1.088	43.205	
2075	1100	0	771	0	232.9	0	6	Concrete	0.013	3.3164	131.692	
2157	MH-7458	0	MH-7293	0	233.6	0	6	PVC	0.013	5.581	221.617	
4462	1178	23.98	MH-7368	0	233.2	10.284	8	PVC	0.013	4.7298	0.272	
4643	MH-7752	0	1217	112	233.2	Min. Slope	8	PVC	0.013	0.5194	0.014	
4246	1147	188.13	MH-7753	0	233.3	80.655	8	PVC	0.013	0.4532	0.009	
3109	34	248.07	1061	245.38	233.7	1.151	6	PVC	0.013	3.4133	1.263	
7588	1363	249.9	1060	248.38	234.7	0.648	8	PVC	0.013	108.0915	24.766	
3603	223	45.97	367	44.95	234.3	0.435	10	PVC	0.013	57.8774	8.92	
1178	117	216.39	116	0	234.5	92.277	8	PVC	0.013	14.1924	0.272	
4131	MH-7755	0	24	0	235.3	0	6	PVC	0.013	0.9728	38.63	
3794	323	0	322	16.48	235.4	Min. Slope	8	PVC	0.013	2.0086	0.14	
4165	1126	0	1125	0	235.7	0	6	PVC	0.013	1.3355	53.033	
2270	581	0	578	0	235.1	0	6	Concrete	0.013	39.8306	1,581.66	
2579	MH-7757	257.86	647	256.92	235.7	0.4	6	Asbestos Cement	0.013	0.7221	0.453	
957	84	235.82	85	234.13	236	0.716	8	PVC	0.013	1.3694	0.298	
2909	794	0	797	0	235.4	0	8	PVC	0.013	4.5878	84.592	
3893	348	81.38	352	74.4	235.4	2.966	8	PVC	0.013	21.0125	2.25	
2971	795	260.37	800	255.05	236.2	2.253	8	PVC	0.013	3.3951	0.417	
2046	MH-7756	118.14	680	117.2	235.7	0.4	6	PVC	0.013	1.4444	0.907	
3032	809	0	810	101.88	236.3	Min. Slope	8	Asbestos Cement	0.013	9.7886	0.275	
3441	MH-7758	0	979	0	236.5	0	6	PVC	0.013	0.8983	35.67	
3235	883	57.76	MH-7354	56.81	236.5	0.4	6	Vitrified Clay	0.013	27.5624	17.305	
2415	526	0	359	41.93	236.8	Min. Slope	8	PVC	0.013	3.9673	0.174	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4517	1188	31.43	863	3.7	236.3	11.736	10	PVC	0.013	557.6041	16.552	
3981	260	0	1074	15.9	236.1	Min. Slope	8	PVC	0.013	17.5785	1.249	
2041	20	107.33	1276	106.39	236.3	0.4	6	Concrete	0.013	1.2395	0.778	
1153	139	0	140	161.24	236.4	Min. Slope	8	Concrete	0.013	2.4001	0.054	
2083	418	206.25	426	178.41	237.1	11.74	8	PVC	0.013	13.8188	0.744	
3141	905	20.22	902	19.59	236.4	0.266	18	Concrete	0.013	1,272.57	52.289	
2252	1149	0	599	0	237.2	0	6	Concrete	0.013	19.5381	775.85	
1185	148	0	150	153.74	237.1	Min. Slope	8	Concrete	0.013	0.3871	0.009	
3639	946	60.11	948	50.41	237.7	4.08	8	PVC	0.013	5.582	0.51	
3110	1062	244.61	1064	243.64	237.9	0.408	8	PVC	0.013	10.753	3.105	
3638	949	37.79	957	35.19	238.2	1.092	8	PVC	0.013	4.2175	0.744	
1177	119	212.58	117	216.39	238.5	Min. Slope	8	PVC	0.013	2.482	0.362	
2116	409	221.44	414	206.6	238.6	6.22	8	PVC	0.013	60.198	4.451	
3276	888	68.07	874	66.91	238.1	0.487	10	Vitrified Clay	0.013	61.5565	8.969	
3607	222	42.22	368	41.3	238.9	0.385	10	PVC	0.013	58.5206	9.589	
2121	474	143.74	473	135.92	238.3	3.281	8	PVC	0.013	5.7195	0.582	
129	1165	247.75	81	0	239.4	103.504	8	PVC	0.013	3.2433	0.059	
1909	776	0	777	99.22	239.3	Min. Slope	6	Concrete	0.013	3.7578	0.232	
7600	575	124.36	20	107.33	238.7	7.135	6	Concrete	0.013	0.3153	0.047	
442	176	219.28	88	218.26	239.8	0.425	8	Concrete	0.013	177.1713	50.089	
4399	1172	0	1111	0	239.7	0	8	PVC	0.013	6.6867	123.293	
2124	MH-7322	0	457	160.44	239.1	Min. Slope	8	PVC	0.013	2.8226	0.064	
4223	1140	9.28	1139	8.22	239.1	0.443	30	PVC	0.013	4,021.74	32.809	
214	1112	31.62	940	31.03	240	0.246	12	PVC	0.013	75.6605	9.543	
1652	MH-7759	114.63	373	113.67	240	0.4	6	Vitrified Clay	0.013	0.8173	0.513	
2585	MH-7761	0	474	143.74	240.2	Min. Slope	8	PVC	0.013	1.8388	0.044	
965	820	238.89	84	235.82	239.9	1.28	8	PVC	0.013	0.6422	0.105	
2260	607	0	609	134.8	239.8	Min. Slope	8	PVC	0.013	0.6876	0.017	
3646	MH-7363	0	965	21.06	239.9	Min. Slope	8	PVC	0.013	7.3157	0.455	
4005	MH-7760	0	1083	0	240.2	0	8	PVC	0.013	0.7609	14.029	
3680	938	0	939	0	240.8	0	8	PVC	0.013	0.1608	2.965	
3184	860	7.52	859	6.56	241	0.4	8	Asbestos Cement	0.013	0.129	0.038	
7587	1358	257.4	1352	256.2	240.5	0.499	8	PVC	0.013	105.3928	27.509	
1012	MH-7762	0	181	207.93	241.2	Min. Slope	8	PVC	0.013	0.8908	0.018	
1992	689	0	619	0	240.6	0	8	PVC	0.013	3.623	66.803	
1491	MH-7763	85.73	556	84.76	241.6	0.4	6	PVC	0.013	0.0731	0.046	
35	848	0	259	0	241	0	8	PVC	0.013	14.5254	267.827	
2327	660	121.75	MH-7445	120.79	241.5	0.4	8	Vitrified Clay	0.013	50.7974	14.808	
3965	211	233.2	210	232.83	86.6	0.427	8	PVC	0.013	291.9246	82.329	SM 5
4175	1129	227.4	1128	203.1	242.5	10.021	8	PVC	0.013	0.4979	0.029	
635	975	0	MH-7764	0	242.6	0	6	Vitrified Clay	0.013	5.3689	213.197	
3084	837	0	838	0	242.8	0	8	PVC	0.013	27.7146	511.016	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1132	93	204.2	94	203.24	242.4	0.396	8	Concrete	0.013	7.9924	2.342	
787	420	204.32	MH-7249	189.16	251.6	6.026	6	PVC	0.013	2.8118	0.455	
4499	593	141.94	1186	136.12	242.8	2.397	6	Vitrified Clay	0.013	2.2489	0.577	
2232	747	0	739	0	243.3	0	8	Concrete	0.013	4.4674	82.371	
2175	MH-7767	93.91	646	92.94	243.2	0.4	6	Vitrified Clay	0.013	0.8849	0.556	
5294	MH-7765	0	776	0	242.9	0	8	PVC	0.013	0.4876	8.991	
3545	283	0	281	0	243.7	0	8	Concrete	0.013	28.8212	531.419	
3337	912	61.79	1050	60.71	243.9	0.443	8	PVC	0.013	1.1407	0.316	
2152	MH-7768	0	506	0	244	0	8	PVC	0.013	1.7176	31.67	
1314	205	228.88	164	223.38	244.1	2.253	8	Concrete	0.013	9.82	1.206	
3532	968	27.14	969	25.13	243.5	0.826	8	PVC	0.013	6.3843	1.296	
3931	908	9.54	1051	8.54	244.2	0.409	18	Concrete	0.013	130.3963	4.322	
5081	1256	63.14	1255	55.28	243.6	3.227	8	PVC	0.013	2.076	0.213	
2269	592	0	581	0	244.5	0	8	PVC	0.013	2.2914	42.25	
3967	207	235.69	208	235.01	130.2	0.522	8	PVC	0.013	283.659	72.366	SM 5
2129	453	0	464	0	244.8	0	6	PVC	0.013	2.3844	94.682	
3687	MH-7331	0	327	0	245.4	0	8	PVC	0.013	3.296	60.773	
3536	961	0	962	0	245.6	0	8	PVC	0.013	20.0253	369.236	
3108	1061	245.38	79	245.17	246.4	0.085	8	PVC	0.013	7.593	4.795	
2482	688	15.49	1068	14.95	246.1	0.219	12	PVC	0.013	0.5888	0.079	
872	61	240	388	236.16	246.5	1.558	8	PVC	0.013	3.1361	0.463	
3539	270	0	271	0	245.9	0	8	PVC	0.013	7.4802	137.923	
6291	1298	0	445	210.15	246.3	Min. Slope	8	PVC	0.013	22.3176	0.446	
6643	MH-7770	0	138	0	246	0	8	PVC	0.013	0.2798	5.159	
404	1116	0	MH-7339	0	246.6	0	8	PVC	0.013	2.8785	53.076	
942	77	0	1059	191.69	246.9	Min. Slope	8	PVC	0.013	282.4147	5.91	
3894	340	78.69	337	77.59	274.5	0.4	8	PVC	0.013	9.8462	2.871	
80	49	226.02	50	215.21	247.4	4.37	8	PVC	0.013	3.8427	0.339	
3083	763	5.96	817	4.97	247.2	0.4	8	PVC	0.013	0.8036	0.234	
3151	234	173.42	232	168.8	246.9	1.871	6	Concrete	0.013	17.0894	4.961	
3968	213	236.33	207	235.69	131.8	0.486	8	PVC	0.013	282.6356	74.772	SM 5
1786	MH-7772	0	1273	0	248	0	6	PVC	0.013	1.205	47.852	
3620	965	21.06	963	16.79	247.4	1.726	8	PVC	0.013	11.5982	1.628	
284	MH-7771	0	748	0	254	0	8	PVC	0.013	1.2631	23.289	
2224	645	0	649	0	247.7	0	8	Concrete	0.013	5.393	99.438	
7685	1375	242.1	1376	240.2	201.5	0.943	8	PVC	0.013	245.5438	46.629	SM 5
2162	MH-7773	161.94	658	160.95	248.5	0.4	6	Vitrified Clay	0.013	288.2467	180.979	
2001	596	0	377	0	248.8	0	8	PVC	0.013	5.498	101.375	
4245	MH-7753	0	451	185.69	248.2	Min. Slope	8	PVC	0.013	1.824	0.039	
2033	1262	174.73	656	126.67	248.4	19.346	6	Vitrified Clay	0.013	9.6054	0.867	
806	359	0	220	41.57	248	Min. Slope	8	PVC	0.013	4.4732	0.201	
1186	142	167.92	150	153.74	249.4	5.686	8	Concrete	0.013	248.7938	19.238	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1313	206	222.8	163	221.8	249.4	0.4	8	Concrete	0.013	11.3728	3.316	
2336	1425	129.73	632	128.73	249.3	0.4	6	PVC	0.013	1.5261	0.958	
834	701	0	515	24.5	248.9	Min. Slope	8	PVC	0.013	14.3826	0.845	
2271	578	0	572	0	249.6	0	6	Concrete	0.013	44.6357	1,772.46	
3030	807	0	808	0	249.8	0	8	PVC	0.013	4.3817	80.791	
1154	140	161.24	146	148.88	249.9	4.947	8	Concrete	0.013	524.5273	43.484	
1270	179	229.03	178	227.58	250	0.58	8	PVC	0.013	2.7434	0.664	
3725	16	0	41	0	250	0	8	PVC	0.013	0.3102	5.72	
2099	471	105.31	478	90.95	250	5.744	10	Concrete	0.013	48.7744	2.07	
3895	346	57.16	347	56.18	249.7	0.392	8	PVC	0.013	28.0744	8.263	
1142	110	0	111	181.73	249.5	Min. Slope	8	Concrete	0.013	4.0071	0.087	
1190	137	0	138	0	250.4	0	6	Concrete	0.013	2.7925	110.888	
1264	173	229.4	164	223.38	241.7	2.491	8	Concrete	0.013	301.4963	35.224	SM 5
1979	371	231.48	714	229.99	250.4	0.595	8	PVC	0.013	110.91	26.513	
1122	169	0	170	213.9	249.9	Min. Slope	8	Concrete	0.013	11.318	0.226	
504	625	101.82	616	100.86	241.3	0.4	6	Vitrified Clay	0.013	2.6608	1.671	
3096	MH-7774	101.91	370	100.91	250.1	0.4	8	PVC	0.013	0.9743	0.284	
636	MH-7764	0	926	11.48	250	Min. Slope	6	Vitrified Clay	0.013	6.0879	1.128	
2477	566	41.54	573	40.51	255.9	0.4	8	Concrete	0.013	14.5168	4.232	
594	839	0	35	0	250.6	0	8	Asbestos Cement	0.013	30.6327	564.822	
4417	1176	179	234	173.42	251	2.223	8	PVC	0.013	5.811	0.719	
3622	963	16.79	964	13.74	250.3	1.218	8	PVC	0.013	14.6509	2.447	
2166	1201	169.15	693	168.15	250.6	0.4	6	Vitrified Clay	0.013	3.4667	2.177	
2062	600	110.06	590	99	251.1	4.405	6	Vitrified Clay	0.013	3.4383	0.651	
2141	449	0	450	0	250.6	0	8	PVC	0.013	8.2953	152.953	
2149	219	25.08	842	14.96	250.7	4.037	8	PVC	0.013	2.9495	0.271	
2732	276	0	277	0	250.7	0	8	PVC	0.013	3.2514	59.952	
2144	MH-7383	39.09	490	38.08	251.6	0.4	8	PVC	0.013	1.4	0.408	
1196	180	215.1	182	209.5	251.7	2.225	8	Asbestos Cement	0.013	1.2673	0.157	
17	38	0	39	131.7	250.8	Min. Slope	8	PVC	0.013	0.74	0.019	
2258	589	0	377	0	250.9	0	6	Concrete	0.013	24.4881	972.414	
5101	1260	0	569	0	251.7	0	6	Concrete	0.013	7.8602	312.124	
1121	163	221.8	170	213.9	251.9	3.136	8	Concrete	0.013	12.6327	1.315	
6062	465	0	1099	90.04	251.9	Min. Slope	6	Concrete	0.013	2.0308	0.135	
7809	1387	0	MH-7872	0	256.3	0	8	PVC	0.013	1.4502	26.739	
3637	944	46.54	949	37.79	251.7	3.476	8	PVC	0.013	2.4508	0.242	
2111	392	0	403	0	252.3	0	8	PVC	0.013	2.9774	54.899	
8049	861	9.81	1407	8.8	251.9	0.4	8	Asbestos Cement	0.013	0.043	0.013	
3690	950	16.01	960	15.07	252.3	0.373	8	Asbestos Cement	0.013	1.9476	0.588	
2247	1325	0	615	0	252.5	0	6	Concrete	0.013	4.0564	161.079	
2030	484	134.98	485	132.79	251.9	0.869	8	PVC	0.013	322.1859	63.718	
2245	MH-7776	223.24	670	222.23	252.8	0.4	6	Vitrified Clay	0.013	0.9484	0.595	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1128	95	0	96	203.5	252.4	Min. Slope	8	PVC	0.013	2.6783	0.055	
665	331	84.33	332	62.87	253.2	8.475	8	PVC	0.013	2.3397	0.148	
1126	165	222.71	172	217.91	254.3	1.888	8	Concrete	0.013	312.5951	41.952	SM 5
1316	178	227.58	218	224.89	253.5	1.061	8	PVC	0.013	20.411	3.654	
2122	466	146.56	473	135.92	254.3	4.183	8	PVC	0.013	130.1519	11.733	
2262	586	0	584	0	253.4	0	6	Concrete	0.013	32.3505	1,284.63	
2168	693	168.15	620	159.92	253.9	3.241	6	Vitrified Clay	0.013	4.5207	0.997	
2481	687	14.79	746	14.45	253.9	0.134	30	PVC	0.013	3,823.08	56.75	
600	MH-7777	0	36	0	253.9	0	8	PVC	0.013	0.7358	13.567	
1315	204	231.18	173	229.4	275.7	0.646	8	PVC	0.013	293.9645	67.459	SM 5
5906	992	10.16	994	9.47	254.1	0.271	8	Asbestos Cement	0.013	46.1452	16.329	
506	MH-7778	132.89	697	131.87	254.9	0.4	6	Vitrified Clay	0.013	0.6143	0.386	
7860	1397	66.95	1398	59.2	255.2	3.037	8	PVC	0.013	1.6587	0.176	
2173	621	133.79	1259	123.85	255.2	3.895	6	Vitrified Clay	0.013	2.1081	0.424	
2600	704	0	702	26.24	255.2	Min. Slope	8	PVC	0.013	5.7742	0.332	
3604	367	44.95	366	44.37	255.5	0.227	10	PVC	0.013	58.0382	12.387	
2118	1249	0	434	174.61	255.8	Min. Slope	8	PVC	0.013	99.8414	2.228	
486	698	99.54	597	89.36	255.7	3.982	6	Vitrified Clay	0.013	5.2087	1.037	
2254	637	172.86	MH-7521	171.84	255.3	0.4	6	PVC	0.013	11.4747	7.204	
2355	579	107.1	576	106.35	255.3	0.294	6	Concrete	0.013	3.5223	2.58	
6437	1318	229.04	1317	216.12	255.5	5.056	6	PVC	0.013	1.1476	0.203	
3261	898	163.4	877	162.38	255.9	0.4	6	Vitrified Clay	0.013	34.3133	21.546	
2153	506	0	248	24.9	255.8	Min. Slope	8	PVC	0.013	4.6687	0.276	
817	470	165.46	476	148.35	256.8	6.664	8	PVC	0.013	314.1615	22.439	
2148	496	26.1	219	25.08	256.1	0.4	8	PVC	0.013	2.0268	0.591	
2234	741	0	740	0	256.8	0	8	Concrete	0.013	2.1558	39.749	
4226	1143	11.26	1142	10.62	256.1	0.25	30	PVC	0.013	3,862.80	41.971	
3549	273	23.25	271	22.53	256.9	0.28	10	Asbestos Cement	0.013	59.5541	11.441	
3538	272	0	270	0	257.1	0	8	PVC	0.013	6.0626	111.785	
1156	151	136.04	154	126.8	257.1	3.594	8	PVC	0.013	4.3133	0.42	
3635	982	0	983	0	256.5	0	8	PVC	0.013	3.1431	57.954	
4356	1163	46	1162	0	256.5	17.935	8	PVC	0.013	4.2865	0.187	
4630	1214	62.82	1213	50.37	257.4	4.836	8	PVC	0.013	1.3703	0.115	
3775	313	0	314	0	256.7	0	8	Concrete	0.013	2.9796	54.94	
1259	184	0	185	197.59	256.9	Min. Slope	8	PVC	0.013	37.5997	0.791	
3689	970	13.8	972	12.96	257.7	0.326	8	Asbestos Cement	0.013	35.5291	11.475	
4506	1187	29.54	13	0	257.2	11.485	8	PVC	0.013	1.6061	0.087	
1203	187	186.1	190	171.7	258.3	5.574	8	Concrete	0.013	91.9103	7.178	
3555	275	22.8	1002	22.13	241.7	0.277	10	Asbestos Cement	0.013	73.1705	14.134	
2079	770	175	772	164.46	258.6	4.075	6	Concrete	0.013	3.9015	0.767	
4055	1093	92.61	1092	88.54	257.8	1.579	8	PVC	0.013	3.2434	0.476	
2227	750	0	751	0	258.7	0	8	Concrete	0.013	1.8314	33.769	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
20	43	0	327	0	258.2	0	8	PVC	0.013	2.6115	48.152	
4640	1219	106.2	1220	96.8	258.3	3.64	8	PVC	0.013	2.3026	0.223	
1184	135	181.83	142	167.92	259.2	5.367	8	Concrete	0.013	248.0196	19.741	
3632	983	0	981	19.17	258.3	Min. Slope	8	PVC	0.013	4.4994	0.305	
4642	1217	112	1218	108.9	258.3	1.2	8	PVC	0.013	1.1626	0.196	
958	825	2.45	86	1.41	259.2	0.4	8	Asbestos Cement	0.013	3.098	0.903	
512	790	235.75	768	234	259.4	0.675	8	PVC	0.013	5.5577	1.248	
2095	446	0	447	144.47	258.7	Min. Slope	6	Concrete	0.013	3.2758	0.174	
4398	1173	35.4	1172	0	259.4	13.648	8	PVC	0.013	6.2043	0.31	
2242	668	230.02	676	214.73	258.9	5.906	6	Vitrified Clay	0.013	5.5192	0.902	
3890	350	62.83	349	61.8	258.7	0.398	8	PVC	0.013	21.4949	6.281	
7634	1369	52.12	1367	49.42	259.5	1.04	8	PVC	0.013	0.8596	0.155	
3547	279	0	278	0	259.6	0	8	Concrete	0.013	54.3393	1,001.93	
1205	190	171.7	191	155.73	259.8	6.147	8	Concrete	0.013	126.0391	9.373	
3543	1054	0	1053	0	259.7	0	8	Concrete	0.013	26.3411	485.689	
4396	1175	47.1	1174	37.1	259	3.861	8	PVC	0.013	3.1579	0.296	
3188	1202	3.81	858	1.7	259.7	0.812	8	PVC	0.013	179.3322	36.687	
7011	MH-7780	144.45	623	143.41	259.4	0.4	6	Vitrified Clay	0.013	2.6685	1.675	
4611	1207	212.33	1205	210.25	260	0.8	8	PVC	0.013	1.9067	0.393	
1206	191	155.6	192	131.43	260.2	9.289	8	Concrete	0.013	129.7112	7.847	
349	19	0	649	0	260.2	0	8	PVC	0.013	6.492	119.703	
42	70	0	71	20.17	260.3	Min. Slope	8	PVC	0.013	2.522	0.167	
2218	670	222.23	677	171.71	259.7	19.451	6	Vitrified Clay	0.013	5.0983	0.459	
4023	337	77.59	353	80.97	260.2	Min. Slope	8	PVC	0.013	10.571	1.71	
3544	1053	0	283	0	260.2	0	8	Concrete	0.013	28.2593	521.059	
3817	302	0	303	0	259.5	0	8	PVC	0.013	1.2233	22.556	
2126	480	115.53	486	98.91	260.5	6.381	8	PVC	0.013	137.4534	10.033	
2981	803	0	761	0	260.5	0	8	PVC	0.013	1.5933	29.378	
2034	686	175.77	1262	174.73	259.9	0.4	6	Vitrified Clay	0.013	5.3568	3.364	
7700	694	123.68	1379	118.56	260	1.971	6	Vitrified Clay	0.013	3.8726	1.095	
2436	MH-7355	119.88	MH-7624	118.84	260.4	0.4	6	Vitrified Clay	0.013	2.4425	1.533	
2435	677	171.71	684	170.67	260.4	0.4	6	Vitrified Clay	0.013	11.5633	7.26	
1191	138	0	144	0	260.8	0	6	Concrete	0.013	3.8558	153.112	
3125	730	199.65	83	193.75	260.7	2.263	8	Concrete	0.013	2.2125	0.271	
2358	569	0	564	0	260	0	8	Asbestos Cement	0.013	57.0593	1,052.09	
3533	994	9.47	991	8.62	259.9	0.327	8	Asbestos Cement	0.013	46.655	15.044	
2244	MH-7782	239.7	676	214.73	261.1	9.564	6	Vitrified Clay	0.013	7.6708	0.985	
2817	MH-7304	0	722	224.94	260.1	Min. Slope	8	PVC	0.013	1.1784	0.023	
3152	441	174.03	232	168.8	260.9	2.004	10	PVC	0.013	105.3555	7.568	
2145	490	38.08	360	37.04	260.2	0.4	8	PVC	0.013	2.1516	0.627	
4321	1154	35.8	1153	28.2	260	2.923	8	PVC	0.013	1.9856	0.214	
2733	278	0	277	0	260.8	0	8	Concrete	0.013	54.4294	1,003.60	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2225	649	0	654	0	260.2	0	8	Concrete	0.013	12.7123	234.395	
6252	886	77.57	MH-7781	76.53	260.5	0.4	10	Vitrified Clay	0.013	130.4941	20.981	
19	42	0	43	111.8	260.3	Min. Slope	8	PVC	0.013	1.0574	0.03	
2071	78	239.39	765	235.35	260.4	1.552	8	PVC	0.013	23.6143	3.496	
4644	1216	118.6	1217	112	261.1	2.528	8	PVC	0.013	0.4824	0.056	
2088	381	0	454	135.91	260.5	Min. Slope	8	Concrete	0.013	20.9072	0.534	
3836	303	0	276	0	260.4	0	8	PVC	0.013	3.1613	58.29	
3795	325	0	324	18.03	261.2	Min. Slope	8	PVC	0.013	3.2001	0.225	
2073	765	235.35	836	231.3	260.8	1.553	8	PVC	0.013	27.3209	4.042	
1127	172	217.91	96	203.5	261.9	5.503	8	Concrete	0.013	312.9823	24.601	
3898	336	55	339	54.34	261.6	0.252	10	PVC	0.013	31.9655	6.472	
2555	1379	118.56	937	117.51	261.3	0.4	6	Vitrified Clay	0.013	4.7913	3.008	
2097	454	135.91	463	120.87	262	5.742	8	Concrete	0.013	44.9602	3.46	
2133	452	0	465	0	262	0	6	PVC	0.013	1.3117	52.086	
2731	1009	23.53	275	22.8	257.3	0.284	10	Asbestos Cement	0.013	73.0804	13.953	
250	14	0	15	0	262.5	0	8	PVC	0.013	2.0549	37.89	
916	68	16.7	69	16.38	262.5	0.122	30	Concrete	0.013	3,785.19	58.888	
2170	396	144.34	1103	143.29	262.6	0.4	8	Vitrified Clay	0.013	11.262	3.283	
2131	464	0	472	0	262.8	0	6	Concrete	0.013	4.4847	178.085	
3815	314	0	312	0	262.7	0	8	Concrete	0.013	4.2516	78.393	
3826	295	0	1054	0	262.7	0	8	Concrete	0.013	25.4548	469.349	
2077	773	0	774	153.47	262.3	Min. Slope	8	PVC	0.013	1.7278	0.042	
2171	1330	146.72	593	141.94	262.5	1.821	6	Vitrified Clay	0.013	0.9242	0.272	
3825	299	0	281	0	262.3	0	8	Concrete	0.013	8.4023	154.925	
1738	235	0	449	0	263.1	0	8	PVC	0.013	6.5263	120.334	
1042	90	0	160	122.44	263.8	Min. Slope	8	PVC	0.013	1.3886	0.038	
2729	922	25.06	MH-7784	24.33	263.7	0.277	10	Asbestos Cement	0.013	72.9002	14.091	
2313	MH-7478	0	467	0	263.1	0	8	PVC	0.013	1.5674	28.901	
2117	414	206.6	415	205.41	263.2	0.452	8	PVC	0.013	67.4637	18.5	
3363	940	31.03	913	30.43	264	0.227	12	PVC	0.013	82.1073	10.77	
3692	945	29.65	951	23.84	264	2.201	8	PVC	0.013	2.5566	0.318	
1349	740	0	304	0	264	0	8	Concrete	0.013	2.8651	52.828	
4641	1218	108.9	1219	106.2	263.5	1.025	8	PVC	0.013	2.1418	0.39	
816	451	185.69	461	175.47	264.7	3.86	8	PVC	0.013	291.1522	27.323	
4380	1171	0	1170	220.4	264.1	Min. Slope	8	PVC	0.013	1.264	0.026	
3763	312	0	310	0	264.8	0	8	Concrete	0.013	5.7275	105.607	
3031	808	0	809	0	264.9	0	8	PVC	0.013	7.626	140.612	
2360	548	0	541	0	264.4	0	8	Concrete	0.013	62.4913	1,152.25	
3995	1076	6.08	1075	5.28	264.7	0.302	8	Vitrified Clay	0.013	175.975	59.021	
18	39	0	41	0	264.4	0	8	PVC	0.013	2.0664	38.102	
4357	1162	0	1111	0	264.4	0	8	PVC	0.013	6.4796	119.475	
951	1119	100.44	MH-7485	77.61	265	8.617	6	PVC	0.013	1.3587	0.184	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
4379	1170	220.4	95	0	265.8	82.91	8	PVC	0.013	1.6511	0.033	
954	85	234.13	175	232.45	265.2	0.634	8	PVC	0.013	7.3933	1.713	
2074	775	0	776	0	266	0	8	PVC	0.013	1.8566	34.233	
2123	457	0	466	146.56	266	Min. Slope	8	PVC	0.013	129.3182	3.212	
7683	1376	240.2	1378	238.6	291.9	0.548	8	PVC	0.013	245.9308	61.247	SM 5
2132	472	0	1263	0	266.2	0	6	Concrete	0.013	6.5781	261.212	
7916	1399	148.08	660	147.02	266	0.4	8	Vitrified Clay	0.013	10.4631	3.05	
487	761	0	755	0	265.5	0	8	PVC	0.013	3.3475	61.723	
1157	146	148.88	147	148.49	27.1	1.44	8	Concrete	0.013	526.1566	80.848	SM 6
2276	736	30.7	537	0	265.6	11.559	8	PVC	0.013	6.5185	0.354	
4698	1225	256	1224	254.56	265.9	0.542	8	PVC	0.013	0	0	
4358	1164	0	1163	46	265.9	Min. Slope	8	PVC	0.013	3.5632	0.158	
2085	426	178.41	436	159.78	266.8	6.983	8	PVC	0.013	17.3793	1.213	
3964	233	178.3	234	173.42	266.1	1.834	6	Concrete	0.013	10.2191	2.996	
7632	1257	110.55	1365	80.3	266.8	11.341	6	Vitrified Clay	0.013	8.6452	1.019	
4322	1153	28.2	1152	23.88	266.1	1.623	8	PVC	0.013	6.2768	0.908	
3117	780	28.78	853	8.5	267.3	7.586	8	PVC	0.013	8.512	0.57	
3605	366	44.37	2	43.41	267.3	0.359	10	PVC	0.013	58.199	9.875	
4140	26	0	272	0	267.8	0	8	PVC	0.013	2.7331	50.395	
4699	1224	254.56	1223	253.1	267.3	0.546	8	PVC	0.013	0.9352	0.233	
2076	771	0	772	164.46	267.5	Min. Slope	6	Concrete	0.013	6.0727	0.308	
3286	267	0	998	0	267.4	0	8	Concrete	0.013	3.6552	67.396	
3835	306	0	330	0	267.6	0	8	Concrete	0.013	15.362	283.251	
3694	955	20.78	960	15.07	267.6	2.134	8	Asbestos Cement	0.013	28.2024	3.56	
3113	1064	243.64	78	239.39	268.6	1.582	8	PVC	0.013	20.3336	2.981	
4340	1159	34.13	1160	31.2	267.8	1.094	8	PVC	0.013	4.4505	0.784	
4007	MH-7785	0	1085	0	268	0	8	PVC	0.013	0.8877	16.367	
2315	MH-7786	0	467	0	268.7	0	6	PVC	0.013	1.0978	43.595	
4221	1138	7	1137	6.74	268.5	0.097	30	PVC	0.013	4,022.64	70.225	
7580	1357	258.8	1358	257.4	268.9	0.521	8	PVC	0.013	105.0167	26.838	
3133	531	20.6	1309	19.58	269.7	0.378	10	Asbestos Cement	0.013	583.7496	96.53	
3224	890	5.52	900	4.44	269.8	0.4	8	Vitrified Clay	0.013	30.3044	8.835	
1351	737	0	302	0	269	0	8	PVC	0.013	0.2703	4.984	
3114	81	0	1064	243.64	269.4	Min. Slope	8	PVC	0.013	9.1935	0.178	
3922	343	53.24	1	50.02	270.3	1.191	10	PVC	0.013	42.5439	3.964	
3667	999	19.6	355	18.7	270.3	0.333	12	Asbestos Cement	0.013	147.4283	15.979	
4219	1136	6.48	1135	6.12	269.8	0.133	30	PVC	0.013	4,023.46	59.837	
4220	1137	6.74	1136	6.48	270	0.096	30	PVC	0.013	4,023.20	70.428	
1959	835	0	837	0	271	0	8	PVC	0.013	25.6891	473.668	
3535	947	22.22	952	20.38	270.9	0.679	8	PVC	0.013	86.6815	19.395	
2098	463	120.87	471	105.31	271	5.741	10	Concrete	0.013	46.1455	1.959	
3814	315	0	295	0	270.2	0	8	Concrete	0.013	24.9814	460.62	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2431	388	236.16	399	227.39	271.1	3.235	8	PVC	0.013	4.1072	0.421	
1182	124	191.96	128	188.87	271.1	1.14	8	Concrete	0.013	242.1803	41.823	
2142	778	50.62	779	49.54	270.4	0.4	8	PVC	0.013	0.9415	0.274	
4397	1174	37.1	1173	35.4	270.4	0.629	8	PVC	0.013	4.1072	0.955	
2115	404	234.07	409	221.44	271.4	4.653	8	PVC	0.013	58.2255	4.977	
2061	937	117.51	582	96.33	271.3	7.806	8	Vitrified Clay	0.013	25.2518	1.667	
4553	1199	96.87	1066	67	271.4	11.004	8	PVC	0.013	0.6689	0.037	
4578	1200	0	510	42.99	271.6	Min. Slope	6	Concrete	0.013	21.009	2.097	
2086	774	153.47	381	143.74	271.2	3.588	8	Concrete	0.013	15.9159	1.549	
2441	588	0	1260	0	271.8	0	6	Concrete	0.013	4.5633	181.205	
1980	408	232.78	371	231.48	271.1	0.48	8	PVC	0.013	107.7809	28.697	
3153	854	2.81	843	2.21	271.4	0.221	12	Asbestos Cement	0.013	0.3601	0.048	
2231	748	0	747	0	272.1	0	8	Concrete	0.013	3.0249	55.774	
5215	403	0	1270	0	271.7	0	8	PVC	0.013	4.7379	87.36	
2067	1336	97.42	582	96.33	272	0.4	6	Vitrified Clay	0.013	0.4223	0.265	
2432	515	0	525	32.88	272.9	Min. Slope	8	PVC	0.013	22.2135	1.18	
2000	620	159.92	1310	150.56	272.4	3.436	6	Vitrified Clay	0.013	5.7101	1.223	
2096	448	156.38	446	150.53	272.3	2.148	6	Concrete	0.013	2.0006	0.542	
2154	1400	0	505	48.54	273.2	Min. Slope	8	PVC	0.013	5.9334	0.26	
2290	536	0	535	0	272.4	0	8	PVC	0.013	8.085	149.075	
263	22	90.35	293	89.26	273.2	0.4	8	PVC	0.013	2.223	0.648	
2105	390	241.4	401	234.64	273.4	2.472	8	PVC	0.013	23.2732	2.729	
1129	96	203.5	94	203.24	46.2	0.562	8	Concrete	0.013	316.0476	77.712	SM 6
3283	870	0.73	864	0.35	273.4	0.142	10	Asbestos Cement	0.013	81.3194	21.925	
3602	354	46.76	223	45.97	273.6	0.289	10	PVC	0.013	57.7166	10.924	
3670	914	59.55	948	50.41	272.9	3.349	8	PVC	0.013	2.816	0.284	
3050	832	6.09	831	5	273.4	0.4	8	Asbestos Cement	0.013	3.1851	0.929	
4719	MH-7788	0	459	197.28	274	Min. Slope	8	PVC	0.013	1.7776	0.039	
2031	450	0	462	0	274.1	0	8	PVC	0.013	12.1111	223.311	
2375	572	0	569	0	273.6	0	8	Asbestos Cement	0.013	48.082	886.56	
2078	772	164.46	774	153.47	274.4	4.005	8	Concrete	0.013	11.1587	1.028	
2539	690	165.72	634	160.58	273.9	1.877	6	Vitrified Clay	0.013	1.5331	0.444	
4452	1177	111.73	471	0	273.9	40.792	8	PVC	0.013	1.3533	0.039	
593	35	0	183	202.43	274	Min. Slope	8	Vitrified Clay	0.013	35.9479	0.771	
1	36	0	618	182.45	274	Min. Slope	8	PVC	0.013	0.8482	0.019	
2081	768	234	769	223.73	275.3	3.731	8	PVC	0.013	7.7507	0.74	
2331	639	149.18	1399	148.08	275	0.4	8	Vitrified Clay	0.013	6.7701	1.974	
1151	134	167.93	140	161.24	248.7	2.69	8	Concrete	0.013	519.8197	58.437	SM 6
2268	584	0	581	0	274.9	0	6	Concrete	0.013	35.749	1,419.58	
1134	99	200.73	103	198.69	250.4	0.815	8	Concrete	0.013	350.2509	71.554	SM 6
1130	171	212.59	94	203.24	276.3	3.384	8	Concrete	0.013	25.3419	2.54	
1348	739	0	304	0	275.2	0	8	Concrete	0.013	5.6485	104.149	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2226	654	0	751	0	275.2	0	8	Concrete	0.013	18.2933	337.302	
2237	663	255.14	673	228.28	275.9	9.737	6	PVC	0.013	4.4397	0.565	
3891	351	73.66	350	62.83	275.4	3.933	8	PVC	0.013	21.3341	1.983	
3601	1	50.02	354	46.76	276.1	1.181	10	PVC	0.013	48.4903	4.538	
4222	1139	8.22	1138	7	275.5	0.443	30	PVC	0.013	4,021.92	32.829	
3925	910	10.89	909	10.51	275.5	0.138	18	Concrete	0.013	126.5851	7.23	
2091	447	144.4	454	135.91	276.7	3.069	8	Concrete	0.013	22.8868	2.409	
3162	232	168.8	457	160.44	276.8	3.02	8	PVC	0.013	125.1267	13.276	
967	834	244.54	1268	243.37	276.2	0.424	8	PVC	0.013	121.0463	34.29	
1354	245	31.7	736	30.7	276.1	0.362	8	PVC	0.013	5.0433	1.545	
4942	MH-7790	0	1154	35.8	277	Min. Slope	8	PVC	0.013	1.4161	0.073	
2989	MH-7789	0	801	250.23	277.2	Min. Slope	8	PVC	0.013	2.7563	0.053	
2037	462	0	461	175.47	276.4	Min. Slope	8	PVC	0.013	13.3714	0.309	
2216	673	228.28	MH-7716	227.17	277.3	0.4	6	Vitrified Clay	0.013	6.0356	3.79	
1118	115	193.94	123	190.85	275.9	1.12	8	Concrete	0.013	351.0917	61.167	SM 6
2730	MH-7784	24.33	1009	23.53	285.7	0.28	10	Asbestos Cement	0.013	72.9903	14.027	
2161	1416	64.78	661	63.67	278.6	0.4	6	Vitrified Clay	0.013	5.542	3.479	
1170	104	204.73	112	197.86	279.2	2.46	8	Concrete	0.013	205.5512	24.163	
4844	1236	86.56	556	84.76	279	0.645	6	Concrete	0.013	7.7374	3.825	
2324	365	45.5	851	25.18	279.7	7.265	10	Asbestos Cement	0.013	555.6305	20.964	
3556	1002	22.13	1001	21.3	295.7	0.281	10	Asbestos Cement	0.013	73.2606	14.062	
1608	843	2.21	372	1.43	279.9	0.279	10	Asbestos Cement	0.013	221.62	42.692	
2556	1324	125.52	694	123.68	279.6	0.658	6	Vitrified Clay	0.013	1.8714	0.916	
5425	MH-7791	0	MH-7308	0	279.6	0	6	Concrete	0.013	0.4932	19.583	
3316	990	11.09	992	10.16	279.8	0.332	8	Asbestos Cement	0.013	45.6355	14.596	
4373	1169	56.98	944	46.54	280.8	3.718	8	PVC	0.013	2.2101	0.211	
1183	128	188.87	135	181.83	281.1	2.505	8	Concrete	0.013	242.5674	28.261	
1263	111	181.73	122	177.84	281.3	1.383	8	Concrete	0.013	7.9997	1.254	
1179	116	0	112	197.86	280.6	Min. Slope	8	Concrete	0.013	29.7906	0.654	
3064	1063	246.71	833	245.19	281.6	0.54	8	PVC	0.013	119.4979	29.991	
2257	615	0	613	0	280.8	0	6	Concrete	0.013	12.8324	509.569	
1363	1365	80.3	881	79.17	281.4	0.4	6	Vitrified Clay	0.013	10.9668	6.886	
1380	369	219.22	418	206.25	282.1	4.598	8	PVC	0.013	3.8466	0.331	
511	1331	79.13	382	72.53	282.1	2.339	6	Vitrified Clay	0.013	4.7913	1.244	
2038	1261	107.42	675	106.29	281.8	0.4	6	Vitrified Clay	0.013	10.454	6.563	
4133	MH-7286	244	17	242.87	282	0.4	6	PVC	0.013	1.4924	0.937	
3621	959	0	963	16.79	282.5	Min. Slope	8	PVC	0.013	1.2965	0.098	
1323	1060	248.38	1063	246.71	282.7	0.591	8	PVC	0.013	112.155	26.906	
4176	1130	204.6	1128	203.1	282.1	0.532	8	PVC	0.013	28.6673	7.248	
3095	5	82.87	4	79.38	282.2	1.237	8	Asbestos Cement	0.013	537.9812	89.202	
3933	1066	67	946	60.11	283	2.435	8	PVC	0.013	1.597	0.189	
811	735	0	251	0	283.1	0	8	PVC	0.013	10.7748	198.671	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2158	499	0	498	76.94	282.7	Min. Slope	6	Vitrified Clay	0.013	3.6343	0.277	
1197	182	209.5	181	207.93	282.8	0.555	8	Asbestos Cement	0.013	3.0098	0.745	
3627	964	13.74	971	12.63	283.6	0.391	8	PVC	0.013	123.3618	36.357	
4051	1092	88.54	1091	74.56	281.8	4.96	8	PVC	0.013	5.5262	0.458	
3282	894	9.23	862	5.83	283.6	1.198	10	Vitrified Clay	0.013	19.6298	1.824	
2140	429	195.31	430	189.16	282.8	2.174	8	PVC	0.013	3.1213	0.39	
2207	1186	136.12	605	131.24	283.7	1.72	8	Vitrified Clay	0.013	3.6467	0.513	
3771	319	0	320	18.52	284	Min. Slope	8	PVC	0.013	4.8824	0.353	
3761	296	0	MH-7435	0	284	0	8	PVC	0.013	25.7574	474.928	
1365	1366	98.48	682	97.34	283.9	0.4	6	Vitrified Clay	0.013	4.1265	2.591	
2261	609	134.8	596	0	284.4	47.392	8	PVC	0.013	4.0587	0.109	
336	30	17.72	29	17.57	283.7	0.053	30	PVC	0.013	3,695.40	87.295	
1148	127	176.8	134	167.93	284.8	3.115	8	Concrete	0.013	368.845	38.536	
3238	876	3.4	887	3.4	284.6	0	10	Asbestos Cement	0.013	49.0646	498.961	
3186	863	3.7	866	2.9	284.5	0.28	10	Vitrified Clay	0.013	557.6471	107.177	
4435	1421	78.12	89	76.98	284.5	0.4	8	PVC	0.013	0.1194	0.035	
4227	911	11.92	1143	11.26	284.7	0.232	30	PVC	0.013	3,862.71	43.577	
790	410	232.39	416	231.45	285.8	0.329	8	PVC	0.013	8.2943	2.667	
2326	665	113.91	675	106.29	285.6	2.668	8	Vitrified Clay	0.013	79.9861	9.029	
3189	864	0.35	869	-0.8	286.4	0.4	10	Asbestos Cement	0.013	81.3624	13.081	
810	220	0	530	0	286.5	0	8	PVC	0.013	5.1284	94.561	
1162	174	238.7	175	232.45	287.3	2.175	8	PVC	0.013	125.8737	15.737	
3272	885	6.67	890	5.52	287.9	0.4	8	Vitrified Clay	0.013	28.7614	8.385	
3970	901	24.5	904	23.82	287.9	0.236	18	Concrete	0.013	1,180.93	51.542	
1767	500	0	502	0	288.4	0	8	Asbestos Cement	0.013	12.5976	232.281	
2813	731	0	77	0	288.5	0	8	PVC	0.013	1.8027	33.238	
3691	MH-7795	0	950	16.01	289.8	Min. Slope	8	Concrete	0.013	0.8402	0.066	
2155	505	48.54	509	33.34	289.9	5.243	8	PVC	0.013	7.0341	0.566	
3240	897	4	876	3.4	289.9	0.207	10	Asbestos Cement	0.013	33.7751	7.55	
2289	538	0	535	0	290.1	0	8	PVC	0.013	10.851	200.076	
2167	643	163.57	634	160.58	290	1.031	6	Vitrified Clay	0.013	1.8714	0.732	
1135	103	198.69	115	193.94	300.3	1.582	8	Concrete	0.013	350.638	51.407	SM 6
2422	MH-7796	150.34	639	149.18	290.5	0.4	6	Vitrified Clay	0.013	2.5875	1.625	
3228	892	62.27	895	55.41	290.2	2.365	10	Vitrified Clay	0.013	523.9211	34.644	
4845	1237	240.86	MH-7782	239.7	290.6	0.4	6	Vitrified Clay	0.013	5.2969	3.325	
3778	309	0	307	0	290.8	0	8	Concrete	0.013	1.892	34.886	
960	823	2.57	86	1.41	290.3	0.4	8	PVC	0.013	56.7338	16.54	
3550	271	22.53	920	21.72	290.2	0.279	10	Asbestos Cement	0.013	73.3073	14.11	
1181	114	194.7	124	191.96	291.4	0.94	8	Concrete	0.013	237.3121	45.126	
2109	389	240.33	394	237.31	291.3	1.037	8	PVC	0.013	1.2108	0.219	
6525	MH-7328	22.77	MH-7472	22.7	80	0.087	18	PVC	0.013	1,232.35	88.37	SM 7
6241	1288	0	1287	0	291.1	0	8		0.013	1.8457	34.032	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2264	617	0	611	0	291.8	0	8	PVC	0.013	1.2296	22.671	
4075	1096	57.53	1095	55.55	291.6	0.679	8	PVC	0.013	2.1572	0.483	
2058	561	4.5	6	3.68	292	0.28	10	PVC	0.013	42.4223	8.153	
1963	MH-7797	0	1100	0	292.8	0	6	PVC	0.013	1.0501	41.698	
3257	896	85.1	875	83.93	292.5	0.4	8	Vitrified Clay	0.013	116.6409	34.004	
3142	906	20.32	905	20.22	159.1	0.063	18	Concrete	0.013	1,267.44	107.246	SM 7
3273	1321	10.4	894	9.23	293.1	0.4	8	Vitrified Clay	0.013	19.5868	5.71	
2172	1103	143.29	605	131.24	293.1	4.111	8	Vitrified Clay	0.013	14.1983	1.291	
3908	339	54.34	343	53.24	293.7	0.375	10	PVC	0.013	36.5808	6.078	
2135	478	90.95	479	90.04	174.8	0.521	12	Concrete	0.013	1,012.37	87.738	SM 7
2068	605	131.24	937	117.51	293.7	4.675	8	Vitrified Clay	0.013	19.0682	1.626	
3256	875	83.93	886	77.57	293.8	2.165	8	Vitrified Clay	0.013	123.3259	15.454	
3242	881	79.17	885	6.67	293.4	24.707	6	Vitrified Clay	0.013	15.0799	1.205	
2069	393	0	78	239.39	293.3	Min. Slope	8	PVC	0.013	1.4148	0.029	
2026	1189	95.28	696	75.81	294.1	6.619	6	Vitrified Clay	0.013	4.261	0.658	
3239	364	33.4	MH-7508	32.22	294.5	0.4	6	PVC	0.013	6.8492	4.3	
2087	380	148.98	381	143.74	294.8	1.777	6	Concrete	0.013	3.771	1.123	
2169	634	160.58	1310	150.56	294.5	3.402	6	Vitrified Clay	0.013	4.5938	0.989	
2367	525	23.48	903	22.8	217.3	0.313	10	Asbestos Cement	0.013	578.7973	105.216	SM 7
3253	1364	78.75	886	77.57	294.5	0.4	6	Vitrified Clay	0.013	5.0282	3.157	
2273	577	0	570	0	295.1	0	8	Concrete	0.013	9.9865	184.136	
3090	MH-7798	0	1100	0	294.6	0	6	Concrete	0.013	0.71	28.194	
507	661	63.67	671	62.48	295.5	0.4	6	Vitrified Clay	0.013	8.2684	5.192	
3616	952	20.38	958	15.03	295.9	1.808	8	PVC	0.013	86.8423	11.909	
2353	574	105.95	565	87.46	295.4	6.259	6	Concrete	0.013	6.3734	1.012	
2797	721	205.4	429	195.31	296.1	3.407	8	PVC	0.013	0.7013	0.07	
2125	473	135.92	480	116.16	296.3	6.668	8	PVC	0.013	136.1512	9.722	
3537	1000	20.5	999	19.6	296.3	0.304	12		0.013	146.8382	16.663	
2490	845	2.18	855	1	295.8	0.4	8	Asbestos Cement	0.013	0.0731	0.021	
3190	862	5.83	866	2.9	296.8	0.987	10	Vitrified Clay	0.013	20.4909	2.098	
3271	887	2.79	891	1.6	296.9	0.4	10	Asbestos Cement	0.013	65.2869	10.498	
92	MH-7799	0	54	146.1	297.7	Min. Slope	8	PVC	0.013	1.0417	0.027	
2056	MH-7570	2.85	MH-7469	2.05	288.5	0.28	10	Vitrified Clay	0.013	54.1844	10.413	
3053	829	5.99	828	4.8	298	0.4	8	Asbestos Cement	0.013	1.0527	0.307	
3073	MH-7800	0	833	245.19	297.7	Min. Slope	8	PVC	0.013	0.3871	0.008	
2434	1272	166.79	685	165.6	297.9	0.4	6	Vitrified Clay	0.013	12.0248	7.55	
3124	844	193.76	1059	191.69	297.8	0.695	8	PVC	0.013	2.6019	0.575	
1317	349	61.8	242	60.8	298.2	0.334	8	PVC	0.013	25.8777	8.259	
2462	565	87.46	1236	86.56	298.1	0.302	6	Concrete	0.013	6.751	4.879	
6278	MH-7801	0	258	0	299	0	8	PVC	0.013	1.0552	19.456	
4535	1192	62.89	1193	38.3	299.2	8.217	8	PVC	0.013	2.1529	0.138	
90	53	16.15	688	15.49	299.6	0.22	12	PVC	0.013	0.4416	0.059	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1978	729	215.17	732	207.11	299.8	2.689	8	PVC	0.013	3.5156	0.395	
7818	1390	121.8	1389	120.3	299.2	0.501	8	PVC	0.013	0.4824	0.126	
2137	481	89.04	483	87.05	290.6	0.685	12	Concrete	0.013	1,017.49	76.891	SM 7
3154	852	-0.2	854	-1.4	299.8	0.4	8	Asbestos Cement	0.013	0.287	0.084	
3546	281	0	279	0	300.5	0	8	Concrete	0.013	37.3135	688.006	
4608	1209	233	1205	210.25	299.7	7.591	8	PVC	0.013	1.8831	0.126	
3534	991	8.62	993	7.64	299.6	0.327	8	Asbestos Cement	0.013	46.8575	15.106	
808	519	0	520	0	299.9	0	8	PVC	0.013	0.5933	10.939	
2220	675	106.29	682	97.34	300.8	2.976	8	Vitrified Clay	0.013	96.4399	10.308	
2491	855	1	852	-0.2	300.6	0.4	8	Asbestos Cement	0.013	0.1462	0.043	
3187	866	2.9	858	1.7	300.5	0.4	10	Vitrified Clay	0.013	637.9447	102.583	
503	697	131.87	625	101.82	310.1	9.688	6	Vitrified Clay	0.013	1.161	0.148	
2042	23	0	513	0	300.7	0	8	PVC	0.013	5.3718	99.049	
3245	899	58.96	883	57.76	301.4	0.4	6	Vitrified Clay	0.013	26.1142	16.397	
1334	242	60.8	240	59.6	301.2	0.4	8	PVC	0.013	26.3056	7.669	
2039	MH-7507	115.11	665	113.91	301.2	0.4	6	Vitrified Clay	0.013	19.5005	12.243	
2138	483	87.05	487	84.9	301.1	0.714	12	Concrete	0.013	1,025.85	75.927	SM 7
109	8	91.54	237	90.33	300.9	0.401	8	PVC	0.013	1.1058	0.322	
3036	812	7.69	814	6.49	302	0.4	8	PVC	0.013	49.174	14.337	
3161	437	183.54	233	178.3	302	1.735	6	Concrete	0.013	8.7566	2.64	
620	MH-7488	14.82	6	13.62	302.4	0.4	6	Vitrified Clay	0.013	4.6102	2.894	
1360	683	4.7	897	4	302.5	0.231	10	Asbestos Cement	0.013	22.2527	4.704	
3702	943	45.91	945	29.65	302.6	5.374	8	PVC	0.013	0.7206	0.057	
2475	MH-7802	0	1110	178.9	302.3	Min. Slope	8	PVC	0.013	1.0451	0.025	
3668	1001	21.3	1000	20.5	303.2	0.264	12		0.013	146.7481	17.866	
4134	646	92.94	55	87.91	303.1	1.659	6	Asbestos Cement	0.013	2.2434	0.692	
2043	672	5.5	683	4.7	303.4	0.264	10	Asbestos Cement	0.013	19.6133	3.884	
2310	460	198.98	459	197.28	302.7	0.562	8	Asbestos Cement	0.013	175.7449	43.244	
2134	1099	0	479	90.04	304.1	Min. Slope	6	Concrete	0.013	3.1915	0.233	
2743	384	0	500	0	304.1	0	8	PVC	0.013	10.9784	202.425	
3618	958	15.03	964	13.74	304.5	0.424	8	PVC	0.013	87.0031	24.647	
3445	960	15.07	918	13.84	305.3	0.403	8	Asbestos Cement	0.013	32.1786	9.347	
2159	498	76.94	1228	42.99	305.5	11.113	6	Concrete	0.013	11.1321	1.326	
2190	507	0	511	0	305.6	0	6	Asbestos Cement	0.013	14.1373	561.387	
3277	MH-7781	76.53	MH-7295	75.67	305	0.28	10	PVC	0.013	133.8596	25.726	
3230	872	63.58	892	62.27	326.6	0.4	10	Vitrified Clay	0.013	70.7115	11.371	
2469	570	0	MH-7610	0	305.9	0	6	Concrete	0.013	10.7868	428.338	
3169	856	6.95	867	5.72	305.4	0.4	8	Vitrified Clay	0.013	151.1782	44.073	
37	524	0	848	0	306	0	8	PVC	0.013	9.1026	167.838	
2312	459	197.28	458	192.87	305.3	1.444	8	Asbestos Cement	0.013	179.1334	27.483	
4135	55	87.91	1331	79.13	306	2.869	6	Vitrified Clay	0.013	3.602	0.844	
4177	1131	218.5	1130	204.6	306.5	4.535	8	PVC	0.013	22.5249	1.95	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2311	456	201.47	455	199.74	305.6	0.566	8	Asbestos Cement	0.013	169.1902	41.461	
628	344	93.5	345	92.28	306	0.4	8	PVC	0.013	0.8221	0.24	
91	54	0	482	146.25	307.8	Min. Slope	8	PVC	0.013	1.931	0.052	
4602	1203	5.08	1202	3.81	306.5	0.414	10	PVC	0.013	176.061	27.814	
1318	244	58.33	346	57.16	306.9	0.381	8	PVC	0.013	27.9136	8.336	
1326	MH-7803	0	1060	248.38	306.7	Min. Slope	8	PVC	0.013	0.9363	0.019	
3258	MH-7804	80.28	MH-7459	79.05	307.6	0.4	6	Vitrified Clay	0.013	1.8659	1.172	
7414	MH-7805	108.93	MH-7806	107.69	307.8	0.4	6	Vitrified Clay	0.013	1.703	1.069	
2314	467	0	468	175.36	307.9	Min. Slope	8	PVC	0.013	3.0414	0.074	
7677	1372	245	1373	242.7	309.2	0.744	8	PVC	0.013	0.7399	0.158	
3226	891	1.6	870	0.73	309.1	0.28	10	Asbestos Cement	0.013	70.9279	13.63	
666	MH-7807	85.56	331	84.33	308.4	0.4	8	PVC	0.013	0.6689	0.195	
4536	1193	38.3	1194	36.5	309.6	0.581	8	PVC	0.013	2.3001	0.556	
3779	307	0	306	0	309.6	0	8	Concrete	0.013	3.3607	61.966	
2303	422	0	421	228.26	309.5	Min. Slope	8	PVC	0.013	0.6681	0.014	
7822	1392	92	1393	61.2	310	9.937	8	PVC	0.013	1.1256	0.066	
2557	MH-7808	167.57	695	166.33	310	0.4	6	Vitrified Clay	0.013	0.1408	0.088	
3666	355	18.7	998	17.87	311.1	0.267	12	Asbestos Cement	0.013	149.1183	18.056	
2812	725	0	1299	201.29	310.4	Min. Slope	8	PVC	0.013	7.8176	0.179	
3074	1395	4.64	764	3.39	311.4	0.4	8	Asbestos Cement	0.013	214.6758	62.583	
3686	328	0	1057	0	310.9	0	8	PVC	0.013	14.605	269.294	
2438	MH-7809	87.75	MH-7810	86.51	311.4	0.4	6	Vitrified Clay	0.013	0.5747	0.361	
3145	1059	191.69	451	185.69	312.5	1.92	8	PVC	0.013	287.4735	38.255	
2818	MH-7432	0	728	214.12	313.4	Min. Slope	6	PVC	0.013	3.0958	0.149	
5012	MH-7811	0	1251	225.4	313.3	Min. Slope	8	PVC	0.013	1.2017	0.026	
2189	497	0	507	0	314.6	0	6	Asbestos Cement	0.013	1.08	42.887	
3072	MH-7812	0	834	244.54	313.9	Min. Slope	8	PVC	0.013	0.3871	0.008	
2351	614	135.17	629	132.17	314.8	0.953	8	Vitrified Clay	0.013	1.8477	0.349	
2222	MH-7813	99.98	678	98.72	314.6	0.4	6	Vitrified Clay	0.013	3.3252	2.088	
4151	1113	0	7	0	314.3	0	8	PVC	0.013	1.3382	24.675	
3675	293	89.26	290	88	315.5	0.4	8	PVC	0.013	2.6229	0.765	
5011	1251	225.4	1250	223.56	315	0.584	8	PVC	0.013	2.4387	0.588	
3140	902	19.59	252	19.72	315.1	Min. Slope	18	Concrete	0.013	1,274.81	133.122	SM 7
1169	102	210.86	104	204.73	315.8	1.941	8	Concrete	0.013	205.0756	27.139	
3679	289	51.28	1	50.02	315.9	0.4	8	PVC	0.013	5.5465	1.617	
3523	1090	95.74	288	94.47	317	0.4	8	PVC	0.013	1.1833	0.345	
1282	216	0	214	0	317.2	0	8	PVC	0.013	0.8621	15.895	
2443	674	107.93	681	105.09	318.2	0.893	6	PVC	0.013	9.0334	3.797	
3281	895	55.41	MH-7317	54.14	317.8	0.4	10	Vitrified Clay	0.013	554.0571	89.087	
3955	161	109.03	162	107.29	317.7	0.548	12	Concrete	0.013	810.6079	68.504	SM 7
2047	699	131.65	680	117.2	318.6	4.537	6	Vitrified Clay	0.013	2.1418	0.399	
3274	1403	56.68	895	55.41	318.5	0.4	6	Vitrified Clay	0.013	28.9362	18.169	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2211	680	117.2	1257	110.55	318.9	2.085	6	Vitrified Clay	0.013	5.1361	1.412	
2808	719	215.05	840	201.29	319.6	4.306	8	PVC	0.013	268.8581	23.891	
2308	431	218.45	442	206.2	319.6	3.833	8	Asbestos Cement	0.013	135.647	12.775	
682	342	94.72	341	83.56	318.7	3.502	8	PVC	0.013	3.1908	0.314	
3548	277	0	274	0	319.9	0	8	Concrete	0.013	57.7709	1,065.21	
683	341	83.56	343	62.29	319.4	6.66	8	PVC	0.013	4.4873	0.321	
3183	1407	8.8	860	7.52	319.7	0.4	8	Asbestos Cement	0.013	0.086	0.025	
403	1115	0	1116	0	319.6	0	8	PVC	0.013	1.6887	31.137	
664	332	62.87	338	61.59	319.8	0.4	8	PVC	0.013	3.9949	1.165	
2352	623	143.41	630	142.13	320.5	0.4	6	Vitrified Clay	0.013	4.4946	2.822	
1283	217	0	209	0	320.4	0	8	PVC	0.013	2.2521	41.525	
3886	MH-7814	70.63	333	69.34	322.6	0.4	8	PVC	0.013	0.3389	0.099	
681	MH-7815	96.01	342	94.72	323.4	0.4	8	PVC	0.013	1.7149	0.5	
3674	923	25.98	922	25.06	326	0.282	10	Asbestos Cement	0.013	72.8101	13.939	
2300	443	207.81	442	206.2	325.1	0.495	8	Asbestos Cement	0.013	28.0853	7.359	
3595	269	0	268	0	325.1	0	8	PVC	0.013	2.3308	42.976	
522	597	89.36	585	70.46	326	5.798	6	Vitrified Clay	0.013	6.3642	1.05	
7820	1388	119.5	1392	92	325.9	8.439	8	PVC	0.013	0.9648	0.061	
1124	166	233.24	167	230.66	326.3	0.791	8	Concrete	0.013	4.9609	1.029	
2814	715	229.22	720	0	327	70.098	8	PVC	0.013	120.5707	2.655	
784	732	207.11	455	199.74	327.4	2.251	8	Asbestos Cement	0.013	5.0731	0.623	
952	MH-7816	0	179	229.03	326.6	Min. Slope	8	PVC	0.013	0.3871	0.009	
3677	292	48.07	354	46.76	327.2	0.4	8	PVC	0.013	8.5574	2.495	
2206	616	100.86	698	99.54	329.3	0.4	6	Vitrified Clay	0.013	3.9178	2.46	
6298	MH-7370	40.92	561	39.6	329.5	0.4	8	Vitrified Clay	0.013	0.2193	0.064	
2334	631	129.09	641	127.77	330.2	0.4	8	PVC	0.013	11.263	3.284	
3664	995	16.65	988	15.76	330.5	0.269	12	Asbestos Cement	0.013	158.5851	19.113	
3262	1334	85.25	875	83.93	330.1	0.4	6	Vitrified Clay	0.013	2.2316	1.401	
2795	MH-7817	0	711	230.34	330	Min. Slope	8	PVC	0.013	1.2695	0.028	
3093	246	22.6	363	21.95	330.4	0.197	18	Concrete	0.013	1,233.45	58.985	
3597	229	35.9	355	18.7	330.2	5.209	8	PVC	0.013	1.3309	0.108	
3248	MH-7818	118.15	1277	116.83	330.7	0.4	6	Vitrified Clay	0.013	0.6385	0.401	
3676	MH-7819	92.23	291	90.91	330.9	0.4	8	PVC	0.013	0.7696	0.224	
521	1259	123.85	600	110.06	332.9	4.142	6	Vitrified Clay	0.013	2.8239	0.551	
2369	529	22.09	531	20.6	335.7	0.444	10	Asbestos Cement	0.013	583.3735	89.052	
814	261	0	260	20.03	334.7	Min. Slope	8	PVC	0.013	16.1215	1.215	
2343	MH-7283	0	595	0	335.1	0	8	Concrete	0.013	4.3021	79.324	
2794	MH-7820	0	710	234.93	335.5	Min. Slope	8	PVC	0.013	1.4151	0.031	
3143	362	20.86	906	20.32	483.2	0.112	18	Concrete	0.013	1,266.47	80.357	SM 7
2040	MH-7821	145.8	MH-7780	144.45	337.2	0.4	6	Vitrified Clay	0.013	2.6255	1.648	
2341	632	128.73	644	127.38	338.7	0.4	6	PVC	0.013	14.5553	9.139	
2678	241	82.76	348	81.38	344	0.4	8	PVC	0.013	7.9903	2.33	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
821	488	117.9	489	116.09	338.2	0.535	8	PVC	0.013	327.1508	82.451	
4537	1194	36.5	1195	34.7	339.6	0.53	8	PVC	0.013	2.4473	0.62	
4182	1134	241.4	1133	227.8	340.2	3.998	8	PVC	0.013	4.9848	0.46	
1907	MH-7268	85.85	487	84.9	340.2	0.28	10	Concrete	0.013	1.813	0.348	
1208	162	107.29	193	104.52	513.3	0.54	12	Concrete	0.013	814.0904	69.306	SM 7
4332	1157	44.19	1153	28.2	343.1	4.66	8	PVC	0.013	3.712	0.317	
2029	MH-7822	135.09	398	133.72	343	0.4	6	Vitrified Clay	0.013	2.7784	1.744	
2055	603	74.81	1101	55.5	343.5	5.622	6	Vitrified Clay	0.013	7.4909	1.255	
2584	695	166.33	700	164.16	343.6	0.631	6	Vitrified Clay	0.013	0.383	0.191	
3474	969	25.13	955	20.78	344.7	1.262	8	PVC	0.013	8.1264	1.334	
2304	413	232.63	421	228.26	345	1.267	8	PVC	0.013	5.0779	0.832	
3088	MH-7823	0	82	249.08	344.1	Min. Slope	8	PVC	0.013	2.1499	0.047	
961	1396	7.37	829	5.99	344.7	0.4	8	Asbestos Cement	0.013	0.993	0.29	
4054	1094	96.74	1093	92.61	344.3	1.199	8	PVC	0.013	0.5906	0.099	
1103	97	0	129	0	345.5	0	8	PVC	0.013	1.2524	23.091	
3720	972	12.96	980	11.89	345.7	0.309	8	Asbestos Cement	0.013	36.7262	12.173	
3071	82	249.08	1063	246.71	345.6	0.686	8	PVC	0.013	5.4419	1.212	
2437	678	98.72	682	97.34	345.9	0.4	6	Vitrified Clay	0.013	7.3559	4.619	
2805	1338	0	716	215.84	347.3	Min. Slope	8	PVC	0.013	264.1522	6.179	
2416	469	0	470	165.46	346.4	Min. Slope	8	PVC	0.013	1.7024	0.045	
1155	143	150.42	151	136.04	347.4	4.14	8	PVC	0.013	3.2775	0.297	
4121	1104	259.37	1109	253.42	348	1.71	8	PVC	0.013	0.4881	0.069	
2045	671	62.48	MH-7637	61.09	348.7	0.4	6	Vitrified Clay	0.013	14.9548	9.39	
1353	300	30.3	251	25.11	348.8	1.488	8	PVC	0.013	4.0751	0.616	
2318	482	146.25	489	116.09	350.2	8.613	8	Asbestos Cement	0.013	201.6218	12.667	
7590	1361	254.2	1362	250.5	349.2	1.06	8	PVC	0.013	107.3173	19.224	
626	MH-7824	0	514	0	350.4	0	8	PVC	0.013	5.7474	105.973	
2323	4	79.38	365	45.5	350.1	9.678	10	Asbestos Cement	0.013	553.2288	18.085	
3156	226	32.76	257	30.09	350.5	0.762	12	Asbestos Cement	0.013	9.7953	0.702	
3091	MH-7825	26.15	849	22.79	394.6	0.851	10	Asbestos Cement	0.013	11.0299	1.216	
1143	113	0	111	181.73	351	Min. Slope	8	Concrete	0.013	2.0132	0.052	
2428	MH-7806	107.69	675	106.29	351.2	0.4	6	Vitrified Clay	0.013	5.1045	3.205	
1368	MH-7810	86.51	896	85.1	351.4	0.4	6	Vitrified Clay	0.013	2.0574	1.292	
621	556	84.76	555	83.23	352.7	0.434	6	Concrete	0.013	7.8836	4.753	
2430	407	229.17	399	227.39	353.3	0.504	8	PVC	0.013	0.5522	0.143	
785	442	206.2	456	201.47	353.4	1.339	8	Asbestos Cement	0.013	165.3847	26.357	
332	28	17.31	MH-7270	17.11	352.8	0.058	30	PVC	0.013	3,711.22	84.024	
3144	1058	198.66	458	192.87	354	1.635	8	Asbestos Cement	0.013	9.4388	1.361	
2982	802	251.55	753	250.23	353.7	0.373	8	PVC	0.013	8.429	2.544	
3619	953	26.49	965	21.06	354.9	1.53	8	PVC	0.013	2.1334	0.318	
2815	720	0	727	219.47	355	Min. Slope	8	PVC	0.013	121.8818	2.858	
1725	510	42.99	1323	0	355.8	12.083	8	Concrete	0.013	23.4916	1.246	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
2305	421	228.26	432	219.23	356.8	2.531	8	PVC	0.013	7.9975	0.927	
1352	301	0	735	0	356.7	0	8	PVC	0.013	9.2918	171.326	
1119	92	205.7	93	204.2	357.1	0.42	8	Concrete	0.013	4.7509	1.352	
148	544	0	MH-7471	0	358.3	0	6	Concrete	0.013	20.1434	799.886	
280	594	0	40	0	359.9	0	8	Concrete	0.013	9.9452	183.375	
2450	1294	0	645	0	360.1	0	8	Asbestos Cement	0.013	0.6552	12.08	
2325	851	25.18	525	23.48	360.7	0.471	10	Asbestos Cement	0.013	555.6305	82.309	
1280	209	0	208	235.01	362.3	Min. Slope	8	PVC	0.013	4.5314	0.104	
2178	383	2.97	787	2.35	364.3	0.17	14	Asbestos Cement	0.013	879.8679	88.478	
2064	582	96.33	573	40.51	365.1	15.289	8	Vitrified Clay	0.013	26.3899	1.244	
2319	489	116.09	495	100.19	366	4.345	8	Asbestos Cement	0.013	531.8992	47.051	
2054	786	1.72	784	1.09	366.5	0.17	14	Asbestos Cement	0.013	889.215	89.41	
2177	648	3.59	383	2.97	367.3	0.17	14	Asbestos Cement	0.013	876.7166	88.16	
2317	468	175.36	482	146.25	369	7.889	8	Asbestos Cement	0.013	196.2912	12.886	
2980	798	0	755	0	369	0	8	PVC	0.013	11.0833	204.359	
2740	1098	0	626	0	369.7	0	8	PVC	0.013	2.7885	51.415	
3608	3	40.51	221	39.44	368.7	0.29	10	PVC	0.013	58.8422	11.108	
3917	290	84.11	340	78.79	370	1.438	8	PVC	0.013	8.5871	1.32	
1209	MH-7404	78.46	89	76.98	369.6	0.4	6	PVC	0.013	1.4361	0.902	
1281	214	0	213	236.33	370.2	Min. Slope	8	PVC	0.013	2.8878	0.067	
2243	MH-7451	242.59	MH-7263	241.1	372.3	0.4	6	Vitrified Clay	0.013	3.5761	2.245	
2816	722	224.94	729	215.17	373.3	2.617	8	PVC	0.013	2.9449	0.336	
5226	685	165.6	1271	164.11	372.5	0.4	6	Vitrified Clay	0.013	14.563	9.143	
1362	1234	60.46	899	58.96	373.6	0.4	6	Vitrified Clay	0.013	21.2039	13.313	
2165	MH-7827	147.28	651	145.79	372.9	0.4	6	Vitrified Clay	0.013	0.7266	0.456	
2648	224	37.3	300	30.3	372.6	1.879	8	PVC	0.013	2.8249	0.38	
2179	787	2.35	786	1.72	373.9	0.17	14	Asbestos Cement	0.013	889.1419	89.407	
3921	345	92.28	291	90.91	373.7	0.367	8	PVC	0.013	2.8173	0.858	
2176	667	4.23	648	3.59	374.2	0.17	14	Asbestos Cement	0.013	876.542	88.139	
3827	268	0	298	0	373.6	0	8	PVC	0.013	5.1119	94.255	
4764	1232	230.47	1230	228.5	373.7	0.527	8	PVC	0.013	2.2186	0.563	
2272	580	0	577	0	373.7	0	8	Concrete	0.013	7.8207	144.202	
2120	475	0	474	143.74	374.6	Min. Slope	8	PVC	0.013	2.8588	0.085	
3040	826	3.95	825	2.45	375.5	0.4	8	Asbestos Cement	0.013	3.0383	0.886	
1472	MH-7828	93.75	MH-7700	92.25	375.4	0.4	8	Vitrified Clay	0.013	1.3311	0.388	
769	521	0	527	0	449	0	8	PVC	0.013	2.4252	44.716	
3524	288	94.47	289	51.28	375.5	11.5	8	PVC	0.013	3.0898	0.168	
2150	487	84.9	493	58.21	377.5	7.07	12	Concrete	0.013	1,168.94	27.493	
2819	728	214.12	733	202.85	378	2.981	8	Asbestos Cement	0.013	4.874	0.52	
777	518	0	MH-7297	0	380.1	0	6	PVC	0.013	24.4925	972.588	
1139	132	0	134	167.93	380.5	Min. Slope	8	Concrete	0.013	145.9489	4.051	
4534	1191	111.58	1192	62.89	381.7	12.757	8	PVC	0.013	1.7222	0.089	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
1688	MH-7829	0	580	0	382	0	6	Concrete	0.013	1.0856	43.108	
4148	7	0	328	0	382	0	8	PVC	0.013	3.1428	57.949	
3818	298	0	301	0	382.7	0	8	PVC	0.013	7.787	143.58	
3280	900	4.44	866	2.9	384.1	0.4	8	Vitrified Clay	0.013	49.3516	14.388	
1355	746	14.45	318	13.94	385.1	0.132	30	PVC	0.013	3,823.22	57.072	
4137	MH-7681	187.49	MH-7296	185.94	388.6	0.4	6	Concrete	0.013	3.7975	2.384	
3828	265	0	297	0	387.2	0	8	PVC	0.013	4.368	80.54	
2316	458	192.87	468	175.36	388.9	4.503	8	Asbestos Cement	0.013	191.2381	16.617	
3075	810	101.88	777	99.22	532.7	0.499	12	Concrete	0.013	958.1187	84.795	SM 7
2473	789	209.04	788	0	390.5	53.526	8	PVC	0.013	2.0035	0.05	
1653	373	113.67	397	106.81	391.1	1.754	6	Vitrified Clay	0.013	2.0743	0.622	
3606	2	43.41	222	42.22	390.5	0.305	10	PVC	0.013	58.3598	10.75	
3998	1080	0	1079	0	392.5	0	8	PVC	0.013	10.6987	197.268	
3999	1079	0	1078	0	394.3	0	8	PVC	0.013	12.0308	221.83	
3116	247	6.92	853	5.19	395	0.438	8	PVC	0.013	6.642	1.85	
947	195	10.93	1346	9.34	396.2	0.4	8	PVC	0.013	10.6712	3.111	
3089	836	231.3	821	225.36	396.7	1.497	8	Concrete	0.013	34.5932	5.213	
1117	147	148.49	156	124.8	398.5	5.945	8	Concrete	0.013	528.4615	39.962	
962	821	225.36	176	219.28	397.7	1.529	8	Concrete	0.013	39.2783	5.857	
2591	703	0	701	25.64	399.8	Min. Slope	8	PVC	0.013	5.7045	0.415	
2240	653	256.38	666	254.78	399.7	0.4	6	Vitrified Clay	0.013	2.3775	1.493	
3035	815	4.88	816	3.27	400.3	0.4	8	PVC	0.013	56.6144	16.505	
944	MH-7830	0	186	193	400	Min. Slope	8	Vitrified Clay	0.013	2.1967	0.058	
3833	287	0	319	24.41	400.2	Min. Slope	8	PVC	0.013	1.2888	0.096	
3037	814	6.49	815	4.88	402.3	0.4	8	PVC	0.013	49.3979	14.401	
2806	717	0	716	215.84	403	Min. Slope	8	PVC	0.013	2.8866	0.073	
1212	201	3.54	199	1.93	404.6	0.4	8	Asbestos Cement	0.013	15.2089	4.434	
1146	123	190.85	122	177.84	408.3	3.186	8	Concrete	0.013	357.4456	36.922	
2478	63	15.52	1069	15.16	409.5	0.088	30	PVC	0.013	3,822.05	70.026	
2296	428	227.99	1298	210.15	410.4	4.347	8	PVC	0.013	20.8533	1.844	
1193	153	0	161	109.03	414.4	Min. Slope	6	Concrete	0.013	16.3009	1.262	
1346	751	0	317	0	414.7	0	8	Concrete	0.013	21.6115	398.483	
2275	546	0	544	0	415.3	0	8	Asbestos Cement	0.013	6.0961	112.403	
4113	297	0	1120	13.64	423.1	Min. Slope	8	PVC	0.013	8.348	0.857	
4117	MH-7832	0	1107	0	424	0	1	PVC	0.013	1.0733	5,066.39	
4112	120	13.71	1120	12.76	423	0.225	30	PVC	0.013	3,827.91	43.878	
1137	MH-7833	0	133	165.9	426	Min. Slope	8	PVC	0.013	4.407	0.13	
2106	757	0	391	0	431.3	0	8	PVC	0.013	19.9772	368.349	
1370	1271	164.11	877	162.38	432.4	0.4	6	Vitrified Clay	0.013	16.0872	10.1	
3259	882	71.71	888	68.07	435.4	0.836	10	Vitrified Clay	0.013	60.2433	6.701	
1781	718	226.52	724	218.49	439.1	1.829	8	PVC	0.013	3.098	0.422	
2442	659	113.21	674	107.93	440.9	1.197	6	Vitrified Clay	0.013	4.6813	1.699	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) 1	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
43	545	0	66	0	444.3	0	8	PVC	0.013	4.9229	90.77	
2236	647	256.92	663	255.14	444.1	0.4	6	Vitrified Clay	0.013	2.6891	1.688	
1976	713	231.68	714	229.99	443.5	0.381	8	PVC	0.013	5.6751	1.695	
3596	230	37.8	229	35.9	443.9	0.428	8	PVC	0.013	0.6152	0.173	
141	10	0	527	0	448.3	0	8	PVC	0.013	1.3537	24.96	
2471	MH-7834	217.93	1317	216.12	451.5	0.4	6	Vitrified Clay	0.013	0.7598	0.477	
3625	962	0	964	13.74	450.8	Min. Slope	8	PVC	0.013	20.9282	2.21	
2359	564	0	548	0	460.1	0	8	Concrete	0.013	60.0357	1,106.97	
3157	227	21.99	362	20.86	459.7	0.246	18	Concrete	0.013	1,266.19	54.169	
2796	MH-7835	0	712	222.88	461.4	Min. Slope	8	PVC	0.013	1.3896	0.037	
3158	257	30.09	MH-7825	26.15	462.6	0.852	12	Asbestos Cement	0.013	10.074	0.683	
3624	1056	0	961	0	464.3	0	8	PVC	0.013	18.8299	347.195	
2363	MH-7836	0	512	0	465.7	0	8	PVC	0.013	2.3071	42.539	
3927	907	11.45	910	10.89	466.1	0.12	18	Concrete	0.013	2.4193	0.148	
1195	MH-7837	0	162	107.29	468	Min. Slope	8	Vitrified Clay	0.013	0.2798	0.011	
3137	254	19.21	253	18.56	467.9	0.139	18	Concrete	0.013	1,364.52	77.657	
1359	MH-7267	9.37	880	7.5	469.4	0.4	6	Vitrified Clay	0.013	11.3168	7.105	
1361	679	91.46	1274	43.5	469.5	10.215	6	Vitrified Clay	0.013	6.2694	0.779	
6331	MH-7838	0	510	42.99	470	Min. Slope	8	Concrete	0.013	1.4625	0.089	
3120	493	58.21	248	24.9	471.7	7.061	12	Concrete	0.013	1,172.01	27.583	
2793	MH-7839	0	429	195.31	470.5	Min. Slope	8	PVC	0.013	0.2798	0.008	
1766	83	193.75	235	178.3	481.7	3.207	6	Concrete	0.013	2.8515	0.632	
3813	329	34.13	245	31.7	480.6	0.506	8	PVC	0.013	1.9568	0.507	
3092(1)	522	23.41	MH-7869	22.88	341	0.155	18	Concrete	0.013	1,196.34	64.369	SM 7
2048	662	93.4	679	91.46	485.7	0.4	6	Vitrified Clay	0.013	1.2203	0.766	
2465	635	165.52	643	163.57	486.6	0.4	6	Vitrified Clay	0.013	0.8849	0.556	
3669	1052	0	264	0	488.3	0	8	PVC	0.013	0.1608	2.965	
3932	909	10.51	908	9.54	489.8	0.198	18	Concrete	0.013	128.3897	6.12	
1675	MH-7840	0	595	0	493.7	0	8	PVC	0.013	3.4221	63.099	
1606	785	63.88	1410	0.26	498.3	12.769	6	Vitrified Clay	0.013	6.6114	0.735	
4147	1111	32.72	1112	31.62	500.6	0.22	12	PVC	0.013	15.1802	2.024	
1364	684	170.67	MH-7348	168.73	483.8	0.4	6	Vitrified Clay	0.013	28.8478	18.112	
5196	1269	176.51	655	174.47	510	0.4	6	Vitrified Clay	0.013	0.4228	0.265	
3092(2)	MH-7869	22.88	849	22.79	59.1	0.152	18	Concrete	0.013	1,220.76	66.374	SM 7
4237	1144	158.3	1103	143.29	519.8	2.888	6	Vitrified Clay	0.013	2.0852	0.487	
2219	676	214.73	684	170.67	519.9	8.475	6	Vitrified Clay	0.013	16.108	2.197	
3626	264	0	971	12.63	520.7	Min. Slope	8	PVC	0.013	0.3216	0.038	
4120	MH-7841	0	448	156.38	529.3	Min. Slope	6	Concrete	0.013	0.2798	0.02	
2163	658	160.95	664	140.67	214.2	9.465	8	Vitrified Clay	0.013	293.6936	17.602	SM 9
3275	1197	63.45	892	62.27	293.5	0.4	8	Vitrified Clay	0.013	316.8134	92.369	SM 9
3229	874	66.91	872	63.58	533.3	0.624	10	Vitrified Clay	0.013	66.4071	8.546	
1528	769	223.73	418	206.25	542.4	3.223	8	PVC	0.013	9.3522	0.961	

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5-Year (2028) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%) [1]	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow/Capacity (Design) (%)	CIP
7993	664	140.67	1402	139.49	294.8	0.4	6	Vitrified Clay	0.013	298.6788	187.534	SM 9
505	MH-7842	136	621	133.79	553.3	0.4	6	Vitrified Clay	0.013	1.4938	0.938	
3115	853	9.92	812	7.69	557	0.4	8	PVC	0.013	16.1989	4.723	
2208	1265	133.89	699	131.65	559	0.4	6	Vitrified Clay	0.013	2.0988	1.318	
1908	1384	99.1	478	91.31	627	1.242	12	Concrete	0.013	963.0219	54.032	
CO-14	824	1.13	W-Port	0	7.5	14.984	8		0.013	75.2198	3.583	
CO-18	395	0	W-31st St	212.35	7.9	Min. Slope	8		0.013	5.9062	0.021	
CO-20	MH-7299	0.8	W-Gaines St	0.77	20	0.15	15		0.013	1,191.21	106.076	
CO-25	MH-7315	5.95	O-2	5.95	5.5	0.079	24	PVC	0.013	4,210.24	147.263	
2044	1402	139.49	1332	137.93	389.9	0.4	6	Vitrified Clay	0.013	307.5524	193.103	SM 9
1358	1332	137.93	879	135.73	550.7	0.4	8	Vitrified Clay	0.013	309.9501	90.361	SM 9
121(1)	792	1.42	MH-7870	1.31	48.7	0.22	12	Vitrified Clay	0.013	73.1094	9.752	
121(2)	MH-7870	1.31	9	0.85	211.3	0.22	12	Vitrified Clay	0.013	79.867	10.648	
CO-29	882	71.71	1409	74.51	122.2	2.288	6	Vitrified Clay	0.013	7.0845	1.86	
CO-30	1409	74.51	884	74.13	94.1	Min. Slope	6	Vitrified Clay	0.013	5.7713	3.624	
2361(1)	571	0	MH-7871	0	397.2	0	8	Concrete	0.013	17.9504	330.978	
2361(2)	MH-7871	0	541	0	221	0	8	Concrete	0.013	21.7894	401.763	
343(1)	40	0	MH-7872	0	166.4	0	8	Concrete	0.013	11.0028	202.876	
343(2)	MH-7872	0	571	0	132.2	0	8	Concrete	0.013	13.043	240.493	
CO-35	MH-7882	28.03	968	27.14	222.7	0.4	12		0.013	0	0	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
3541	MH-7233	0	977	35.66	4.2	Min. Slope	8	PVC	0.013	0.1946	0.001	
6295	MH-7237	0	1301	160.15	5	Min. Slope	8	PVC	0.013	1.607	0.005	
6309	MH-7238	0	1304	227.84	5	Min. Slope	6	PVC	0.013	0.4493	0.003	
7697	MH-7236	0	1139	8.22	5	Min. Slope	8	PVC	0.013	0.1447	0.002	
6286	MH-7240	0	1296	0	4.7	0	8	PVC	0.013	3.3326	61.449	
4349	MH-7241	0	1160	31.2	5.6	Min. Slope	8	PVC	0.013	0.6249	0.005	
2661	MH-7242	0	709	238.29	6.1	Min. Slope	6	PVC	0.013	251.842	1.599	
3941	MH-7246	0	375	232.16	7	Min. Slope	8	PVC	0.013	0.7686	0.002	
8050	1408	0.03	W-Point Hudson	0	7.5	0.402	8	PVC	0.013	3.3192	0.965	
4601	1075	5.28	1203	5.08	7.9	2.529	10	PVC	0.013	176.2529	11.27	
6968	MH-7249	0	430	189.16	8	Min. Slope	6	PVC	0.013	4.0531	0.033	
2744	MH-7251	0	1098	0	8.1	0	8	PVC	0.013	3.0889	56.954	
5378	MH-7252	65.68	MH-7253	65.64	8.1	0.401	6	PVC	0.013	0.8218	0.515	
2568	MH-7254	0	MH-7255	0	8.3	0	6	PVC	0.013	1.3811	54.843	
7664	1371	0	MH-7251	0	8.4	0	8	PVC	0.013	2.4851	45.821	
4682	MH-7256	0	423	229.23	8.4	Min. Slope	8	PVC	0.013	4.7445	0.017	
5243	MH-7257	7.41	1396	7.37	8.7	0.398	8	PVC	0.013	0.9695	0.283	
4277	MH-7258	0	379	0	8.9	0	6	PVC	0.013	0.8436	33.498	
7075	MH-7259	230.42	MH-7260	230.38	9	0.4	6	PVC	0.013	0.6727	0.422	
5083	MH-7261	0	1256	63.14	9.2	Min. Slope	8	PVC	0.013	0.5571	0.004	
5293	1276	106.39	576	106.35	9.4	0.401	6	Concrete	0.013	1.8207	1.142	
7767	777	99.22	1384	99.1	9.6	1.251	12	Concrete	0.013	1,223.68	68.43	
5104	MH-7263	241.1	MH-7264	241.06	9.6	0.399	6	PVC	0.013	4.0659	2.555	
5618	263	102.77	MH-7267	102.73	10.1	0.399	6	PVC	0.013	10.1735	6.398	
8090	1422	0	MH-7268	0	10.7	0	8	PVC	0.013	1.2794	23.591	
914	532	0	68	0	11.5	0	6	PVC	0.013	1.0954	43.499	
4437	125	0	W-Island Vista	0	10.7	0	8		0.013	15.4896	285.605	
4074	MH-7269	57.58	1096	57.53	11.8	0.425	8	PVC	0.013	0.2582	0.073	
6445	MH-7272	54.08	1188	31.43	12	188.75	10	Vitrified Clay	0.013	559.9639	4.145	
909	MH-7270	17.11	65	17.1	12	0.047	30	PVC	0.013	4,064.93	101.959	
7636	MH-7271	0	1367	49.42	12	Min. Slope	8	PVC	0.013	0.4674	0.004	
4020	386	0	395	0	12.4	0	8	PVC	0.013	0	0	
4652	MH-7275	0	1216	118.6	12.9	Min. Slope	8	PVC	0.013	0.2582	0.002	
108	MH-7276	91.59	8	91.54	13	0.384	6	PVC	0.013	0.8429	0.54	
5627	MH-7277	95.28	MH-7278	95.28	13	0	6	PVC	0.013	3.8184	151.628	
4395	MH-7279	0	1175	47.1	13.3	Min. Slope	8	PVC	0.013	0.7364	0.007	
2299	444	209.12	443	207.81	13.4	9.746	8	PVC	0.013	31.2924	1.848	
6265	MH-7280	0	1291	0	13.6	0	8	PVC	0.013	0.5957	10.985	
7637	MH-7284	0	1369	52.12	14	Min. Slope	8	PVC	0.013	0.7962	0.008	
6780	MH-7281	90.28	MH-7282	90.23	14	0.4	6	PVC	0.013	0.4557	0.286	
6655	1333	0	MH-7283	0	14	0	8	PVC	0.013	3.8429	70.857	
7663	1370	0	1371	0	14.1	0	8	PVC	0.013	1.2076	22.266	

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SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
4701	MH-7285	0	1222	245.52	14.7	Min. Slope	8	PVC	0.013	0	0	
4822	1235	244.06	MH-7286	244	14.8	0.401	6	PVC	0.013	1.2636	0.792	
4073	MH-7287	57.59	1096	57.53	14.8	0.4	8	PVC	0.013	1.1398	0.332	
5025	MH-7288	0	1252	0	15	0	8	PVC	0.013	0.8566	15.795	
6544	MH-7289	0	624	0	15.2	0	6	Concrete	0.013	1.9616	77.895	
8082	1490	0	1420	237.45	15.3	Min. Slope	6	PVC	0.013	0.6216	0.006	
4330	MH-7290	0	1156	0	16	0	6	PVC	0.013	0.5706	22.66	
7457	MH-7291	0	MH-7292	0	16	0	8	PVC	0.013	27.0551	498.856	
5095	MH-7293	0	498	76.94	16.2	Min. Slope	6	Concrete	0.013	8.7381	0.159	
3170	857	1.61	W-Monroe	1.56	16.6	0.28	10		0.013	909.8579	174.917	
4658	MH-7294	0	1218	108.9	16.8	Min. Slope	8	PVC	0.013	0.9157	0.007	
6256	MH-7295	75.67	892	62.27	17	78.826	10	Asbestos Cement	0.013	136.3751	1.562	
8093	1424	115.86	579	107.1	17.1	51.303	8	PVC	0.013	0.979	0.025	
4427	MH-7296	185.94	636	185.87	17.2	0.4	6	PVC	0.013	5.1573	3.24	
5090	MH-7297	0	528	0	17.5	0	6	Asbestos Cement	0.013	27.0989	1,076.09	
118	9	0.85	783	0.82	17.5	0.15	15	PVC	0.013	85.2561	7.6	
4653	MH-7298	0	1216	118.6	17.6	Min. Slope	8	PVC	0.013	0.2582	0.002	
117	783	0.82	MH-7299	0.8	17.9	0.112	18	PVC	0.013	307.6868	19.54	
7339	MH-7300	145.64	MH-7301	134.11	18	64.056	6	PVC	0.013	2.1442	0.106	
3961	MH-7302	0	178	227.58	18.1	Min. Slope	8	PVC	0.013	17.5151	0.091	
6250	1148	0	538	0	18.3	0	8	PVC	0.013	3.2619	60.145	
3171	869	1.68	857	1.61	18.6	0.4	10		0.013	82.6087	13.279	
6917	MH-7303	0	MH-7304	224.94	18.7	Min. Slope	6	PVC	0.013	0.6038	0.007	
8030	1458	0	1214	62.82	19.2	Min. Slope	8		0.013	0.2364	0.002	
1415	MH-7305	38.16	490	38.08	19	0.4	8	PVC	0.013	0.3148	0.092	
4784	MH-7306	0	1232	230.47	19.9	Min. Slope	8	PVC	0.013	0.4566	0.002	
6259	MH-7307	0	714	229.99	20	Min. Slope	8	PVC	0.013	0.6038	0.003	
6656	MH-7308	0	1333	0	20	0	6	PVC	0.013	0.8858	35.175	
6852	MH-7309	0	974	0	20	0	8	PVC	0.013	0.587	10.823	
7644	850	12.04	1070	15.65	20.1	Min. Slope	8	PVC	0.013	2.3368	0.102	
8004	MH-7310	229.8	MH-7311	229.72	20.1	0.399	6	PVC	0.013	0.8236	0.518	
2636	987	5.97	MH-7315	5.95	20.4	0.08	24	PVC	0.013	4,606.70	160.249	
81	MH-7314	0	181	207.93	20.3	Min. Slope	6	PVC	0.013	0.7631	0.009	
3949	MH-7316	0	509	33.34	20.8	Min. Slope	6	PVC	0.013	0.816	0.026	
6444	MH-7317	54.14	MH-7272	54.08	21	0.28	10	PVC	0.013	559.8948	107.603	
4628	1211	200.67	W-Hamilton Heights	0	21	954.232	8	PVC	0.013	9.0703	0.054	
7743	MH-7318	13.05	1382	12.97	21.1	0.399	6	Vitrified Clay	0.013	7.2295	4.542	
3804	MH-7319	0	MH-7320	0	21.3	0	6	PVC	0.013	0.8222	32.65	
7225	MH-7323	0	MH-7324	0	22	0	6	PVC	0.013	14.0222	556.815	
3948	MH-7321	0	1050	60.71	22	Min. Slope	8	PVC	0.013	2.0476	0.023	
4797	1233	165.9	MH-7322	0	22	754.961	8	PVC	0.013	2.8818	0.019	
7195	MH-7325	0	38	0	22	0	8	PVC	0.013	0.2582	4.761	

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10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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4793	MH-7326	0	457	0	22.2	0	6	PVC	0.013	0.4493	17.842	
1175	MH-7327	0	118	216.24	22.7	Min. Slope	8	PVC	0.013	0.8544	0.005	
6639	6	3.68	1328	3.62	22.6	0.28	10	Vitrified Clay	0.013	50.5609	9.725	
6526	849	22.79	MH-7328	22.77	22.8	0.088	18	Concrete	0.013	1,530.18	109.69	
6779	MH-7329	90.12	MH-7330	90.02	24	0.4	6	PVC	0.013	0.6905	0.434	
2002	377	0	586	0	24.4	0	6	Concrete	0.013	33.585	1,333.65	
7192	41	0	MH-7331	0	24.6	0	8	PVC	0.013	3.3532	61.828	
4085	MH-7332	0	708	0	24.6	0	6	PVC	0.013	0.1805	7.168	
5290	MH-7333	2.89	887	2.79	24.7	0.401	6	PVC	0.013	3.6344	2.28	
4393	MH-7334	0	1174	37.1	24.7	Min. Slope	8	PVC	0.013	0.2582	0.004	
4017	1087	16.07	1086	16.04	24.7	0.122	30	PVC	0.013	4,146.89	64.62	
2791	MH-7335	0	618	182.45	25	Min. Slope	8	PVC	0.013	1.2863	0.009	
5611	MH-7336	38.69	MH-7337	38.59	25.5	0.4	6	PVC	0.013	9.173	5.759	
5080	1255	55.28	1164	0	25.5	216.568	8	PVC	0.013	2.6264	0.033	
2811	726	210.79	725	210.4	25.6	1.523	8	PVC	0.013	7.2919	1.09	
5430	1088	6.2	1279	6.1	25.8	0.401	8	PVC	0.013	15.2678	4.448	
4164	1125	0	475	0	26	0	6	PVC	0.013	1.9543	77.605	
1104	MH-7338	0	129	0	26.2	0	8	PVC	0.013	9.6233	177.44	
3806	MH-7339	0	325	0	26.2	0	6	PVC	0.013	3.4043	135.184	
4905	MH-7340	0	1243	245.5	26.5	Min. Slope	8	PVC	0.013	0	0	
5432	MH-7341	13.16	MH-7318	13.05	26.8	0.4	6	PVC	0.013	7.1121	4.466	
848	MH-7342	0	MH-7343	0	26.9	0	8	PVC	0.013	0.9313	17.171	
4904	MH-7344	0	1241	244.91	26.9	Min. Slope	8	PVC	0.013	0	0	
6778	MH-7282	90.23	MH-7329	90.12	27	0.4	6	Concrete	0.013	0.5731	0.36	
1161	158	118.13	159	117.39	254.2	0.291	18	PVC	0.013	762.7453	29.988	SM 1
2335	630	142.13	631	129.09	27.3	47.673	8	PVC	0.013	8.9959	0.24	
4348	MH-7346	0	1159	34.13	27.7	Min. Slope	8	PVC	0.013	1.1629	0.019	
3798	MH-7320	0	326	0	27.7	0	8	PVC	0.013	1.0804	19.921	
6428	1310	150.56	396	144.34	28.2	22.047	6	Vitrified Clay	0.013	11.0673	0.936	
3221	MH-7348	168.73	898	163.4	47.2	11.283	6	Vitrified Clay	0.013	35.1577	4.156	
4697	MH-7347	0	1225	256	28.4	Min. Slope	8	PVC	0.013	0	0	
2188	513	0	511	0	28.5	0	8	PVC	0.013	6.3257	116.637	
7602	819	90.93	818	79.5	29	39.369	6	PVC	0.013	1.6296	0.103	
5452	782	1.83	MH-7349	1.75	29	0.28	10	Vitrified Clay	0.013	77.659	14.93	
3954	MH-7350	0	724	218.49	29.5	Min. Slope	6	PVC	0.013	0.6038	0.009	
3963	79	245.17	1062	244.61	30.1	1.863	8	PVC	0.013	10.1779	1.375	
7224	MH-7324	0	544	0	30.1	0	6	Concrete	0.013	14.2586	566.202	
2344	595	0	594	0	30.2	0	8	Concrete	0.013	9.8083	180.849	
6440	1423	0	MH-7351	0	30.4	0	8	PVC	0.013	0.895	16.502	
3945	MH-7352	0	954	44.48	30.4	Min. Slope	8	PVC	0.013	0.1946	0.003	
4346	MH-7353	0	1158	43.3	31	Min. Slope	8	PVC	0.013	0.2364	0.004	
908	71	0	65	18.15	31.1	Min. Slope	8	PVC	0.013	19.2636	0.465	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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8029	MH-7354	56.81	1403	56.68	31.5	0.4	6	Vitrified Clay	0.013	28.1987	17.705	
6317	1307	226.73	49	226.02	32.3	2.198	8	PVC	0.013	4.2203	0.525	
7728	1380	153.85	MH-7355	119.88	32.7	104.037	6	Vitrified Clay	0.013	0.9706	0.038	
3172	858	1.7	857	1.61	32.8	0.28	10		0.013	827.1801	159.01	
6273	657	189.42	1293	187.63	33.1	5.41	8	PVC	0.013	3.4351	0.272	
6652	MH-7356	86.62	MH-7357	86.49	33.1	0.399	6	Vitrified Clay	0.013	0.3349	0.21	
3950	MH-7358	0	509	33.34	33.3	Min. Slope	4	PVC	0.013	2.15	0.252	
34	259	0	1073	0	33.5	0	8	PVC	0.013	15.9214	293.567	
776	516	0	518	0	33.7	0	6	Asbestos Cement	0.013	22.3982	889.424	
6536	252	19.72	MH-7359	19.58	33.8	0.414	18	PVC	0.013	1,674.55	55.181	
3444	918	13.84	970	13.8	33.9	0.118	8	Asbestos Cement	0.013	37.2288	19.989	
3785	MH-7360	64.36	MH-7361	64.23	34	0.4	6	PVC	0.013	5.8958	3.702	
137	MH-7362	0	914	59.55	35	Min. Slope	6	PVC	0.013	1.2108	0.037	
915	67	17	68	16.7	35.1	0.854	30	PVC	0.013	4,116.37	24.193	
7582	1354	270.4	1348	263.2	35.4	20.321	8	PVC	0.013	103.4432	4.231	
4323	1152	23.88	MH-7363	0	35.6	67.086	8	PVC	0.013	6.9006	0.155	
140	MH-7365	0	10	0	36	0	8	PVC	0.013	1.2438	22.934	
3957	MH-7364	0	142	167.92	35.9	Min. Slope	8	PVC	0.013	0.6216	0.005	
1695	MH-7366	0	610	0	36.8	0	6	PVC	0.013	1.0166	40.37	
4623	MH-7367	0	1209	233	37	Min. Slope	8	PVC	0.013	0.7979	0.006	
7691	1377	0	1215	237.3	37.1	Min. Slope	8	PVC	0.013	0.6216	0.005	
38	530	0	848	0	37.1	0	8	PVC	0.013	5.7216	105.498	
3811	MH-7368	0	324	0	37.5	0	8	PVC	0.013	6.0062	110.745	
24	MH-7369	0	44	224.41	37.6	Min. Slope	8	PVC	0.013	0.6038	0.005	
7821	1393	61.2	240	59.6	37.9	4.219	8	PVC	0.013	2.0656	0.185	
7338	651	145.79	MH-7300	145.64	38	0.4	6	Vitrified Clay	0.013	2.0751	1.303	
4737	1228	0	1200	42.99	38.1	Min. Slope	6	Concrete	0.013	16.3964	0.613	
8048	1406	41.07	MH-7370	40.92	38.3	0.4	8	Vitrified Clay	0.013	0.2348	0.068	
7593	1352	256.2	1359	256	38.1	0.524	8	PVC	0.013	108.2736	27.568	
107	MH-7371	91.74	MH-7276	91.59	37.1	0.4	6	PVC	0.013	0.5847	0.367	
7887	MH-7374	0	MH-7375	0	39	0	8	Ductile Iron	0.013	2.6317	48.524	
4773	MH-7376	0	1231	228.5	39.4	Min. Slope	6	PVC	0.013	1.0769	0.018	
3685	984	8.31	986	8.34	39.5	Min. Slope	18	PVC	0.013	148.07	11.395	
8078	1487	242.62	1417	242.34	39.8	0.704	8		0.013	0.6216	0.137	
1993	MH-7377	0	598	0	39.8	0	6	Concrete	0.013	0.5261	20.889	
4052	1091	74.56	MH-7378	48.91	39.9	64.249	8	PVC	0.013	6.6898	0.154	
3080	MH-7379	0	809	0	40	0	8	PVC	0.013	2.0523	37.841	
58	MH-7380	0	519	0	40	0	8	PVC	0.013	0.5353	9.87	
813	249	0	250	24.49	40.4	Min. Slope	8	PVC	0.013	15.9471	0.377	
4774	MH-7382	0	1231	228.5	40.5	Min. Slope	6	PVC	0.013	0.367	0.006	
4098	411	68.14	MH-7383	68.3	40.7	Min. Slope	6	PVC	0.013	0.5081	0.319	
7597	MH-7384	0	136	0	41.6	0	8	PVC	0.013	30.8961	569.678	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

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4413	MH-7387	0	1173	35.4	42	Min. Slope	8	PVC	0.013	1.7526	0.035	
4507	MH-7388	0	1187	29.54	42.1	Min. Slope	8	PVC	0.013	0.1447	0.003	
3029	817	4.97	828	4.8	42.1	0.4	8	PVC	0.013	1.1672	0.34	
1204	189	0	190	171.7	42.7	Min. Slope	8	PVC	0.013	32.5148	0.299	
3996	867	5.72	1076	6.08	42.7	Min. Slope	8	Vitrified Clay	0.013	151.5498	30.635	
6742	MH-7389	0	1315	0	43	0	8	Ductile Iron	0.013	2.2465	41.422	
7680	MH-7390	242.87	1373	242.7	43.1	0.4	8	PVC	0.013	0.6216	0.181	
4276	MH-7391	6	862	5.83	43.2	0.4	6		0.013	0.8442	0.53	
938	MH-7392	0	74	212.1	43.4	Min. Slope	8	PVC	0.013	0.3914	0.003	
4809	MH-7393	0	MH-7394	0	43.6	0	8	PVC	0.013	0.8494	15.662	
4345	MH-7395	0	1158	43.3	43.6	Min. Slope	8	PVC	0.013	0.2364	0.004	
4282	1151	10.62	908	9.54	44.1	2.447	8	PVC	0.013	1.413	0.167	
4018	1086	16.04	1073	15.99	44.2	0.113	30	PVC	0.013	4,147.12	66.992	
2136	479	90.04	481	89.04	44.4	2.252	12	Concrete	0.013	1,287.69	53.666	
3953	MH-7396	0	409	221.44	44.6	Min. Slope	8	PVC	0.013	1.8622	0.015	
7744	1382	12.97	MH-7570	12.79	44.7	0.4	6	PVC	0.013	7.3469	4.613	
6281	1303	0	1294	0	45	0	4		0.013	0.3822	44.745	
5100	583	87.42	MH-7397	15.18	45.4	159.225	6	Vitrified Clay	0.013	4.3238	0.136	
4130	24	0	1089	0	45.5	0	6	PVC	0.013	1.4425	57.279	
627	MH-7400	0	975	0	46.3	0	6	Concrete	0.013	2.2182	88.084	
3684	986	8.34	987	5.97	46.2	5.135	18	PVC	0.013	156.686	1.467	
7617	MH-7398	0	MH-7399	0	46.2	0	6	PVC	0.013	2.15	85.374	
1159	156	124.8	157	123.66	265.8	0.429	18	PVC	0.013	758.2723	24.557	SM 1
5626	MH-7278	95.28	1189	95.28	46.7	0	6	Vitrified Clay	0.013	3.9358	156.29	
5252	MH-7401	0	MH-7402	0	46.9	0	6	PVC	0.013	0.6038	23.977	
4142	818	79.5	303	0	46.9	169.573	6	PVC	0.013	1.7743	0.054	
906	1070	15.65	63	15.52	46.9	0.277	30	PVC	0.013	4,184.74	43.186	
6285	1296	0	413	232.63	48.2	Min. Slope	8	PVC	0.013	3.9364	0.033	
2417	405	234.19	406	233.93	48.2	0.539	8	PVC	0.013	5.6829	1.427	
3768	MH-7405	0	319	0	48.8	0	8	PVC	0.013	1.3723	25.304	
6662	1335	68.14	MH-7404	78.46	48.8	Min. Slope	6	PVC	0.013	0.5643	0.049	
213	356	31.83	1112	31.62	49.7	0.423	12	PVC	0.013	68.7933	6.618	
5103	MH-7264	241.06	1237	240.86	49.8	0.4	6	Vitrified Clay	0.013	4.135	2.596	
339	253	18.56	31	18.01	50	1.1	18	PVC	0.013	1,680.63	33.997	
3946	MH-7406	0	951	23.84	50	Min. Slope	8	PVC	0.013	0.1946	0.005	
6436	1317	216.12	1320	215.13	50.4	1.966	6	Vitrified Clay	0.013	3.831	1.085	
4381	MH-7407	0	1171	0	51	0	8	PVC	0.013	0.6216	11.461	
2291	535	0	534	0	51.3	0	8	PVC	0.013	22.4123	413.249	
6304	1264	0	1149	0	51.6	0	6	Concrete	0.013	17.5054	695.133	
3112	1071	0	841	0	51.7	0	8	PVC	0.013	2.7164	50.085	
7258	MH-7408	86.23	MH-7409	86.02	51.7	0.4	6	Vitrified Clay	0.013	1.3834	0.868	
7810	MH-7410	0	1387	0	52.6	0	8	PVC	0.013	0.7322	13.501	

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SewerGEMS Results

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536	MH-7411	0	62	0	53	0	6	PVC	0.013	0.326	12.944	
1523	MH-7412	0	424	230.12	53.1	Min. Slope	6	PVC	0.013	0.6888	0.013	
6434	1315	0	1314	207.55	53.3	Min. Slope	8	PVC	0.013	4.0766	0.038	
4331	1222	245.52	1156	0	53.2	461.678	8	PVC	0.013	1.3156	0.011	
5118	MH-7413	33.41	195	33.2	53.4	0.4	8	PVC	0.013	3.2156	0.937	
3085	762	9.04	811	8.83	53.6	0.4	8	PVC	0.013	10.5406	3.073	
752	MH-7414	0	592	0	53.9	0	8	PVC	0.013	1.3599	25.075	
8073	1486	0	1418	240.14	54	Min. Slope	8		0.013	0.7656	0.007	
6529	1323	0	1322	0	54.2	0	8	Concrete	0.013	27.1772	501.106	
247	15	0	18	109.67	54.5	Min. Slope	8	PVC	0.013	3.0088	0.039	
5465	682	97.34	MH-7415	86.06	55.1	20.487	8	Vitrified Clay	0.013	110.5613	4.504	
7824	MH-7416	123.42	1391	123.2	55.4	0.4	6	PVC	0.013	0.2582	0.162	
46	76	0	622	164.08	55.6	Min. Slope	8	PVC	0.013	1.6453	0.018	
4364	1166	247.99	1165	247.75	56	0.428	8	PVC	0.013	2.698	0.76	
2015	399	227.39	395	0	56.4	402.843	8	PVC	0.013	5.0064	0.046	
4853	1239	118.24	MH-7348	117.92	79.3	0.4	6	Vitrified Clay	0.013	4.52	2.838	
4508	MH-7418	0	1187	29.54	57.1	Min. Slope	8	PVC	0.013	1.4805	0.038	
249	MH-7419	0	14	0	57.9	0	6	PVC	0.013	2.1138	83.939	
1784	MH-7420	0	723	216.42	58.2	Min. Slope	6	PVC	0.013	1.256	0.026	
1150	318	13.94	120	13.71	58.1	0.396	30	PVC	0.013	4,191.49	36.196	
4178	1316	204.4	1130	204.6	58.2	Min. Slope	8	PVC	0.013	4.9752	1.564	
1265	167	230.66	173	229.42	58.4	2.123	8	Concrete	0.013	7.489	0.948	
3198	MH-7421	3.38	MH-7422	0	59	5.72	6	PVC	0.013	2.3943	0.398	
4626	1212	204	1206	202.4	59.4	2.694	8	PVC	0.013	4.6262	0.52	
7156	1340	0	188	0	59.8	0	8	PVC	0.013	30.8174	568.226	
5190	1266	240.91	215	240.77	60	0.233	8	PVC	0.013	130.024	49.647	
4522	MH-7423	0	1190	25.25	60	Min. Slope	6	PVC	0.013	0.6429	0.039	
3380	MH-7424	0	914	59.55	60.3	Min. Slope	8	PVC	0.013	1.7042	0.032	
5377	640	65.92	MH-7252	65.68	60.4	0.4	6	Vitrified Clay	0.013	0.0691	0.043	
4006	1078	0	1077	0	60.3	0	8	PVC	0.013	12.1259	223.584	
2322	508	0	4	79.38	60.3	Min. Slope	8	Asbestos Cement	0.013	17.8298	0.287	
6003	1145	0	MH-7425	0	60.7	0	6	PVC	0.013	1.2502	49.644	
3696	978	0	975	0	60.7	0	8	PVC	0.013	3.1548	58.169	
341	31	18.01	1309	17.86	61	0.246	30	PVC	0.013	3,421.65	37.489	
7598	650	65.03	1416	64.78	61.1	0.4	6	Vitrified Clay	0.013	3.4286	2.153	
4149	MH-7429	0	1114	0	62	0	8	PVC	0.013	0.7146	13.176	
6648	MH-7427	98.48	MH-7428	98.23	62	0.4	6	Ductile Iron	0.013	0.1174	0.074	
1173	MH-7426	0	118	216.24	62	Min. Slope	8	PVC	0.013	9.1175	0.09	
254	MH-7431	0	232	168.8	62.3	Min. Slope	6	Concrete	0.013	2.0647	0.05	
26	45	0	MH-7432	0	62.8	0	8	PVC	0.013	3.163	58.322	
116	793	0.89	MH-7299	0.8	62.9	0.15	15	PVC	0.013	889.6713	79.204	
5464	MH-7415	86.06	MH-7433	85.8	63.5	0.4	8	PVC	0.013	113.2054	33.007	

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SewerGEMS Results

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6418	MH-7434	0	489	116.09	64	Min. Slope	8	PVC	0.013	2.1168	0.029	
7537	1342	0	1345	165.16	64.2	Min. Slope	8	PVC	0.013	0.7916	0.009	
3929	MH-7435	0	1121	12.47	64.5	Min. Slope	8	PVC	0.013	28.5391	1.197	
6315	1305	227.68	1306	227.09	64.7	0.912	8	PVC	0.013	1.2671	0.245	
7257	MH-7409	86.02	MH-7436	85.76	65	0.4	6	PVC	0.013	1.4525	0.912	
4614	MH-7437	0	1208	224.51	65.3	Min. Slope	8	PVC	0.013	0.9575	0.01	
4025	MH-7438	174.99	1262	174.73	66.1	0.4	6	Vitrified Clay	0.013	3.2299	2.028	
3971	591	0	1072	0	66.2	0	8	Asbestos Cement	0.013	4.6033	84.877	
6653	MH-7357	86.49	MH-7408	86.23	66.1	0.4	6	PVC	0.013	1.1256	0.707	
2093	438	0	440	0	66.4	0	8	PVC	0.013	0.4493	8.284	
5363	554	66.74	1278	66.48	66.3	0.4	8	Concrete	0.013	10.0545	2.93	
7984	1450	0	1401	74.5	66.4	Min. Slope	8		0.013	1.0016	0.017	
6112	971	12.63	1285	12.17	66.6	0.69	10	PVC	0.013	140.0614	17.145	
1705	MH-7439	0	738	0	66.6	0	6	PVC	0.013	0.1447	5.746	
2302	MH-7440	0	456	201.47	67	Min. Slope	6	PVC	0.013	2.6169	0.06	
5331	MH-7441	104.57	MH-7442	74.78	67.4	44.203	6	Vitrified Clay	0.013	4.862	0.29	
8062	781	2.48	843	2.21	67.9	0.397	8	Asbestos Cement	0.013	219.0043	64.051	
6671	MH-7443	0	MH-7444	0	68.5	0	8	PVC	0.013	0.4739	8.738	
4394	1368	47.44	1175	47.1	68.7	0.495	8	PVC	0.013	2.8451	0.746	
1287	203	229.22	205	228.88	68.7	0.495	8	PVC	0.013	4.8578	1.273	
1011	200	77.26	89	76.98	69	0.4	8	PVC	0.013	1.9512	0.569	
2330	MH-7445	120.79	665	113.91	69.3	9.919	8	Vitrified Clay	0.013	60.9415	3.568	
2285	567	0	562	0	69.7	0	8	PVC	0.013	0.9805	18.079	
4768	MH-7447	0	1229	222.79	69.9	Min. Slope	8	PVC	0.013	0.5072	0.005	
959	86	1.41	824	1.13	70	0.4	8	Asbestos Cement	0.013	77.6579	22.634	
4488	MH-7448	0	1184	0	70.3	0	6	PVC	0.013	0.6038	23.977	
1291	MH-7449	0	217	0	70.4	0	8	PVC	0.013	1.2432	22.923	
4636	MH-7450	0	1215	237.3	70.9	Min. Slope	8	PVC	0.013	30.4379	0.307	
1260	159	117.39	160	116	265.7	0.523	18	PVC	0.013	1,039.83	30.492	SM 1
2277	537	0	536	0	71.5	0	8	PVC	0.013	7.5573	139.345	
4132	17	242.87	MH-7451	242.59	71.7	0.4	6	PVC	0.013	1.8527	1.163	
1773	MH-7452	0	728	214.12	71.7	Min. Slope	6	Asbestos Cement	0.013	0.9903	0.023	
8058	1415	254.57	1361	254.2	73.3	0.498	8	PVC	0.013	110.1384	28.78	
6293	1300	0	191	155.6	72	Min. Slope	8	PVC	0.013	3.129	0.039	
3683	981	19.17	986	8.34	72.1	15.015	8	PVC	0.013	8.3579	0.398	
6471	1319	148.44	447	144.4	73	5.538	8	Concrete	0.013	22.8907	1.793	
5061	MH-7454	0	MH-7455	0	72.8	0	6	PVC	0.013	0.3869	15.364	
4867	MH-7456	0	180	215.1	73	Min. Slope	8		0.013	0.4493	0.005	
4218	1135	6.12	987	5.97	73.3	0.205	30	PVC	0.013	4,397.19	52.786	
1001	MH-7457	0	168	232.2	73.3	Min. Slope	6	PVC	0.013	2.2693	0.051	
3160	540	0	225	33.71	74	Min. Slope	8	Asbestos Cement	0.013	9.0411	0.247	
5094	491	95.78	MH-7458	76.94	74.2	25.391	6	PVC	0.013	5.7589	0.454	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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335	29	17.57	28	17.31	74.4	0.35	30	PVC	0.013	4,064.46	37.339	
7626	MH-7459	79.05	1364	78.75	74.7	0.4	6	Vitrified Clay	0.013	3.936	2.472	
1290	MH-7460	0	216	0	74.8	0	8	PVC	0.013	0.6216	11.461	
1668	MH-7461	124.66	575	124.36	74.9	0.4	6	Vitrified Clay	0.013	0.1174	0.074	
4627	MH-7462	0	1211	200.67	75.1	Min. Slope	8	PVC	0.013	9.0703	0.102	
3628	917	30.66	MH-7463	0	75.2	40.79	8	PVC	0.013	1.0544	0.03	
3138	MH-7359	19.58	254	19.21	75.8	0.488	18	Concrete	0.013	1,675.00	50.853	
619	MH-7464	113.51	659	113.21	76.1	0.4	6	Vitrified Clay	0.013	0.9426	0.592	
6025	MH-7466	253.41	1283	253.1	76.4	0.4	8	PVC	0.013	1.8971	0.553	
7578	1349	260.5	1350	260	76.6	0.653	8	PVC	0.013	105.2546	24.016	
6290	423	229.23	1297	227.99	76.8	1.614	8	PVC	0.013	20.9532	3.041	
3987	MH-7467	65.4	MH-7468	65.09	77.6	0.4	6	PVC	0.013	0.0691	0.043	
3988	MH-7468	65.09	1416	64.78	77.8	0.4	6	PVC	0.013	2.227	1.398	
33	1073	15.99	1074	15.9	78.1	0.115	30	PVC	0.013	4,163.28	66.631	
508	MH-7469	2.05	782	1.83	78.2	0.28	10	Vitrified Clay	0.013	77.5416	14.906	
2911	804	0	797	0	77.9	0	8	PVC	0.013	1.9846	36.593	
4119	1105	260.05	1104	259.37	79.1	0.86	8	PVC	0.013	0.1417	0.028	
6314	MH-7470	0	1305	227.68	79.9	Min. Slope	8	PVC	0.013	0.4493	0.005	
601	MH-7471	0	67	0	80	0	8	PVC	0.013	23.9154	440.963	
6284	MH-7508	32.22	873	12	98.5	20.537	8	Vitrified Clay	0.013	19.6835	0.801	SM 10
2256	612	0	1149	0	80.3	0	8	PVC	0.013	3.455	63.705	
5093	1258	121.11	MH-7445	120.79	80.4	0.4	6	Vitrified Clay	0.013	8.9788	5.637	
2566	MH-7255	0	518	0	80.3	0	8	PVC	0.013	1.8286	33.717	
3787	304	0	305	0	80.3	0	8	Concrete	0.013	9.5875	176.78	
1230	MH-7473	0	106	212.61	81	Min. Slope	8	Concrete	0.013	1.3044	0.015	
8070	215	240.77	1418	240.14	81.5	0.773	8	PVC	0.013	130.6455	27.406	
4823	MH-7474	244.39	1235	244.06	81.6	0.4	6	PVC	0.013	0.5973	0.375	
4613	1205	210.25	1206	202.4	81.7	9.605	8	PVC	0.013	4.2207	0.251	
4150	1114	0	1113	0	82.1	0	8	PVC	0.013	1.1901	21.944	
1598	553	66.01	551	65.68	82.4	0.4	6	Concrete	0.013	10.932	6.862	
2113	402	235.19	401	234.64	84.3	0.653	8	PVC	0.013	10.8513	2.477	
7538	144	0	1345	165.16	84.2	Min. Slope	6	Concrete	0.013	15.8794	0.45	
918	65	17.1	66	17	84.4	0.12	30	PVC	0.013	4,084.58	64.041	
3673	993	7.64	989	6.99	84.5	0.77	8	Concrete	0.013	51.9841	10.926	
2112	1270	0	402	235.19	83.3	Min. Slope	8	PVC	0.013	7.426	0.081	
354	33	0	MH-7478	0	84.7	0	8	PVC	0.013	1.6467	30.363	
4179	MH-7477	0	1131	218.5	84.7	Min. Slope	8	PVC	0.013	4.4688	0.051	
5487	MH-7479	0	MH-7480	0	85	0	4	Vitrified Clay	0.013	0.7997	93.628	
261	21	0	MH-7481	0	85.5	0	6	PVC	0.013	2.6047	103.431	
3783	MH-7361	64.23	785	63.88	86.5	0.4	6	Vitrified Clay	0.013	6.0132	3.776	
6527	873	12	1321	10.4	205	0.78	8	Vitrified Clay	0.013	19.7526	4.123	SM 10
4143	MH-7483	0	323	0	87.1	0	6	PVC	0.013	0.6144	24.399	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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4494	1185	210.84	725	0	87.6	240.821	8	PVC	0.013	1.5319	0.018	
1656	MH-7330	90.02	560	89.67	87.8	0.4	6	Concrete	0.013	0.977	0.613	
4229	988	15.76	1141	10.23	87.9	6.291	12	PVC	0.013	164.2444	4.095	
1015	MH-7485	77.61	200	77.26	88	0.4	8	PVC	0.013	1.527	0.445	
1991	MH-7484	0	689	0	88	0	8	PVC	0.013	0.269	4.959	
251	MH-7486	0	MH-7487	0	88.2	0	6	PVC	0.013	1.3007	51.65	
4000	1077	0	W-Hamilton Heights	0	88.6	0	8	PVC	0.013	24.1577	445.432	
2060	MH-7397	15.18	MH-7488	14.82	88.6	0.4	6	PVC	0.013	4.8472	3.043	
7845	831	5	1395	4.64	89	0.4	8	Asbestos Cement	0.013	207.5928	60.521	
5010	1250	223.56	712	222.88	89.2	0.762	8	PVC	0.013	3.4979	0.739	
44	74	0	75	192.04	89.2	Min. Slope	8	PVC	0.013	0.5719	0.007	
2266	606	0	602	0	90	0	8	PVC	0.013	2.558	47.165	
946	MH-7489	0	185	197.59	89.7	Min. Slope	8	Asbestos Cement	0.013	1.0563	0.013	
4538	1195	34.7	1196	32.82	90.2	2.085	8	PVC	0.013	4.5961	0.587	
2110	394	237.31	402	235.19	88.3	2.401	8	PVC	0.013	2.9759	0.354	
6552	1326	41.17	MH-7490	0	90.8	45.317	8	PVC	0.013	0.4675	0.013	
3269	878	104.94	MH-7441	104.57	90.6	0.4	6	PVC	0.013	4.7303	2.97	
3773	317	0	316	0	90.6	0	8	Concrete	0.013	22.5206	415.246	
2238	MH-7260	230.38	668	230.02	91	0.4	6	Vitrified Clay	0.013	1.2594	0.791	
6528	1322	0	MH-7869	0	91.2	0	8	Concrete	0.013	27.6247	509.357	
355	MH-7492	0	33	0	91.5	0	8	PVC	0.013	0.7478	13.789	
1392	MH-7493	0	436	159.78	91.5	Min. Slope	6	Vitrified Clay	0.013	1.243	0.037	
3820	320	0	321	15.46	92.1	Min. Slope	8	PVC	0.013	8.0274	0.361	
6614	1327	144.9	654	0	92.3	156.909	8	PVC	0.013	0.2894	0.004	
907	258	14.57	66	17	92.5	Min. Slope	8	PVC	0.013	2.1229	0.242	
2246	MH-7494	222.6	670	222.23	92.8	0.4	6	PVC	0.013	2.0309	1.275	
4125	1118	0	MH-7405	0	93.6	0	8	PVC	0.013	1.1141	20.543	
4539	1196	32.82	703	0	93.7	35.041	8	PVC	0.013	4.8325	0.151	
1201	136	0	MH-7495	0	93.5	0	8	PVC	0.013	31.3454	577.962	
8089	1494	0	1422	0	93.9	0	8	PVC	0.013	0.4493	8.284	
4290	1108	0	1080	0	93.7	0	8	PVC	0.013	5.1082	94.187	
2634	919	9.29	984	8.31	93.9	1.044	18	PVC	0.013	147.8118	3.069	
7976	MH-7496	115.88	MH-7497	115.51	94.2	0.4	8		0.013	14.3516	4.184	
6334	MH-7498	72.91	382	72.53	94.2	0.4	6	PVC	0.013	0.6586	0.414	
2372	MH-7500	0	542	0	94.6	0	8	PVC	0.013	6.7663	124.761	
4612	MH-7499	0	1207	212.33	94.5	Min. Slope	8	PVC	0.013	0	0	
730	MH-7501	0	588	0	94.9	0	6	PVC	0.013	2.5895	102.829	
1896	MH-7502	37.42	360	37.04	95	0.4	8	PVC	0.013	0.8727	0.254	
2429	455	199.74	460	198.98	95	0.8	8	Asbestos Cement	0.013	186.6809	38.492	
2259	618	182.45	MH-7374	0	95.4	191.218	8	PVC	0.013	2.4512	0.033	
350	MH-7503	107.71	20	107.33	95.5	0.4	6	PVC	0.013	0.591	0.371	
4625	MH-7504	0	1208	224.51	95.6	Min. Slope	8	PVC	0.013	0.3032	0.004	

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SewerGEMS Results

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204	13	0	271	0	95.7	0	8	PVC	0.013	6.4713	119.321	
4362	1168	249.74	1167	249.1	95.9	0.667	8	PVC	0.013	1.0403	0.235	
7579	1350	260	1351	259.6	95.4	0.419	8	PVC	0.013	105.8584	30.151	
4802	MH-7505	0	MH-7449	0	96.7	0	8	PVC	0.013	0.6216	11.461	
2028	MH-7301	134.11	398	133.72	97	0.4	6	Vitrified Clay	0.013	2.7829	1.748	
5212	MH-7422	3.61	897	4	97	Min. Slope	6	Concrete	0.013	11.5316	7.241	
7601	1097	0	606	0	97.4	0	8	PVC	0.013	2.3775	43.837	
2180	551	65.68	558	65.29	97.7	0.4	6	Concrete	0.013	11.0494	6.936	
1062	1341	4.53	196	4.14	97.9	0.4	8	Asbestos Cement	0.013	12.6873	3.699	
6316	1306	227.09	1307	226.73	98.1	0.367	8	PVC	0.013	2.8221	0.859	
2164	MH-7497	115.51	MH-7507	115.11	98	0.4	6	Vitrified Clay	0.013	17.9147	11.25	
2333	641	127.77	644	127.38	98.4	0.4	8	PVC	0.013	12.1545	3.543	
4635	1215	237.3	213	236.33	152	0.638	15	PVC	0.013	484.5417	20.921	SM 2
2338	638	186.89	37	186.5	98.6	0.4	8	PVC	0.013	1.1085	0.323	
6263	1291	0	1290	0	99.1	0	8	PVC	0.013	1.045	19.269	
866	58	0	59	72.38	99.5	Min. Slope	8	PVC	0.013	1.2068	0.026	
2354	576	106.35	574	105.95	99.9	0.4	6	Concrete	0.013	5.7704	3.623	
2251	599	0	MH-7511	0	100.2	0	6	Concrete	0.013	23.4363	930.645	
426	MH-7509	0	87	142.64	100	Min. Slope	6	PVC	0.013	0.8575	0.029	
3887	MH-7510	69.74	333	69.34	100	0.4	8	PVC	0.013	0.9565	0.279	
1929	1067	186.17	770	175	100.5	11.111	8	PVC	0.013	2.5719	0.142	
812	251	0	249	24.53	100.4	Min. Slope	8	PVC	0.013	15.7107	0.586	
6538	MH-7514	0	MH-7424	0	100.7	0	8	PVC	0.013	0.5831	10.752	
160	MH-7515	109.13	11	108.73	100.8	0.4	6	PVC	0.013	0.4557	0.286	
1882	MH-7513	0	414	206.6	100.6	Min. Slope	8	PVC	0.013	0.4493	0.006	
2280	MH-7512	0	627	0	100.6	0	8	PVC	0.013	3.9428	72.699	
7886	MH-7375	0	609	134.8	101	Min. Slope	8	PVC	0.013	3.166	0.051	
5082	MH-7516	0	1256	63.14	100.9	Min. Slope	8	PVC	0.013	1.553	0.036	
1683	MH-7520	0	622	0	101.5	0	8	PVC	0.013	0.1805	3.328	
5609	1101	55.5	MH-7336	38.69	102.2	16.441	6	Vitrified Clay	0.013	9.0218	0.884	
1296	212	0	206	0	102.6	0	6	Vitrified Clay	0.013	10.3902	412.592	
3997	MH-7522	6.49	1076	6.08	102.5	0.4	6	Vitrified Clay	0.013	24.2231	15.209	
2255	MH-7521	171.84	632	128.73	102.4	42.106	6	PVC	0.013	12.4061	0.759	
775	511	0	516	0	102.9	0	8	PVC	0.013	21.5362	397.096	
5292	1275	0	380	148.98	103	Min. Slope	6	Concrete	0.013	3.4083	0.113	
4243	1146	0	MH-7527	0	102.9	0	8	PVC	0.013	0.6216	11.461	
2	MH-7528	0	477	147.39	103	Min. Slope	8	PVC	0.013	3.9196	0.06	
3111	841	0	80	0	103.4	0	8	PVC	0.013	3.7424	69.004	
3107	MH-7530	253.91	1065	253.49	104.1	0.4	8	PVC	0.013	2.8754	0.838	
2425	549	0	543	0	105.2	0	8	PVC	0.013	4.7869	88.263	
1160	157	123.66	158	118.13	105.6	5.237	8	Concrete	0.013	761.1854	61.33	
311	25	237.34	MH-7534	235.75	106	1.499	8	PVC	0.013	1.6072	0.242	

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SewerGEMS Results

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768	MH-7533	0	521	0	106	0	8	PVC	0.013	1.4635	26.984	
3094	MH-7472	22.7	246	22.6	106.9	0.094	18	Concrete	0.013	1,531.07	106.185	
2742	385	0	384	0	107.2	0	8	PVC	0.013	7.3075	134.74	
3065	833	245.19	834	244.54	107.3	0.606	8	PVC	0.013	126.2943	29.925	
4053	MH-7535	97.17	1094	96.74	107	0.4	8	PVC	0.013	0.2582	0.075	
7591	1360	255.1	1415	254.57	107.4	0.498	8	PVC	0.013	109.5168	28.613	
8086	1493	0	1421	78.12	107.6	Min. Slope	8	PVC	0.013	0.0959	0.002	
2783	MH-7540	0	491	95.78	108.1	Min. Slope	8	Vitrified Clay	0.013	5.3114	0.104	
3928	1120	12.76	1121	12.47	107.9	0.269	30	PVC	0.013	4,200.77	44.01	
2349	MH-7539	135.6	614	135.17	108.1	0.4	6	Vitrified Clay	0.013	0.3349	0.21	
2103	MH-7541	0	387	247.06	108.7	Min. Slope	8	PVC	0.013	1.5322	0.019	
2027	398	133.72	655	133.28	108.8	0.4	6	Vitrified Clay	0.013	6.2263	3.91	
8052	1410	0.26	MH-7870	-0.18	109	0.4	6	Vitrified Clay	0.013	7.1275	4.475	
2626	708	0	707	0	109.2	0	8	PVC	0.013	3.0773	56.741	
4605	MH-7542	0	MH-7543	0	109.4	0	6	PVC	0.013	0.2582	10.253	
1286	MH-7545	0	203	229.22	110.4	Min. Slope	8	PVC	0.013	0.7333	0.009	
2128	MH-7546	0	453	0	110.5	0	6	PVC	0.013	1.5016	59.628	
7596	MH-7547	0	1304	227.84	110.5	Min. Slope	8	PVC	0.013	1.5364	0.02	
6308	1304	227.84	MH-7548	0	110.5	206.19	8	PVC	0.013	2.6618	0.034	
3033	811	8.83	813	8.38	111.1	0.4	8	PVC	0.013	22.1841	6.466	
3470	926	11.48	990	11.09	111.1	0.351	8	Asbestos Cement	0.013	49.3272	15.354	
7599	636	185.87	637	172.86	110.8	11.738	8	PVC	0.013	9.2199	0.496	
2101	758	249.26	760	248.56	112	0.625	8	PVC	0.013	17.0777	3.983	
763	MH-7455	0	607	0	111.9	0	6	PVC	0.013	0.5674	22.531	
7841	MH-7549	0	327	0	111.9	0	8	PVC	0.013	1.8821	34.703	
4692	MH-7550	0	977	35.66	113	Min. Slope	8	PVC	0.013	1.5694	0.052	
2627	MH-7551	0	708	0	113.2	0	8	PVC	0.013	2.7163	50.085	
4946	1246	72.64	1245	63.94	113.3	7.675	8	PVC	0.013	1.6252	0.108	
7595	416	231.45	MH-7552	230.12	113.5	1.172	8	PVC	0.013	10.1795	1.734	
5997	11	108.73	1282	107.78	114.3	0.83	6	Concrete	0.013	1.1979	0.522	
516	753	250.23	756	249.53	114.5	0.611	8	PVC	0.013	15.6972	3.702	
3288	996	0	MH-7553	0	114.7	0	8	PVC	0.013	0.8321	15.343	
3780	MH-7554	0	306	0	115.1	0	6	PVC	0.013	1.619	64.29	
5317	1277	116.83	1198	105.51	115.2	9.825	6	Vitrified Clay	0.013	1.4108	0.179	
2489	784	1.09	793	0.89	116.5	0.17	18	PVC	0.01	889.5539	35.203	
7370	652	162	MH-7555	161.53	116.3	0.4	6	Vitrified Clay	0.013	4.6977	2.95	
2182	1278	66.48	553	66.01	116.4	0.4	8	Concrete	0.013	10.8146	3.153	
54	46	0	546	0	116.9	0	6	PVC	0.013	0.7692	30.544	
2479	1069	15.16	1068	14.95	116.7	0.18	30	PVC	0.013	4,185.21	53.583	
1176	118	216.24	117	216.39	116.8	Min. Slope	8	PVC	0.013	10.5935	5.449	
3118	842	7.39	247	6.92	117.1	0.4	8	PVC	0.013	7.1977	2.099	
4610	1210	212.28	1207	212.33	117.2	Min. Slope	8	PVC	0.013	1.7152	1.531	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
6	MH-7556	0	838	207.93	117.2	Min. Slope	8	Asbestos Cement	0.013	0.7701	0.011	
72	MH-7557	109.2	11	108.73	117.3	0.4	6	PVC	0.013	0.6248	0.392	
1750	MH-7558	0	408	232.78	117.7	Min. Slope	6	PVC	0.013	2.4654	0.07	
4846	1238	149.74	MH-7438	149.27	117.6	0.4	6	Vitrified Clay	0.013	2.4772	1.555	
1140	108	0	109	0	117.9	0	8	Concrete	0.013	1.051	19.379	
2635	1051	8.54	919	9.29	118.1	Min. Slope	18	PVC	0.013	147.5536	3.928	
1964	27	0	MH-7552	0	118.5	0	8	PVC	0.013	1.0573	19.495	
7491	619	0	MH-7559	0	118.8	0	8	PVC	0.013	5.2772	97.304	
2066	563	65.25	566	41.54	119	19.927	8	Concrete	0.013	11.8593	0.49	
441	88	218.26	177	217.98	119.5	0.234	8	Concrete	0.013	196.9159	75.01	
3657	997	17.52	995	16.65	119.5	0.728	12	Asbestos Cement	0.013	163.5964	11.99	
1413	MH-7560	29.26	780	28.78	119.4	0.4	8	PVC	0.013	0.3826	0.112	
7858	1398	59.2	MH-7562	0	120.1	49.289	8	PVC	0.013	2.0735	0.054	
2082	425	0	426	178.41	119.9	Min. Slope	8	PVC	0.013	3.3929	0.051	
1928	MH-7561	0	770	175	120	Min. Slope	8	PVC	0.013	1.333	0.02	
6551	MH-7563	0	1326	41.17	119.7	Min. Slope	8	PVC	0.013	0.3228	0.01	
1802	MH-7564	0	450	0	120.3	0	8	PVC	0.013	1.4292	26.353	
4458	1181	27.15	1179	25.69	120.7	1.21	8	PVC	0.013	2.3009	0.386	
4156	1122	0	587	0	120.7	0	8	PVC	0.013	1.1866	21.879	
1262	126	137.95	125	0	120.9	114.073	8	PVC	0.013	14.8964	0.257	
3437	916	0	976	0	121.1	0	8	Asbestos Cement	0.013	1.5564	28.698	
668	338	61.59	339	61.11	120.9	0.4	8	PVC	0.013	4.8441	1.412	
2228	745	0	750	0	121.2	0	8	Concrete	0.013	0.7639	14.085	
4824	MH-7565	244.55	1235	244.06	121.2	0.4	6	PVC	0.013	0.5973	0.375	
2295	1297	0	428	227.99	121.7	Min. Slope	8	PVC	0.013	21.8939	0.295	
2063	696	75.81	MH-7566	75.32	121.7	0.4	6	Vitrified Clay	0.013	4.9486	3.107	
4043	1279	6.1	893	5.61	121.6	0.4	8	PVC	0.013	15.3369	4.471	
4361	MH-7567	0	1168	249.74	121.9	Min. Slope	8	PVC	0.013	0.591	0.008	
4261	MH-7569	0	916	0	122.3	0	6	PVC	0.013	1.3618	54.076	
879	MH-7568	0	918	13.84	122	Min. Slope	6	PVC	0.013	0.7625	0.09	
4765	1231	228.5	1230	228.5	122.6	0	8	PVC	0.013	1.4439	26.623	
7770	1385	3.22	MH-7570	2.85	131.5	0.28	10	Vitrified Clay	0.013	50.7957	9.763	
2340	MH-7572	173.35	637	172.86	122.8	0.4	6	Vitrified Clay	0.013	0.9015	0.566	
3014	MH-7571	100.93	1119	100.44	122.5	0.4	6	PVC	0.013	0.7086	0.445	
911	64	16.22	1087	16.07	122.6	0.122	30	PVC	0.013	4,146.65	64.399	
6430	MH-7573	0	1311	214.57	123	Min. Slope	8	PVC	0.013	0.4493	0.006	
2480	1068	14.95	687	14.79	122.9	0.13	30	PVC	0.013	4,186.39	63.039	
6670	MH-7444	0	542	0	123.5	0	8	PVC	0.013	1.6008	29.517	
6261	419	200.5	1249	174.61	123.6	20.952	8	PVC	0.013	108.5139	4.371	
4607	1204	0	487	84.9	123.6	Min. Slope	8	PVC	0.013	156.506	3.482	
4115	1106	244.91	1107	0	124.1	197.288	8	PVC	0.013	2.6927	0.035	
514	755	0	757	0	125	0	8	PVC	0.013	18.9186	348.83	

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4766	1230	228.5	1229	222.79	126	4.534	8	PVC	0.013	3.9275	0.34	
1257	197	4.72	198	4.21	126	0.4	6	PVC	0.013	0.1918	0.12	
3703	956	25.36	955	20.78	125.7	3.643	8	Asbestos Cement	0.013	18.4713	1.784	
3888	333	69.34	334	62.6	126.3	5.338	8	PVC	0.013	1.8291	0.146	
748	602	0	MH-7577	0	126.5	0	8	PVC	0.013	2.7385	50.493	
3934	517	27.4	262	24.37	126.2	2.401	8	PVC	0.013	13.0652	1.555	
4971	1247	0	912	61.79	126.6	Min. Slope	8	PVC	0.013	0.3892	0.01	
202	MH-7578	0	12	0	126.7	0	8	PVC	0.013	0.1447	2.668	
4521	1190	25.25	MH-7569	0	127.2	19.852	6	PVC	0.013	0.8375	0.075	
1369	MH-7436	85.76	1334	85.25	127	0.4	6	Vitrified Clay	0.013	1.5216	0.955	
3896	347	56.18	335	55.74	127.1	0.346	10	PVC	0.013	32.7156	5.655	
4170	1127	0	806	235.67	127	Min. Slope	8	PVC	0.013	2.5286	0.034	
4503	MH-7579	0	MH-7580	0	127.1	0	8	PVC	0.013	0.1447	2.668	
1702	MH-7581	0	715	234.08	127.3	Min. Slope	8	PVC	0.013	0.6038	0.008	
3509	MH-7582	0	1056	0	127.9	0	8	PVC	0.013	2.5362	46.764	
624	MH-7583	0	552	0	128	0	8	Asbestos Cement	0.013	2.3612	43.536	
2174	MH-7566	75.32	603	74.81	128.5	0.4	6	Vitrified Clay	0.013	6.8589	4.306	
1401	MH-7584	0	503	0	135.8	0	6	PVC	0.013	1.0685	42.428	
1120	199	1.93	86	1.41	128.7	0.4	8	Asbestos Cement	0.013	15.522	4.526	
5038	MH-7585	106.9	1276	106.39	128.9	0.4	6	PVC	0.013	0.2865	0.18	
3149	363	21.95	227	21.99	128.6	Min. Slope	18	Concrete	0.013	1,566.80	188.416	
2784	492	83.53	494	76.41	129.2	5.509	8	PVC	0.013	3.7295	0.293	
7560	1346	9.34	811	8.83	129.6	0.4	8	PVC	0.013	11.5476	3.367	
1289	MH-7586	0	204	231.18	129.7	Min. Slope	8	PVC	0.013	0.6216	0.009	
7817	1391	123.2	1390	121.8	129.7	1.08	8	PVC	0.013	0.5164	0.092	
1301	210	232.83	204	231.18	247.7	0.666	15	PVC	0.013	502.0371	21.217	SM 2
4162	MH-7588	62.72	1124	62.2	130.3	0.4	6	PVC	0.013	0.3439	0.216	
6545	MH-7587	0	1325	0	130	0	6	PVC	0.013	2.0062	79.666	
2621	706	0	705	0	130.1	0	8	PVC	0.013	2.1393	39.446	
45	75	0	76	168.11	130.7	Min. Slope	8	PVC	0.013	0.7524	0.012	
2004	MH-7589	0	458	192.87	130.4	Min. Slope	6	Asbestos Cement	0.013	2.2845	0.075	
1172	107	0	116	0	131.5	0	8	Concrete	0.013	4.6255	85.288	
2810	723	215.47	726	210.79	131.5	3.56	8	PVC	0.013	6.6881	0.654	
4972	MH-7590	0	1247	0	131.5	0	8	PVC	0.013	0.1946	3.588	
867	59	0	60	62.37	131.3	Min. Slope	8	PVC	0.013	4.0647	0.109	
7684	1378	238.6	1215	237.3	336.7	0.386	15	PVC	0.013	452.8606	25.137	SM 2
3439	967	32.63	966	29.62	131.4	2.29	8	PVC	0.013	2.361	0.288	
8072	1419	0	1267	242.47	132	Min. Slope	6	PVC	0.013	0.6216	0.018	
4079	378	0	425	0	132.1	0	8	PVC	0.013	2.0933	38.597	
1329	236	90.87	237	90.34	132.6	0.4	8	PVC	0.013	4.8415	1.412	
3764	MH-7592	0	297	0	132.7	0	6	PVC	0.013	1.8368	72.937	
1635	MH-7591	208.51	669	207.98	132.6	0.4	6	PVC	0.013	0.9265	0.582	

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3682	989	6.99	987	5.97	132.7	0.769	18	PVC	0.013	52.5711	1.272	
4174	1128	203.1	415	205.41	133.1	Min. Slope	8	PVC	0.013	33.0918	4.632	
1258	185	197.59	186	193	133.4	3.44	8	Asbestos Cement	0.013	86.4006	8.589	
1199	183	202.43	185	197.59	133.5	3.624	8	Asbestos Cement	0.013	46.4477	4.499	
430	MH-7593	0	791	100	133.2	Min. Slope	8	PVC	0.013	1.0366	0.022	
2592	702	0	701	25.64	133.2	Min. Slope	8	PVC	0.013	7.2429	0.304	
1292	MH-7594	0	212	0	133.8	0	6	PVC	0.013	8.0378	319.178	
4004	1083	0	1082	0	133.6	0	8	PVC	0.013	11.7782	217.172	
4372	MH-7562	0	1169	56.98	134.1	Min. Slope	8	PVC	0.013	2.4559	0.069	
1332	243	91.4	236	90.87	134.3	0.395	8	PVC	0.013	2.6241	0.77	
2368	903	22.8	529	22.09	133.9	0.53	10	Asbestos Cement	0.013	620.5912	86.672	
4639	1220	96.8	1221	82.2	133.9	10.903	8	PVC	0.013	3.34	0.187	
1436	MH-7595	0	721	205.4	134	Min. Slope	8	PVC	0.013	0.4493	0.007	
7661	1253	0	MH-7596	0	134.4	0	8	PVC	0.013	2.3193	42.764	
4097	1447	68.68	411	68.14	134.4	0.4	6	PVC	0.013	0.3163	0.199	
4044	893	5.61	871	5.07	134.5	0.4	6	Concrete	0.013	19.0395	11.954	
3797	322	0	321	15.36	134.4	Min. Slope	8	PVC	0.013	16.229	0.885	
1336	MH-7597	91.95	243	91.4	135.6	0.406	6	PVC	0.013	1.8315	1.142	
3892	352	74.2	351	73.66	134.5	0.4	8	PVC	0.013	23.4135	6.827	
211	MH-7598	93.15	1093	92.61	135	0.4	8	PVC	0.013	2.171	0.633	
3122	904	23.82	262	23.71	135.2	0.081	18	Concrete	0.013	1,474.15	109.622	
2127	486	98.91	1204	84.9	135.2	10.365	8	PVC	0.013	155.1101	8.883	
2553	692	0	691	116.38	135.5	Min. Slope	8	PVC	0.013	3.6166	0.072	
415	MH-7599	0	93	204.2	135.7	Min. Slope	6	Concrete	0.013	2.3249	0.075	
1711	374	0	654	0	135.7	0	8	PVC	0.013	5.42	99.936	
6242	1287	0	211	233.2	135.6	Min. Slope	8		0.013	3.4053	0.048	
7806	1386	204.68	1067	186.17	136	13.61	8	PVC	0.013	0.9312	0.047	
2785	18	109.67	MH-7540	0	136	80.635	8	PVC	0.013	4.6088	0.095	
912	69	16.38	64	16.22	136.3	0.117	30	Concrete	0.013	4,146.26	65.745	
3012	806	235.67	85	234.13	136.1	1.131	8	PVC	0.013	4.6613	0.808	
807	514	0	520	0	136.5	0	8	PVC	0.013	6.3963	117.939	
3784	382	72.53	MH-7360	64.36	136.4	5.987	6	Vitrified Clay	0.013	5.7784	0.938	
1163	1339	227.86	176	223.4	136.6	3.264	8	PVC	0.013	147.1933	15.023	
2809	724	218.49	723	215.47	136.2	2.217	8	PVC	0.013	4.8282	0.598	
517	417	202.86	419	200.5	136.9	1.724	8	PVC	0.013	108.0646	15.176	
2801	MH-7601	0	435	0	136.6	0	6	PVC	0.013	1.2909	51.26	
2371	228	0	529	22.09	136.9	Min. Slope	8	PVC	0.013	2.2819	0.105	
4076	1095	55.55	336	55	137.7	0.4	8	PVC	0.013	3.8956	1.136	
6024	1283	253.1	1060	248.38	137.9	3.423	8	PVC	0.013	2.5187	0.251	
1974	727	219.47	431	218.45	146.3	0.697	8	PVC	0.013	127.3564	28.119	
2151	503	0	248	24.9	137.7	Min. Slope	8	Asbestos Cement	0.013	2.2591	0.098	
6262	1292	0	441	174.03	137.8	Min. Slope	8	PVC	0.013	3.5214	0.058	

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2032	80	0	81	0	138.2	0	8	PVC	0.013	5.5307	101.979	
6297	MH-7602	0	807	0	138	0	6	PVC	0.013	1.328	52.734	
6433	1313	212.57	MH-7389	0	138.1	153.953	8	PVC	0.013	1.7972	0.027	
595	50	0	35	205.6	138.5	Min. Slope	8	PVC	0.013	5.439	0.082	
3442	MH-7603	0	963	16.79	138.5	Min. Slope	6	PVC	0.013	0.8858	0.101	
5291	1274	43.5	364	33.4	138.6	7.29	6	Vitrified Clay	0.013	6.4429	0.948	
4336	MH-7604	0	1159	34.13	138.8	Min. Slope	8	PVC	0.013	0.2364	0.009	
902	62	0	617	254.05	138.6	Min. Slope	8	PVC	0.013	0.652	0.009	
1977	375	232.16	371	231.48	139.1	0.489	8	PVC	0.013	1.7082	0.45	
4638	1221	82.2	941	61	139	15.247	8	PVC	0.013	3.5982	0.17	
7066	624	0	1325	0	139.4	0	6	Concrete	0.013	2.1421	85.063	
2191	528	0	363	0	140.1	0	6	Concrete	0.013	34.2877	1,361.55	
2625	707	0	689	0	140.2	0	8	PVC	0.013	3.5822	66.049	
7121	175	232.45	1339	227.86	140.6	3.265	8	PVC	0.013	145.2565	14.823	
3788	MH-7607	0	313	0	140.6	0	6	Concrete	0.013	1.4421	57.265	
4615	1206	202.4	MH-7462	0	140.6	143.905	8	PVC	0.013	8.8469	0.136	
809	520	0	524	0	140.6	0	8	PVC	0.013	8.5369	157.408	
3400	MH-7606	0	949	37.79	140.4	Min. Slope	8	PVC	0.013	0.8222	0.029	
2274	MH-7610	0	MH-7323	0	140.9	0	6	Concrete	0.013	13.0733	519.137	
1210	194	33.76	195	33.2	141	0.4	8	PVC	0.013	7.2097	2.102	
3260	877	162.38	882	71.71	141	64.326	6	Vitrified Clay	0.013	53.011	2.625	
1433	MH-7608	51.18	778	50.62	140.7	0.4	8	PVC	0.013	0.918	0.268	
1876	1123	52.04	496	37.5	141.2	10.298	6	PVC	0.013	1.0957	0.136	
2350	MH-7609	135.73	614	135.17	140.8	0.4	6	Vitrified Clay	0.013	0.9485	0.596	
1379	MH-7548	0	369	219.22	141.4	Min. Slope	8	PVC	0.013	4.2448	0.063	
4495	MH-7611	0	1185	210.84	141.4	Min. Slope	8	PVC	0.013	0.9281	0.014	
6613	MH-7612	0	1327	144.9	141.8	Min. Slope	8	PVC	0.013	0.1447	0.003	
8081	1420	237.45	1288	0	142	167.169	8	PVC	0.013	1.2432	0.018	
2057	1328	3.62	1385	3.22	141.8	0.28	10	Vitrified Clay	0.013	50.6783	9.739	
6435	1314	207.55	1316	204.4	141.7	2.223	8	PVC	0.013	4.5259	0.56	
6340	1308	0	584	0	142.1	0	8	PVC	0.013	1.3638	25.146	
2241	666	254.78	668	230.02	143.3	17.283	6	Vitrified Clay	0.013	3.7437	0.358	
751	MH-7613	0	572	0	143	0	6	PVC	0.013	1.3085	51.962	
2552	691	0	580	0	143.2	0	8	Concrete	0.013	5.97	110.078	
2613	1213	50.37	704	28.34	143.6	15.344	8	PVC	0.013	3.5335	0.166	
4550	1198	105.51	878	104.94	143.7	0.4	6	Vitrified Clay	0.013	2.5441	1.597	
3614	939	0	940	31.03	143.9	Min. Slope	8	PVC	0.013	5.9759	0.237	
489	756	249.53	758	249.26	145	0.186	8	PVC	0.013	16.3311	6.978	
4502	MH-7580	0	12	0	144.5	0	8	PVC	0.013	0.2894	5.336	
4518	397	106.81	MH-7277	95.28	145	7.954	6	Vitrified Clay	0.013	3.0245	0.426	
2281	627	0	384	0	144.8	0	8	PVC	0.013	5.191	95.714	
2119	434	0	441	174.03	145.5	Min. Slope	8	PVC	0.013	111.9336	1.887	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
2184	560	89.67	555	83.23	145.6	4.424	6	Concrete	0.013	1.0944	0.207	
4999	MH-7615	0	1248	0	145.7	0	8	PVC	0.013	1.043	19.231	
3119	360	29.36	361	28.78	145.8	0.4	8	PVC	0.013	3.3374	0.973	
6292	1299	0	840	201.29	145.6	Min. Slope	8	PVC	0.013	12.6156	0.198	
4700	1223	253.1	1222	245.52	146.1	5.189	8	PVC	0.013	1.3156	0.106	
1145	121	178.65	122	177.84	146	0.555	8	Concrete	0.013	1.3919	0.345	
2051	1381	2.49	764	1.9	148.4	0.4	6	Concrete	0.013	1.6396	1.03	
3438	966	29.62	968	27.14	146	1.699	8	PVC	0.013	4.3787	0.619	
749	MH-7577	0	591	0	146.6	0	4	Asbestos Cement	0.013	4.4228	517.803	
2419	587	0	588	0	146.2	0	6	Concrete	0.013	2.1338	84.73	
3630	974	0	973	27.56	146.2	Min. Slope	8	PVC	0.013	0.8452	0.036	
7589	1362	250.5	1363	249.9	146.3	0.41	8	PVC	0.013	111.3816	32.066	
2279	539	0	538	0	146.3	0	8	PVC	0.013	8.9587	165.185	
2847	800	255.05	802	251.55	146.5	2.389	8	PVC	0.013	5.879	0.701	
6077	1248	0	1284	0	146.9	0	8	PVC	0.013	3.0656	56.526	
2230	749	0	748	0	146.9	0	8	Concrete	0.013	0.9648	17.79	
164	MH-7511	0	589	0	147	0	8	PVC	0.013	24.4536	450.888	
3139	543	20.59	905	20.22	147	0.252	8	Asbestos Cement	0.013	6.0294	2.216	
2293	412	232.96	410	232.39	146.7	0.388	8	PVC	0.013	8.007	2.369	
2248	MH-7559	0	615	0	146.8	0	8	Concrete	0.013	5.9594	109.883	
260	MH-7487	0	21	0	146.9	0	8	PVC	0.013	2.3683	43.668	
7464	MH-7616	0	486	98.91	147	Min. Slope	8	PVC	0.013	0.9354	0.021	
1994	MH-7617	0	506	0	147	0	8	PVC	0.013	1.0452	19.273	
2448	MH-7555	161.53	658	160.95	147.2	0.4	6	Vitrified Clay	0.013	5.4822	3.442	
838	MH-7618	0	701	25.64	147.8	Min. Slope	6	PVC	0.013	1.3931	0.133	
5072	MH-7351	0	549	0	147.9	0	8	PVC	0.013	1.3425	24.754	
1350	743	0	311	0	147.5	0	8	Concrete	0.013	1.0293	18.978	
2306	433	0	432	219.23	147.6	Min. Slope	8	Asbestos Cement	0.013	0.6038	0.009	
2084	379	0	1275	148.98	148.3	Min. Slope	6	Concrete	0.013	1.2929	0.051	
2983	754	0	802	251.55	148.3	Min. Slope	8	PVC	0.013	1.6277	0.023	
1765	MH-7619	0	464	0	148	0	6	PVC	0.013	0.7238	28.742	
1198	181	207.93	183	202.43	148.4	3.705	8	Asbestos Cement	0.013	6.4171	0.615	
2146	361	28.78	842	14.96	148.9	9.284	8	PVC	0.013	3.6275	0.22	
1256	196	4.14	201	3.54	148.8	0.4	8	Asbestos Cement	0.013	12.7832	3.727	
509	MH-7349	1.75	792	1.42	148.6	0.22	12	Vitrified Clay	0.013	77.7764	10.368	
6953	788	0	1058	198.66	148.6	Min. Slope	8	Asbestos Cement	0.013	11.7951	0.188	
5424	1150	0	1333	0	149	0	6	Concrete	0.013	2.7766	110.257	
4118	MH-7620	0	1105	260.05	149.1	Min. Slope	8	PVC	0.013	0.1417	0.002	
1330	237	90.33	238	89.74	148.6	0.4	8	PVC	0.013	7.0023	2.041	
1138	133	165.9	132	0	149.1	111.233	8	Concrete	0.013	145.5871	2.545	
2474	MH-7622	0	789	209.04	149.6	Min. Slope	8	PVC	0.013	1.6883	0.026	
1367	MH-7624	118.84	1239	118.24	149.7	0.4	6	Vitrified Clay	0.013	3.0837	1.936	

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3551	920	21.72	1001	21.3	149.5	0.281	10	Asbestos Cement	0.013	77.8746	14.944	
5018	MH-7623	62.8	1124	62.2	149.7	0.4	6	PVC	0.013	0.1743	0.109	
2337	633	187.49	638	186.89	150.2	0.4	6	PVC	0.013	1.0394	0.653	
2250	MH-7625	0	589	0	150	0	6	Concrete	0.013	1.1304	44.889	
630	MH-7626	0	MH-7400	0	150.5	0	6	PVC	0.013	1.3744	54.576	
3966	208	235.01	211	233.2	342.9	0.528	15	PVC	0.013	496.9947	23.596	SM 2
4444	MH-7337	38.59	MH-7469	11.98	152	17.505	6	Vitrified Clay	0.013	14.8344	1.408	
3829	327	0	294	0	152.2	0	8	PVC	0.013	9.2454	170.471	
3362	913	30.43	942	30.16	152.2	0.177	12	PVC	0.013	95.4529	14.172	
973	MH-7629	0	137	0	151.9	0	6	Asbestos Cement	0.013	1.7189	68.255	
798	MH-7534	235.75	790	235.75	152.4	0	8	PVC	0.013	4.357	80.336	
3819	326	0	319	24.41	152	Min. Slope	8	PVC	0.013	1.5761	0.073	
1144	105	195.1	111	181.73	153.2	8.728	8	Concrete	0.013	1.3634	0.085	
4225	1142	10.62	1141	10.23	152.7	0.255	30	PVC	0.013	4,229.89	45.464	
5881	1281	0	124	191.96	153	Min. Slope	8	PVC	0.013	0.8169	0.013	
6341	MH-7630	0	1308	0	153.4	0	8	PVC	0.013	0.3869	7.134	
1010	89	76.98	194	76.37	153.6	0.4	8	PVC	0.013	3.7475	1.093	
4461	1179	25.69	1178	23.98	153.4	1.115	8	PVC	0.013	4.0788	0.712	
7	838	0	839	0	153.9	0	8	PVC	0.013	29.4476	542.969	
2249	610	0	615	0	154	0	6	Concrete	0.013	1.494	59.326	
3542	957	35.19	956	25.36	153.7	6.394	8	Asbestos Cement	0.013	16.9019	1.232	
623	MH-7631	9.66	762	9.04	153.9	0.4	8	PVC	0.013	10.4447	3.045	
4451	MH-7632	0	1177	111.73	154.1	Min. Slope	8	PVC	0.013	1.243	0.027	
2160	MH-7253	65.64	650	65.03	154.7	0.4	6	Vitrified Clay	0.013	1.2327	0.774	
2414	MH-7633	0	526	0	154.5	0	8	PVC	0.013	2.7469	50.649	
4099	MH-7634	68.76	411	68.14	154.7	0.4	6	PVC	0.013	0.0959	0.06	
4586	MH-7635	169.77	1201	169.15	155	0.4	6	PVC	0.013	0.3204	0.201	
203	12	0	13	0	155.4	0	8	PVC	0.013	1.6475	30.377	
805	550	0	545	0	155.3	0	8	PVC	0.013	4.3902	80.948	
3123	733	202.85	788	198.66	155.2	2.7	8	Asbestos Cement	0.013	7.9816	0.896	
7819	1389	120.3	1388	119.5	156.1	0.512	8	PVC	0.013	1.0328	0.266	
4443	MH-7636	0	MH-7419	0	156.2	0	6	PVC	0.013	1.4396	57.165	
439	145	150.77	146	148.88	156.3	1.209	8	Concrete	0.013	1.0344	0.173	
4236	700	164.16	1144	158.3	156.5	3.744	6	Vitrified Clay	0.013	1.4685	0.301	
1131	91	0	92	205.7	157.1	Min. Slope	8	Concrete	0.013	0.72	0.012	
120	37	186.5	636	185.87	157.2	0.4	8	PVC	0.013	2.7886	0.813	
2286	562	0	557	0	157.8	0	8	PVC	0.013	1.2169	22.437	
3681	1050	60.71	946	60.11	157.3	0.381	8	PVC	0.013	4.2307	1.263	
7586	1351	259.6	1357	258.8	157.6	0.508	8	PVC	0.013	106.4622	27.552	
4767	1229	222.79	1212	204	158	11.896	8	PVC	0.013	4.4347	0.237	
2798	435	0	235	0	158.6	0	8	PVC	0.013	1.9102	35.222	
2215	MH-7637	61.09	1234	60.46	158.5	0.4	6	Vitrified Clay	0.013	17.714	11.122	

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5192	1267	242.47	1266	240.91	159.2	0.98	8	PVC	0.013	129.4023	24.102	
3227	871	5.07	900	4.44	159.1	0.4	6	Concrete	0.013	19.1086	11.998	
1147	122	177.84	127	176.8	244.8	0.425	15	PVC	0.013	587.3245	31.079	SM 3
518	415	205.41	417	202.86	160	1.594	8	PVC	0.013	107.6153	15.718	
2229	598	0	747	0	159.6	0	6	Concrete	0.013	0.6708	26.635	
25	MH-7402	0	44	224.58	160.4	Min. Slope	6	PVC	0.013	1.3516	0.045	
6240	1289	0	1288	0	160	0	8		0.013	0.9189	16.943	
1710	MH-7638	0	374	0	160	0	6	PVC	0.013	0.8229	32.676	
7081	801	0	753	250.23	160.9	Min. Slope	8	PVC	0.013	4.1541	0.061	
989	MH-7639	0	182	209.5	160.9	Min. Slope	8	PVC	0.013	1.3078	0.021	
3159	225	33.31	226	32.76	161.5	0.34	12	Asbestos Cement	0.013	9.4886	1.017	
1202	MH-7495	0	184	0	161.4	0	8	PVC	0.013	36.2755	668.865	
360	MH-7641	0	34	248.19	161.6	Min. Slope	8	PVC	0.013	1.1125	0.017	
3599	MH-7640	0	265	0	161.5	0	6	PVC	0.013	1.8687	74.203	
3471	980	11.89	926	11.48	162.3	0.253	8	Asbestos Cement	0.013	42.1467	15.46	
1721	MH-7643	0	420	204.32	162.4	Min. Slope	6	PVC	0.013	2.1099	0.075	
2827	714	229.99	715	229.22	162	0.475	8	PVC	0.013	120.4948	32.226	
3249	MH-7442	74.78	884	74.13	162.1	0.4	6	Vitrified Clay	0.013	5.6031	3.518	
2807	716	215.84	719	215.05	162.6	0.486	8	PVC	0.013	271.8975	71.933	
27	44	0	45	222.17	162.4	Min. Slope	8	PVC	0.013	2.5592	0.04	
2362	MH-7644	0	MH-7871	0	169.1	0	6	PVC	0.013	1.6171	64.213	
4001	1082	0	1077	0	164.5	0	8	PVC	0.013	12.0318	221.848	
917	66	17	67	16.7	164.1	0.183	30	PVC	0.013	4,092.22	51.999	
7585	1348	263.2	1356	262.1	164.7	0.668	8	PVC	0.013	104.047	23.474	
1072	198	4.21	201	3.54	167.6	0.4	6	PVC	0.013	0.2877	0.181	
4460	MH-7648	0	1180	34.8	164.8	Min. Slope	1	PVC	0.013	0.2364	2.428	
2307	432	219.23	431	218.45	164.8	0.473	8	Asbestos Cement	0.013	12.1446	3.255	
1180	112	197.86	114	194.7	164.8	1.917	8	Concrete	0.013	259.8057	34.598	
3195	865	0.69	1408	0.03	165.2	0.4	8	PVC	0.013	2.6723	0.78	
4157	MH-7650	0	1122	0	165.8	0	8	PVC	0.013	1.0061	18.551	
1847	MH-7649	0	420	204.32	165.3	Min. Slope	6	PVC	0.013	0.5627	0.02	
1269	186	193	187	186.1	165.8	4.161	8	Concrete	0.013	94.7467	8.564	
2070	MH-7651	240.05	78	239.39	166	0.4	8	PVC	0.013	1.0711	0.312	
2292	534	0	533	0	165.5	0	8	PVC	0.013	23.5392	434.028	
1158	149	156.42	147	148.49	165.6	4.789	8	Concrete	0.013	1.2998	0.11	
3121	248	24.9	901	24.5	165.9	0.241	18	Concrete	0.013	1,471.10	63.551	
2114	401	234.64	404	234.07	166.3	0.343	8	PVC	0.013	63.7087	20.068	
2620	705	0	549	0	165.8	0	8	PVC	0.013	2.9969	55.258	
2466	629	132.17	630	142.13	166.2	Min. Slope	6	Vitrified Clay	0.013	4.3278	0.702	
5191	1268	243.27	1267	242.47	166.6	0.48	8	PVC	0.013	128.1591	34.105	
4416	1284	0	1176	179	166.7	Min. Slope	8	PVC	0.013	4.9101	0.087	
2741	626	0	385	0	166.3	0	8	PVC	0.013	5.0748	93.572	

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7982	494	76.41	1400	48.54	166.9	16.703	8	PVC	0.013	5.5092	0.249	
513	791	100	779	49.54	166.9	30.226	8	PVC	0.013	4.0338	0.135	
2297	445	210.15	444	209.12	166.7	0.618	8	PVC	0.013	27.1568	6.371	
2970	797	0	798	0	167.2	0	8	PVC	0.013	9.238	170.335	
6118	1286	26.17	947	22.22	167.9	2.352	8	PVC	0.013	97.1947	11.685	
2328	656	126.67	660	126	167.7	0.4	8	PVC	0.013	39.1975	11.427	
3019	MH-7652	77.74	822	77.07	168	0.4	6	PVC	0.013	1.7926	1.125	
4139	MH-7653	0	26	0	168.3	0	8	PVC	0.013	1.6587	30.583	
1189	155	130.39	159	117.39	168.6	7.712	8	Concrete	0.013	276.0876	18.332	
6887	711	230.34	1337	222.88	169	4.414	8	PVC	0.013	258.5448	22.69	
402	MH-7655	0	1115	0	169.2	0	8	PVC	0.013	1.3007	23.983	
4238	MH-7654	0	1145	0	168.8	0	6	PVC	0.013	0.8619	34.224	
2108	400	0	401	236.76	168.9	Min. Slope	8	PVC	0.013	25.6494	0.399	
5024	1252	0	1253	0	169.6	0	8	PVC	0.013	1.87	34.479	
4487	1184	0	713	231.68	169.2	Min. Slope	8	PVC	0.013	2.7492	0.043	
3615	942	30.16	1286	26.17	169.8	2.349	8	PVC	0.013	95.7111	11.514	
2278	542	0	539	0	169.4	0	8	PVC	0.013	8.6036	158.637	
7998	MH-7311	229.72	1318	229.04	169.9	0.4	6	Vitrified Clay	0.013	0.8927	0.56	
4268	MH-7657	130.41	1425	129.73	170.2	0.4	6	PVC	0.013	0.4869	0.306	
2294	424	230.12	423	229.23	169.9	0.524	8	PVC	0.013	15.6048	3.975	
1550	MH-7343	0	844	193.76	170.2	Min. Slope	8	PVC	0.013	1.5351	0.027	
3648	MH-7463	0	973	27.56	170.6	Min. Slope	8	PVC	0.013	2.1793	0.1	
73	1282	107.78	579	107.1	170.2	0.4	6	Concrete	0.013	2.2962	1.442	
3726	MH-7658	0	968	27.14	171.1	Min. Slope	6	PVC	0.013	2.102	0.21	
4571	MH-7659	0	736	30.7	171.3	Min. Slope	8	PVC	0.013	1.0017	0.044	
7079	512	0	23	0	170.9	0	8	PVC	0.013	4.4899	82.788	
1686	MH-7660	0	613	0	171.5	0	8	PVC	0.013	1.46	26.921	
3034	813	8.38	812	7.69	171.9	0.4	8	PVC	0.013	22.28	6.495	
3776	305	0	306	0	171.3	0	8	Concrete	0.013	10.7348	197.933	
4459	1180	34.8	1179	25.69	171.6	5.309	8	PVC	0.013	0.7993	0.064	
2804	1337	0	712	222.88	172	Min. Slope	8	PVC	0.013	260.1067	4.213	
2263	MH-7662	0	584	0	172	0	6	Concrete	0.013	1.3305	52.832	
6530	MH-7661	126.21	1324	125.52	171.7	0.4	6	Vitrified Clay	0.013	0.388	0.244	
440	MH-7663	0	88	224.56	172.6	Min. Slope	8	PVC	0.013	1.6359	0.026	
4902	1242	236.4	MH-7437	0	172.8	136.828	8	PVC	0.013	0.9575	0.015	
2143	779	49.54	780	28.78	173.3	11.977	8	PVC	0.013	5.617	0.299	
1164	218	224.89	177	223.55	173.4	0.773	8	PVC	0.013	22.5014	4.72	
3749	MH-7664	0	307	0	177.6	0	6	PVC	0.013	1.3	51.624	
1167	101	214.9	100	213.24	173	0.96	8	Concrete	0.013	222.9837	41.971	
4498	MH-7665	0	1186	136.12	174.7	Min. Slope	6	PVC	0.013	1.0307	0.046	
1194	160	116	161	109.03	273	2.553	18	PVC	0.013	1,043.20	13.848	SM 3
4690	MH-7666	0	1191	111.58	175.1	Min. Slope	6	PVC	0.013	1.3135	0.065	

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2282	MH-7667	0	385	0	175.3	0	8	PVC	0.013	1.1017	20.314	
1366	MH-7433	85.8	896	85.1	175.6	0.4	8	Vitrified Clay	0.013	113.6518	33.13	
3611	357	32.63	356	31.83	175.4	0.456	12	PVC	0.013	68.5351	6.347	
804	559	0	550	0	175.9	0	8	PVC	0.013	3.7679	69.474	
6889	712	222.88	1338	215.84	176	4	8	PVC	0.013	266.1226	24.534	
3055	816	5.68	823	2.57	175.6	1.77	8	PVC	0.013	58.5565	8.116	
2332	644	127.38	656	126.67	176.5	0.4	8	PVC	0.013	28.1404	8.205	
963	822	77.07	194	76.37	176.1	0.4	8	PVC	0.013	2.6	0.758	
4609	1208	224.51	1210	212.28	176.1	6.944	8	PVC	0.013	1.3163	0.092	
4008	1081	0	1080	0	176.9	0	8	PVC	0.013	4.5982	84.783	
1152	141	0	140	161.24	176.8	Min. Slope	8	Concrete	0.013	0.6216	0.012	
1934	MH-7668	0	80	0	176.9	0	8	PVC	0.013	1.1668	21.513	
4141	1102	112.27	819	90.93	177.4	12.027	6	PVC	0.013	0.9505	0.109	
4457	1182	35.04	1181	27.15	177.7	4.441	8	PVC	0.013	1.5895	0.139	
3289	MH-7553	0	997	0	177.2	0	8	Asbestos Cement	0.013	3.1885	58.791	
520	590	99	583	87.42	177.8	6.513	6	Vitrified Clay	0.013	3.9697	0.618	
1347	744	0	313	0	177.6	0	8	Concrete	0.013	1.0554	19.46	
2239	MH-7671	257.09	653	256.38	178	0.4	6	Vitrified Clay	0.013	0.0691	0.043	
622	MH-7669	0	492	83.53	177.7	Min. Slope	8	PVC	0.013	1.5813	0.043	
427	87	142.64	157	123.66	178.3	10.646	8	PVC	0.013	1.4791	0.084	
3907	MH-7670	92.99	345	92.28	177.9	0.4	8	PVC	0.013	1.3043	0.38	
6272	MH-7672	188.34	1293	187.63	178	0.4	6	PVC	0.013	0.8083	0.508	
2932	805	260.23	795	260.37	178.5	Min. Slope	8	PVC	0.013	1.0725	0.706	
1261	129	0	126	137.95	178.6	Min. Slope	8	PVC	0.013	13.1826	0.277	
6318	MH-7673	0	1306	227.09	178.5	Min. Slope	8	PVC	0.013	0.9334	0.015	
3777	311	0	309	0	179	0	8	Concrete	0.013	1.9111	35.238	
2476	1110	178.9	461	175.47	178.5	1.921	8	PVC	0.013	4.6707	0.621	
4002	1085	0	1084	0	178.8	0	8	PVC	0.013	1.6168	29.812	
7844	MH-7674	5.36	1395	4.64	179	0.4	8	PVC	0.013	0.3204	0.093	
2183	555	83.23	554	66.74	178.9	9.217	6	Concrete	0.013	9.9371	1.3	
803	568	0	559	0	179.7	0	8	PVC	0.013	2.6409	48.694	
2233	742	0	741	0	179.7	0	8	Concrete	0.013	1.2357	22.784	
4551	MH-7677	106.23	1198	105.51	179.8	0.4	6	PVC	0.013	0.2559	0.161	
2003	MH-7675	0	495	100.19	179.5	Min. Slope	8	PVC	0.013	1.9144	0.047	
1605	MH-7676	0	408	232.78	179.7	Min. Slope	8	PVC	0.013	2.4283	0.039	
1328	239	89.01	241	82.76	180.5	3.464	8	PVC	0.013	7.964	0.789	
3969	168	232.2	166	233.24	180.4	Min. Slope	8	PVC	0.013	3.1154	0.757	
4391	MH-7543	0	1172	0	181.1	0	6	PVC	0.013	0.5164	20.506	
2284	MH-7678	0	567	0	181.8	0	8	PVC	0.013	0.2364	4.359	
3436	976	0	980	11.89	182	Min. Slope	6	Vitrified Clay	0.013	1.751	0.272	
4569	MH-7679	0	245	31.7	182.6	Min. Slope	8	PVC	0.013	0.5646	0.025	
2790	MH-7680	188.23	MH-7681	187.49	183.1	0.4	6	Concrete	0.013	1.9506	1.225	

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General Sewer Plan
SewerGEMS Results

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1331	238	89.74	239	89.01	183.1	0.399	8	PVC	0.013	7.2605	2.12	
4428	MH-7682	1.47	870	0.73	183.2	0.4	8	PVC	0.013	1.6172	0.472	
3430	MH-7490	0	272	0	183.1	0	8	PVC	0.013	0.8794	16.214	
405	1117	0	1118	0	182.4	0	8	PVC	0.013	0.8559	15.782	
4785	MH-7683	0	1212	204	183.7	Min. Slope	8	PVC	0.013	0.1915	0.003	
433	MH-7684	0	137	0	184	0	6	PVC	0.013	0.5933	23.562	
3926	1285	12.17	910	10.89	184	0.696	10	PVC	0.013	140.3196	17.109	
3129	541	20.24	252	19.72	184	0.283	10	Concrete	0.013	94.8984	18.155	
125	MH-7685	239.24	25	237.34	184.1	1.032	8	PVC	0.013	1.1579	0.21	
1023	188	0	189	0	184.2	0	8	PVC	0.013	31.2667	576.511	
3449	221	39.44	231	38.29	184.8	0.622	10	PVC	0.013	67.0872	8.649	
5105	1263	0	483	87.05	185.2	Min. Slope	6	Concrete	0.013	8.6519	0.501	
1768	502	0	508	0	185.2	0	8	Asbestos Cement	0.013	16.7666	309.15	
625	552	0	546	0	185.5	0	8	Asbestos Cement	0.013	3.874	71.431	
3051	830	5.74	831	5	185.5	0.4	8	Asbestos Cement	0.013	204.2459	59.543	
3598	266	0	267	0	185.3	0	6	Concrete	0.013	0.4137	16.427	
6264	1290	0	1292	0	186.2	0	8	PVC	0.013	2.3692	43.684	
4171	MH-7686	0	1127	0	186.4	0	6	PVC	0.013	1.3763	54.653	
1166	202	216.89	101	214.9	186.5	1.067	8	Concrete	0.013	1.3923	0.249	
2802	709	238.29	710	234.93	186.6	1.801	8	PVC	0.013	252.4458	34.688	
4116	1156	0	1106	244.91	186.6	Min. Slope	8	PVC	0.013	1.8863	0.03	
2288	547	0	1148	0	187	0	8	PVC	0.013	2.6693	49.218	
865	MH-7687	0	59	72.38	187.2	Min. Slope	8	PVC	0.013	1.0632	0.032	
2803	710	234.93	711	230.34	187.4	2.449	8	PVC	0.013	256.4438	30.213	
4181	1133	227.8	1132	225.7	187.6	1.12	8	PVC	0.013	12.0224	2.095	
30	MH-7688	0	190	171.7	187.4	Min. Slope	6	PVC	0.013	0.617	0.026	
7635	1367	49.42	1368	47.44	188.7	1.049	8	PVC	0.013	1.78	0.32	
6982	MH-7690	41.83	1406	41.07	188.7	0.4	8	Vitrified Clay	0.013	0.1174	0.034	
1149	MH-7689	0	134	167.93	188.6	Min. Slope	6	PVC	0.013	2.2771	0.096	
4341	1160	31.2	MH-7500	0	189.2	16.492	8	PVC	0.013	5.9362	0.27	
3796	324	0	322	16.48	188.7	Min. Slope	8	PVC	0.013	10.105	0.63	
4334	MH-7691	0	1158	43.3	189.3	Min. Slope	6	PVC	0.013	2.73	0.227	
4161	1124	62.2	1123	52.04	189.8	5.354	6	PVC	0.013	0.9998	0.172	
8094	1496	116.62	1424	115.86	189.8	0.4	8	PVC	0.013	0.6586	0.192	
1187	150	153.74	152	145.37	190.4	4.397	8	Concrete	0.013	274.5592	24.143	
4363	1167	249.1	1166	247.99	189.4	0.586	8	PVC	0.013	1.4896	0.359	
2467	MH-7692	132.99	629	132.17	204	0.4	6	Vitrified Clay	0.013	0.4489	0.282	
1426	MH-7693	29.54	780	28.78	190	0.4	8	PVC	0.013	1.6213	0.473	
3830	294	0	328	0	190.7	0	8	PVC	0.013	10.0416	185.151	
2210	681	105.09	263	102.77	191	1.215	6	PVC	0.013	10.1044	3.641	
6431	1311	214.57	1312	213.62	191.5	0.496	8	PVC	0.013	0.8986	0.235	
1123	170	213.9	171	212.59	191.2	0.685	8	Concrete	0.013	25.7449	5.734	

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1116	98	0	126	137.95	191.8	Min. Slope	8	PVC	0.013	1.4501	0.032	
7592	1359	256	1360	255.1	191.6	0.47	8	PVC	0.013	108.8952	29.3	
2734	274	23.79	273	23.25	192	0.281	10	Concrete	0.013	62.2507	11.936	
5249	MH-7696	4.18	876	3.4	194.2	0.4	6	Vitrified Clay	0.013	0.1976	0.124	
1948	MH-7697	0	773	0	193	0	8	PVC	0.013	1.2752	23.512	
2253	622	0	612	0	192.9	0	8	PVC	0.013	2.6594	49.036	
7682	1374	240.8	1378	238.6	192.5	1.143	8	PVC	0.013	2.8392	0.49	
4289	1107	0	1108	0	192.7	0	8	PVC	0.013	4.4436	81.933	
7456	MH-7292	0	68	0	192.7	0	8	Asbestos Cement	0.013	27.2915	503.215	
2156	509	33.34	517	27.4	193.5	3.07	6	PVC	0.013	11.2915	2.559	
3972	1072	0	578	0	193.6	0	6	Concrete	0.013	5.226	207.524	
3520	977	35.66	978	0	193.2	18.455	8	PVC	0.013	2.5119	0.108	
2433	613	0	1264	0	193.4	0	6	Concrete	0.013	17.1809	682.246	
3382	915	37.3	967	32.63	193.7	2.411	8	PVC	0.013	0.787	0.093	
1188	152	145.37	155	130.39	194.4	7.704	8	Concrete	0.013	275.4661	18.299	
3150	262	23.71	522	23.41	194.6	0.154	18	Concrete	0.013	1,489.13	80.441	
4122	1109	253.42	57	0	194.9	130.004	8	PVC	0.013	3.474	0.056	
3405	MH-7698	0	977	35.66	195.1	Min. Slope	8	PVC	0.013	0.5532	0.024	
6306	154	126.8	156	124.8	194.9	1.026	8	PVC	0.013	6.2442	1.137	
7681	1373	242.7	1374	240.8	195.2	0.974	8	PVC	0.013	2.2176	0.414	
3106	1065	253.49	1061	245.38	196	4.138	8	PVC	0.013	3.6681	0.332	
3270	889	2.38	891	1.6	196.1	0.4	8	Asbestos Cement	0.013	4.0833	1.191	
1171	106	212.61	107	0	196	108.498	8	Concrete	0.013	1.926	0.034	
4901	1240	236	MH-7367	0	195.9	120.476	8	PVC	0.013	0.7979	0.013	
2739	MH-7399	0	515	0	196	0	6	PVC	0.013	2.7538	109.351	
4796	MH-7699	0	1233	165.9	197	Min. Slope	6	PVC	0.013	1.8656	0.081	
3409	MH-7274	0	943	45.91	197.4	Min. Slope	6	PVC	0.013	0.4337	0.036	
1478	MH-7700	92.25	679	91.46	197.7	0.4	8	PVC	0.013	3.0974	0.903	
4329	MH-7701	0	730	199.65	198.2	Min. Slope	6	Concrete	0.013	1.5623	0.062	
4239	MH-7425	0	599	0	198.1	0	6	Concrete	0.013	1.4307	56.811	
6654	MH-7702	0	1330	146.72	198.3	Min. Slope	6	Vitrified Clay	0.013	0.5571	0.026	
2848	799	0	800	255.05	198.4	Min. Slope	8	PVC	0.013	1.0725	0.017	
2357	MH-7480	0	564	0	198.9	0	6	Asbestos Cement	0.013	2.0467	81.275	
4180	1132	225.7	1131	218.5	199	3.617	8	PVC	0.013	16.3354	1.584	
3443	MH-7703	0	917	30.66	199.2	Min. Slope	8	PVC	0.013	0.4973	0.023	
2423	250	0	261	22.82	198.9	Min. Slope	8	PVC	0.013	16.1835	0.881	
3194	868	1.49	865	0.69	199.5	0.401	8	PVC	0.013	2.0832	0.607	
3889	334	62.6	349	61.8	199.4	0.4	8	PVC	0.013	2.6216	0.764	
3897	335	55.74	336	55	199.4	0.371	10	PVC	0.013	32.9738	5.504	
943	840	201.29	77	0	200.1	100.597	8	PVC	0.013	285.7207	5.253	
2100	759	0	760	248.56	199.8	Min. Slope	8	PVC	0.013	1.6645	0.028	
1165	177	217.98	101	214.9	199.8	1.542	8	Concrete	0.013	220.0389	32.677	

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1141	109	0	110	0	200	0	8	Concrete	0.013	2.9564	54.512	
429	MH-7705	0	1109	253.42	200.5	Min. Slope	8	PVC	0.013	2.545	0.042	
3001	MH-7704	0	807	0	200.2	0	6	PVC	0.013	2.557	101.536	
3816	308	0	310	0	200.3	0	8	Concrete	0.013	0.5587	10.302	
3278	MH-7706	67.71	874	66.91	200.8	0.4	6	Vitrified Clay	0.013	1.0637	0.668	
4281	MH-7708	0	1151	10.62	201.4	Min. Slope	8	PVC	0.013	0.5272	0.042	
8071	1417	242.24	1418	240.14	200.9	1.045	8		0.013	1.2432	0.224	
1133	94	203.24	99	200.73	278.4	0.902	15	PVC	0.013	566.2303	20.568	SM 3
617	585	70.46	MH-7341	13.16	201.5	28.441	6	PVC	0.013	6.9947	0.521	
3936	MH-7707	5.52	197	4.72	201.3	0.4	6	PVC	0.013	0.0959	0.06	
2287	557	0	547	0	201.9	0	8	PVC	0.013	1.8392	33.912	
4948	1244	62.89	349	61.8	202.1	0.539	8	PVC	0.013	2.1416	0.538	
820	485	132.79	488	117.9	202.6	7.348	8	PVC	0.013	339.5258	23.095	
7983	1401	74.5	1397	66.95	203	3.719	8		0.013	1.6843	0.161	
2065	558	65.29	563	65.25	203	0.02	6	Concrete	0.013	11.1668	31.589	
6668	MH-7428	98.23	1336	97.42	203	0.4	6	Vitrified Clay	0.013	0.3363	0.211	
4224	1141	10.23	1140	9.28	202.8	0.468	30	PVC	0.013	4,394.28	34.879	
3940	MH-7552	0	424	230.12	204	Min. Slope	8	PVC	0.013	13.5185	0.235	
3982	1074	15.9	1070	15.65	204.1	0.123	30	PVC	0.013	4,182.17	64.906	
1724	MH-7709	0	517	27.4	203.8	Min. Slope	4	PVC	0.013	0.816	0.261	
3609	231	38.29	358	33.4	204.2	2.394	10	PVC	0.013	67.3454	4.426	
2090	436	159.78	1319	148.44	204.7	5.539	8	Concrete	0.013	22.2633	1.744	
41	533	0	MH-7291	0	204.2	0	8	Asbestos Cement	0.013	25.7041	473.945	
3440	MH-7710	0	967	32.63	205	Min. Slope	8	PVC	0.013	0.9717	0.045	
966	193	104.52	810	101.88	530.6	0.498	18	PVC	0.013	1,206.40	36.28	SM 4
2104	387	247.06	390	241.4	206.3	2.743	8	PVC	0.013	22.4724	2.502	
3255	MH-7711	84.75	875	83.93	206	0.4	6	Vitrified Clay	0.013	1.2844	0.806	
3623	1057	0	1056	0	206	0	8	PVC	0.013	16.9649	312.806	
3237	880	7.5	885	6.67	206.6	0.4	6	Vitrified Clay	0.013	13.3654	8.392	
1200	130	0	MH-7384	0	207.1	0	8	PVC	0.013	29.9231	551.737	
7823	1394	145.2	1388	123.8	207.1	10.333	8	PVC	0.013	0.2582	0.015	
2265	611	0	1097	0	207.5	0	8	PVC	0.013	1.7576	32.408	
3236	1155	3.62	887	2.79	207.1	0.4	8	Asbestos Cement	0.013	9.4969	2.769	
2102	760	248.56	387	247.06	207.5	0.723	8	PVC	0.013	20.3053	4.404	
4947	1245	63.94	1244	62.89	209	0.502	8	PVC	0.013	1.8834	0.49	
3185	859	6.56	867	5.72	208.9	0.4	8	Asbestos Cement	0.013	0.2764	0.081	
4738	MH-7714	0	1228	0	208.6	0	8	PVC	0.013	1.1189	20.631	
2321	501	91.32	5	82.87	209.4	4.035	8	Asbestos Cement	0.013	568.6896	52.204	
144	527	0	528	0	208.9	0	8	PVC	0.013	6.7413	124.3	
3665	998	17.87	997	17.52	209.5	0.167	12	Asbestos Cement	0.013	159.6356	24.424	
3678	MH-7378	48.91	292	48.07	209.7	0.4	8	PVC	0.013	7.3067	2.13	
89	52	16.61	53	16.15	210.5	0.219	12	PVC	0.013	0.4728	0.063	

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2298	MH-7394	0	444	209.12	210.7	Min. Slope	8	PVC	0.013	3.2815	0.061	
7583	1353	282.5	1355	279.4	211.4	1.467	8	PVC	0.013	101.4638	15.448	
88	51	17.08	52	16.61	211.5	0.222	12	PVC	0.013	0.2364	0.031	
6288	MH-7715	144.44	623	143.41	258.6	0.4	6	Vitrified Clay	0.013	0.0691	0.043	
4456	1183	43.48	1182	35.04	211.2	3.996	8	PVC	0.013	1.3531	0.125	
7662	MH-7717	0	1370	0	212	0	8	PVC	0.013	0.6038	11.133	
7620	MH-7716	227.17	1272	166.79	211.8	28.507	6	Vitrified Clay	0.013	10.0967	0.751	
5129	MH-7718	134.74	1265	133.89	212	0.4	6	PVC	0.013	1.3604	0.854	
3054	828	4.8	826	3.95	212.5	0.4	8	Asbestos Cement	0.013	2.4243	0.707	
4155	1121	12.47	911	11.92	212.4	0.259	30	PVC	0.013	4,229.46	45.146	
1125	164	223.38	165	222.71	71.2	0.942	8	Concrete	0.013	524.1191	99.589	SM 5
330	MH-7719	22.85	227	21.99	214.4	0.401	6	Concrete	0.013	1.1006	0.69	
6294	1301	160.15	1300	0	213.9	74.871	8	PVC	0.013	2.0563	0.044	
6432	1312	213.62	1313	212.57	214.9	0.489	8	PVC	0.013	1.3479	0.356	
8092	1495	0	1423	0	214.8	0	8	PVC	0.013	0.4475	8.251	
2320	495	100.19	501	91.32	214.8	4.129	8	Asbestos Cement	0.013	566.5281	51.406	
5102	MH-7720	108.28	1261	107.42	214.5	0.4	6	Vitrified Clay	0.013	5.9937	3.763	
3241	MH-7721	80.03	881	79.17	214.9	0.4	6	Vitrified Clay	0.013	0.5036	0.316	
2329	655	133.28	1258	121.11	218	5.585	6	Vitrified Clay	0.013	7.5045	1.261	
3634	979	0	982	0	215.1	0	8	PVC	0.013	2.4813	45.752	
2147	MH-7722	38.36	496	37.5	215	0.4	8	PVC	0.013	0.5747	0.168	
3821	321	0	296	0	215.7	0	8	PVC	0.013	28.1362	518.789	
2342	669	207.98	MH-7723	190.32	215.9	8.179	6	Vitrified Clay	0.013	1.5237	0.212	
4585	MH-7724	170.02	1201	169.15	216	0.4	6	Vitrified Clay	0.013	2.722	1.709	
425	MH-7725	0	174	238.7	216.5	Min. Slope	8	PVC	0.013	1.0468	0.018	
1607	372	1.43	783	0.82	216.6	0.282	10	Asbestos Cement	0.013	222.3133	42.604	
3965	211	233.2	210	232.83	86.6	0.427	8	PVC	0.013	501.0216	141.299	SM 5
2217	1320	215.13	677	171.71	217.5	19.959	6	Vitrified Clay	0.013	4.7301	0.42	
340	1309	17.86	30	17.72	217.7	0.064	30	PVC	0.013	4,048.09	86.711	
1953	MH-7596	0	771	0	218.5	0	8	PVC	0.013	2.7686	51.048	
2538	MH-7726	166.59	690	165.72	218.1	0.4	6	Vitrified Clay	0.013	0.7601	0.477	
4003	1084	0	1083	0	218.6	0	8	PVC	0.013	7.863	144.981	
98	57	0	1081	0	218.7	0	8	PVC	0.013	4.1689	76.868	
2370	MH-7727	0	228	0	219.2	0	6	PVC	0.013	1.4406	57.207	
3600	291	90.91	290	84.11	218.7	3.109	8	PVC	0.013	5.1015	0.533	
7576	1355	279.4	1354	270.4	219.8	4.095	8	PVC	0.013	102.8394	9.371	
815	461	175.47	470	165.46	220.2	4.546	8	PVC	0.013	320.7768	27.74	
4689	MH-7728	58.47	MH-7287	57.59	219.7	0.4	8	PVC	0.013	0.8816	0.257	
1311	1418	240.14	174	238.7	220.5	0.653	8	PVC	0.013	133.276	30.412	
3693	951	23.84	955	20.78	220.6	1.387	8	PVC	0.013	3.6442	0.571	
3446	368	41.3	3	40.51	220.9	0.358	10	PVC	0.013	66.5708	11.322	
1441	MH-7730	0	769	223.73	220.5	Min. Slope	8	PVC	0.013	0.4493	0.008	

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2235	738	0	737	0	221.2	0	6	PVC	0.013	0.2894	11.492	
822	406	233.93	412	232.96	221.8	0.437	8	PVC	0.013	6.2867	1.753	
4168	MH-7731	0	18	109.67	221.5	Min. Slope	6	PVC	0.013	0.4475	0.025	
1192	1345	165.16	153	0	222.2	74.314	6	Concrete	0.013	17.1204	0.789	
2221	MH-7732	154.74	1380	153.85	222.8	0.4	6	Vitrified Clay	0.013	0.2559	0.161	
1335	240	59.6	244	58.33	222.8	0.57	8	PVC	0.013	31.941	7.801	
2424	628	0	619	0	223.7	0	8	PVC	0.013	0.6818	12.571	
7577	1356	262.1	1349	260.5	223.8	0.715	8	PVC	0.013	104.6508	22.82	
7633	MH-7733	99.37	1366	98.48	223.7	0.4	6	Vitrified Clay	0.013	3.3663	2.114	
3641	954	44.48	957	35.19	223.8	4.151	8	PVC	0.013	11.2016	1.014	
4903	1243	245.5	1242	236.4	224	4.063	8	PVC	0.013	0.6862	0.063	
786	430	189.16	437	183.54	224.7	2.501	6	Concrete	0.013	9.0386	2.269	
2662	1089	0	691	116.55	224	Min. Slope	8	PVC	0.013	2.117	0.054	
8099	192	131.43	193	104.52	224.8	11.97	8	Concrete	0.013	137.9047	7.35	
4900	1241	244.91	1240	236	224.4	3.971	8	PVC	0.013	0.2234	0.021	
3762	310	0	299	0	225.2	0	8	Concrete	0.013	7.5296	138.834	
1136	131	166.8	133	165.9	224.7	0.4	8	Concrete	0.013	137.9571	40.223	
2209	MH-7734	162.9	652	162	225	0.4	6	Vitrified Clay	0.013	0.7907	0.496	
3251	MH-7735	64.35	1197	63.45	225.1	0.4	6	Vitrified Clay	0.013	1.3983	0.878	
2426	MH-7723	190.32	657	189.42	225.5	0.4	6	Vitrified Clay	0.013	2.3474	1.474	
3250	MH-7736	136.63	879	135.73	225.6	0.4	6	Vitrified Clay	0.013	2.355	1.479	
2050	764	3.39	781	2.48	226	0.403	8	Asbestos Cement	0.013	216.8911	63.018	
3254	MH-7737	86	896	85.1	226.1	0.4	6	Vitrified Clay	0.013	1.1705	0.735	
32	MH-7738	0	329	34.13	227	Min. Slope	8	PVC	0.013	1.3348	0.063	
2427	1293	187.63	686	175.77	227	5.225	8	PVC	0.013	4.6922	0.378	
3366	MH-7739	0	939	0	227.1	0	8	PVC	0.013	0.2582	4.761	
1646	60	0	515	0	227.5	0	8	PVC	0.013	6.0997	112.469	
1965	MH-7740	0	405	234.19	227.7	Min. Slope	8	PVC	0.013	4.8155	0.088	
818	476	148.35	477	147.39	227.2	0.423	8	PVC	0.013	327.3509	92.846	
2910	796	0	794	0	227.3	0	8	PVC	0.013	3.0003	55.32	
2080	767	0	768	234	227.6	Min. Slope	8	PVC	0.013	0.8691	0.016	
709	370	100.91	791	100	227.7	0.4	8	PVC	0.013	2.8263	0.824	
2059	573	40.51	561	39.6	228.3	0.4	8	Vitrified Clay	0.013	45.0094	13.123	
3431	MH-7741	0	270	0	228.2	0	8	PVC	0.013	0.4915	9.063	
3885	353	80.97	348	81.38	228.7	Min. Slope	8	PVC	0.013	13.0203	5.67	
2094	440	0	448	156.38	229	Min. Slope	8	PVC	0.013	1.3548	0.03	
7603	504	0	60	0	228.9	0	8	PVC	0.013	0.6038	11.133	
3610	358	33.4	357	32.63	228.5	0.337	10	PVC	0.013	67.6036	11.844	
2035	MH-7745	150.66	1238	149.74	228.8	0.4	6	Vitrified Clay	0.013	1.8422	1.157	
3225	MH-7744	1.66	870	0.73	230.5	0.4	8	Vitrified Clay	0.013	2.0455	0.596	
3613	941	61	939	0	228.5	26.696	8	PVC	0.013	4.2748	0.153	
130	MH-7527	0	393	0	228.8	0	8	PVC	0.013	1.4967	27.596	

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3774	316	0	315	0	229.5	0	8	Concrete	0.013	24.1101	444.554	
3640	948	50.41	954	44.48	229.9	2.579	8	PVC	0.013	9.9457	1.142	
262	MH-7481	0	692	0	229.9	0	8	PVC	0.013	3.1676	58.406	
1168	100	213.24	102	210.86	229.8	1.036	8	Concrete	0.013	223.7232	40.531	
1999	MH-7747	0	586	0	230.4	0	6	Concrete	0.013	1.0283	40.831	
93	56	0	790	235.75	230	Min. Slope	8	PVC	0.013	0.7314	0.013	
2072	766	239.24	765	235.35	230.7	1.686	8	PVC	0.013	0.9901	0.141	
1764	MH-7746	0	1062	244.61	232.7	Min. Slope	8	PVC	0.013	0.8169	0.015	
2223	642	0	645	0	230.6	0	8	Concrete	0.013	3.1943	58.898	
1785	1273	0	485	132.79	231.4	Min. Slope	8	PVC	0.013	3.1477	0.077	
5053	MH-7748	102.75	625	101.82	231.5	0.4	6	PVC	0.013	0.591	0.371	
3531	330	0	279	0	231.3	0	8	Concrete	0.013	18.0276	332.402	
6327	MH-7750	0	533	0	232	0	6	Concrete	0.013	1.3051	51.824	
4335	1158	43.3	1159	34.13	231.4	3.962	8	PVC	0.013	3.4392	0.319	
819	477	147.39	484	134.98	232.6	5.335	8	PVC	0.013	332.9274	26.578	
2107	391	0	400	0	232.9	0	8	PVC	0.013	22.8062	420.512	
36	MH-7751	0	524	0	232.3	0	6	PVC	0.013	0.2364	9.387	
3629	973	27.56	981	19.17	233.3	3.597	8	PVC	0.013	3.2827	0.319	
2267	MH-7754	0	581	0	233.4	0	6	Concrete	0.013	1.1561	45.91	
2075	1100	0	771	0	232.9	0	6	Concrete	0.013	3.8249	151.884	
2157	MH-7458	0	MH-7293	0	233.6	0	6	PVC	0.013	7.1002	281.944	
4462	1178	23.98	MH-7368	0	233.2	10.284	8	PVC	0.013	5.3542	0.308	
4643	MH-7752	0	1217	112	233.2	Min. Slope	8	PVC	0.013	0.6168	0.016	
4246	1147	188.13	MH-7753	0	233.3	80.655	8	PVC	0.013	0.6809	0.014	
3109	34	248.07	1061	245.38	233.7	1.151	6	PVC	0.013	3.8173	1.413	
7588	1363	249.9	1060	248.38	234.7	0.648	8	PVC	0.013	112.0032	25.662	
3603	223	45.97	367	44.95	234.3	0.435	10	PVC	0.013	65.2798	10.061	
1178	117	216.39	116	0	234.5	92.277	8	PVC	0.013	15.3649	0.295	
4131	MH-7755	0	24	0	235.3	0	6	PVC	0.013	1.062	42.172	
3794	323	0	322	16.48	235.4	Min. Slope	8	PVC	0.013	2.2034	0.154	
4165	1126	0	1125	0	235.7	0	6	PVC	0.013	1.505	59.764	
2270	581	0	578	0	235.1	0	6	Concrete	0.013	43.6442	1,733.09	
2579	MH-7757	257.86	647	256.92	235.7	0.4	6	Asbestos Cement	0.013	0.7482	0.47	
957	84	235.82	85	234.13	236	0.716	8	PVC	0.013	1.8384	0.401	
2909	794	0	797	0	235.4	0	8	PVC	0.013	4.9268	90.842	
3893	348	81.38	352	74.4	235.4	2.966	8	PVC	0.013	23.1553	2.479	
2971	795	260.37	800	255.05	236.2	2.253	8	PVC	0.013	3.7341	0.459	
2046	MH-7756	118.14	680	117.2	235.7	0.4	6	PVC	0.013	1.4705	0.923	
3032	809	0	810	101.88	236.3	Min. Slope	8	Asbestos Cement	0.013	10.8056	0.303	
3441	MH-7758	0	979	0	236.5	0	6	PVC	0.013	0.9717	38.585	
3235	883	57.76	MH-7354	56.81	236.5	0.4	6	Vitrified Clay	0.013	27.9017	17.518	
2415	526	0	359	41.93	236.8	Min. Slope	8	PVC	0.013	4.1457	0.182	

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4517	1188	31.43	863	3.7	236.3	11.736	10	PVC	0.013	562.1977	16.689	
3981	260	0	1074	15.9	236.1	Min. Slope	8	PVC	0.013	18.6489	1.325	
2041	20	107.33	1276	106.39	236.3	0.4	6	Concrete	0.013	1.4167	0.89	
1153	139	0	140	161.24	236.4	Min. Slope	8	Concrete	0.013	2.6346	0.059	
2083	418	206.25	426	178.41	237.1	11.74	8	PVC	0.013	16.3613	0.88	
3141	905	20.22	902	19.59	236.4	0.266	18	Concrete	0.013	1,576.41	64.774	
2252	1149	0	599	0	237.2	0	6	Concrete	0.013	21.3768	848.864	
1185	148	0	150	153.74	237.1	Min. Slope	8	Concrete	0.013	0.6216	0.014	
3639	946	60.11	948	50.41	237.7	4.08	8	PVC	0.013	6.1932	0.565	
3110	1062	244.61	1064	243.64	237.9	0.408	8	PVC	0.013	12.564	3.628	
3638	949	37.79	957	35.19	238.2	1.092	8	PVC	0.013	4.8781	0.861	
1177	119	212.58	117	216.39	238.5	Min. Slope	8	PVC	0.013	2.7165	0.396	
2116	409	221.44	414	206.6	238.6	6.22	8	PVC	0.013	66.4695	4.914	
3276	888	68.07	874	66.91	238.1	0.487	10	Vitrified Clay	0.013	62.992	9.179	
3607	222	42.22	368	41.3	238.9	0.385	10	PVC	0.013	66.3126	10.866	
2121	474	143.74	473	135.92	238.3	3.281	8	PVC	0.013	6.567	0.668	
129	1165	247.75	81	0	239.4	103.504	8	PVC	0.013	4.2208	0.076	
1909	776	0	777	99.22	239.3	Min. Slope	6	Concrete	0.013	4.2663	0.263	
7600	575	124.36	20	107.33	238.7	7.135	6	Concrete	0.013	0.4039	0.06	
442	176	219.28	88	218.26	239.8	0.425	8	Concrete	0.013	194.6585	55.033	
4399	1172	0	1111	0	239.7	0	8	PVC	0.013	8.0503	148.436	
2124	MH-7322	0	457	160.44	239.1	Min. Slope	8	PVC	0.013	3.3311	0.075	
4223	1140	9.28	1139	8.22	239.1	0.443	30	PVC	0.013	4,394.43	35.849	
214	1112	31.62	940	31.03	240	0.246	12	PVC	0.013	86.3745	10.894	
1652	MH-7759	114.63	373	113.67	240	0.4	6	Vitrified Clay	0.013	0.8616	0.541	
2585	MH-7761	0	474	143.74	240.2	Min. Slope	8	PVC	0.013	2.0083	0.048	
965	820	238.89	84	235.82	239.9	1.28	8	PVC	0.013	0.8767	0.143	
2260	607	0	609	134.8	239.8	Min. Slope	8	PVC	0.013	0.8919	0.022	
3646	MH-7363	0	965	21.06	239.9	Min. Slope	8	PVC	0.013	7.8761	0.49	
4005	MH-7760	0	1083	0	240.2	0	8	PVC	0.013	0.7609	14.029	
3680	938	0	939	0	240.8	0	8	PVC	0.013	0.2582	4.761	
3184	860	7.52	859	6.56	241	0.4	8	Asbestos Cement	0.013	0.2073	0.06	
7587	1358	257.4	1352	256.2	240.5	0.499	8	PVC	0.013	107.6698	28.103	
1012	MH-7762	0	181	207.93	241.2	Min. Slope	8	PVC	0.013	1.0603	0.021	
1992	689	0	619	0	240.6	0	8	PVC	0.013	4.0316	74.337	
1491	MH-7763	85.73	556	84.76	241.6	0.4	6	PVC	0.013	0.1174	0.074	
35	848	0	259	0	241	0	8	PVC	0.013	15.685	289.208	
2327	660	121.75	MH-7445	120.79	241.5	0.4	8	Vitrified Clay	0.013	51.8936	15.127	
3967	207	235.69	208	235.01	130.2	0.522	8	PVC	0.013	490.1765	125.053	SM 5
4175	1129	227.4	1128	203.1	242.5	10.021	8	PVC	0.013	0.6674	0.039	
635	975	0	MH-7764	0	242.6	0	6	Vitrified Clay	0.013	5.9561	236.515	
3084	837	0	838	0	242.8	0	8	PVC	0.013	28.0536	517.267	

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1132	93	204.2	94	203.24	242.4	0.396	8	Concrete	0.013	8.9304	2.616	
787	420	204.32	MH-7249	189.16	251.6	6.026	6	PVC	0.013	3.3203	0.537	
4499	593	141.94	1186	136.12	242.8	2.397	6	Vitrified Clay	0.013	2.3818	0.611	
2232	747	0	739	0	243.3	0	8	Concrete	0.013	4.795	88.412	
2175	MH-7767	93.91	646	92.94	243.2	0.4	6	Vitrified Clay	0.013	0.9292	0.583	
5294	MH-7765	0	776	0	242.9	0	8	PVC	0.013	0.6571	12.116	
3545	283	0	281	0	243.7	0	8	Concrete	0.013	29.9678	552.56	
3337	912	61.79	1050	60.71	243.9	0.443	8	PVC	0.013	1.3609	0.377	
2152	MH-7768	0	506	0	244	0	8	PVC	0.013	1.8871	34.795	
1314	205	228.88	164	223.38	244.1	2.253	8	Concrete	0.013	10.5235	1.293	
3532	968	27.14	969	25.13	243.5	0.826	8	PVC	0.013	6.8247	1.385	
3931	908	9.54	1051	8.54	244.2	0.409	18	Concrete	0.013	147.2954	4.883	
5081	1256	63.14	1255	55.28	243.6	3.227	8	PVC	0.013	2.3682	0.243	
2269	592	0	581	0	244.5	0	8	PVC	0.013	2.4276	44.762	
3968	213	236.33	207	235.69	131.8	0.486	8	PVC	0.013	488.9186	129.345	SM 5
2129	453	0	464	0	244.8	0	6	PVC	0.013	2.7234	108.144	
3687	MH-7331	0	327	0	245.4	0	8	PVC	0.013	3.8804	71.549	
3536	961	0	962	0	245.6	0	8	PVC	0.013	21.9487	404.7	
3108	1061	245.38	79	245.17	246.4	0.085	8	PVC	0.013	8.7005	5.495	
2482	688	15.49	1068	14.95	246.1	0.219	12	PVC	0.013	0.9456	0.126	
872	61	240	388	236.16	246.5	1.558	8	PVC	0.013	3.1361	0.463	
3539	270	0	271	0	245.9	0	8	PVC	0.013	7.917	145.977	
6291	1298	0	445	210.15	246.3	Min. Slope	8	PVC	0.013	25.7331	0.514	
6643	MH-7770	0	138	0	246	0	8	PVC	0.013	0.4493	8.284	
404	1116	0	MH-7339	0	246.6	0	8	PVC	0.013	3.1461	58.01	
942	77	0	1059	191.69	246.9	Min. Slope	8	PVC	0.013	289.018	6.049	
3894	340	78.69	337	77.59	274.5	0.4	8	PVC	0.013	10.7228	3.126	
80	49	226.02	50	215.21	247.4	4.37	8	PVC	0.013	4.9897	0.44	
3083	763	5.96	817	4.97	247.2	0.4	8	PVC	0.013	0.8398	0.245	
3151	234	173.42	232	168.8	246.9	1.871	6	Concrete	0.013	19.8014	5.748	
7685	1375	242.1	1376	240.2	201.5	0.943	8	PVC	0.013	448.7782	85.223	SM 5
1786	MH-7772	0	1273	0	248	0	6	PVC	0.013	1.4327	56.894	
3620	965	21.06	963	16.79	247.4	1.726	8	PVC	0.013	12.3534	1.734	
284	MH-7771	0	748	0	254	0	8	PVC	0.013	1.3177	24.296	
2224	645	0	649	0	247.7	0	8	Concrete	0.013	5.6114	103.465	
1264	173	229.4	164	223.38	241.7	2.491	8	Concrete	0.013	512.4693	59.873	SM 5
2162	MH-7773	161.94	658	160.95	248.5	0.4	6	Vitrified Clay	0.013	288.2728	180.995	
2001	596	0	377	0	248.8	0	8	PVC	0.013	6.2471	115.187	
4245	MH-7753	0	451	185.69	248.2	Min. Slope	8	PVC	0.013	2.2794	0.049	
2033	1262	174.73	656	126.67	248.4	19.346	6	Vitrified Clay	0.013	9.8925	0.893	
806	359	0	220	41.57	248	Min. Slope	8	PVC	0.013	4.7408	0.213	
1186	142	167.92	150	153.74	249.4	5.686	8	Concrete	0.013	273.316	21.135	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

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1313	206	222.8	163	221.8	249.4	0.4	8	Concrete	0.013	12.0763	3.521	
2336	1425	129.73	632	128.73	249.3	0.4	6	PVC	0.013	1.5783	0.991	
834	701	0	515	24.5	248.9	Min. Slope	8	PVC	0.013	16.4131	0.965	
2271	578	0	572	0	249.6	0	6	Concrete	0.013	49.1984	1,953.65	
3030	807	0	808	0	249.8	0	8	PVC	0.013	4.8902	90.167	
1154	140	161.24	146	148.88	249.9	4.947	8	Concrete	0.013	746.0528	61.849	
1270	179	229.03	178	227.58	250	0.58	8	PVC	0.013	3.2124	0.778	
3725	16	0	41	0	250	0	8	PVC	0.013	0.4076	7.516	
2099	471	105.31	478	90.95	250	5.744	10	Concrete	0.013	57.7579	2.451	
3895	346	57.16	347	56.18	249.7	0.392	8	PVC	0.013	32.4574	9.553	
1142	110	0	111	181.73	249.5	Min. Slope	8	Concrete	0.013	4.7106	0.102	
1190	137	0	138	0	250.4	0	6	Concrete	0.013	3.301	131.081	
1126	165	222.71	172	217.91	254.3	1.888	8	Concrete	0.013	524.7407	70.423	SM 5
1979	371	231.48	714	229.99	250.4	0.595	8	PVC	0.013	112.2762	26.839	
1122	169	0	170	213.9	249.9	Min. Slope	8	Concrete	0.013	11.5525	0.23	
504	625	101.82	616	100.86	241.3	0.4	6	Vitrified Clay	0.013	2.838	1.782	
3096	MH-7774	101.91	370	100.91	250.1	0.4	8	PVC	0.013	1.0105	0.295	
636	MH-7764	0	926	11.48	250	Min. Slope	6	Vitrified Clay	0.013	6.7485	1.251	
2477	566	41.54	573	40.51	255.9	0.4	8	Concrete	0.013	15.9344	4.645	
594	839	0	35	0	250.6	0	8	Asbestos Cement	0.013	31.4802	580.448	
4417	1176	179	234	173.42	251	2.223	8	PVC	0.013	6.489	0.802	
3622	963	16.79	964	13.74	250.3	1.218	8	PVC	0.013	15.6983	2.622	
2166	1201	169.15	693	168.15	250.6	0.4	6	Vitrified Clay	0.013	3.5996	2.26	
2062	600	110.06	590	99	251.1	4.405	6	Vitrified Clay	0.013	3.6155	0.684	
2141	449	0	450	0	250.6	0	8	PVC	0.013	9.54	175.904	
2149	219	25.08	842	14.96	250.7	4.037	8	PVC	0.013	3.2029	0.294	
2732	276	0	277	0	250.7	0	8	PVC	0.013	3.7428	69.012	
2144	MH-7383	39.09	490	38.08	251.6	0.4	8	PVC	0.013	1.5448	0.45	
1196	180	215.1	182	209.5	251.7	2.225	8	Asbestos Cement	0.013	1.6063	0.199	
17	38	0	39	131.7	250.8	Min. Slope	8	PVC	0.013	0.9348	0.024	
2258	589	0	377	0	250.9	0	6	Concrete	0.013	26.8035	1,064.36	
5101	1260	0	569	0	251.7	0	6	Concrete	0.013	8.2688	328.349	
1121	163	221.8	170	213.9	251.9	3.136	8	Concrete	0.013	13.5707	1.413	
6062	465	0	1099	90.04	251.9	Min. Slope	6	Concrete	0.013	2.3698	0.157	
7809	1387	0	MH-7872	0	256.3	0	8	PVC	0.013	1.5864	29.25	
3637	944	46.54	949	37.79	251.7	3.476	8	PVC	0.013	2.9646	0.293	
2111	392	0	403	0	252.3	0	8	PVC	0.013	3.1469	58.024	
8049	861	9.81	1407	8.8	251.9	0.4	8	Asbestos Cement	0.013	0.0691	0.02	
3690	950	16.01	960	15.07	252.3	0.373	8	Asbestos Cement	0.013	2.0944	0.633	
2247	1325	0	615	0	252.5	0	6	Concrete	0.013	4.3288	171.896	
2030	484	134.98	485	132.79	251.9	0.869	8	PVC	0.013	334.3602	66.126	
2245	MH-7776	223.24	670	222.23	252.8	0.4	6	Vitrified Clay	0.013	0.9745	0.612	

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1128	95	0	96	203.5	252.4	Min. Slope	8	PVC	0.013	3.6163	0.074	
665	331	84.33	332	62.87	253.2	8.475	8	PVC	0.013	2.5345	0.161	
1315	204	231.18	173	229.4	275.7	0.646	8	PVC	0.013	503.7651	115.604	SM 5
1316	178	227.58	218	224.89	253.5	1.061	8	PVC	0.013	21.349	3.822	
2122	466	146.56	473	135.92	254.3	4.183	8	PVC	0.013	145.2374	13.093	
2262	586	0	584	0	253.4	0	6	Concrete	0.013	35.6193	1,414.43	
2168	693	168.15	620	159.92	253.9	3.241	6	Vitrified Clay	0.013	4.6979	1.036	
2481	687	14.79	746	14.45	253.9	0.134	30	PVC	0.013	4,186.63	62.146	
600	MH-7777	0	36	0	253.9	0	8	PVC	0.013	0.8039	14.823	
7683	1376	240.2	1378	238.6	291.9	0.548	8	PVC	0.013	449.3999	111.919	SM 5
5906	992	10.16	994	9.47	254.1	0.271	8	Asbestos Cement	0.013	50.8668	18	
506	MH-7778	132.89	697	131.87	254.9	0.4	6	Vitrified Clay	0.013	0.6586	0.414	
7860	1397	66.95	1398	59.2	255.2	3.037	8	PVC	0.013	1.8789	0.199	
2173	621	133.79	1259	123.85	255.2	3.895	6	Vitrified Clay	0.013	2.1967	0.442	
2600	704	0	702	26.24	255.2	Min. Slope	8	PVC	0.013	6.131	0.353	
3604	367	44.95	366	44.37	255.5	0.227	10	PVC	0.013	65.538	13.988	
2118	1249	0	434	174.61	255.8	Min. Slope	8	PVC	0.013	109.8419	2.451	
486	698	99.54	597	89.36	255.7	3.982	6	Vitrified Clay	0.013	5.4745	1.089	
2254	637	172.86	MH-7521	171.84	255.3	0.4	6	PVC	0.013	11.7096	7.351	
2355	579	107.1	576	106.35	255.3	0.294	6	Concrete	0.013	3.8324	2.807	
6437	1318	229.04	1317	216.12	255.5	5.056	6	PVC	0.013	1.2259	0.216	
3261	898	163.4	877	162.38	255.9	0.4	6	Vitrified Clay	0.013	35.2268	22.119	
2153	506	0	248	24.9	255.8	Min. Slope	8	PVC	0.013	5.1772	0.306	
817	470	165.46	476	148.35	256.8	6.664	8	PVC	0.013	325.425	23.244	
2148	496	26.1	219	25.08	256.1	0.4	8	PVC	0.013	2.244	0.654	
2234	741	0	740	0	256.8	0	8	Concrete	0.013	2.265	41.763	
4226	1143	11.26	1142	10.62	256.1	0.25	30	PVC	0.013	4,229.75	45.958	
3549	273	23.25	271	22.53	256.9	0.28	10	Asbestos Cement	0.013	63.0485	12.112	
3538	272	0	270	0	257.1	0	8	PVC	0.013	6.3902	117.825	
1156	151	136.04	154	126.8	257.1	3.594	8	PVC	0.013	4.7823	0.465	
3635	982	0	983	0	256.5	0	8	PVC	0.013	3.3633	62.014	
4356	1163	46	1162	0	256.5	17.935	8	PVC	0.013	4.8709	0.212	
4630	1214	62.82	1213	50.37	257.4	4.836	8	PVC	0.013	1.5487	0.13	
3775	313	0	314	0	256.7	0	8	Concrete	0.013	3.1434	57.96	
1259	184	0	185	197.59	256.9	Min. Slope	8	PVC	0.013	38.4472	0.808	
3689	970	13.8	972	12.96	257.7	0.326	8	Asbestos Cement	0.013	38.8561	12.549	
4506	1187	29.54	13	0	257.2	11.485	8	PVC	0.013	1.7699	0.096	
1203	187	186.1	190	171.7	258.3	5.574	8	Concrete	0.013	97.2948	7.599	
3555	275	22.8	1002	22.13	241.7	0.277	10	Asbestos Cement	0.013	73.4435	14.187	
2079	770	175	772	164.46	258.6	4.075	6	Concrete	0.013	4.5795	0.901	
4055	1093	92.61	1092	88.54	257.8	1.579	8	PVC	0.013	3.633	0.533	
2227	750	0	751	0	258.7	0	8	Concrete	0.013	1.9406	35.782	

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SewerGEMS Results

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20	43	0	327	0	258.2	0	8	PVC	0.013	2.8063	51.744	
4640	1219	106.2	1220	96.8	258.3	3.64	8	PVC	0.013	3.0818	0.298	
1184	135	181.83	142	167.92	259.2	5.367	8	Concrete	0.013	272.0728	21.655	
3632	983	0	981	19.17	258.3	Min. Slope	8	PVC	0.013	4.817	0.326	
4642	1217	112	1218	108.9	258.3	1.2	8	PVC	0.013	1.6496	0.278	
958	825	2.45	86	1.41	259.2	0.4	8	Asbestos Cement	0.013	3.3876	0.988	
512	790	235.75	768	234	259.4	0.675	8	PVC	0.013	6.4052	1.438	
2095	446	0	447	144.47	258.7	Min. Slope	6	Concrete	0.013	4.1233	0.219	
4398	1173	35.4	1172	0	259.4	13.648	8	PVC	0.013	7.2757	0.363	
2242	668	230.02	676	214.73	258.9	5.906	6	Vitrified Clay	0.013	5.6758	0.927	
3890	350	62.83	349	61.8	258.7	0.398	8	PVC	0.013	23.9299	6.992	
7634	1369	52.12	1367	49.42	259.5	1.04	8	PVC	0.013	1.0544	0.191	
3547	279	0	278	0	259.6	0	8	Concrete	0.013	57.1239	1,053.28	
1205	190	171.7	191	155.73	259.8	6.147	8	Concrete	0.013	132.2711	9.837	
3543	1054	0	1053	0	259.7	0	8	Concrete	0.013	27.3785	504.817	
4396	1175	47.1	1174	37.1	259	3.861	8	PVC	0.013	3.8397	0.36	
3188	1202	3.81	858	1.7	259.7	0.812	8	PVC	0.013	179.6193	36.746	
7011	MH-7780	144.45	623	143.41	259.4	0.4	6	Vitrified Clay	0.013	2.7207	1.708	
4611	1207	212.33	1205	210.25	260	0.8	8	PVC	0.013	1.9067	0.393	
1206	191	155.6	192	131.43	260.2	9.289	8	Concrete	0.013	136.6212	8.265	
349	19	0	649	0	260.2	0	8	PVC	0.013	6.5466	120.71	
42	70	0	71	20.17	260.3	Min. Slope	8	PVC	0.013	2.6112	0.173	
2218	670	222.23	677	171.71	259.7	19.451	6	Vitrified Clay	0.013	5.1766	0.466	
4023	337	77.59	353	80.97	260.2	Min. Slope	8	PVC	0.013	11.545	1.868	
3544	1053	0	283	0	260.2	0	8	Concrete	0.013	29.3513	541.194	
3817	302	0	303	0	259.5	0	8	PVC	0.013	1.4417	26.583	
2126	480	115.53	486	98.91	260.5	6.381	8	PVC	0.013	153.7254	11.221	
2981	803	0	761	0	260.5	0	8	PVC	0.013	1.7628	32.503	
2034	686	175.77	1262	174.73	259.9	0.4	6	Vitrified Clay	0.013	5.5395	3.478	
7700	694	123.68	1379	118.56	260	1.971	6	Vitrified Clay	0.013	4.0055	1.133	
2436	MH-7355	119.88	MH-7624	118.84	260.4	0.4	6	Vitrified Clay	0.013	2.5208	1.583	
2435	677	171.71	684	170.67	260.4	0.4	6	Vitrified Clay	0.013	11.8243	7.424	
1191	138	0	144	0	260.8	0	6	Concrete	0.013	4.7033	186.766	
3125	730	199.65	83	193.75	260.7	2.263	8	Concrete	0.013	2.5515	0.313	
2358	569	0	564	0	260	0	8	Asbestos Cement	0.013	62.2349	1,147.52	
3533	994	9.47	991	8.62	259.9	0.327	8	Asbestos Cement	0.013	51.45	16.59	
2244	MH-7782	239.7	676	214.73	261.1	9.564	6	Vitrified Clay	0.013	7.9318	1.018	
2817	MH-7304	0	722	224.94	260.1	Min. Slope	8	PVC	0.013	1.6338	0.032	
3152	441	174.03	232	168.8	260.9	2.004	10	PVC	0.013	116.373	8.359	
2145	490	38.08	360	37.04	260.2	0.4	8	PVC	0.013	2.3688	0.691	
4321	1154	35.8	1153	28.2	260	2.923	8	PVC	0.013	2.1564	0.233	
2733	278	0	277	0	260.8	0	8	Concrete	0.013	57.2686	1,055.95	

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2225	649	0	654	0	260.2	0	8	Concrete	0.013	13.0399	240.435	
6252	886	77.57	MH-7781	76.53	260.5	0.4	10	Vitrified Clay	0.013	132.6865	21.333	
19	42	0	43	111.8	260.3	Min. Slope	8	PVC	0.013	1.1548	0.032	
2071	78	239.39	765	235.35	260.4	1.552	8	PVC	0.013	28.9823	4.29	
4644	1216	118.6	1217	112	261.1	2.528	8	PVC	0.013	0.7746	0.09	
2088	381	0	454	135.91	260.5	Min. Slope	8	Concrete	0.013	24.4667	0.625	
3836	303	0	276	0	260.4	0	8	PVC	0.013	3.5981	66.344	
3795	325	0	324	18.03	261.2	Min. Slope	8	PVC	0.013	3.6625	0.257	
2073	765	235.35	836	231.3	260.8	1.553	8	PVC	0.013	33.1579	4.906	
1127	172	217.91	96	203.5	261.9	5.503	8	Concrete	0.013	525.3622	41.295	
3898	336	55	339	54.34	261.6	0.252	10	PVC	0.013	37.1277	7.517	
2555	1379	118.56	937	117.51	261.3	0.4	6	Vitrified Clay	0.013	4.9685	3.119	
2097	454	135.91	463	120.87	262	5.742	8	Concrete	0.013	53.2657	4.099	
2133	452	0	465	0	262	0	6	PVC	0.013	1.4812	58.816	
2731	1009	23.53	275	22.8	257.3	0.284	10	Asbestos Cement	0.013	73.2988	13.995	
250	14	0	15	0	262.5	0	8	PVC	0.013	2.5613	47.227	
916	68	16.7	69	16.38	262.5	0.122	30	Concrete	0.013	4,145.00	64.485	
2170	396	144.34	1103	143.29	262.6	0.4	8	Vitrified Clay	0.013	11.7936	3.438	
2131	464	0	472	0	262.8	0	6	Concrete	0.013	5.1627	205.008	
3815	314	0	312	0	262.7	0	8	Concrete	0.013	4.47	82.42	
3826	295	0	1054	0	262.7	0	8	Concrete	0.013	26.4376	487.47	
2077	773	0	774	153.47	262.3	Min. Slope	8	PVC	0.013	2.0668	0.05	
2171	1330	146.72	593	141.94	262.5	1.821	6	Vitrified Clay	0.013	1.0128	0.298	
3825	299	0	281	0	262.3	0	8	Concrete	0.013	8.8391	162.979	
1738	235	0	449	0	263.1	0	8	PVC	0.013	7.5433	139.086	
1042	90	0	160	122.44	263.8	Min. Slope	8	PVC	0.013	1.5581	0.042	
2729	922	25.06	MH-7784	24.33	263.7	0.277	10	Asbestos Cement	0.013	73.0094	14.112	
2313	MH-7478	0	467	0	263.1	0	8	PVC	0.013	2.2505	41.496	
2117	414	206.6	415	205.41	263.2	0.452	8	PVC	0.013	74.0742	20.312	
3363	940	31.03	913	30.43	264	0.227	12	PVC	0.013	94.2823	12.367	
3692	945	29.65	951	23.84	264	2.201	8	PVC	0.013	2.7768	0.345	
1349	740	0	304	0	264	0	8	Concrete	0.013	3.0289	55.848	
4641	1218	108.9	1219	106.2	263.5	1.025	8	PVC	0.013	2.8236	0.514	
816	451	185.69	461	175.47	264.7	3.86	8	PVC	0.013	299.3494	28.093	
4380	1171	0	1170	220.4	264.1	Min. Slope	8	PVC	0.013	1.733	0.035	
3763	312	0	310	0	264.8	0	8	Concrete	0.013	6.0005	110.641	
3031	808	0	809	0	264.9	0	8	PVC	0.013	8.304	153.114	
2360	548	0	541	0	264.4	0	8	Concrete	0.013	67.9393	1,252.70	
3995	1076	6.08	1075	5.28	264.7	0.302	8	Vitrified Clay	0.013	176.1838	59.091	
18	39	0	41	0	264.4	0	8	PVC	0.013	2.3586	43.49	
4357	1162	0	1111	0	264.4	0	8	PVC	0.013	7.1614	132.046	
951	1119	100.44	MH-7485	77.61	265	8.617	6	PVC	0.013	1.4311	0.194	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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4379	1170	220.4	95	0	265.8	82.91	8	PVC	0.013	2.3546	0.048	
954	85	234.13	175	232.45	265.2	0.634	8	PVC	0.013	8.8003	2.039	
2074	775	0	776	0	266	0	8	PVC	0.013	2.0261	37.358	
2123	457	0	466	146.56	266	Min. Slope	8	PVC	0.013	144.2342	3.583	
1157	146	148.88	147	148.49	27.1	1.44	8	Concrete	0.013	748.1511	114.958	SM 6
2132	472	0	1263	0	266.2	0	6	Concrete	0.013	7.4256	294.866	
7916	1399	148.08	660	147.02	266	0.4	8	Vitrified Clay	0.013	10.5414	3.073	
487	761	0	755	0	265.5	0	8	PVC	0.013	3.6865	67.974	
1129	96	203.5	94	203.24	46.2	0.562	8	Concrete	0.013	529.6001	130.222	SM 6
2276	736	30.7	537	0	265.6	11.559	8	PVC	0.013	7.0537	0.383	
4698	1225	256	1224	254.56	265.9	0.542	8	PVC	0.013	0	0	
4358	1164	0	1163	46	265.9	Min. Slope	8	PVC	0.013	4.0502	0.18	
2085	426	178.41	436	159.78	266.8	6.983	8	PVC	0.013	20.4303	1.426	
3964	233	178.3	234	173.42	266.1	1.834	6	Concrete	0.013	12.0836	3.543	
7632	1257	110.55	1365	80.3	266.8	11.341	6	Vitrified Clay	0.013	8.8018	1.038	
4322	1153	28.2	1152	23.88	266.1	1.623	8	PVC	0.013	6.6424	0.961	
3117	780	28.78	853	8.5	267.3	7.586	8	PVC	0.013	8.874	0.594	
3605	366	44.37	2	43.41	267.3	0.359	10	PVC	0.013	65.7962	11.164	
4140	26	0	272	0	267.8	0	8	PVC	0.013	2.8423	52.408	
4699	1224	254.56	1223	253.1	267.3	0.546	8	PVC	0.013	0.9352	0.233	
2076	771	0	772	164.46	267.5	Min. Slope	6	Concrete	0.013	7.4287	0.376	
3286	267	0	998	0	267.4	0	8	Concrete	0.013	3.7644	69.41	
3835	306	0	330	0	267.6	0	8	Concrete	0.013	16.3994	302.379	
3694	955	20.78	960	15.07	267.6	2.134	8	Asbestos Cement	0.013	31.089	3.924	
3113	1064	243.64	78	239.39	268.6	1.582	8	PVC	0.013	24.5291	3.596	
4340	1159	34.13	1160	31.2	267.8	1.094	8	PVC	0.013	5.0749	0.895	
4007	MH-7785	0	1085	0	268	0	8	PVC	0.013	0.8877	16.367	
2315	MH-7786	0	467	0	268.7	0	6	PVC	0.013	1.3255	52.637	
4221	1138	7	1137	6.74	268.5	0.097	30	PVC	0.013	4,395.53	76.735	
7580	1357	258.8	1358	257.4	268.9	0.521	8	PVC	0.013	107.066	27.361	
3133	531	20.6	1309	19.58	269.7	0.378	10	Asbestos Cement	0.013	625.0506	103.36	
3224	890	5.52	900	4.44	269.8	0.4	8	Vitrified Clay	0.013	30.7742	8.972	
1351	737	0	302	0	269	0	8	PVC	0.013	0.4341	8.004	
3114	81	0	1064	243.64	269.4	Min. Slope	8	PVC	0.013	11.3435	0.22	
3922	343	53.24	1	50.02	270.3	1.191	10	PVC	0.013	48.5827	4.527	
3667	999	19.6	355	18.7	270.3	0.333	12	Asbestos Cement	0.013	152.3969	16.517	
4219	1136	6.48	1135	6.12	269.8	0.133	30	PVC	0.013	4,396.54	65.385	
4220	1137	6.74	1136	6.48	270	0.096	30	PVC	0.013	4,396.19	76.958	
1959	835	0	837	0	271	0	8	PVC	0.013	25.8586	476.794	
3535	947	22.22	952	20.38	270.9	0.679	8	PVC	0.013	99.2461	22.206	
2098	463	120.87	471	105.31	271	5.741	10	Concrete	0.013	54.6205	2.318	
3814	315	0	295	0	270.2	0	8	Concrete	0.013	25.9096	477.734	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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2431	388	236.16	399	227.39	271.1	3.235	8	PVC	0.013	4.1072	0.421	
1182	124	191.96	128	188.87	271.1	1.14	8	Concrete	0.013	265.7645	45.896	
2142	778	50.62	779	49.54	270.4	0.4	8	PVC	0.013	1.0139	0.296	
4397	1174	37.1	1173	35.4	270.4	0.629	8	PVC	0.013	4.9838	1.159	
2115	404	234.07	409	221.44	271.4	4.653	8	PVC	0.013	64.158	5.484	
2061	937	117.51	582	96.33	271.3	7.806	8	Vitrified Clay	0.013	26.4922	1.748	
4553	1199	96.87	1066	67	271.4	11.004	8	PVC	0.013	0.7663	0.043	
4578	1200	0	510	42.99	271.6	Min. Slope	6	Concrete	0.013	23.541	2.35	
2086	774	153.47	381	143.74	271.2	3.588	8	Concrete	0.013	18.6279	1.813	
2441	588	0	1260	0	271.8	0	6	Concrete	0.013	4.9038	194.726	
1980	408	232.78	371	231.48	271.1	0.48	8	PVC	0.013	108.464	28.878	
3153	854	2.81	843	2.21	271.4	0.221	12	Asbestos Cement	0.013	0.5373	0.071	
2231	748	0	747	0	272.1	0	8	Concrete	0.013	3.1887	58.795	
5215	403	0	1270	0	271.7	0	8	PVC	0.013	5.0769	93.61	
2067	1336	97.42	582	96.33	272	0.4	6	Vitrified Clay	0.013	0.5552	0.349	
2432	515	0	525	32.88	272.9	Min. Slope	8	PVC	0.013	26.0656	1.385	
2000	620	159.92	1310	150.56	272.4	3.436	6	Vitrified Clay	0.013	5.9316	1.271	
2096	448	156.38	446	150.53	272.3	2.148	6	Concrete	0.013	2.6786	0.726	
2154	1400	0	505	48.54	273.2	Min. Slope	8	PVC	0.013	6.6086	0.289	
2290	536	0	535	0	272.4	0	8	PVC	0.013	8.7986	162.233	
263	22	90.35	293	89.26	273.2	0.4	8	PVC	0.013	2.3204	0.676	
2105	390	241.4	401	234.64	273.4	2.472	8	PVC	0.013	25.9852	3.047	
1151	134	167.93	140	161.24	248.7	2.69	8	Concrete	0.013	740.6417	83.262	SM 6
3283	870	0.73	864	0.35	273.4	0.142	10	Asbestos Cement	0.013	81.7109	22.031	
3602	354	46.76	223	45.97	273.6	0.289	10	PVC	0.013	65.0216	12.306	
3670	914	59.55	948	50.41	272.9	3.349	8	PVC	0.013	3.1096	0.313	
3050	832	6.09	831	5	273.4	0.4	8	Asbestos Cement	0.013	3.2294	0.941	
4719	MH-7788	0	459	197.28	274	Min. Slope	8	PVC	0.013	2.0053	0.044	
2031	450	0	462	0	274.1	0	8	PVC	0.013	13.8112	254.658	
2375	572	0	569	0	273.6	0	8	Asbestos Cement	0.013	52.7809	973.201	
2078	772	164.46	774	153.47	274.4	4.005	8	Concrete	0.013	13.3622	1.231	
2539	690	165.72	634	160.58	273.9	1.877	6	Vitrified Clay	0.013	1.6217	0.47	
4452	1177	111.73	471	0	273.9	40.792	8	PVC	0.013	1.6923	0.049	
593	35	0	183	202.43	274	Min. Slope	8	Vitrified Clay	0.013	38.2814	0.821	
1	36	0	618	182.45	274	Min. Slope	8	PVC	0.013	0.9844	0.022	
2081	768	234	769	223.73	275.3	3.731	8	PVC	0.013	8.9372	0.853	
2331	639	149.18	1399	148.08	275	0.4	8	Vitrified Clay	0.013	6.8223	1.989	
1134	99	200.73	103	198.69	250.4	0.815	8	Concrete	0.013	566.8519	115.803	SM 6
2268	584	0	581	0	274.9	0	6	Concrete	0.013	39.2902	1,560.20	
1118	115	193.94	123	190.85	275.9	1.12	8	Concrete	0.013	568.1617	98.985	SM 6
1130	171	212.59	94	203.24	276.3	3.384	8	Concrete	0.013	26.9834	2.705	
1348	739	0	304	0	275.2	0	8	Concrete	0.013	6.0307	111.196	

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SewerGEMS Results

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2226	654	0	751	0	275.2	0	8	Concrete	0.013	18.8939	348.376	
2237	663	255.14	673	228.28	275.9	9.737	6	PVC	0.013	4.518	0.575	
3891	351	73.66	350	62.83	275.4	3.933	8	PVC	0.013	23.6717	2.201	
3601	1	50.02	354	46.76	276.1	1.181	10	PVC	0.013	54.9187	5.14	
4222	1139	8.22	1138	7	275.5	0.443	30	PVC	0.013	4,394.72	35.871	
3925	910	10.89	909	10.51	275.5	0.138	18	Concrete	0.013	143.0945	8.173	
2091	447	144.4	454	135.91	276.7	3.069	8	Concrete	0.013	27.4633	2.891	
3162	232	168.8	457	160.44	276.8	3.02	8	PVC	0.013	139.1952	14.768	
967	834	244.54	1268	243.37	276.2	0.424	8	PVC	0.013	127.5375	36.129	
1354	245	31.7	736	30.7	276.1	0.362	8	PVC	0.013	5.4001	1.654	
4942	MH-7790	0	1154	35.8	277	Min. Slope	8	PVC	0.013	1.5135	0.078	
2989	MH-7789	0	801	250.23	277.2	Min. Slope	8	PVC	0.013	2.9258	0.057	
2037	462	0	461	175.47	276.4	Min. Slope	8	PVC	0.013	15.2992	0.354	
2216	673	228.28	MH-7716	227.17	277.3	0.4	6	Vitrified Clay	0.013	6.14	3.855	
1135	103	198.69	115	193.94	300.3	1.582	8	Concrete	0.013	567.4736	83.197	SM 6
2730	MH-7784	24.33	1009	23.53	285.7	0.28	10	Asbestos Cement	0.013	73.1541	14.058	
2161	1416	64.78	661	63.67	278.6	0.4	6	Vitrified Clay	0.013	5.7247	3.594	
1170	104	204.73	112	197.86	279.2	2.46	8	Concrete	0.013	226.0869	26.577	
4844	1236	86.56	556	84.76	279	0.645	6	Concrete	0.013	8.4905	4.198	
2324	365	45.5	851	25.18	279.7	7.265	10	Asbestos Cement	0.013	591.7132	22.326	
3556	1002	22.13	1001	21.3	295.7	0.281	10	Asbestos Cement	0.013	73.5882	14.125	
1608	843	2.21	372	1.43	279.9	0.279	10	Asbestos Cement	0.013	222.1959	42.803	
2556	1324	125.52	694	123.68	279.6	0.658	6	Vitrified Clay	0.013	1.96	0.959	
5425	MH-7791	0	MH-7308	0	279.6	0	6	Concrete	0.013	0.5613	22.288	
3316	990	11.09	992	10.16	279.8	0.332	8	Asbestos Cement	0.013	50.2837	16.082	
4373	1169	56.98	944	46.54	280.8	3.718	8	PVC	0.013	2.6505	0.253	
1183	128	188.87	135	181.83	281.1	2.505	8	Concrete	0.013	266.3861	31.036	
1263	111	181.73	122	177.84	281.3	1.383	8	Concrete	0.013	9.4067	1.475	
1179	116	0	112	197.86	280.6	Min. Slope	8	Concrete	0.013	31.9011	0.7	
3064	1063	246.71	833	245.19	281.6	0.54	8	PVC	0.013	125.0511	31.384	
2257	615	0	613	0	280.8	0	6	Concrete	0.013	13.922	552.836	
1363	1365	80.3	881	79.17	281.4	0.4	6	Vitrified Clay	0.013	11.1495	7.001	
1380	369	219.22	418	206.25	282.1	4.598	8	PVC	0.013	4.6941	0.404	
511	1331	79.13	382	72.53	282.1	2.339	6	Vitrified Clay	0.013	4.9685	1.29	
2038	1261	107.42	675	106.29	281.8	0.4	6	Vitrified Clay	0.013	10.5062	6.596	
4133	MH-7286	244	17	242.87	282	0.4	6	PVC	0.013	1.5968	1.003	
3621	959	0	963	16.79	282.5	Min. Slope	8	PVC	0.013	1.3939	0.105	
1323	1060	248.38	1063	246.71	282.7	0.591	8	PVC	0.013	117.0047	28.069	
4176	1130	204.6	1128	203.1	282.1	0.532	8	PVC	0.013	31.0403	7.848	
3095	5	82.87	4	79.38	282.2	1.237	8	Asbestos Cement	0.013	570.4208	94.58	
3933	1066	67	946	60.11	283	2.435	8	PVC	0.013	1.7678	0.209	
811	735	0	251	0	283.1	0	8	PVC	0.013	11.2208	206.895	

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2158	499	0	498	76.94	282.7	Min. Slope	6	Vitrified Clay	0.013	3.8031	0.289	
1197	182	209.5	181	207.93	282.8	0.555	8	Asbestos Cement	0.013	3.6878	0.913	
3627	964	13.74	971	12.63	283.6	0.391	8	PVC	0.013	139.2868	41.05	
4051	1092	88.54	1091	74.56	281.8	4.96	8	PVC	0.013	6.0132	0.498	
3282	894	9.23	862	5.83	283.6	1.198	10	Vitrified Clay	0.013	19.8908	1.848	
2140	429	195.31	430	189.16	282.8	2.174	8	PVC	0.013	3.7993	0.475	
2207	1186	136.12	605	131.24	283.7	1.72	8	Vitrified Clay	0.013	3.8682	0.544	
3771	319	0	320	18.52	284	Min. Slope	8	PVC	0.013	5.6616	0.409	
3761	296	0	MH-7435	0	284	0	8	PVC	0.013	28.3944	523.55	
1365	1366	98.48	682	97.34	283.9	0.4	6	Vitrified Clay	0.013	4.1787	2.624	
2261	609	134.8	596	0	284.4	47.392	8	PVC	0.013	4.7397	0.127	
336	30	17.72	29	17.57	283.7	0.053	30	PVC	0.013	4,048.70	95.641	
1148	127	176.8	134	167.93	284.8	3.115	8	Concrete	0.013	588.26	61.46	
3238	876	3.4	887	3.4	284.6	0	10	Asbestos Cement	0.013	49.2473	500.819	
3186	863	3.7	866	2.9	284.5	0.28	10	Vitrified Clay	0.013	562.2668	108.065	
4435	1421	78.12	89	76.98	284.5	0.4	8	PVC	0.013	0.1918	0.056	
4227	911	11.92	1143	11.26	284.7	0.232	30	PVC	0.013	4,229.60	47.716	
790	410	232.39	416	231.45	285.8	0.329	8	PVC	0.013	9.4328	3.033	
2326	665	113.91	675	106.29	285.6	2.668	8	Vitrified Clay	0.013	81.4477	9.194	
3189	864	0.35	869	-0.8	286.4	0.4	10	Asbestos Cement	0.013	81.78	13.149	
810	220	0	530	0	286.5	0	8	PVC	0.013	5.4852	101.139	
1162	174	238.7	175	232.45	287.3	2.175	8	PVC	0.013	134.9444	16.871	
3272	885	6.67	890	5.52	287.9	0.4	8	Vitrified Clay	0.013	29.2051	8.514	
3970	901	24.5	904	23.82	287.9	0.236	18	Concrete	0.013	1,472.62	64.272	
1767	500	0	502	0	288.4	0	8	Asbestos Cement	0.013	15.33	282.662	
2813	731	0	77	0	288.5	0	8	PVC	0.013	2.0304	37.437	
3691	MH-7795	0	950	16.01	289.8	Min. Slope	8	Concrete	0.013	0.9136	0.072	
2155	505	48.54	509	33.34	289.9	5.243	8	PVC	0.013	7.8781	0.634	
3240	897	4	876	3.4	289.9	0.207	10	Asbestos Cement	0.013	33.9056	7.579	
2289	538	0	535	0	290.1	0	8	PVC	0.013	12.7242	234.615	
2167	643	163.57	634	160.58	290	1.031	6	Vitrified Clay	0.013	1.96	0.767	
6525	MH-7328	22.77	MH-7472	22.7	80	0.087	18	PVC	0.013	1,530.63	109.758	SM 7
2422	MH-7796	150.34	639	149.18	290.5	0.4	6	Vitrified Clay	0.013	2.6136	1.641	
3228	892	62.27	895	55.41	290.2	2.365	10	Vitrified Clay	0.013	528.0188	34.915	
4845	1237	240.86	MH-7782	239.7	290.6	0.4	6	Vitrified Clay	0.013	5.5318	3.473	
3778	309	0	307	0	290.8	0	8	Concrete	0.013	2.0558	37.907	
960	823	2.57	86	1.41	290.3	0.4	8	PVC	0.013	58.6524	17.099	
3550	271	22.53	920	21.72	290.2	0.279	10	Asbestos Cement	0.013	77.7299	14.961	
1181	114	194.7	124	191.96	291.4	0.94	8	Concrete	0.013	260.4273	49.522	
2109	389	240.33	394	237.31	291.3	1.037	8	PVC	0.013	1.3803	0.25	
3142	906	20.32	905	20.22	159.1	0.063	18	Concrete	0.013	1,569.94	132.842	SM 7
6241	1288	0	1287	0	291.1	0	8		0.013	2.7837	51.327	

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10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
2264	617	0	611	0	291.8	0	8	PVC	0.013	1.4339	26.438	
4075	1096	57.53	1095	55.55	291.6	0.679	8	PVC	0.013	2.5468	0.57	
2058	561	4.5	6	3.68	292	0.28	10	PVC	0.013	45.479	8.741	
1963	MH-7797	0	1100	0	292.8	0	6	PVC	0.013	1.2196	48.429	
3257	896	85.1	875	83.93	292.5	0.4	8	Vitrified Clay	0.013	118.5201	34.552	
2135	478	90.95	479	90.04	174.8	0.521	12	Concrete	0.013	1,283.21	111.211	SM 7
3273	1321	10.4	894	9.23	293.1	0.4	8	Vitrified Clay	0.013	19.8217	5.779	
2172	1103	143.29	605	131.24	293.1	4.111	8	Vitrified Clay	0.013	14.9514	1.36	
3908	339	54.34	343	53.24	293.7	0.375	10	PVC	0.013	42.23	7.017	
2367	525	23.48	903	22.8	217.3	0.313	10	Asbestos Cement	0.013	618.9599	112.517	SM 7
2068	605	131.24	937	117.51	293.7	4.675	8	Vitrified Clay	0.013	20.0871	1.713	
3256	875	83.93	886	77.57	293.8	2.165	8	Vitrified Clay	0.013	125.4139	15.716	
3242	881	79.17	885	6.67	293.4	24.707	6	Vitrified Clay	0.013	15.3148	1.223	
2069	393	0	78	239.39	293.3	Min. Slope	8	PVC	0.013	2.1183	0.043	
2026	1189	95.28	696	75.81	294.1	6.619	6	Vitrified Clay	0.013	4.5268	0.699	
3239	364	33.4	MH-7508	32.22	294.5	0.4	6	PVC	0.013	7.0058	4.398	
2087	380	148.98	381	143.74	294.8	1.777	6	Concrete	0.013	4.449	1.325	
2169	634	160.58	1310	150.56	294.5	3.402	6	Vitrified Clay	0.013	4.8153	1.037	
2137	481	89.04	483	87.05	290.6	0.685	12	Concrete	0.013	1,289.18	97.423	SM 7
3253	1364	78.75	886	77.57	294.5	0.4	6	Vitrified Clay	0.013	5.1065	3.206	
2273	577	0	570	0	295.1	0	8	Concrete	0.013	11.0569	203.872	
3090	MH-7798	0	1100	0	294.6	0	6	Concrete	0.013	0.8795	34.925	
507	661	63.67	671	62.48	295.5	0.4	6	Vitrified Clay	0.013	8.4772	5.323	
3616	952	20.38	958	15.03	295.9	1.808	8	PVC	0.013	99.5043	13.646	
2353	574	105.95	565	87.46	295.4	6.259	6	Concrete	0.013	7.0379	1.117	
2797	721	205.4	429	195.31	296.1	3.407	8	PVC	0.013	1.0403	0.104	
2125	473	135.92	480	116.16	296.3	6.668	8	PVC	0.013	152.2537	10.872	
3537	1000	20.5	999	19.6	296.3	0.304	12		0.013	151.7522	17.22	
2490	845	2.18	855	1	295.8	0.4	8	Asbestos Cement	0.013	0.1174	0.034	
3190	862	5.83	866	2.9	296.8	0.987	10	Vitrified Clay	0.013	20.8041	2.13	
3271	887	2.79	891	1.6	296.9	0.4	10	Asbestos Cement	0.013	65.5479	10.54	
92	MH-7799	0	54	146.1	297.7	Min. Slope	8	PVC	0.013	1.2694	0.033	
2056	MH-7570	2.85	MH-7469	2.05	288.5	0.28	10	Vitrified Clay	0.013	58.26	11.196	
3053	829	5.99	828	4.8	298	0.4	8	Asbestos Cement	0.013	1.1613	0.339	
3073	MH-7800	0	833	245.19	297.7	Min. Slope	8	PVC	0.013	0.6216	0.013	
2434	1272	166.79	685	165.6	297.9	0.4	6	Vitrified Clay	0.013	12.1814	7.648	
3124	844	193.76	1059	191.69	297.8	0.695	8	PVC	0.013	3.285	0.726	
1317	349	61.8	242	60.8	298.2	0.334	8	PVC	0.013	29.0919	9.285	
2462	565	87.46	1236	86.56	298.1	0.302	6	Concrete	0.013	7.4598	5.391	
6278	MH-7801	0	258	0	299	0	8	PVC	0.013	1.1444	21.101	
4535	1192	62.89	1193	38.3	299.2	8.217	8	PVC	0.013	2.6975	0.174	
90	53	16.15	688	15.49	299.6	0.22	12	PVC	0.013	0.7092	0.095	

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SewerGEMS Results

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1978	729	215.17	732	207.11	299.8	2.689	8	PVC	0.013	4.4264	0.498	
7818	1390	121.8	1389	120.3	299.2	0.501	8	PVC	0.013	0.7746	0.202	
2138	483	87.05	487	84.9	301.1	0.714	12	Concrete	0.013	1,298.73	96.124	SM 7
3154	852	-0.2	854	-1.4	299.8	0.4	8	Asbestos Cement	0.013	0.4199	0.122	
3546	281	0	279	0	300.5	0	8	Concrete	0.013	38.9515	718.208	
4608	1209	233	1205	210.25	299.7	7.591	8	PVC	0.013	1.8831	0.126	
3534	991	8.62	993	7.64	299.6	0.327	8	Asbestos Cement	0.013	51.7259	16.676	
808	519	0	520	0	299.9	0	8	PVC	0.013	0.7717	14.228	
2220	675	106.29	682	97.34	300.8	2.976	8	Vitrified Clay	0.013	98.032	10.478	
2491	855	1	852	-0.2	300.6	0.4	8	Asbestos Cement	0.013	0.2348	0.068	
3187	866	2.9	858	1.7	300.5	0.4	10	Vitrified Clay	0.013	643.504	103.477	
503	697	131.87	625	101.82	310.1	9.688	6	Vitrified Clay	0.013	1.2496	0.159	
2042	23	0	513	0	300.7	0	8	PVC	0.013	5.8782	108.386	
3245	899	58.96	883	57.76	301.4	0.4	6	Vitrified Clay	0.013	26.4274	16.594	
1334	242	60.8	240	59.6	301.2	0.4	8	PVC	0.013	29.6172	8.635	
2039	MH-7507	115.11	665	113.91	301.2	0.4	6	Vitrified Clay	0.013	19.5788	12.292	
3140	902	19.59	252	19.72	315.1	Min. Slope	18	Concrete	0.013	1,578.83	164.868	SM 7
109	8	91.54	237	90.33	300.9	0.401	8	PVC	0.013	1.398	0.407	
3036	812	7.69	814	6.49	302	0.4	8	PVC	0.013	50.9478	14.854	
3161	437	183.54	233	178.3	302	1.735	6	Concrete	0.013	10.4516	3.151	
620	MH-7488	14.82	6	13.62	302.4	0.4	6	Vitrified Clay	0.013	4.9646	3.117	
1360	683	4.7	897	4	302.5	0.231	10	Asbestos Cement	0.013	22.3049	4.715	
3702	943	45.91	945	29.65	302.6	5.374	8	PVC	0.013	0.8674	0.069	
2475	MH-7802	0	1110	178.9	302.3	Min. Slope	8	PVC	0.013	1.2728	0.031	
3668	1001	21.3	1000	20.5	303.2	0.264	12		0.013	151.6075	18.458	
4134	646	92.94	55	87.91	303.1	1.659	6	Asbestos Cement	0.013	2.332	0.719	
2043	672	5.5	683	4.7	303.4	0.264	10	Asbestos Cement	0.013	19.6394	3.889	
2310	460	198.98	459	197.28	302.7	0.562	8	Asbestos Cement	0.013	187.813	46.213	
2134	1099	0	479	90.04	304.1	Min. Slope	6	Concrete	0.013	3.7	0.27	
2743	384	0	500	0	304.1	0	8	PVC	0.013	13.4831	248.608	
3618	958	15.03	964	13.74	304.5	0.424	8	PVC	0.013	99.7625	28.262	
3445	960	15.07	918	13.84	305.3	0.403	8	Asbestos Cement	0.013	35.2854	10.25	
2159	498	76.94	1228	42.99	305.5	11.113	6	Concrete	0.013	13.1577	1.567	
2190	507	0	511	0	305.6	0	6	Asbestos Cement	0.013	14.4749	574.793	
3277	MH-7781	76.53	MH-7295	75.67	305	0.28	10	PVC	0.013	136.0781	26.152	
3230	872	63.58	892	62.27	326.6	0.4	10	Vitrified Clay	0.013	72.2253	11.614	
2469	570	0	MH-7610	0	305.9	0	6	Concrete	0.013	11.9464	474.386	
3169	856	6.95	867	5.72	305.4	0.4	8	Vitrified Clay	0.013	151.2043	44.081	
37	524	0	848	0	306	0	8	PVC	0.013	9.727	179.351	
2312	459	197.28	458	192.87	305.3	1.444	8	Asbestos Cement	0.013	191.6569	29.404	
4135	55	87.91	1331	79.13	306	2.869	6	Vitrified Clay	0.013	3.7349	0.876	
4177	1131	218.5	1130	204.6	306.5	4.535	8	PVC	0.013	23.3724	2.024	

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2311	456	201.47	455	199.74	305.6	0.566	8	Asbestos Cement	0.013	179.6645	44.027	
628	344	93.5	345	92.28	306	0.4	8	PVC	0.013	0.9195	0.268	
91	54	0	482	146.25	307.8	Min. Slope	8	PVC	0.013	2.3864	0.064	
4602	1203	5.08	1202	3.81	306.5	0.414	10	PVC	0.013	176.322	27.855	
1318	244	58.33	346	57.16	306.9	0.381	8	PVC	0.013	32.1992	9.616	
1326	MH-7803	0	1060	248.38	306.7	Min. Slope	8	PVC	0.013	1.1708	0.024	
3258	MH-7804	80.28	MH-7459	79.05	307.6	0.4	6	Vitrified Clay	0.013	1.892	1.188	
7414	MH-7805	108.93	MH-7806	107.69	307.8	0.4	6	Vitrified Clay	0.013	1.7291	1.086	
2314	467	0	468	175.36	307.9	Min. Slope	8	PVC	0.013	4.1799	0.102	
7677	1372	245	1373	242.7	309.2	0.744	8	PVC	0.013	0.9744	0.208	
3226	891	1.6	870	0.73	309.1	0.28	10	Asbestos Cement	0.013	71.2411	13.69	
666	MH-7807	85.56	331	84.33	308.4	0.4	8	PVC	0.013	0.7663	0.223	
4536	1193	38.3	1194	36.5	309.6	0.581	8	PVC	0.013	2.9339	0.709	
3779	307	0	306	0	309.6	0	8	Concrete	0.013	3.6337	67	
2303	422	0	421	228.26	309.5	Min. Slope	8	PVC	0.013	0.8958	0.019	
7822	1392	92	1393	61.2	310	9.937	8	PVC	0.013	1.8074	0.106	
2557	MH-7808	167.57	695	166.33	310	0.4	6	Vitrified Clay	0.013	0.1851	0.116	
3666	355	18.7	998	17.87	311.1	0.267	12	Asbestos Cement	0.013	154.2507	18.677	
2812	725	0	1299	201.29	310.4	Min. Slope	8	PVC	0.013	9.8669	0.226	
3074	1395	4.64	764	3.39	311.4	0.4	8	Asbestos Cement	0.013	214.8973	62.648	
3686	328	0	1057	0	310.9	0	8	PVC	0.013	16.1388	297.575	
2438	MH-7809	87.75	MH-7810	86.51	311.4	0.4	6	Vitrified Clay	0.013	0.6008	0.377	
3145	1059	191.69	451	185.69	312.5	1.92	8	PVC	0.013	294.9876	39.255	
2818	MH-7432	0	728	214.12	313.4	Min. Slope	6	PVC	0.013	4.462	0.214	
5012	MH-7811	0	1251	225.4	313.3	Min. Slope	8	PVC	0.013	1.4294	0.031	
2189	497	0	507	0	314.6	0	6	Asbestos Cement	0.013	1.2488	49.59	
3072	MH-7812	0	834	244.54	313.9	Min. Slope	8	PVC	0.013	0.6216	0.013	
2351	614	135.17	629	132.17	314.8	0.953	8	Vitrified Clay	0.013	1.926	0.364	
2222	MH-7813	99.98	678	98.72	314.6	0.4	6	Vitrified Clay	0.013	3.3513	2.104	
4151	1113	0	7	0	314.3	0	8	PVC	0.013	1.6058	29.609	
3675	293	89.26	290	88	315.5	0.4	8	PVC	0.013	2.8177	0.822	
5011	1251	225.4	1250	223.56	315	0.584	8	PVC	0.013	2.8941	0.698	
3955	161	109.03	162	107.29	317.7	0.548	12	Concrete	0.013	1,062.68	89.806	SM 7
1169	102	210.86	104	204.73	315.8	1.941	8	Concrete	0.013	225.3768	29.826	
3679	289	51.28	1	50.02	315.9	0.4	8	PVC	0.013	5.8387	1.702	
3523	1090	95.74	288	94.47	317	0.4	8	PVC	0.013	1.2807	0.373	
1282	216	0	214	0	317.2	0	8	PVC	0.013	1.3311	24.543	
2443	674	107.93	681	105.09	318.2	0.893	6	PVC	0.013	9.1117	3.83	
3281	895	55.41	MH-7317	54.14	317.8	0.4	10	Vitrified Clay	0.013	558.5724	89.813	
3143	362	20.86	906	20.32	483.2	0.112	18	Concrete	0.013	1,568.79	99.539	SM 7
2047	699	131.65	680	117.2	318.6	4.537	6	Vitrified Clay	0.013	2.2201	0.414	
3274	1403	56.68	895	55.41	318.5	0.4	6	Vitrified Clay	0.013	29.3277	18.415	

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2211	680	117.2	1257	110.55	318.9	2.085	6	Vitrified Clay	0.013	5.2666	1.448	
2808	719	215.05	840	201.29	319.6	4.306	8	PVC	0.013	272.5013	24.214	
2308	431	218.45	442	206.2	319.6	3.833	8	Asbestos Cement	0.013	140.8841	13.268	
682	342	94.72	341	83.56	318.7	3.502	8	PVC	0.013	3.3856	0.334	
3548	277	0	274	0	319.9	0	8	Concrete	0.013	61.1561	1,127.63	
683	341	83.56	343	62.29	319.4	6.66	8	PVC	0.013	4.7795	0.341	
3183	1407	8.8	860	7.52	319.7	0.4	8	Asbestos Cement	0.013	0.1382	0.04	
403	1115	0	1116	0	319.6	0	8	PVC	0.013	1.8671	34.427	
664	332	62.87	338	61.59	319.8	0.4	8	PVC	0.013	4.2871	1.25	
2352	623	143.41	630	142.13	320.5	0.4	6	Vitrified Clay	0.013	4.599	2.888	
1283	217	0	209	0	320.4	0	8	PVC	0.013	2.9556	54.496	
3886	MH-7814	70.63	333	69.34	322.6	0.4	8	PVC	0.013	0.4363	0.127	
681	MH-7815	96.01	342	94.72	323.4	0.4	8	PVC	0.013	1.8123	0.528	
3674	923	25.98	922	25.06	326	0.282	10	Asbestos Cement	0.013	72.8647	13.949	
2300	443	207.81	442	206.2	325.1	0.495	8	Asbestos Cement	0.013	32.6393	8.552	
3595	269	0	268	0	325.1	0	8	PVC	0.013	2.42	44.621	
522	597	89.36	585	70.46	326	5.798	6	Vitrified Clay	0.013	6.6743	1.101	
7820	1388	119.5	1392	92	325.9	8.439	8	PVC	0.013	1.5492	0.098	
1124	166	233.24	167	230.66	326.3	0.791	8	Concrete	0.013	5.6644	1.175	
2814	715	229.22	720	0	327	70.098	8	PVC	0.013	123.5308	2.72	
784	732	207.11	455	199.74	327.4	2.251	8	Asbestos Cement	0.013	6.2116	0.763	
952	MH-7816	0	179	229.03	326.6	Min. Slope	8	PVC	0.013	0.6216	0.014	
3677	292	48.07	354	46.76	327.2	0.4	8	PVC	0.013	9.3366	2.722	
2206	616	100.86	698	99.54	329.3	0.4	6	Vitrified Clay	0.013	4.1393	2.599	
6298	MH-7370	40.92	561	39.6	329.5	0.4	8	Vitrified Clay	0.013	0.3522	0.103	
2334	631	129.09	641	127.77	330.2	0.4	8	PVC	0.013	11.5501	3.368	
3664	995	16.65	988	15.76	330.5	0.269	12	Asbestos Cement	0.013	164.0997	19.777	
3262	1334	85.25	875	83.93	330.1	0.4	6	Vitrified Clay	0.013	2.3882	1.499	
2795	MH-7817	0	711	230.34	330	Min. Slope	8	PVC	0.013	1.4972	0.033	
3093	246	22.6	363	21.95	330.4	0.197	18	Concrete	0.013	1,532.06	73.265	
3597	229	35.9	355	18.7	330.2	5.209	8	PVC	0.013	1.4401	0.116	
3248	MH-7818	118.15	1277	116.83	330.7	0.4	6	Vitrified Clay	0.013	0.6646	0.417	
3676	MH-7819	92.23	291	90.91	330.9	0.4	8	PVC	0.013	0.867	0.253	
521	1259	123.85	600	110.06	332.9	4.142	6	Vitrified Clay	0.013	2.9568	0.577	
2369	529	22.09	531	20.6	335.7	0.444	10	Asbestos Cement	0.013	624.4469	95.322	
814	261	0	260	20.03	334.7	Min. Slope	8	PVC	0.013	17.1027	1.289	
2343	MH-7283	0	595	0	335.1	0	8	Concrete	0.013	4.6426	85.602	
2794	MH-7820	0	710	234.93	335.5	Min. Slope	8	PVC	0.013	1.6428	0.036	
1208	162	107.29	193	104.52	513.3	0.54	12	Concrete	0.013	1,066.50	90.794	SM 7
2040	MH-7821	145.8	MH-7780	144.45	337.2	0.4	6	Vitrified Clay	0.013	2.6516	1.665	
2341	632	128.73	644	127.38	338.7	0.4	6	PVC	0.013	14.8946	9.352	
2678	241	82.76	348	81.38	344	0.4	8	PVC	0.013	8.9643	2.614	

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SewerGEMS Results

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821	488	117.9	489	116.09	338.2	0.535	8	PVC	0.013	340.2359	85.749	
4537	1194	36.5	1195	34.7	339.6	0.53	8	PVC	0.013	3.1703	0.803	
4182	1134	241.4	1133	227.8	340.2	3.998	8	PVC	0.013	5.1543	0.475	
1907	MH-7268	85.85	487	84.9	340.2	0.28	10	Concrete	0.013	2.3215	0.446	
3075	810	101.88	777	99.22	532.7	0.499	12	Concrete	0.013	1,218.96	107.88	SM 7
4332	1157	44.19	1153	28.2	343.1	4.66	8	PVC	0.013	3.8094	0.325	
2029	MH-7822	135.09	398	133.72	343	0.4	6	Vitrified Clay	0.013	2.8045	1.761	
2055	603	74.81	1101	55.5	343.5	5.622	6	Vitrified Clay	0.013	7.8896	1.321	
2584	695	166.33	700	164.16	343.6	0.631	6	Vitrified Clay	0.013	0.4716	0.236	
3474	969	25.13	955	20.78	344.7	1.262	8	PVC	0.013	8.6402	1.418	
2304	413	232.63	421	228.26	345	1.267	8	PVC	0.013	5.761	0.944	
3088	MH-7823	0	82	249.08	344.1	Min. Slope	8	PVC	0.013	2.3844	0.052	
961	1396	7.37	829	5.99	344.7	0.4	8	Asbestos Cement	0.013	1.0654	0.311	
4054	1094	96.74	1093	92.61	344.3	1.199	8	PVC	0.013	0.7854	0.132	
1103	97	0	129	0	345.5	0	8	PVC	0.013	1.2524	23.091	
3720	972	12.96	980	11.89	345.7	0.309	8	Asbestos Cement	0.013	40.1266	13.3	
3071	82	249.08	1063	246.71	345.6	0.686	8	PVC	0.013	5.9109	1.316	
2437	678	98.72	682	97.34	345.9	0.4	6	Vitrified Clay	0.013	7.4081	4.651	
2805	1338	0	716	215.84	347.3	Min. Slope	8	PVC	0.013	267.1123	6.248	
2416	469	0	470	165.46	346.4	Min. Slope	8	PVC	0.013	1.9301	0.051	
1155	143	150.42	151	136.04	347.4	4.14	8	PVC	0.013	3.512	0.318	
4121	1104	259.37	1109	253.42	348	1.71	8	PVC	0.013	0.4881	0.069	
2045	671	62.48	MH-7637	61.09	348.7	0.4	6	Vitrified Clay	0.013	15.1897	9.537	
1353	300	30.3	251	25.11	348.8	1.488	8	PVC	0.013	4.2535	0.643	
2318	482	146.25	489	116.09	350.2	8.613	8	Asbestos Cement	0.013	219.6101	13.798	
7590	1361	254.2	1362	250.5	349.2	1.06	8	PVC	0.013	110.76	19.841	
626	MH-7824	0	514	0	350.4	0	8	PVC	0.013	5.8366	107.618	
2323	4	79.38	365	45.5	350.1	9.678	10	Asbestos Cement	0.013	589.0839	19.257	
3156	226	32.76	257	30.09	350.5	0.762	12	Asbestos Cement	0.013	10.3017	0.738	
3091	MH-7825	26.15	849	22.79	394.6	0.851	10	Asbestos Cement	0.013	11.8739	1.309	
1143	113	0	111	181.73	351	Min. Slope	8	Concrete	0.013	2.2477	0.058	
2428	MH-7806	107.69	675	106.29	351.2	0.4	6	Vitrified Clay	0.013	5.1567	3.238	
1368	MH-7810	86.51	896	85.1	351.4	0.4	6	Vitrified Clay	0.013	2.1096	1.324	
621	556	84.76	555	83.23	352.7	0.434	6	Concrete	0.013	8.7253	5.261	
2430	407	229.17	399	227.39	353.3	0.504	8	PVC	0.013	0.5522	0.143	
785	442	206.2	456	201.47	353.4	1.339	8	Asbestos Cement	0.013	175.4035	27.954	
332	28	17.31	MH-7270	17.11	352.8	0.058	30	PVC	0.013	4,064.69	92.027	
3144	1058	198.66	458	192.87	354	1.635	8	Asbestos Cement	0.013	12.3989	1.788	
2982	802	251.55	753	250.23	353.7	0.373	8	PVC	0.013	9.446	2.851	
3619	953	26.49	965	21.06	354.9	1.53	8	PVC	0.013	2.2308	0.333	
2815	720	0	727	219.47	355	Min. Slope	8	PVC	0.013	125.0696	2.933	
1725	510	42.99	1323	0	355.8	12.083	8	Concrete	0.013	26.3612	1.398	

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2305	421	228.26	432	219.23	356.8	2.531	8	PVC	0.013	9.136	1.059	
1352	301	0	735	0	356.7	0	8	PVC	0.013	9.6486	177.905	
1119	92	205.7	93	204.2	357.1	0.42	8	Concrete	0.013	5.2199	1.485	
148	544	0	MH-7471	0	358.3	0	6	Concrete	0.013	22.0166	874.27	
280	594	0	40	0	359.9	0	8	Concrete	0.013	10.49	193.42	
2450	1294	0	645	0	360.1	0	8	Asbestos Cement	0.013	0.7644	14.094	
2325	851	25.18	525	23.48	360.7	0.471	10	Asbestos Cement	0.013	591.7132	87.654	
1280	209	0	208	235.01	362.3	Min. Slope	8	PVC	0.013	5.4694	0.125	
2178	383	2.97	787	2.35	364.3	0.17	14	Asbestos Cement	0.013	880.0009	88.491	
2064	582	96.33	573	40.51	365.1	15.289	8	Vitrified Clay	0.013	27.8075	1.311	
2319	489	116.09	495	100.19	366	4.345	8	Asbestos Cement	0.013	563.428	49.84	
2054	786	1.72	784	1.09	366.5	0.17	14	Asbestos Cement	0.013	889.4365	89.432	
2177	648	3.59	383	2.97	367.3	0.17	14	Asbestos Cement	0.013	876.8052	88.169	
2317	468	175.36	482	146.25	369	7.889	8	Asbestos Cement	0.013	213.5964	14.022	
2980	798	0	755	0	369	0	8	PVC	0.013	11.9308	219.985	
2740	1098	0	626	0	369.7	0	8	PVC	0.013	3.927	72.408	
3608	3	40.51	221	39.44	368.7	0.29	10	PVC	0.013	66.829	12.615	
3917	290	84.11	340	78.79	370	1.438	8	PVC	0.013	9.3663	1.44	
1209	MH-7404	78.46	89	76.98	369.6	0.4	6	PVC	0.013	1.5085	0.947	
1281	214	0	213	236.33	370.2	Min. Slope	8	PVC	0.013	3.5913	0.083	
2243	MH-7451	242.59	MH-7263	241.1	372.3	0.4	6	Vitrified Clay	0.013	3.7327	2.344	
2816	722	224.94	729	215.17	373.3	2.617	8	PVC	0.013	3.628	0.413	
5226	685	165.6	1271	164.11	372.5	0.4	6	Vitrified Clay	0.013	14.7457	9.258	
1362	1234	60.46	899	58.96	373.6	0.4	6	Vitrified Clay	0.013	21.491	13.493	
2165	MH-7827	147.28	651	145.79	372.9	0.4	6	Vitrified Clay	0.013	0.7527	0.473	
2648	224	37.3	300	30.3	372.6	1.879	8	PVC	0.013	2.9141	0.392	
2179	787	2.35	786	1.72	373.9	0.17	14	Asbestos Cement	0.013	889.319	89.425	
3921	345	92.28	291	90.91	373.7	0.367	8	PVC	0.013	3.1095	0.947	
2176	667	4.23	648	3.59	374.2	0.17	14	Asbestos Cement	0.013	876.5863	88.143	
3827	268	0	298	0	373.6	0	8	PVC	0.013	5.2903	97.545	
4764	1232	230.47	1230	228.5	373.7	0.527	8	PVC	0.013	2.2186	0.563	
2272	580	0	577	0	373.7	0	8	Concrete	0.013	8.8019	162.294	
2120	475	0	474	143.74	374.6	Min. Slope	8	PVC	0.013	3.3673	0.1	
3040	826	3.95	825	2.45	375.5	0.4	8	Asbestos Cement	0.013	3.2917	0.96	
1472	MH-7828	93.75	MH-7700	92.25	375.4	0.4	8	Vitrified Clay	0.013	1.3572	0.396	
769	521	0	527	0	449	0	8	PVC	0.013	2.7628	50.941	
3524	288	94.47	289	51.28	375.5	11.5	8	PVC	0.013	3.2846	0.179	
2150	487	84.9	493	58.21	377.5	7.07	12	Concrete	0.013	1,459.28	34.322	
2819	728	214.12	733	202.85	378	2.981	8	Asbestos Cement	0.013	6.6956	0.715	
777	518	0	MH-7297	0	380.1	0	6	PVC	0.013	26.3493	1,046.32	
1139	132	0	134	167.93	380.5	Min. Slope	8	Concrete	0.013	146.8869	4.077	
4534	1191	111.58	1192	62.89	381.7	12.757	8	PVC	0.013	2.1776	0.112	

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1688	MH-7829	0	580	0	382	0	6	Concrete	0.013	1.1748	46.65	
4148	7	0	328	0	382	0	8	PVC	0.013	3.5078	64.679	
3818	298	0	301	0	382.7	0	8	PVC	0.013	8.0546	148.514	
3280	900	4.44	866	2.9	384.1	0.4	8	Vitrified Clay	0.013	49.9519	14.563	
1355	746	14.45	318	13.94	385.1	0.132	30	PVC	0.013	4,186.87	62.5	
4137	MH-7681	187.49	MH-7296	185.94	388.6	0.4	6	Concrete	0.013	3.8497	2.417	
3828	265	0	297	0	387.2	0	8	PVC	0.013	4.4772	82.553	
2316	458	192.87	468	175.36	388.9	4.503	8	Asbestos Cement	0.013	207.1771	18.002	
3092(1)	522	23.41	MH-7869	22.88	341	0.155	18	Concrete	0.013	1,490.23	80.181	SM 7
2473	789	209.04	788	0	390.5	53.526	8	PVC	0.013	2.4589	0.062	
1653	373	113.67	397	106.81	391.1	1.754	6	Vitrified Clay	0.013	2.1629	0.648	
3606	2	43.41	222	42.22	390.5	0.305	10	PVC	0.013	66.0544	12.168	
3998	1080	0	1079	0	392.5	0	8	PVC	0.013	10.6987	197.268	
3999	1079	0	1078	0	394.3	0	8	PVC	0.013	12.0308	221.83	
3116	247	6.92	853	5.19	395	0.438	8	PVC	0.013	7.2936	2.032	
947	195	10.93	1346	9.34	396.2	0.4	8	PVC	0.013	11.178	3.259	
3089	836	231.3	821	225.36	396.7	1.497	8	Concrete	0.013	40.6647	6.128	
1117	147	148.49	156	124.8	398.5	5.945	8	Concrete	0.013	750.925	56.785	
962	821	225.36	176	219.28	397.7	1.529	8	Concrete	0.013	45.5843	6.798	
2591	703	0	701	25.64	399.8	Min. Slope	8	PVC	0.013	6.6951	0.487	
2240	653	256.38	666	254.78	399.7	0.4	6	Vitrified Clay	0.013	2.4297	1.525	
3035	815	4.88	816	3.27	400.3	0.4	8	PVC	0.013	58.4606	17.043	
944	MH-7830	0	186	193	400	Min. Slope	8	Vitrified Clay	0.013	2.3662	0.063	
3833	287	0	319	24.41	400.2	Min. Slope	8	PVC	0.013	1.3862	0.104	
3037	814	6.49	815	4.88	402.3	0.4	8	PVC	0.013	51.2079	14.928	
2806	717	0	716	215.84	403	Min. Slope	8	PVC	0.013	3.1143	0.078	
1212	201	3.54	199	1.93	404.6	0.4	8	Asbestos Cement	0.013	15.4261	4.497	
1146	123	190.85	122	177.84	408.3	3.186	8	Concrete	0.013	574.75	59.368	
2478	63	15.52	1069	15.16	409.5	0.088	30	PVC	0.013	4,184.97	76.675	
2296	428	227.99	1298	210.15	410.4	4.347	8	PVC	0.013	24.0411	2.126	
1193	153	0	161	109.03	414.4	Min. Slope	6	Concrete	0.013	17.8264	1.38	
1346	751	0	317	0	414.7	0	8	Concrete	0.013	22.3759	412.577	
2275	546	0	544	0	415.3	0	8	Asbestos Cement	0.013	6.4529	118.982	
4113	297	0	1120	13.64	423.1	Min. Slope	8	PVC	0.013	8.5664	0.88	
4117	MH-7832	0	1107	0	424	0	1	PVC	0.013	1.0733	5,066.39	
4112	120	13.71	1120	12.76	423	0.225	30	PVC	0.013	4,191.73	48.049	
1137	MH-7833	0	133	165.9	426	Min. Slope	8	PVC	0.013	4.6415	0.137	
2106	757	0	391	0	431.3	0	8	PVC	0.013	21.5027	396.477	
1370	1271	164.11	877	162.38	432.4	0.4	6	Vitrified Clay	0.013	16.296	10.231	
3259	882	71.71	888	68.07	435.4	0.836	10	Vitrified Clay	0.013	61.6527	6.858	
1781	718	226.52	724	218.49	439.1	1.829	8	PVC	0.013	3.3257	0.453	
2442	659	113.21	674	107.93	440.9	1.197	6	Vitrified Clay	0.013	4.7335	1.718	

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43	545	0	66	0	444.3	0	8	PVC	0.013	5.2797	97.349	
2236	647	256.92	663	255.14	444.1	0.4	6	Vitrified Clay	0.013	2.7413	1.721	
1976	713	231.68	714	229.99	443.5	0.381	8	PVC	0.013	6.3582	1.899	
3596	230	37.8	229	35.9	443.9	0.428	8	PVC	0.013	0.6698	0.189	
141	10	0	527	0	448.3	0	8	PVC	0.013	1.6913	31.185	
2471	MH-7834	217.93	1317	216.12	451.5	0.4	6	Vitrified Clay	0.013	0.7859	0.493	
3625	962	0	964	13.74	450.8	Min. Slope	8	PVC	0.013	22.949	2.424	
2359	564	0	548	0	460.1	0	8	Concrete	0.013	65.4156	1,206.17	
3157	227	21.99	362	20.86	459.7	0.246	18	Concrete	0.013	1,568.34	67.095	
2796	MH-7835	0	712	222.88	461.4	Min. Slope	8	PVC	0.013	1.6173	0.043	
3158	257	30.09	MH-7825	26.15	462.6	0.852	12	Asbestos Cement	0.013	10.7492	0.728	
3624	1056	0	961	0	464.3	0	8	PVC	0.013	20.6559	380.864	
2363	MH-7836	0	512	0	465.7	0	8	PVC	0.013	2.4759	45.651	
3927	907	11.45	910	10.89	466.1	0.12	18	Concrete	0.013	2.5167	0.154	
1195	MH-7837	0	162	107.29	468	Min. Slope	8	Vitrified Clay	0.013	0.4493	0.017	
3137	254	19.21	253	18.56	467.9	0.139	18	Concrete	0.013	1,675.61	95.362	
1359	MH-7267	9.37	880	7.5	469.4	0.4	6	Vitrified Clay	0.013	11.4734	7.204	
1361	679	91.46	1274	43.5	469.5	10.215	6	Vitrified Clay	0.013	6.3738	0.792	
6331	MH-7838	0	510	42.99	470	Min. Slope	8	Concrete	0.013	1.6313	0.099	
3120	493	58.21	248	24.9	471.7	7.061	12	Concrete	0.013	1,462.52	34.42	
2793	MH-7839	0	429	195.31	470.5	Min. Slope	8	PVC	0.013	0.4493	0.013	
1766	83	193.75	235	178.3	481.7	3.207	6	Concrete	0.013	3.36	0.745	
3813	329	34.13	245	31.7	480.6	0.506	8	PVC	0.013	2.1352	0.554	
3092(2)	MH-7869	22.88	849	22.79	59.1	0.152	18	Concrete	0.013	1,517.86	82.527	SM 7
2048	662	93.4	679	91.46	485.7	0.4	6	Vitrified Clay	0.013	1.2464	0.783	
2465	635	165.52	643	163.57	486.6	0.4	6	Vitrified Clay	0.013	0.9292	0.583	
3669	1052	0	264	0	488.3	0	8	PVC	0.013	0.2582	4.761	
3932	909	10.51	908	9.54	489.8	0.198	18	Concrete	0.013	144.9965	6.912	
1675	MH-7840	0	595	0	493.7	0	8	PVC	0.013	3.4902	64.354	
1606	785	63.88	1410	0.26	498.3	12.769	6	Vitrified Clay	0.013	7.0101	0.779	
4147	1111	32.72	1112	31.62	500.6	0.22	12	PVC	0.013	17.323	2.31	
1364	684	170.67	MH-7348	168.73	483.8	0.4	6	Vitrified Clay	0.013	29.5786	18.571	
5196	1269	176.51	655	174.47	510	0.4	6	Vitrified Clay	0.013	0.4489	0.282	
2163	658	160.95	664	140.67	214.2	9.465	8	Vitrified Clay	0.013	293.8241	17.61	SM 9
4237	1144	158.3	1103	143.29	519.8	2.888	6	Vitrified Clay	0.013	2.2624	0.529	
2219	676	214.73	684	170.67	519.9	8.475	6	Vitrified Clay	0.013	16.5517	2.258	
3626	264	0	971	12.63	520.7	Min. Slope	8	PVC	0.013	0.5164	0.061	
4120	MH-7841	0	448	156.38	529.3	Min. Slope	6	Concrete	0.013	0.4493	0.033	
3252	879	135.73	1197	63.45	292.7	24.692	8	Vitrified Clay	0.013	314.9755	11.688	SM 9
3275	1197	63.45	892	62.27	293.5	0.4	8	Vitrified Clay	0.013	317.1266	92.461	SM 9
3229	874	66.91	872	63.58	533.3	0.624	10	Vitrified Clay	0.013	67.8948	8.738	
1528	769	223.73	418	206.25	542.4	3.223	8	PVC	0.013	10.8777	1.117	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

10-Year (2033) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
7993	664	140.67	1402	139.49	294.8	0.4	6	Vitrified Clay	0.013	298.8354	187.633	SM 9
505	MH-7842	136	621	133.79	553.3	0.4	6	Vitrified Clay	0.013	1.5381	0.966	
3115	853	9.92	812	7.69	557	0.4	8	PVC	0.013	17.2487	5.029	
2208	1265	133.89	699	131.65	559	0.4	6	Vitrified Clay	0.013	2.151	1.351	
1908	1384	99.1	478	91.31	627	1.242	12	Concrete	0.013	1,224.71	68.715	
CO-14	824	1.13	W-Port	0	7.5	14.984	8		0.013	77.7538	3.704	
CO-18	395	0	W-31st St	212.35	7.9	Min. Slope	8		0.013	5.9062	0.021	
CO-20	MH-7299	0.8	W-Gaines St	0.77	20	0.15	15		0.013	1,197.54	106.64	
CO-25	MH-7315	5.95	O-2	5.95	5.5	0.079	24	PVC	0.013	4,606.96	161.139	
2044	1402	139.49	1332	137.93	389.9	0.4	6	Vitrified Clay	0.013	307.7351	193.218	SM 9
1358	1332	137.93	879	135.73	550.7	0.4	8	Vitrified Clay	0.013	310.1589	90.422	SM 9
121(1)	792	1.42	MH-7870	1.31	48.7	0.22	12	Vitrified Clay	0.013	77.8938	10.39	
121(2)	MH-7870	1.31	9	0.85	211.3	0.22	12	Vitrified Clay	0.013	85.1387	11.351	
CO-29	882	71.71	1409	74.51	122.2	2.288	6	Vitrified Clay	0.013	7.3194	1.921	
CO-30	1409	74.51	884	74.13	94.1	Min. Slope	6	Vitrified Clay	0.013	5.9801	3.755	
2361(1)	571	0	MH-7871	0	397.2	0	8	Concrete	0.013	18.7676	346.046	
2361(2)	MH-7871	0	541	0	221	0	8	Concrete	0.013	22.6747	418.087	
343(1)	40	0	MH-7872	0	166.4	0	8	Concrete	0.013	11.6157	214.177	
343(2)	MH-7872	0	571	0	132.2	0	8	Concrete	0.013	13.7921	254.306	
CO-35	MH-7882	28.03	968	27.14	222.7	0.4	12		0.013	0	0	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

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3541	MH-7233	0	977	35.66	4.2	Min. Slope	8	PVC	0.013	0.3324	0.002	
6295	MH-7237	0	1301	160.15	5	Min. Slope	8	PVC	0.013	1.9253	0.006	
6309	MH-7238	0	1304	227.84	5	Min. Slope	6	PVC	0.013	0.7676	0.005	
7697	MH-7236	0	1139	8.22	5	Min. Slope	8	PVC	0.013	0.2472	0.004	
6286	MH-7240	0	1296	0	4.7	0	8	PVC	0.013	3.7604	69.337	
4349	MH-7241	0	1160	31.2	5.6	Min. Slope	8	PVC	0.013	0.7923	0.006	
2661	MH-7242	0	709	238.29	6.1	Min. Slope	6	PVC	0.013	252.2698	1.601	
3941	MH-7246	0	375	232.16	7	Min. Slope	8	PVC	0.013	1.1964	0.004	
8050	1408	0.03	W-Point Hudson	0	7.5	0.402	8	PVC	0.013	3.3192	0.965	
4601	1075	5.28	1203	5.08	7.9	2.529	10	PVC	0.013	176.693	11.298	
6968	MH-7249	0	430	189.16	8	Min. Slope	6	PVC	0.013	5.3263	0.043	
2744	MH-7251	0	1098	0	8.1	0	8	PVC	0.013	4.8001	88.506	
5378	MH-7252	65.68	MH-7253	65.64	8.1	0.401	6	PVC	0.013	0.9196	0.577	
2568	MH-7254	0	MH-7255	0	8.3	0	6	PVC	0.013	1.6982	67.435	
7664	1371	0	MH-7251	0	8.4	0	8	PVC	0.013	3.7685	69.485	
4682	MH-7256	0	423	229.23	8.4	Min. Slope	8	PVC	0.013	5.1723	0.018	
5243	MH-7257	7.41	1396	7.37	8.7	0.398	8	PVC	0.013	1.0374	0.303	
4277	MH-7258	0	379	0	8.9	0	6	PVC	0.013	1.1619	46.138	
7075	MH-7259	230.42	MH-7260	230.38	9	0.4	6	PVC	0.013	0.7216	0.453	
5083	MH-7261	0	1256	63.14	9.2	Min. Slope	8	PVC	0.013	0.74	0.005	
5293	1276	106.39	576	106.35	9.4	0.401	6	Concrete	0.013	2.3193	1.455	
7767	777	99.22	1384	99.1	9.6	1.251	12	Concrete	0.013	1,737.56	97.167	
5104	MH-7263	241.1	MH-7264	241.06	9.6	0.399	6	PVC	0.013	4.4082	2.771	
5618	263	102.77	MH-7267	102.73	10.1	0.399	6	PVC	0.013	10.418	6.552	
8090	1422	0	MH-7268	0	10.7	0	8	PVC	0.013	1.916	35.329	
914	532	0	68	0	11.5	0	6	PVC	0.013	1.2628	50.146	
4437	125	0	W-Island Vista	0	10.7	0	8		0.013	15.4896	285.605	
4074	MH-7269	57.58	1096	57.53	11.8	0.425	8	PVC	0.013	0.4411	0.125	
6445	MH-7272	54.08	1188	31.43	12	188.75	10	Vitrified Clay	0.013	568.5213	4.208	
909	MH-7270	17.11	65	17.1	12	0.047	30	PVC	0.013	4,751.69	119.185	
7636	MH-7271	0	1367	49.42	12	Min. Slope	8	PVC	0.013	0.6503	0.006	
4020	386	0	395	0	12.4	0	8	PVC	0.013	0	0	
4652	MH-7275	0	1216	118.6	12.9	Min. Slope	8	PVC	0.013	0.4411	0.003	
108	MH-7276	91.59	8	91.54	13	0.384	6	PVC	0.013	1.2087	0.774	
5627	MH-7277	95.28	MH-7278	95.28	13	0	6	PVC	0.013	4.1508	164.828	
4395	MH-7279	0	1175	47.1	13.3	Min. Slope	8	PVC	0.013	0.9193	0.009	
2299	444	209.12	443	207.81	13.4	9.746	8	PVC	0.013	39.4206	2.328	
6265	MH-7280	0	1291	0	13.6	0	8	PVC	0.013	0.914	16.854	
7637	MH-7284	0	1369	52.12	14	Min. Slope	8	PVC	0.013	0.9791	0.009	
6780	MH-7281	90.28	MH-7282	90.23	14	0.4	6	PVC	0.013	0.5388	0.338	
6655	1333	0	MH-7283	0	14	0	8	PVC	0.013	4.3541	80.283	
7663	1370	0	1371	0	14.1	0	8	PVC	0.013	2.0632	38.042	
4701	MH-7285	0	1222	245.52	14.7	Min. Slope	8	PVC	0.013	0	0	
4822	1235	244.06	MH-7286	244	14.8	0.401	6	PVC	0.013	1.4103	0.884	
4073	MH-7287	57.59	1096	57.53	14.8	0.4	8	PVC	0.013	1.5056	0.439	
5025	MH-7288	0	1252	0	15	0	8	PVC	0.013	1.1749	21.664	

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General Sewer Plan
SewerGEMS Results

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6544	MH-7289	0	624	0	15.2	0	6	Concrete	0.013	2.0894	82.97	
8082	1490	0	1420	237.45	15.3	Min. Slope	6	PVC	0.013	1.0619	0.011	
4330	MH-7290	0	1156	0	16	0	6	PVC	0.013	0.5706	22.66	
7457	MH-7291	0	MH-7292	0	16	0	8	PVC	0.013	32.7467	603.801	
5095	MH-7293	0	498	76.94	16.2	Min. Slope	6	Concrete	0.013	11.9091	0.217	
3170	857	1.61	W-Monroe	1.56	16.6	0.28	10		0.013	921.7406	177.202	
4658	MH-7294	0	1218	108.9	16.8	Min. Slope	8	PVC	0.013	1.0986	0.008	
6256	MH-7295	75.67	892	62.27	17	78.826	10	Asbestos Cement	0.013	140.5805	1.61	
8093	1424	115.86	579	107.1	17.1	51.303	8	PVC	0.013	1.1452	0.029	
4427	MH-7296	185.94	636	185.87	17.2	0.4	6	PVC	0.013	5.304	3.332	
5090	MH-7297	0	528	0	17.5	0	6	Asbestos Cement	0.013	30.9041	1,227.19	
118	9	0.85	783	0.82	17.5	0.15	15	PVC	0.013	95.2281	8.489	
4653	MH-7298	0	1216	118.6	17.6	Min. Slope	8	PVC	0.013	0.4411	0.003	
117	783	0.82	MH-7299	0.8	17.9	0.112	18	PVC	0.013	318.9053	20.252	
7339	MH-7300	145.64	MH-7301	134.11	18	64.056	6	PVC	0.013	2.2909	0.114	
3961	MH-7302	0	178	227.58	18.1	Min. Slope	8	PVC	0.013	17.9554	0.093	
6250	1148	0	538	0	18.3	0	8	PVC	0.013	4.2663	78.665	
3171	869	1.68	857	1.61	18.6	0.4	10		0.013	83.44	13.412	
6917	MH-7303	0	MH-7304	224.94	18.7	Min. Slope	6	PVC	0.013	1.0316	0.012	
8030	1458	0	1214	62.82	19.2	Min. Slope	8		0.013	0.4038	0.004	
1415	MH-7305	38.16	490	38.08	19	0.4	8	PVC	0.013	0.3827	0.112	
4784	MH-7306	0	1232	230.47	19.9	Min. Slope	8	PVC	0.013	0.4566	0.002	
6259	MH-7307	0	714	229.99	20	Min. Slope	8	PVC	0.013	1.0316	0.006	
6656	MH-7308	0	1333	0	20	0	6	PVC	0.013	1.1414	45.325	
6852	MH-7309	0	974	0	20	0	8	PVC	0.013	0.7699	14.195	
7644	850	12.04	1070	15.65	20.1	Min. Slope	8	PVC	0.013	2.5042	0.109	
8004	MH-7310	229.8	MH-7311	229.72	20.1	0.399	6	PVC	0.013	0.8725	0.548	
2636	987	5.97	MH-7315	5.95	20.4	0.08	24	PVC	0.013	5,374.32	186.952	
81	MH-7314	0	181	207.93	20.3	Min. Slope	6	PVC	0.013	1.0814	0.013	
3949	MH-7316	0	509	33.34	20.8	Min. Slope	6	PVC	0.013	1.1331	0.036	
6444	MH-7317	54.14	MH-7272	54.08	21	0.28	10	PVC	0.013	568.4034	109.239	
4628	1211	200.67	W-Hamilton Heights	0	21	954.232	8	PVC	0.013	9.0703	0.054	
7743	MH-7318	13.05	1382	12.97	21.1	0.399	6	Vitrified Clay	0.013	8.0605	5.064	
3804	MH-7319	0	MH-7320	0	21.3	0	6	PVC	0.013	1.0051	39.913	
7225	MH-7323	0	MH-7324	0	22	0	6	PVC	0.013	16.5332	656.526	
3948	MH-7321	0	1050	60.71	22	Min. Slope	8	PVC	0.013	2.1854	0.024	
4797	1233	165.9	MH-7322	0	22	754.961	8	PVC	0.013	3.5184	0.024	
7195	MH-7325	0	38	0	22	0	8	PVC	0.013	0.4411	8.133	
4793	MH-7326	0	457	0	22.2	0	6	PVC	0.013	0.7676	30.481	
1175	MH-7327	0	118	216.24	22.7	Min. Slope	8	PVC	0.013	1.2947	0.008	
6639	6	3.68	1328	3.62	22.6	0.28	10	Vitrified Clay	0.013	57.0427	10.972	
6526	849	22.79	MH-7328	22.77	22.8	0.088	18	Concrete	0.013	2,112.77	151.453	
6779	MH-7329	90.12	MH-7330	90.02	24	0.4	6	PVC	0.013	0.9398	0.59	
2002	377	0	586	0	24.4	0	6	Concrete	0.013	39.4638	1,567.09	
7192	41	0	MH-7331	0	24.6	0	8	PVC	0.013	4.2677	78.69	
4085	MH-7332	0	708	0	24.6	0	6	PVC	0.013	0.3083	12.242	

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SewerGEMS Results

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5290	MH-7333	2.89	887	2.79	24.7	0.401	6	PVC	0.013	3.6833	2.311	
4393	MH-7334	0	1174	37.1	24.7	Min. Slope	8	PVC	0.013	0.4411	0.007	
4017	1087	16.07	1086	16.04	24.7	0.122	30	PVC	0.013	4,845.87	75.512	
2791	MH-7335	0	618	182.45	25	Min. Slope	8	PVC	0.013	1.4141	0.01	
5611	MH-7336	38.69	MH-7337	38.59	25.5	0.4	6	PVC	0.013	10.0871	6.333	
5080	1255	55.28	1164	0	25.5	216.568	8	PVC	0.013	3.358	0.042	
2811	726	210.79	725	210.4	25.6	1.523	8	PVC	0.013	9.8587	1.473	
5430	1088	6.2	1279	6.1	25.8	0.401	8	PVC	0.013	15.3167	4.462	
4164	1125	0	475	0	26	0	6	PVC	0.013	2.5909	102.885	
1104	MH-7338	0	129	0	26.2	0	8	PVC	0.013	9.6233	177.44	
3806	MH-7339	0	325	0	26.2	0	6	PVC	0.013	4.0894	162.389	
4905	MH-7340	0	1243	245.5	26.5	Min. Slope	8	PVC	0.013	0	0	
5432	MH-7341	13.16	MH-7318	13.05	26.8	0.4	6	PVC	0.013	7.86	4.935	
848	MH-7342	0	MH-7343	0	26.9	0	8	PVC	0.013	1.3591	25.059	
4904	MH-7344	0	1241	244.91	26.9	Min. Slope	8	PVC	0.013	0	0	
6778	MH-7282	90.23	MH-7329	90.12	27	0.4	6	Concrete	0.013	0.7393	0.464	
1161	158	118.13	159	117.39	254.2	0.291	18	PVC	0.013	1,206.81	47.447	SM 1
2335	630	142.13	631	129.09	27.3	47.673	8	PVC	0.013	9.4849	0.253	
4348	MH-7346	0	1159	34.13	27.7	Min. Slope	8	PVC	0.013	1.3303	0.022	
3798	MH-7320	0	326	0	27.7	0	8	PVC	0.013	1.4462	26.666	
6428	1310	150.56	396	144.34	28.2	22.047	6	Vitrified Clay	0.013	11.9814	1.013	
3221	MH-7348	168.73	898	163.4	47.2	11.283	6	Vitrified Clay	0.013	36.8203	4.353	
4697	MH-7347	0	1225	256	28.4	Min. Slope	8	PVC	0.013	0	0	
2188	513	0	511	0	28.5	0	8	PVC	0.013	7.5941	140.024	
7602	819	90.93	818	79.5	29	39.369	6	PVC	0.013	1.8346	0.116	
5452	782	1.83	MH-7349	1.75	29	0.28	10	Vitrified Clay	0.013	86.4676	16.623	
3954	MH-7350	0	724	218.49	29.5	Min. Slope	6	PVC	0.013	1.0316	0.015	
3963	79	245.17	1062	244.61	30.1	1.863	8	PVC	0.013	12.6977	1.715	
7224	MH-7324	0	544	0	30.1	0	6	Concrete	0.013	16.937	672.561	
2344	595	0	594	0	30.2	0	8	Concrete	0.013	10.7029	197.345	
6440	1423	0	MH-7351	0	30.4	0	8	PVC	0.013	1.5292	28.196	
3945	MH-7352	0	954	44.48	30.4	Min. Slope	8	PVC	0.013	0.3324	0.005	
4346	MH-7353	0	1158	43.3	31	Min. Slope	8	PVC	0.013	0.4038	0.006	
908	71	0	65	18.15	31.1	Min. Slope	8	PVC	0.013	19.5984	0.473	
8029	MH-7354	56.81	1403	56.68	31.5	0.4	6	Vitrified Clay	0.013	28.8833	18.135	
6317	1307	226.73	49	226.02	32.3	2.198	8	PVC	0.013	6.0558	0.753	
7728	1380	153.85	MH-7355	119.88	32.7	104.037	6	Vitrified Clay	0.013	1.0684	0.042	
3172	858	1.7	857	1.61	32.8	0.28	10		0.013	838.1826	161.125	
6273	657	189.42	1293	187.63	33.1	5.41	8	PVC	0.013	3.6307	0.288	
6652	MH-7356	86.62	MH-7357	86.49	33.1	0.399	6	Vitrified Clay	0.013	0.3838	0.241	
3950	MH-7358	0	509	33.34	33.3	Min. Slope	4	PVC	0.013	2.4671	0.289	
34	259	0	1073	0	33.5	0	8	PVC	0.013	18.265	336.78	
776	516	0	518	0	33.7	0	6	Asbestos Cement	0.013	24.935	990.159	
6536	252	19.72	MH-7359	19.58	33.8	0.414	18	PVC	0.013	2,280.77	75.158	
3444	918	13.84	970	13.8	33.9	0.118	8	Asbestos Cement	0.013	43.3371	23.269	
3785	MH-7360	64.36	MH-7361	64.23	34	0.4	6	PVC	0.013	6.4775	4.067	

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SewerGEMS Results

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137	MH-7362	0	914	59.55	35	Min. Slope	6	PVC	0.013	1.3486	0.041	
915	67	17	68	16.7	35.1	0.854	30	PVC	0.013	4,808.66	28.261	
7582	1354	270.4	1348	263.2	35.4	20.321	8	PVC	0.013	104.7266	4.284	
4323	1152	23.88	MH-7363	0	35.6	67.086	8	PVC	0.013	7.77	0.175	
140	MH-7365	0	10	0	36	0	8	PVC	0.013	1.5609	28.781	
3957	MH-7364	0	142	167.92	35.9	Min. Slope	8	PVC	0.013	1.0619	0.009	
1695	MH-7366	0	610	0	36.8	0	6	PVC	0.013	1.1444	45.445	
4623	MH-7367	0	1209	233	37	Min. Slope	8	PVC	0.013	0.7979	0.006	
7691	1377	0	1215	237.3	37.1	Min. Slope	8	PVC	0.013	1.0619	0.008	
38	530	0	848	0	37.1	0	8	PVC	0.013	6.5586	120.931	
3811	MH-7368	0	324	0	37.5	0	8	PVC	0.013	7.3454	135.437	
24	MH-7369	0	44	224.41	37.6	Min. Slope	8	PVC	0.013	1.0316	0.008	
7821	1393	61.2	240	59.6	37.9	4.219	8	PVC	0.013	3.5288	0.317	
7338	651	145.79	MH-7300	145.64	38	0.4	6	Vitrified Clay	0.013	2.1729	1.364	
4737	1228	0	1200	42.99	38.1	Min. Slope	6	Concrete	0.013	20.8358	0.779	
8048	1406	41.07	MH-7370	40.92	38.3	0.4	8	Vitrified Clay	0.013	0.401	0.117	
7593	1352	256.2	1359	256	38.1	0.524	8	PVC	0.013	112.9794	28.767	
107	MH-7371	91.74	MH-7276	91.59	37.1	0.4	6	PVC	0.013	0.7676	0.482	
7887	MH-7374	0	MH-7375	0	39	0	8	Ductile Iron	0.013	3.2707	60.306	
4773	MH-7376	0	1231	228.5	39.4	Min. Slope	6	PVC	0.013	1.0769	0.018	
3685	984	8.31	986	8.34	39.5	Min. Slope	18	PVC	0.013	180.3517	13.879	
8078	1487	242.62	1417	242.34	39.8	0.704	8		0.013	1.0619	0.233	
1993	MH-7377	0	598	0	39.8	0	6	Concrete	0.013	0.6286	24.96	
4052	1091	74.56	MH-7378	48.91	39.9	64.249	8	PVC	0.013	7.7872	0.179	
3080	MH-7379	0	809	0	40	0	8	PVC	0.013	2.3706	43.71	
58	MH-7380	0	519	0	40	0	8	PVC	0.013	0.7027	12.956	
813	249	0	250	24.49	40.4	Min. Slope	8	PVC	0.013	17.4537	0.413	
4774	MH-7382	0	1231	228.5	40.5	Min. Slope	6	PVC	0.013	0.367	0.006	
4098	411	68.14	MH-7383	68.3	40.7	Min. Slope	6	PVC	0.013	0.7118	0.447	
7597	MH-7384	0	136	0	41.6	0	8	PVC	0.013	31.5327	581.416	
4413	MH-7387	0	1173	35.4	42	Min. Slope	8	PVC	0.013	1.9355	0.039	
4507	MH-7388	0	1187	29.54	42.1	Min. Slope	8	PVC	0.013	0.2472	0.005	
3029	817	4.97	828	4.8	42.1	0.4	8	PVC	0.013	1.303	0.38	
1204	189	0	190	171.7	42.7	Min. Slope	8	PVC	0.013	33.4697	0.308	
3996	867	5.72	1076	6.08	42.7	Min. Slope	8	Vitrified Clay	0.013	151.8432	30.694	
6742	MH-7389	0	1315	0	43	0	8	Ductile Iron	0.013	3.838	70.767	
7680	MH-7390	242.87	1373	242.7	43.1	0.4	8	PVC	0.013	1.0619	0.309	
4276	MH-7391	6	862	5.83	43.2	0.4	6		0.013	0.8931	0.561	
938	MH-7392	0	74	212.1	43.4	Min. Slope	8	PVC	0.013	0.5192	0.004	
4809	MH-7393	0	MH-7394	0	43.6	0	8	PVC	0.013	1.2772	23.55	
4345	MH-7395	0	1158	43.3	43.6	Min. Slope	8	PVC	0.013	0.4038	0.007	
4282	1151	10.62	908	9.54	44.1	2.447	8	PVC	0.013	1.7788	0.21	
4018	1086	16.04	1073	15.99	44.2	0.113	30	PVC	0.013	4,846.27	78.286	
2136	479	90.04	481	89.04	44.4	2.252	12	Concrete	0.013	1,820.35	75.866	
3953	MH-7396	0	409	221.44	44.6	Min. Slope	8	PVC	0.013	2.1805	0.018	
7744	1382	12.97	MH-7570	12.79	44.7	0.4	6	PVC	0.013	8.261	5.187	

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20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
6281	1303	0	1294	0	45	0	4		0.013	0.4847	56.745	
5100	583	87.42	MH-7397	15.18	45.4	159.225	6	Vitrified Clay	0.013	4.8224	0.152	
4130	24	0	1089	0	45.5	0	6	PVC	0.013	1.7773	70.574	
627	MH-7400	0	975	0	46.3	0	6	Concrete	0.013	2.4938	99.028	
3684	986	8.34	987	5.97	46.2	5.135	18	PVC	0.013	191.0272	1.788	
7617	MH-7398	0	MH-7399	0	46.2	0	6	PVC	0.013	2.5778	102.362	
1159	156	124.8	157	123.66	265.8	0.429	18	PVC	0.013	1,200.58	38.882	SM 1
5626	MH-7278	95.28	1189	95.28	46.7	0	6	Vitrified Clay	0.013	4.3513	172.79	
5252	MH-7401	0	MH-7402	0	46.9	0	6	PVC	0.013	1.0316	40.964	
4142	818	79.5	303	0	46.9	169.573	6	PVC	0.013	2.0818	0.063	
906	1070	15.65	63	15.52	46.9	0.277	30	PVC	0.013	4,888.91	50.453	
6285	1296	0	413	232.63	48.2	Min. Slope	8	PVC	0.013	4.792	0.04	
2417	405	234.19	406	233.93	48.2	0.539	8	PVC	0.013	6.5385	1.642	
3768	MH-7405	0	319	0	48.8	0	8	PVC	0.013	1.921	35.421	
6662	1335	68.14	MH-7404	78.46	48.8	Min. Slope	6	PVC	0.013	0.6322	0.055	
213	356	31.83	1112	31.62	49.7	0.423	12	PVC	0.013	84.7056	8.149	
5103	MH-7264	241.06	1237	240.86	49.8	0.4	6	Vitrified Clay	0.013	4.5262	2.842	
339	253	18.56	31	18.01	50	1.1	18	PVC	0.013	2,288.01	46.284	
3946	MH-7406	0	951	23.84	50	Min. Slope	8	PVC	0.013	0.3324	0.009	
6436	1317	216.12	1320	215.13	50.4	1.966	6	Vitrified Clay	0.013	4.0755	1.154	
4381	MH-7407	0	1171	0	51	0	8	PVC	0.013	1.0619	19.58	
2291	535	0	534	0	51.3	0	8	PVC	0.013	27.4343	505.847	
6304	1264	0	1149	0	51.6	0	6	Concrete	0.013	19.9336	791.556	
3112	1071	0	841	0	51.7	0	8	PVC	0.013	3.1567	58.204	
7258	MH-7408	86.23	MH-7409	86.02	51.7	0.4	6	Vitrified Clay	0.013	1.5301	0.96	
7810	MH-7410	0	1387	0	52.6	0	8	PVC	0.013	0.86	15.857	
536	MH-7411	0	62	0	53	0	6	PVC	0.013	0.4538	18.019	
1523	MH-7412	0	424	230.12	53.1	Min. Slope	6	PVC	0.013	1.1166	0.021	
6434	1315	0	1314	207.55	53.3	Min. Slope	8	PVC	0.013	5.9864	0.056	
4331	1222	245.52	1156	0	53.2	461.678	8	PVC	0.013	1.3156	0.011	
5118	MH-7413	33.41	195	33.2	53.4	0.4	8	PVC	0.013	3.2835	0.957	
3085	762	9.04	811	8.83	53.6	0.4	8	PVC	0.013	10.6764	3.112	
752	MH-7414	0	592	0	53.9	0	8	PVC	0.013	1.4877	27.432	
8073	1486	0	1418	240.14	54	Min. Slope	8		0.013	1.2059	0.011	
6529	1323	0	1322	0	54.2	0	8	Concrete	0.013	32.885	606.349	
247	15	0	18	109.67	54.5	Min. Slope	8	PVC	0.013	4.2772	0.056	
5465	682	97.34	MH-7415	86.06	55.1	20.487	8	Vitrified Clay	0.013	113.7888	4.635	
7824	MH-7416	123.42	1391	123.2	55.4	0.4	6	PVC	0.013	0.4411	0.277	
46	76	0	622	164.08	55.6	Min. Slope	8	PVC	0.013	2.1565	0.023	
4364	1166	247.99	1165	247.75	56	0.428	8	PVC	0.013	4.0932	1.153	
2015	399	227.39	395	0	56.4	402.843	8	PVC	0.013	5.0064	0.046	
4853	1239	118.24	MH-7348	117.92	79.3	0.4	6	Vitrified Clay	0.013	4.7645	2.991	
4508	MH-7418	0	1187	29.54	57.1	Min. Slope	8	PVC	0.013	1.583	0.041	
249	MH-7419	0	14	0	57.9	0	6	PVC	0.013	2.748	109.123	
1784	MH-7420	0	723	216.42	58.2	Min. Slope	6	PVC	0.013	1.6838	0.035	
1150	318	13.94	120	13.71	58.1	0.396	30	PVC	0.013	4,897.34	42.292	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
4178	1316	204.4	1130	204.6	58.2	Min. Slope	8	PVC	0.013	7.5216	2.365	
1265	167	230.66	173	229.42	58.4	2.123	8	Concrete	0.013	9.2502	1.171	
3198	MH-7421	3.38	MH-7422	0	59	5.72	6	PVC	0.013	2.4432	0.406	
4626	1212	204	1206	202.4	59.4	2.694	8	PVC	0.013	4.6262	0.52	
7156	1340	0	188	0	59.8	0	8	PVC	0.013	31.1357	574.095	
5190	1266	240.91	215	240.77	60	0.233	8	PVC	0.013	143.9761	54.974	
4522	MH-7423	0	1190	25.25	60	Min. Slope	6	PVC	0.013	0.7807	0.048	
3380	MH-7424	0	914	59.55	60.3	Min. Slope	8	PVC	0.013	1.9798	0.037	
5377	640	65.92	MH-7252	65.68	60.4	0.4	6	Vitrified Clay	0.013	0.118	0.074	
4006	1078	0	1077	0	60.3	0	8	PVC	0.013	12.1259	223.584	
2322	508	0	4	79.38	60.3	Min. Slope	8	Asbestos Cement	0.013	23.819	0.383	
6003	1145	0	MH-7425	0	60.7	0	6	PVC	0.013	1.5058	59.793	
3696	978	0	975	0	60.7	0	8	PVC	0.013	3.8438	70.873	
341	31	18.01	1309	17.86	61	0.246	30	PVC	0.013	4,029.47	44.148	
7598	650	65.03	1416	64.78	61.1	0.4	6	Vitrified Clay	0.013	3.6242	2.276	
4149	MH-7429	0	1114	0	62	0	8	PVC	0.013	0.882	16.263	
6648	MH-7427	98.48	MH-7428	98.23	62	0.4	6	Ductile Iron	0.013	0.2005	0.126	
1173	MH-7426	0	118	216.24	62	Min. Slope	8	PVC	0.013	9.5578	0.094	
254	MH-7431	0	232	168.8	62.3	Min. Slope	6	Concrete	0.013	2.383	0.058	
26	45	0	MH-7432	0	62.8	0	8	PVC	0.013	5.302	97.762	
116	793	0.89	MH-7299	0.8	62.9	0.15	15	PVC	0.013	890.253	79.255	
5464	MH-7415	86.06	MH-7433	85.8	63.5	0.4	8	PVC	0.013	116.4817	33.963	
6418	MH-7434	0	489	116.09	64	Min. Slope	8	PVC	0.013	2.5446	0.035	
7537	1342	0	1345	165.16	64.2	Min. Slope	8	PVC	0.013	1.1099	0.013	
3929	MH-7435	0	1121	12.47	64.5	Min. Slope	8	PVC	0.013	33.5923	1.409	
6315	1305	227.68	1306	227.09	64.7	0.912	8	PVC	0.013	1.9037	0.368	
7257	MH-7409	86.02	MH-7436	85.76	65	0.4	6	PVC	0.013	1.6481	1.035	
4614	MH-7437	0	1208	224.51	65.3	Min. Slope	8	PVC	0.013	0.9575	0.01	
4025	MH-7438	174.99	1262	174.73	66.1	0.4	6	Vitrified Clay	0.013	3.3766	2.12	
3971	591	0	1072	0	66.2	0	8	Asbestos Cement	0.013	5.7535	106.085	
6653	MH-7357	86.49	MH-7408	86.23	66.1	0.4	6	PVC	0.013	1.2234	0.768	
2093	438	0	440	0	66.4	0	8	PVC	0.013	0.7676	14.153	
5363	554	66.74	1278	66.48	66.3	0.4	8	Concrete	0.013	12.2151	3.56	
7984	1450	0	1401	74.5	66.4	Min. Slope	8		0.013	1.1394	0.02	
6112	971	12.63	1285	12.17	66.6	0.69	10	PVC	0.013	170.5141	20.872	
1705	MH-7439	0	738	0	66.6	0	6	PVC	0.013	0.2472	9.816	
2302	MH-7440	0	456	201.47	67	Min. Slope	6	PVC	0.013	3.0447	0.07	
5331	MH-7441	104.57	MH-7442	74.78	67.4	44.203	6	Vitrified Clay	0.013	5.1554	0.308	
8062	781	2.48	843	2.21	67.9	0.397	8	Asbestos Cement	0.013	219.6691	64.246	
6671	MH-7443	0	MH-7444	0	68.5	0	8	PVC	0.013	0.6413	11.824	
4394	1368	47.44	1175	47.1	68.7	0.495	8	PVC	0.013	3.7596	0.985	
1287	203	229.22	205	228.88	68.7	0.495	8	PVC	0.013	5.7384	1.504	
1011	200	77.26	89	76.98	69	0.4	8	PVC	0.013	2.2228	0.648	
2330	MH-7445	120.79	665	113.91	69.3	9.919	8	Vitrified Clay	0.013	63.4843	3.717	
2285	567	0	562	0	69.7	0	8	PVC	0.013	1.3153	24.252	
4768	MH-7447	0	1229	222.79	69.9	Min. Slope	8	PVC	0.013	0.5072	0.005	

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959	86	1.41	824	1.13	70	0.4	8	Asbestos Cement	0.013	82.343	23.999	
4488	MH-7448	0	1184	0	70.3	0	6	PVC	0.013	1.0316	40.964	
1291	MH-7449	0	217	0	70.4	0	8	PVC	0.013	2.1238	39.16	
4636	MH-7450	0	1215	237.3	70.9	Min. Slope	8	PVC	0.013	30.8782	0.311	
1260	159	117.39	160	116	265.7	0.523	18	PVC	0.013	1,532.14	44.929	SM 1
2277	537	0	536	0	71.5	0	8	PVC	0.013	8.7291	160.951	
4132	17	242.87	MH-7451	242.59	71.7	0.4	6	PVC	0.013	2.0972	1.317	
1773	MH-7452	0	728	214.12	71.7	Min. Slope	6	Asbestos Cement	0.013	1.4181	0.033	
8058	1415	254.57	1361	254.2	73.3	0.498	8	PVC	0.013	116.1651	30.355	
6293	1300	0	191	155.6	72	Min. Slope	8	PVC	0.013	4.0839	0.051	
3683	981	19.17	986	8.34	72.1	15.015	8	PVC	0.013	10.2345	0.487	
6471	1319	148.44	447	144.4	73	5.538	8	Concrete	0.013	29.575	2.317	
5061	MH-7454	0	MH-7455	0	72.8	0	6	PVC	0.013	0.5147	20.439	
4867	MH-7456	0	180	215.1	73	Min. Slope	8		0.013	0.7676	0.008	
4218	1135	6.12	987	5.97	73.3	0.205	30	PVC	0.013	5,120.78	61.473	
1001	MH-7457	0	168	232.2	73.3	Min. Slope	6	PVC	0.013	2.7096	0.06	
3160	540	0	225	33.71	74	Min. Slope	8	Asbestos Cement	0.013	9.3582	0.256	
5094	491	95.78	MH-7458	76.94	74.2	25.391	6	PVC	0.013	8.2957	0.654	
335	29	17.57	28	17.31	74.4	0.35	30	PVC	0.013	4,750.89	43.645	
7626	MH-7459	79.05	1364	78.75	74.7	0.4	6	Vitrified Clay	0.013	4.0338	2.533	
1290	MH-7460	0	216	0	74.8	0	8	PVC	0.013	1.0619	19.58	
1668	MH-7461	124.66	575	124.36	74.9	0.4	6	Vitrified Clay	0.013	0.2005	0.126	
4627	MH-7462	0	1211	200.67	75.1	Min. Slope	8	PVC	0.013	9.0703	0.102	
3628	917	30.66	MH-7463	0	75.2	40.79	8	PVC	0.013	1.4202	0.041	
3138	MH-7359	19.58	254	19.21	75.8	0.488	18	Concrete	0.013	2,281.53	69.267	
619	MH-7464	113.51	659	113.21	76.1	0.4	6	Vitrified Clay	0.013	0.9915	0.623	
6025	MH-7466	253.41	1283	253.1	76.4	0.4	8	PVC	0.013	2.3374	0.681	
7578	1349	260.5	1350	260	76.6	0.653	8	PVC	0.013	107.8214	24.601	
6290	423	229.23	1297	227.99	76.8	1.614	8	PVC	0.013	26.0868	3.786	
3987	MH-7467	65.4	MH-7468	65.09	77.6	0.4	6	PVC	0.013	0.118	0.074	
3988	MH-7468	65.09	1416	64.78	77.8	0.4	6	PVC	0.013	2.3248	1.46	
33	1073	15.99	1074	15.9	78.1	0.115	30	PVC	0.013	4,864.94	77.861	
508	MH-7469	2.05	782	1.83	78.2	0.28	10	Vitrified Clay	0.013	86.2671	16.584	
2911	804	0	797	0	77.9	0	8	PVC	0.013	2.3029	42.462	
4119	1105	260.05	1104	259.37	79.1	0.86	8	PVC	0.013	0.1417	0.028	
6314	MH-7470	0	1305	227.68	79.9	Min. Slope	8	PVC	0.013	0.7676	0.008	
601	MH-7471	0	67	0	80	0	8	PVC	0.013	27.5982	508.869	
6284	MH-7508	32.22	873	12	98.5	20.537	8	Vitrified Clay	0.013	20.0258	0.815	SM 10
2256	612	0	1149	0	80.3	0	8	PVC	0.013	4.3496	80.2	
5093	1258	121.11	MH-7445	120.79	80.4	0.4	6	Vitrified Clay	0.013	9.4189	5.913	
2566	MH-7255	0	518	0	80.3	0	8	PVC	0.013	2.4628	45.41	
3787	304	0	305	0	80.3	0	8	Concrete	0.013	10.715	197.569	
1230	MH-7473	0	106	212.61	81	Min. Slope	8	Concrete	0.013	1.7447	0.02	
8070	215	240.77	1418	240.14	81.5	0.773	8	PVC	0.013	145.0379	30.425	
4823	MH-7474	244.39	1235	244.06	81.6	0.4	6	PVC	0.013	0.6462	0.406	
4613	1205	210.25	1206	202.4	81.7	9.605	8	PVC	0.013	4.2207	0.251	

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Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
4150	1114	0	1113	0	82.1	0	8	PVC	0.013	1.5249	28.117	
1598	553	66.01	551	65.68	82.4	0.4	6	Concrete	0.013	13.2588	8.323	
2113	402	235.19	401	234.64	84.3	0.653	8	PVC	0.013	12.7611	2.913	
7538	144	0	1345	165.16	84.2	Min. Slope	6	Concrete	0.013	17.7892	0.505	
918	65	17.1	66	17	84.4	0.12	30	PVC	0.013	4,771.85	74.816	
3673	993	7.64	989	6.99	84.5	0.77	8	Concrete	0.013	61.3069	12.886	
2112	1270	0	402	235.19	83.3	Min. Slope	8	PVC	0.013	8.3809	0.092	
354	33	0	MH-7478	0	84.7	0	8	PVC	0.013	2.5023	46.139	
4179	MH-7477	0	1131	218.5	84.7	Min. Slope	8	PVC	0.013	4.7871	0.055	
5487	MH-7479	0	MH-7480	0	85	0	4	Vitrified Clay	0.013	0.9275	108.59	
261	21	0	MH-7481	0	85.5	0	6	PVC	0.013	3.1069	123.373	
3783	MH-7361	64.23	785	63.88	86.5	0.4	6	Vitrified Clay	0.013	6.678	4.194	
6527	873	12	1321	10.4	205	0.78	8	Vitrified Clay	0.013	20.1438	4.205	SM 10
4143	MH-7483	0	323	0	87.1	0	6	PVC	0.013	0.7973	31.661	
4494	1185	210.84	725	0	87.6	240.821	8	PVC	0.013	2.3875	0.028	
1656	MH-7330	90.02	560	89.67	87.8	0.4	6	Concrete	0.013	1.3094	0.822	
4229	988	15.76	1141	10.23	87.9	6.291	12	PVC	0.013	174.6994	4.356	
1015	MH-7485	77.61	200	77.26	88	0.4	8	PVC	0.013	1.7307	0.504	
1991	MH-7484	0	689	0	88	0	8	PVC	0.013	0.3968	7.316	
251	MH-7486	0	MH-7487	0	88.2	0	6	PVC	0.013	1.4681	58.297	
4000	1077	0	W-Hamilton Heights	0	88.6	0	8	PVC	0.013	24.1577	445.432	
2060	MH-7397	15.18	MH-7488	14.82	88.6	0.4	6	PVC	0.013	5.4289	3.409	
7845	831	5	1395	4.64	89	0.4	8	Asbestos Cement	0.013	207.8421	60.594	
5010	1250	223.56	712	222.88	89.2	0.762	8	PVC	0.013	4.7813	1.01	
44	74	0	75	192.04	89.2	Min. Slope	8	PVC	0.013	0.8275	0.01	
2266	606	0	602	0	90	0	8	PVC	0.013	3.3248	61.304	
946	MH-7489	0	185	197.59	89.7	Min. Slope	8	Asbestos Cement	0.013	1.3746	0.017	
4538	1195	34.7	1196	32.82	90.2	2.085	8	PVC	0.013	6.1213	0.782	
2110	394	237.31	402	235.19	88.3	2.401	8	PVC	0.013	3.6125	0.43	
6552	1326	41.17	MH-7490	0	90.8	45.317	8	PVC	0.013	0.6725	0.018	
3269	878	104.94	MH-7441	104.57	90.6	0.4	6	PVC	0.013	4.9748	3.123	
3773	317	0	316	0	90.6	0	8	Concrete	0.013	24.0581	443.595	
2238	MH-7260	230.38	668	230.02	91	0.4	6	Vitrified Clay	0.013	1.3572	0.852	
6528	1322	0	MH-7869	0	91.2	0	8	Concrete	0.013	33.6496	620.447	
355	MH-7492	0	33	0	91.5	0	8	PVC	0.013	1.1756	21.677	
1392	MH-7493	0	436	159.78	91.5	Min. Slope	6	Vitrified Clay	0.013	1.5613	0.047	
3820	320	0	321	15.46	92.1	Min. Slope	8	PVC	0.013	9.6735	0.435	
6614	1327	144.9	654	0	92.3	156.909	8	PVC	0.013	0.4944	0.007	
907	258	14.57	66	17	92.5	Min. Slope	8	PVC	0.013	2.4577	0.28	
2246	MH-7494	222.6	670	222.23	92.8	0.4	6	PVC	0.013	2.0798	1.306	
4125	1118	0	MH-7405	0	93.6	0	8	PVC	0.013	1.4799	27.288	
4539	1196	32.82	703	0	93.7	35.041	8	PVC	0.013	6.5251	0.203	
1201	136	0	MH-7495	0	93.5	0	8	PVC	0.013	32.3003	595.569	
8089	1494	0	1422	0	93.9	0	8	PVC	0.013	0.7676	14.153	
4290	1108	0	1080	0	93.7	0	8	PVC	0.013	5.1082	94.187	
2634	919	9.29	984	8.31	93.9	1.044	18	PVC	0.013	179.9106	3.735	

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SewerGEMS Results

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7976	MH-7496	115.88	MH-7497	115.51	94.2	0.4	8		0.013	14.4005	4.198	
6334	MH-7498	72.91	382	72.53	94.2	0.4	6	PVC	0.013	0.7417	0.466	
2372	MH-7500	0	542	0	94.6	0	8	PVC	0.013	8.4403	155.627	
4612	MH-7499	0	1207	212.33	94.5	Min. Slope	8	PVC	0.013	0	0	
730	MH-7501	0	588	0	94.9	0	6	PVC	0.013	2.7173	107.903	
1896	MH-7502	37.42	360	37.04	95	0.4	8	PVC	0.013	0.9406	0.274	
2429	455	199.74	460	198.98	95	0.8	8	Asbestos Cement	0.013	208.9265	43.078	
2259	618	182.45	MH-7374	0	95.4	191.218	8	PVC	0.013	2.9624	0.04	
350	MH-7503	107.71	20	107.33	95.5	0.4	6	PVC	0.013	0.6741	0.423	
4625	MH-7504	0	1208	224.51	95.6	Min. Slope	8	PVC	0.013	0.3032	0.004	
204	13	0	271	0	95.7	0	8	PVC	0.013	7.2913	134.44	
4362	1168	249.74	1167	249.1	95.9	0.667	8	PVC	0.013	1.6769	0.379	
7579	1350	260	1351	259.6	95.4	0.419	8	PVC	0.013	108.853	31.004	
4802	MH-7505	0	MH-7449	0	96.7	0	8	PVC	0.013	1.0619	19.58	
2028	MH-7301	134.11	398	133.72	97	0.4	6	Vitrified Clay	0.013	2.9785	1.87	
5212	MH-7422	3.61	897	4	97	Min. Slope	6	Concrete	0.013	11.6294	7.303	
7601	1097	0	606	0	97.4	0	8	PVC	0.013	3.0165	55.619	
2180	551	65.68	558	65.29	97.7	0.4	6	Concrete	0.013	13.4593	8.449	
1062	1341	4.53	196	4.14	97.9	0.4	8	Asbestos Cement	0.013	12.7552	3.719	
6316	1306	227.09	1307	226.73	98.1	0.367	8	PVC	0.013	4.3393	1.321	
2164	MH-7497	115.51	MH-7507	115.11	98	0.4	6	Vitrified Clay	0.013	18.0125	11.311	
2333	641	127.77	644	127.38	98.4	0.4	8	PVC	0.013	12.7413	3.714	
4635	1215	237.3	213	236.33	152	0.638	15	PVC	0.013	892.9447	38.554	SM 2
2338	638	186.89	37	186.5	98.6	0.4	8	PVC	0.013	1.2063	0.352	
6263	1291	0	1290	0	99.1	0	8	PVC	0.013	1.6816	31.007	
866	58	0	59	72.38	99.5	Min. Slope	8	PVC	0.013	1.6346	0.035	
2354	576	106.35	574	105.95	99.9	0.4	6	Concrete	0.013	6.9338	4.353	
2251	599	0	MH-7511	0	100.2	0	6	Concrete	0.013	27.3981	1,087.97	
426	MH-7509	0	87	142.64	100	Min. Slope	6	PVC	0.013	1.2978	0.043	
3887	MH-7510	69.74	333	69.34	100	0.4	8	PVC	0.013	1.1394	0.332	
1929	1067	186.17	770	175	100.5	11.111	8	PVC	0.013	3.2085	0.177	
812	251	0	249	24.53	100.4	Min. Slope	8	PVC	0.013	17.0499	0.636	
6538	MH-7514	0	MH-7424	0	100.7	0	8	PVC	0.013	0.7209	13.293	
160	MH-7515	109.13	11	108.73	100.8	0.4	6	PVC	0.013	0.5388	0.338	
1882	MH-7513	0	414	206.6	100.6	Min. Slope	8	PVC	0.013	0.7676	0.01	
2280	MH-7512	0	627	0	100.6	0	8	PVC	0.013	4.3706	80.587	
7886	MH-7375	0	609	134.8	101	Min. Slope	8	PVC	0.013	3.9328	0.063	
5082	MH-7516	0	1256	63.14	100.9	Min. Slope	8	PVC	0.013	1.7359	0.04	
1683	MH-7520	0	622	0	101.5	0	8	PVC	0.013	0.3083	5.685	
5609	1101	55.5	MH-7336	38.69	102.2	16.441	6	Vitrified Clay	0.013	9.8528	0.965	
1296	212	0	206	0	102.6	0	6	Vitrified Clay	0.013	11.2708	447.561	
3997	MH-7522	6.49	1076	6.08	102.5	0.4	6	Vitrified Clay	0.013	24.272	15.24	
2255	MH-7521	171.84	632	128.73	102.4	42.106	6	PVC	0.013	12.8951	0.789	
775	511	0	516	0	102.9	0	8	PVC	0.013	23.7559	438.024	
5292	1275	0	380	148.98	103	Min. Slope	6	Concrete	0.013	4.3632	0.144	
4243	1146	0	MH-7527	0	102.9	0	8	PVC	0.013	1.0619	19.58	

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2	MH-7528	0	477	147.39	103	Min. Slope	8	PVC	0.013	4.3474	0.067	
3111	841	0	80	0	103.4	0	8	PVC	0.013	4.623	85.241	
3107	MH-7530	253.91	1065	253.49	104.1	0.4	8	PVC	0.013	3.3157	0.967	
2425	549	0	543	0	105.2	0	8	PVC	0.013	6.6895	123.344	
1160	157	123.66	158	118.13	105.6	5.237	8	Concrete	0.013	1,204.81	97.073	
311	25	237.34	MH-7534	235.75	106	1.499	8	PVC	0.013	2.2438	0.338	
768	MH-7533	0	521	0	106	0	8	PVC	0.013	1.7806	32.831	
3094	MH-7472	22.7	246	22.6	106.9	0.094	18	Concrete	0.013	2,114.30	146.634	
2742	385	0	384	0	107.2	0	8	PVC	0.013	10.7299	197.844	
3065	833	245.19	834	244.54	107.3	0.606	8	PVC	0.013	137.6047	32.605	
4053	MH-7535	97.17	1094	96.74	107	0.4	8	PVC	0.013	0.4411	0.129	
7591	1360	255.1	1415	254.57	107.4	0.498	8	PVC	0.013	115.1032	30.073	
8086	1493	0	1421	78.12	107.6	Min. Slope	8	PVC	0.013	0.1638	0.004	
2783	MH-7540	0	491	95.78	108.1	Min. Slope	8	Vitrified Clay	0.013	7.5311	0.148	
3928	1120	12.76	1121	12.47	107.9	0.269	30	PVC	0.013	4,907.30	51.412	
2349	MH-7539	135.6	614	135.17	108.1	0.4	6	Vitrified Clay	0.013	0.3838	0.241	
2103	MH-7541	0	387	247.06	108.7	Min. Slope	8	PVC	0.013	1.8505	0.023	
2027	398	133.72	655	133.28	108.8	0.4	6	Vitrified Clay	0.013	6.5197	4.094	
8052	1410	0.26	MH-7870	-0.18	109	0.4	6	Vitrified Clay	0.013	7.9585	4.997	
2626	708	0	707	0	109.2	0	8	PVC	0.013	3.4607	63.81	
4605	MH-7542	0	MH-7543	0	109.4	0	6	PVC	0.013	0.4411	17.516	
1286	MH-7545	0	203	229.22	110.4	Min. Slope	8	PVC	0.013	1.1736	0.015	
2128	MH-7546	0	453	0	110.5	0	6	PVC	0.013	1.8199	72.267	
7596	MH-7547	0	1304	227.84	110.5	Min. Slope	8	PVC	0.013	1.8547	0.024	
6308	1304	227.84	MH-7548	0	110.5	206.19	8	PVC	0.013	3.6167	0.046	
3033	811	8.83	813	8.38	111.1	0.4	8	PVC	0.013	23.4063	6.822	
3470	926	11.48	990	11.09	111.1	0.351	8	Asbestos Cement	0.013	57.9159	18.027	
7599	636	185.87	637	172.86	110.8	11.738	8	PVC	0.013	9.5622	0.515	
2101	758	249.26	760	248.56	112	0.625	8	PVC	0.013	20.579	4.8	
763	MH-7455	0	607	0	111.9	0	6	PVC	0.013	0.823	32.681	
7841	MH-7549	0	327	0	111.9	0	8	PVC	0.013	2.065	38.075	
4692	MH-7550	0	977	35.66	113	Min. Slope	8	PVC	0.013	1.7072	0.056	
2627	MH-7551	0	708	0	113.2	0	8	PVC	0.013	2.8441	52.441	
4946	1246	72.64	1245	63.94	113.3	7.675	8	PVC	0.013	1.8081	0.12	
7595	416	231.45	MH-7552	230.12	113.5	1.172	8	PVC	0.013	12.7463	2.171	
5997	11	108.73	1282	107.78	114.3	0.83	6	Concrete	0.013	1.4472	0.631	
516	753	250.23	756	249.53	114.5	0.611	8	PVC	0.013	18.5619	4.378	
3288	996	0	MH-7553	0	114.7	0	8	PVC	0.013	0.9346	17.233	
3780	MH-7554	0	306	0	115.1	0	6	PVC	0.013	1.7215	68.36	
5317	1277	116.83	1198	105.51	115.2	9.825	6	Vitrified Clay	0.013	1.5086	0.191	
2489	784	1.09	793	0.89	116.5	0.17	18	PVC	0.013	890.0525	45.789	
7370	652	162	MH-7555	161.53	116.3	0.4	6	Vitrified Clay	0.013	4.7955	3.011	
2182	1278	66.48	553	66.01	116.4	0.4	8	Concrete	0.013	13.0583	3.807	
54	46	0	546	0	116.9	0	6	PVC	0.013	0.9366	37.191	
2479	1069	15.16	1068	14.95	116.7	0.18	30	PVC	0.013	4,889.72	62.603	
1176	118	216.24	117	216.39	116.8	Min. Slope	8	PVC	0.013	11.9144	6.129	

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3118	842	7.39	247	6.92	117.1	0.4	8	PVC	0.013	8.352	2.435	
4610	1210	212.28	1207	212.33	117.2	Min. Slope	8	PVC	0.013	1.7152	1.531	
6	MH-7556	0	838	207.93	117.2	Min. Slope	8	Asbestos Cement	0.013	1.0884	0.015	
72	MH-7557	109.2	11	108.73	117.3	0.4	6	PVC	0.013	0.7079	0.444	
1750	MH-7558	0	408	232.78	117.7	Min. Slope	6	PVC	0.013	2.8932	0.082	
4846	1238	149.74	MH-7438	149.27	117.6	0.4	6	Vitrified Clay	0.013	2.575	1.617	
1140	108	0	109	0	117.9	0	8	Concrete	0.013	1.4913	27.498	
2635	1051	8.54	919	9.29	118.1	Min. Slope	18	PVC	0.013	179.4695	4.777	
1964	27	0	MH-7552	0	118.5	0	8	PVC	0.013	1.4851	27.383	
7491	619	0	MH-7559	0	118.8	0	8	PVC	0.013	6.2996	116.155	
2066	563	65.25	566	41.54	119	19.927	8	Concrete	0.013	14.4354	0.596	
441	88	218.26	177	217.98	119.5	0.234	8	Concrete	0.013	230.6338	87.854	
3657	997	17.52	995	16.65	119.5	0.728	12	Asbestos Cement	0.013	173.8464	12.741	
1413	MH-7560	29.26	780	28.78	119.4	0.4	8	PVC	0.013	0.4505	0.131	
7858	1398	59.2	MH-7562	0	120.1	49.289	8	PVC	0.013	2.6247	0.069	
2082	425	0	426	178.41	119.9	Min. Slope	8	PVC	0.013	4.0295	0.061	
1928	MH-7561	0	770	175	120	Min. Slope	8	PVC	0.013	1.6513	0.025	
6551	MH-7563	0	1326	41.17	119.7	Min. Slope	8	PVC	0.013	0.4253	0.013	
1802	MH-7564	0	450	0	120.3	0	8	PVC	0.013	1.857	34.241	
4458	1181	27.15	1179	25.69	120.7	1.21	8	PVC	0.013	2.8031	0.47	
4156	1122	0	587	0	120.7	0	8	PVC	0.013	1.4422	26.592	
1262	126	137.95	125	0	120.9	114.073	8	PVC	0.013	14.8964	0.257	
3437	916	0	976	0	121.1	0	8	Asbestos Cement	0.013	2.1076	38.861	
668	338	61.59	339	61.11	120.9	0.4	8	PVC	0.013	5.5757	1.625	
2228	745	0	750	0	121.2	0	8	Concrete	0.013	0.8664	15.975	
4824	MH-7565	244.55	1235	244.06	121.2	0.4	6	PVC	0.013	0.6462	0.406	
2295	1297	0	428	227.99	121.7	Min. Slope	8	PVC	0.013	27.4553	0.37	
2063	696	75.81	MH-7566	75.32	121.7	0.4	6	Vitrified Clay	0.013	5.5303	3.473	
4043	1279	6.1	893	5.61	121.6	0.4	8	PVC	0.013	15.4347	4.499	
4361	MH-7567	0	1168	249.74	121.9	Min. Slope	8	PVC	0.013	0.9093	0.012	
4261	MH-7569	0	916	0	122.3	0	6	PVC	0.013	1.7752	70.492	
879	MH-7568	0	918	13.84	122	Min. Slope	6	PVC	0.013	0.9003	0.106	
4765	1231	228.5	1230	228.5	122.6	0	8	PVC	0.013	1.4439	26.623	
7770	1385	3.22	MH-7570	2.85	131.5	0.28	10	Vitrified Clay	0.013	57.4437	11.04	
2340	MH-7572	173.35	637	172.86	122.8	0.4	6	Vitrified Clay	0.013	0.9504	0.597	
3014	MH-7571	100.93	1119	100.44	122.5	0.4	6	PVC	0.013	0.7765	0.488	
911	64	16.22	1087	16.07	122.6	0.122	30	PVC	0.013	4,845.47	75.252	
6430	MH-7573	0	1311	214.57	123	Min. Slope	8	PVC	0.013	0.7676	0.011	
2480	1068	14.95	687	14.79	122.9	0.13	30	PVC	0.013	4,891.74	73.66	
6670	MH-7444	0	542	0	123.5	0	8	PVC	0.013	1.9356	35.69	
6261	419	200.5	1249	174.61	123.6	20.952	8	PVC	0.013	126.9753	5.115	
4607	1204	0	487	84.9	123.6	Min. Slope	8	PVC	0.013	188.0177	4.183	
4115	1106	244.91	1107	0	124.1	197.288	8	PVC	0.013	2.6927	0.035	
514	755	0	757	0	125	0	8	PVC	0.013	21.465	395.781	
4766	1230	228.5	1229	222.79	126	4.534	8	PVC	0.013	3.9275	0.34	
1257	197	4.72	198	4.21	126	0.4	6	PVC	0.013	0.3276	0.206	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

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3703	956	25.36	955	20.78	125.7	3.643	8	Asbestos Cement	0.013	22.0992	2.135	
3888	333	69.34	334	62.6	126.3	5.338	8	PVC	0.013	2.3778	0.19	
748	602	0	MH-7577	0	126.5	0	8	PVC	0.013	3.6331	66.988	
3934	517	27.4	262	24.37	126.2	2.401	8	PVC	0.013	16.2362	1.932	
4971	1247	0	912	61.79	126.6	Min. Slope	8	PVC	0.013	0.6648	0.018	
202	MH-7578	0	12	0	126.7	0	8	PVC	0.013	0.2472	4.558	
4521	1190	25.25	MH-7569	0	127.2	19.852	6	PVC	0.013	1.1131	0.099	
1369	MH-7436	85.76	1334	85.25	127	0.4	6	Vitrified Clay	0.013	1.7661	1.109	
3896	347	56.18	335	55.74	127.1	0.346	10	PVC	0.013	41.129	7.109	
4170	1127	0	806	235.67	127	Min. Slope	8	PVC	0.013	3.4092	0.046	
4503	MH-7579	0	MH-7580	0	127.1	0	8	PVC	0.013	0.2472	4.558	
1702	MH-7581	0	715	234.08	127.3	Min. Slope	8	PVC	0.013	1.0316	0.014	
3509	MH-7582	0	1056	0	127.9	0	8	PVC	0.013	2.7191	50.137	
624	MH-7583	0	552	0	128	0	8	Asbestos Cement	0.013	2.5286	46.623	
2174	MH-7566	75.32	603	74.81	128.5	0.4	6	Vitrified Clay	0.013	7.5237	4.724	
1401	MH-7584	0	503	0	135.8	0	6	PVC	0.013	1.3868	55.068	
1120	199	1.93	86	1.41	128.7	0.4	8	Asbestos Cement	0.013	15.9973	4.664	
5038	MH-7585	106.9	1276	106.39	128.9	0.4	6	PVC	0.013	0.3696	0.232	
3149	363	21.95	227	21.99	128.6	Min. Slope	18	Concrete	0.013	2,156.37	259.314	
2784	492	83.53	494	76.41	129.2	5.509	8	PVC	0.013	4.3637	0.343	
7560	1346	9.34	811	8.83	129.6	0.4	8	PVC	0.013	12.5661	3.664	
1289	MH-7586	0	204	231.18	129.7	Min. Slope	8	PVC	0.013	1.0619	0.015	
7817	1391	123.2	1390	121.8	129.7	1.08	8	PVC	0.013	0.8822	0.157	
1301	210	232.83	204	231.18	247.7	0.666	15	PVC	0.013	917.9251	38.792	SM 2
4162	MH-7588	62.72	1124	62.2	130.3	0.4	6	PVC	0.013	0.4118	0.259	
6545	MH-7587	0	1325	0	130	0	6	PVC	0.013	2.134	84.74	
2621	706	0	705	0	130.1	0	8	PVC	0.013	2.4564	45.293	
45	75	0	76	168.11	130.7	Min. Slope	8	PVC	0.013	1.1358	0.018	
2004	MH-7589	0	458	192.87	130.4	Min. Slope	6	Asbestos Cement	0.013	2.7123	0.089	
1172	107	0	116	0	131.5	0	8	Concrete	0.013	5.9464	109.643	
2810	723	215.47	726	210.79	131.5	3.56	8	PVC	0.013	8.8271	0.863	
4972	MH-7590	0	1247	0	131.5	0	8	PVC	0.013	0.3324	6.129	
867	59	0	60	62.37	131.3	Min. Slope	8	PVC	0.013	5.3481	0.143	
7684	1378	238.6	1215	237.3	336.7	0.386	15	PVC	0.013	859.9427	47.734	SM 2
3439	967	32.63	966	29.62	131.4	2.29	8	PVC	0.013	2.7744	0.338	
8072	1419	0	1267	242.47	132	Min. Slope	6	PVC	0.013	1.0619	0.031	
4079	378	0	425	0	132.1	0	8	PVC	0.013	2.4116	44.466	
1329	236	90.87	237	90.34	132.6	0.4	8	PVC	0.013	5.3902	1.572	
3764	MH-7592	0	297	0	132.7	0	6	PVC	0.013	1.9393	77.007	
1635	MH-7591	208.51	669	207.98	132.6	0.4	6	PVC	0.013	0.9754	0.612	
3682	989	6.99	987	5.97	132.7	0.769	18	PVC	0.013	62.0768	1.502	
4174	1128	203.1	415	205.41	133.1	Min. Slope	8	PVC	0.013	38.1846	5.345	
1258	185	197.59	186	193	133.4	3.44	8	Asbestos Cement	0.013	95.557	9.499	
1199	183	202.43	185	197.59	133.5	3.624	8	Asbestos Cement	0.013	53.376	5.17	
430	MH-7593	0	791	100	133.2	Min. Slope	8	PVC	0.013	1.1045	0.024	
2592	702	0	701	25.64	133.2	Min. Slope	8	PVC	0.013	8.3403	0.351	

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SewerGEMS Results

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1292	MH-7594	0	212	0	133.8	0	6	PVC	0.013	8.4781	336.662	
4004	1083	0	1082	0	133.6	0	8	PVC	0.013	11.7782	217.172	
4372	MH-7562	0	1169	56.98	134.1	Min. Slope	8	PVC	0.013	3.1449	0.089	
1332	243	91.4	236	90.87	134.3	0.395	8	PVC	0.013	2.9899	0.877	
2368	903	22.8	529	22.09	133.9	0.53	10	Asbestos Cement	0.013	696.4732	97.27	
4639	1220	96.8	1221	82.2	133.9	10.903	8	PVC	0.013	4.9861	0.278	
1436	MH-7595	0	721	205.4	134	Min. Slope	8	PVC	0.013	0.7676	0.011	
7661	1253	0	MH-7596	0	134.4	0	8	PVC	0.013	3.2742	60.371	
4097	1447	68.68	411	68.14	134.4	0.4	6	PVC	0.013	0.3842	0.241	
4044	893	5.61	871	5.07	134.5	0.4	6	Concrete	0.013	19.1862	12.046	
3797	322	0	321	15.36	134.4	Min. Slope	8	PVC	0.013	19.1678	1.045	
1336	MH-7597	91.95	243	91.4	135.6	0.406	6	PVC	0.013	2.0144	1.256	
3892	352	74.2	351	73.66	134.5	0.4	8	PVC	0.013	27.6202	8.053	
211	MH-7598	93.15	1093	92.61	135	0.4	8	PVC	0.013	2.3539	0.686	
3122	904	23.82	262	23.71	135.2	0.081	18	Concrete	0.013	2,045.01	152.073	
2127	486	98.91	1204	84.9	135.2	10.365	8	PVC	0.013	186.3035	10.67	
2553	692	0	691	116.38	135.5	Min. Slope	8	PVC	0.013	4.4536	0.089	
415	MH-7599	0	93	204.2	135.7	Min. Slope	6	Concrete	0.013	2.7652	0.09	
1711	374	0	654	0	135.7	0	8	PVC	0.013	5.625	103.716	
6242	1287	0	211	233.2	135.6	Min. Slope	8		0.013	5.6068	0.079	
7806	1386	204.68	1067	186.17	136	13.61	8	PVC	0.013	1.2495	0.062	
2785	18	109.67	MH-7540	0	136	80.635	8	PVC	0.013	6.5114	0.134	
912	69	16.38	64	16.22	136.3	0.117	30	Concrete	0.013	4,844.91	76.823	
3012	806	235.67	85	234.13	136.1	1.131	8	PVC	0.013	5.9822	1.037	
807	514	0	520	0	136.5	0	8	PVC	0.013	6.7311	124.112	
3784	382	72.53	MH-7360	64.36	136.4	5.987	6	Vitrified Clay	0.013	6.277	1.019	
1163	1339	227.86	176	223.4	136.6	3.264	8	PVC	0.013	167.7499	17.121	
2809	724	218.49	723	215.47	136.2	2.217	8	PVC	0.013	6.1116	0.757	
517	417	202.86	419	200.5	136.9	1.724	8	PVC	0.013	126.2077	17.724	
2801	MH-7601	0	435	0	136.6	0	6	PVC	0.013	1.6092	63.899	
2371	228	0	529	22.09	136.9	Min. Slope	8	PVC	0.013	3.1375	0.144	
4076	1095	55.55	336	55	137.7	0.4	8	PVC	0.013	4.8101	1.402	
6024	1283	253.1	1060	248.38	137.9	3.423	8	PVC	0.013	3.3993	0.339	
1974	727	219.47	431	218.45	146.3	0.697	8	PVC	0.013	133.7734	29.536	
2151	503	0	248	24.9	137.7	Min. Slope	8	Asbestos Cement	0.013	2.8957	0.126	
6262	1292	0	441	174.03	137.8	Min. Slope	8	PVC	0.013	4.7946	0.079	
2032	80	0	81	0	138.2	0	8	PVC	0.013	7.2919	134.452	
6297	MH-7602	0	807	0	138	0	6	PVC	0.013	1.6463	65.373	
6433	1313	212.57	MH-7389	0	138.1	153.953	8	PVC	0.013	3.0704	0.046	
595	50	0	35	205.6	138.5	Min. Slope	8	PVC	0.013	7.9111	0.12	
3442	MH-7603	0	963	16.79	138.5	Min. Slope	6	PVC	0.013	1.0687	0.122	
5291	1274	43.5	364	33.4	138.6	7.29	6	Vitrified Clay	0.013	6.6874	0.984	
4336	MH-7604	0	1159	34.13	138.8	Min. Slope	8	PVC	0.013	0.4038	0.015	
902	62	0	617	254.05	138.6	Min. Slope	8	PVC	0.013	0.9076	0.012	
1977	375	232.16	371	231.48	139.1	0.489	8	PVC	0.013	2.5638	0.676	
4638	1221	82.2	941	61	139	15.247	8	PVC	0.013	5.4272	0.256	

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7066	624	0	1325	0	139.4	0	6	Concrete	0.013	2.3977	95.212	
2191	528	0	363	0	140.1	0	6	Concrete	0.013	39.9955	1,588.20	
2625	707	0	689	0	140.2	0	8	PVC	0.013	4.0934	75.475	
7121	175	232.45	1339	227.86	140.6	3.265	8	PVC	0.013	165.3728	16.876	
3788	MH-7607	0	313	0	140.6	0	6	Concrete	0.013	1.5446	61.335	
4615	1206	202.4	MH-7462	0	140.6	143.905	8	PVC	0.013	8.8469	0.136	
809	520	0	524	0	140.6	0	8	PVC	0.013	9.3739	172.841	
3400	MH-7606	0	949	37.79	140.4	Min. Slope	8	PVC	0.013	0.96	0.034	
2274	MH-7610	0	MH-7323	0	140.9	0	6	Concrete	0.013	15.4169	612.2	
1210	194	33.76	195	33.2	141	0.4	8	PVC	0.013	8.0245	2.339	
3260	877	162.38	882	71.71	141	64.326	6	Vitrified Clay	0.013	55.1626	2.731	
1433	MH-7608	51.18	778	50.62	140.7	0.4	8	PVC	0.013	0.9859	0.287	
1876	1123	52.04	496	37.5	141.2	10.298	6	PVC	0.013	1.3673	0.169	
2350	MH-7609	135.73	614	135.17	140.8	0.4	6	Vitrified Clay	0.013	0.9974	0.626	
1379	MH-7548	0	369	219.22	141.4	Min. Slope	8	PVC	0.013	5.518	0.082	
4495	MH-7611	0	1185	210.84	141.4	Min. Slope	8	PVC	0.013	1.3559	0.02	
6613	MH-7612	0	1327	144.9	141.8	Min. Slope	8	PVC	0.013	0.2472	0.005	
8081	1420	237.45	1288	0	142	167.169	8	PVC	0.013	2.1238	0.03	
2057	1328	3.62	1385	3.22	141.8	0.28	10	Vitrified Clay	0.013	57.2432	11.001	
6435	1314	207.55	1316	204.4	141.7	2.223	8	PVC	0.013	6.754	0.835	
6340	1308	0	584	0	142.1	0	8	PVC	0.013	1.6194	29.859	
2241	666	254.78	668	230.02	143.3	17.283	6	Vitrified Clay	0.013	3.8904	0.372	
751	MH-7613	0	572	0	143	0	6	PVC	0.013	1.4363	57.037	
2552	691	0	580	0	143.2	0	8	Concrete	0.013	7.4766	137.857	
2613	1213	50.37	704	28.34	143.6	15.344	8	PVC	0.013	4.0357	0.19	
4550	1198	105.51	878	104.94	143.7	0.4	6	Vitrified Clay	0.013	2.7397	1.72	
3614	939	0	940	31.03	143.9	Min. Slope	8	PVC	0.013	8.5365	0.339	
489	756	249.53	758	249.26	145	0.186	8	PVC	0.013	19.5141	8.338	
4502	MH-7580	0	12	0	144.5	0	8	PVC	0.013	0.4944	9.116	
4518	397	106.81	MH-7277	95.28	145	7.954	6	Vitrified Clay	0.013	3.2738	0.461	
2281	627	0	384	0	144.8	0	8	PVC	0.013	6.0466	111.49	
2119	434	0	441	174.03	145.5	Min. Slope	8	PVC	0.013	131.0316	2.209	
2184	560	89.67	555	83.23	145.6	4.424	6	Concrete	0.013	1.5099	0.285	
4999	MH-7615	0	1248	0	145.7	0	8	PVC	0.013	1.3613	25.1	
3119	360	29.36	361	28.78	145.8	0.4	8	PVC	0.013	3.8806	1.131	
6292	1299	0	840	201.29	145.6	Min. Slope	8	PVC	0.013	16.8936	0.265	
4700	1223	253.1	1222	245.52	146.1	5.189	8	PVC	0.013	1.3156	0.106	
1145	121	178.65	122	177.84	146	0.555	8	Concrete	0.013	1.8322	0.454	
2051	1381	2.49	764	1.9	148.4	0.4	6	Concrete	0.013	1.7227	1.082	
3438	966	29.62	968	27.14	146	1.699	8	PVC	0.013	4.9299	0.697	
749	MH-7577	0	591	0	146.6	0	4	Asbestos Cement	0.013	5.4452	637.503	
2419	587	0	588	0	146.2	0	6	Concrete	0.013	2.5172	99.955	
3630	974	0	973	27.56	146.2	Min. Slope	8	PVC	0.013	1.211	0.051	
7589	1362	250.5	1363	249.9	146.3	0.41	8	PVC	0.013	118.2889	34.054	
2279	539	0	538	0	146.3	0	8	PVC	0.013	11.3023	208.397	
2847	800	255.05	802	251.55	146.5	2.389	8	PVC	0.013	7.1522	0.853	

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6077	1248	0	1284	0	146.9	0	8	PVC	0.013	3.7022	68.264	
2230	749	0	748	0	146.9	0	8	Concrete	0.013	1.0673	19.68	
164	MH-7511	0	589	0	147	0	8	PVC	0.013	28.5432	526.294	
3139	543	20.59	905	20.22	147	0.252	8	Asbestos Cement	0.013	8.2491	3.032	
2293	412	232.96	410	232.39	146.7	0.388	8	PVC	0.013	9.7182	2.875	
2248	MH-7559	0	615	0	146.8	0	8	Concrete	0.013	7.1096	131.091	
260	MH-7487	0	21	0	146.9	0	8	PVC	0.013	2.7031	49.841	
7464	MH-7616	0	486	98.91	147	Min. Slope	8	PVC	0.013	1.2537	0.028	
1994	MH-7617	0	506	0	147	0	8	PVC	0.013	1.3635	25.142	
2448	MH-7555	161.53	658	160.95	147.2	0.4	6	Vitrified Clay	0.013	5.6289	3.534	
838	MH-7618	0	701	25.64	147.8	Min. Slope	6	PVC	0.013	1.8209	0.174	
5072	MH-7351	0	549	0	147.9	0	8	PVC	0.013	2.2938	42.294	
1350	743	0	311	0	147.5	0	8	Concrete	0.013	1.1318	20.868	
2306	433	0	432	219.23	147.6	Min. Slope	8	Asbestos Cement	0.013	1.0316	0.016	
2084	379	0	1275	148.98	148.3	Min. Slope	6	Concrete	0.013	1.9295	0.076	
2983	754	0	802	251.55	148.3	Min. Slope	8	PVC	0.013	1.946	0.028	
1765	MH-7619	0	464	0	148	0	6	PVC	0.013	1.0421	41.382	
1198	181	207.93	183	202.43	148.4	3.705	8	Asbestos Cement	0.013	8.6452	0.828	
2146	361	28.78	842	14.96	148.9	9.284	8	PVC	0.013	4.2386	0.256	
1256	196	4.14	201	3.54	148.8	0.4	8	Asbestos Cement	0.013	12.919	3.767	
509	MH-7349	1.75	792	1.42	148.6	0.22	12	Vitrified Clay	0.013	86.6681	11.554	
6953	788	0	1058	198.66	148.6	Min. Slope	8	Asbestos Cement	0.013	16.9287	0.27	
5424	1150	0	1333	0	149	0	6	Concrete	0.013	2.9044	115.332	
4118	MH-7620	0	1105	260.05	149.1	Min. Slope	8	PVC	0.013	0.1417	0.002	
1330	237	90.33	238	89.74	148.6	0.4	8	PVC	0.013	8.2826	2.415	
1138	133	165.9	132	0	149.1	111.233	8	Concrete	0.013	146.908	2.568	
2474	MH-7622	0	789	209.04	149.6	Min. Slope	8	PVC	0.013	2.1161	0.033	
1367	MH-7624	118.84	1239	118.24	149.7	0.4	6	Vitrified Clay	0.013	3.2793	2.059	
3551	920	21.72	1001	21.3	149.5	0.281	10	Asbestos Cement	0.013	86.2796	16.556	
5018	MH-7623	62.8	1124	62.2	149.7	0.4	6	PVC	0.013	0.2422	0.152	
2337	633	187.49	638	186.89	150.2	0.4	6	PVC	0.013	1.0883	0.683	
2250	MH-7625	0	589	0	150	0	6	Concrete	0.013	1.2582	49.964	
630	MH-7626	0	MH-7400	0	150.5	0	6	PVC	0.013	1.5122	60.048	
3966	208	235.01	211	233.2	342.9	0.528	15	PVC	0.013	909.8006	43.195	SM 2
4444	MH-7337	38.59	MH-7469	11.98	152	17.505	6	Vitrified Clay	0.013	15.8316	1.503	
3829	327	0	294	0	152.2	0	8	PVC	0.013	11.0744	204.195	
3362	913	30.43	942	30.16	152.2	0.177	12	PVC	0.013	118.4983	17.594	
973	MH-7629	0	137	0	151.9	0	6	Asbestos Cement	0.013	2.0372	80.895	
798	MH-7534	235.75	790	235.75	152.4	0	8	PVC	0.013	5.3119	97.943	
3819	326	0	319	24.41	152	Min. Slope	8	PVC	0.013	2.1248	0.098	
1144	105	195.1	111	181.73	153.2	8.728	8	Concrete	0.013	1.8037	0.113	
4225	1142	10.62	1141	10.23	152.7	0.255	30	PVC	0.013	4,941.88	53.117	
5881	1281	0	124	191.96	153	Min. Slope	8	PVC	0.013	1.2572	0.021	
6341	MH-7630	0	1308	0	153.4	0	8	PVC	0.013	0.5147	9.49	
1010	89	76.98	194	76.37	153.6	0.4	8	PVC	0.013	4.3586	1.271	
4461	1179	25.69	1178	23.98	153.4	1.115	8	PVC	0.013	5.0832	0.888	

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20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
7	838	0	839	0	153.9	0	8	PVC	0.013	30.7208	566.445	
2249	610	0	615	0	154	0	6	Concrete	0.013	1.7496	69.476	
3542	957	35.19	956	25.36	153.7	6.394	8	Asbestos Cement	0.013	20.392	1.487	
623	MH-7631	9.66	762	9.04	153.9	0.4	8	PVC	0.013	10.5126	3.064	
4451	MH-7632	0	1177	111.73	154.1	Min. Slope	8	PVC	0.013	1.5613	0.034	
2160	MH-7253	65.64	650	65.03	154.7	0.4	6	Vitrified Clay	0.013	1.3794	0.866	
2414	MH-7633	0	526	0	154.5	0	8	PVC	0.013	2.9143	53.736	
4099	MH-7634	68.76	411	68.14	154.7	0.4	6	PVC	0.013	0.1638	0.103	
4586	MH-7635	169.77	1201	169.15	155	0.4	6	PVC	0.013	0.4035	0.253	
203	12	0	13	0	155.4	0	8	PVC	0.013	2.0575	37.937	
805	550	0	545	0	155.3	0	8	PVC	0.013	4.8924	90.208	
3123	733	202.85	788	198.66	155.2	2.7	8	Asbestos Cement	0.013	11.8318	1.328	
7819	1389	120.3	1388	119.5	156.1	0.512	8	PVC	0.013	1.7644	0.454	
4443	MH-7636	0	MH-7419	0	156.2	0	6	PVC	0.013	1.7567	69.756	
439	145	150.77	146	148.88	156.3	1.209	8	Concrete	0.013	1.4747	0.247	
4236	700	164.16	1144	158.3	156.5	3.744	6	Vitrified Clay	0.013	1.7178	0.353	
1131	91	0	92	205.7	157.1	Min. Slope	8	Concrete	0.013	1.1603	0.019	
120	37	186.5	636	185.87	157.2	0.4	8	PVC	0.013	2.9353	0.856	
2286	562	0	557	0	157.8	0	8	PVC	0.013	1.7191	31.697	
3681	1050	60.71	946	60.11	157.3	0.381	8	PVC	0.013	4.9197	1.469	
7586	1351	259.6	1357	258.8	157.6	0.508	8	PVC	0.013	109.8846	28.438	
4767	1229	222.79	1212	204	158	11.896	8	PVC	0.013	4.4347	0.237	
2798	435	0	235	0	158.6	0	8	PVC	0.013	2.5468	46.96	
2215	MH-7637	61.09	1234	60.46	158.5	0.4	6	Vitrified Clay	0.013	18.203	11.429	
5192	1267	242.47	1266	240.91	159.2	0.98	8	PVC	0.013	142.9142	26.619	
3227	871	5.07	900	4.44	159.1	0.4	6	Concrete	0.013	19.3042	12.121	
1147	122	177.84	127	176.8	244.8	0.425	15	PVC	0.013	1,021.71	54.065	SM 3
518	415	205.41	417	202.86	160	1.594	8	PVC	0.013	125.4401	18.321	
2229	598	0	747	0	159.6	0	6	Concrete	0.013	0.8758	34.776	
25	MH-7402	0	44	224.58	160.4	Min. Slope	6	PVC	0.013	2.2072	0.074	
6240	1289	0	1288	0	160	0	8		0.013	1.3592	25.062	
1710	MH-7638	0	374	0	160	0	6	PVC	0.013	0.9254	36.746	
7081	801	0	753	250.23	160.9	Min. Slope	8	PVC	0.013	4.7907	0.071	
989	MH-7639	0	182	209.5	160.9	Min. Slope	8	PVC	0.013	1.6261	0.026	
3159	225	33.31	226	32.76	161.5	0.34	12	Asbestos Cement	0.013	10.1228	1.085	
1202	MH-7495	0	184	0	161.4	0	8	PVC	0.013	37.5486	692.34	
360	MH-7641	0	34	248.19	161.6	Min. Slope	8	PVC	0.013	1.4308	0.021	
3599	MH-7640	0	265	0	161.5	0	6	PVC	0.013	1.9712	78.274	
3471	980	11.89	926	11.48	162.3	0.253	8	Asbestos Cement	0.013	49.3574	18.105	
1721	MH-7643	0	420	204.32	162.4	Min. Slope	6	PVC	0.013	2.4282	0.086	
2827	714	229.99	715	229.22	162	0.475	8	PVC	0.013	125.2007	33.485	
3249	MH-7442	74.78	884	74.13	162.1	0.4	6	Vitrified Clay	0.013	5.9454	3.733	
2807	716	215.84	719	215.05	162.6	0.486	8	PVC	0.013	278.3145	73.631	
27	44	0	45	222.17	162.4	Min. Slope	8	PVC	0.013	4.2704	0.067	
2362	MH-7644	0	MH-7871	0	169.1	0	6	PVC	0.013	1.7449	69.288	
4001	1082	0	1077	0	164.5	0	8	PVC	0.013	12.0318	221.848	

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SewerGEMS Results

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917	66	17	67	16.7	164.1	0.183	30	PVC	0.013	4,780.66	60.747	
7585	1348	263.2	1356	262.1	164.7	0.668	8	PVC	0.013	105.7582	23.86	
1072	198	4.21	201	3.54	167.6	0.4	6	PVC	0.013	0.4914	0.309	
4460	MH-7648	0	1180	34.8	164.8	Min. Slope	1	PVC	0.013	0.4038	4.147	
2307	432	219.23	431	218.45	164.8	0.473	8	Asbestos Cement	0.013	15.1392	4.057	
1180	112	197.86	114	194.7	164.8	1.917	8	Concrete	0.013	302.7699	40.319	
3195	865	0.69	1408	0.03	165.2	0.4	8	PVC	0.013	2.6723	0.78	
4157	MH-7650	0	1122	0	165.8	0	8	PVC	0.013	1.1339	20.908	
1847	MH-7649	0	420	204.32	165.3	Min. Slope	6	PVC	0.013	0.881	0.031	
1269	186	193	187	186.1	165.8	4.161	8	Concrete	0.013	104.5397	9.449	
2070	MH-7651	240.05	78	239.39	166	0.4	8	PVC	0.013	1.5114	0.441	
2292	534	0	533	0	165.5	0	8	PVC	0.013	28.7286	529.713	
1158	149	156.42	147	148.49	165.6	4.789	8	Concrete	0.013	1.7401	0.147	
3121	248	24.9	901	24.5	165.9	0.241	18	Concrete	0.013	2,041.33	88.184	
2114	401	234.64	404	234.07	166.3	0.343	8	PVC	0.013	74.5309	23.477	
2620	705	0	549	0	165.8	0	8	PVC	0.013	3.6311	66.952	
2466	629	132.17	630	142.13	166.2	Min. Slope	6	Vitrified Clay	0.013	4.5723	0.742	
5191	1268	243.27	1267	242.47	166.6	0.48	8	PVC	0.013	140.7903	37.466	
4416	1284	0	1176	179	166.7	Min. Slope	8	PVC	0.013	5.865	0.104	
2741	626	0	385	0	166.3	0	8	PVC	0.013	7.6416	140.9	
7982	494	76.41	1400	48.54	166.9	16.703	8	PVC	0.013	6.4605	0.291	
513	791	100	779	49.54	166.9	30.226	8	PVC	0.013	4.3054	0.144	
2297	445	210.15	444	209.12	166.7	0.618	8	PVC	0.013	34.0016	7.977	
2970	797	0	798	0	167.2	0	8	PVC	0.013	10.5112	193.811	
6118	1286	26.17	947	22.22	167.9	2.352	8	PVC	0.013	120.6059	14.5	
2328	656	126.67	660	126	167.7	0.4	8	PVC	0.013	41.0557	11.969	
3019	MH-7652	77.74	822	77.07	168	0.4	6	PVC	0.013	1.8605	1.168	
4139	MH-7653	0	26	0	168.3	0	8	PVC	0.013	1.7612	32.473	
1189	155	130.39	159	117.39	168.6	7.712	8	Concrete	0.013	323.8952	21.506	
6887	711	230.34	1337	222.88	169	4.414	8	PVC	0.013	261.1116	22.915	
402	MH-7655	0	1115	0	169.2	0	8	PVC	0.013	1.4681	27.07	
4238	MH-7654	0	1145	0	168.8	0	6	PVC	0.013	0.9897	39.299	
2108	400	0	401	236.76	168.9	Min. Slope	8	PVC	0.013	29.1507	0.454	
5024	1252	0	1253	0	169.6	0	8	PVC	0.013	2.5066	46.217	
4487	1184	0	713	231.68	169.2	Min. Slope	8	PVC	0.013	3.6048	0.057	
3615	942	30.16	1286	26.17	169.8	2.349	8	PVC	0.013	118.9394	14.309	
2278	542	0	539	0	169.4	0	8	PVC	0.013	10.7798	198.762	
7998	MH-7311	229.72	1318	229.04	169.9	0.4	6	Vitrified Clay	0.013	0.9905	0.622	
4268	MH-7657	130.41	1425	129.73	170.2	0.4	6	PVC	0.013	0.5358	0.336	
2294	424	230.12	423	229.23	169.9	0.524	8	PVC	0.013	19.8828	5.065	
1550	MH-7343	0	844	193.76	170.2	Min. Slope	8	PVC	0.013	2.3907	0.041	
3648	MH-7463	0	973	27.56	170.6	Min. Slope	8	PVC	0.013	2.728	0.125	
73	1282	107.78	579	107.1	170.2	0.4	6	Concrete	0.013	2.6286	1.651	
3726	MH-7658	0	968	27.14	171.1	Min. Slope	6	PVC	0.013	2.2398	0.223	
4571	MH-7659	0	736	30.7	171.3	Min. Slope	8	PVC	0.013	1.1691	0.051	
7079	512	0	23	0	170.9	0	8	PVC	0.013	5.1241	94.481	

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1686	MH-7660	0	613	0	171.5	0	8	PVC	0.013	1.5878	29.277	
3034	813	8.38	812	7.69	171.9	0.4	8	PVC	0.013	23.5701	6.871	
3776	305	0	306	0	171.3	0	8	Concrete	0.013	11.9648	220.612	
4459	1180	34.8	1179	25.69	171.6	5.309	8	PVC	0.013	1.1341	0.091	
2804	1337	0	712	222.88	172	Min. Slope	8	PVC	0.013	263.1013	4.261	
2263	MH-7662	0	584	0	172	0	6	Concrete	0.013	1.4583	57.907	
6530	MH-7661	126.21	1324	125.52	171.7	0.4	6	Vitrified Clay	0.013	0.4711	0.296	
440	MH-7663	0	88	224.56	172.6	Min. Slope	8	PVC	0.013	2.0762	0.034	
4902	1242	236.4	MH-7437	0	172.8	136.828	8	PVC	0.013	0.9575	0.015	
2143	779	49.54	780	28.78	173.3	11.977	8	PVC	0.013	6.0923	0.325	
1164	218	224.89	177	223.55	173.4	0.773	8	PVC	0.013	24.7029	5.182	
3749	MH-7664	0	307	0	177.6	0	6	PVC	0.013	1.4025	55.694	
1167	101	214.9	100	213.24	173	0.96	8	Concrete	0.013	260.224	48.98	
4498	MH-7665	0	1186	136.12	174.7	Min. Slope	6	PVC	0.013	1.1138	0.05	
1194	160	116	161	109.03	273	2.553	18	PVC	0.013	1,536.15	20.391	SM 3
4690	MH-7666	0	1191	111.58	175.1	Min. Slope	6	PVC	0.013	1.7413	0.087	
2282	MH-7667	0	385	0	175.3	0	8	PVC	0.013	1.5295	28.202	
1366	MH-7433	85.8	896	85.1	175.6	0.4	8	Vitrified Clay	0.013	116.977	34.1	
3611	357	32.63	356	31.83	175.4	0.456	12	PVC	0.013	84.2645	7.804	
804	559	0	550	0	175.9	0	8	PVC	0.013	4.1027	75.647	
6889	712	222.88	1338	215.84	176	4	8	PVC	0.013	271.2562	25.008	
3055	816	5.68	823	2.57	175.6	1.77	8	PVC	0.013	62.0873	8.605	
2332	644	127.38	656	126.67	176.5	0.4	8	PVC	0.013	29.4118	8.576	
963	822	77.07	194	76.37	176.1	0.4	8	PVC	0.013	2.7358	0.798	
4609	1208	224.51	1210	212.28	176.1	6.944	8	PVC	0.013	1.3163	0.092	
4008	1081	0	1080	0	176.9	0	8	PVC	0.013	4.5982	84.783	
1152	141	0	140	161.24	176.8	Min. Slope	8	Concrete	0.013	1.0619	0.021	
1934	MH-7668	0	80	0	176.9	0	8	PVC	0.013	1.6071	29.632	
4141	1102	112.27	819	90.93	177.4	12.027	6	PVC	0.013	1.053	0.121	
4457	1182	35.04	1181	27.15	177.7	4.441	8	PVC	0.013	1.9243	0.168	
3289	MH-7553	0	997	0	177.2	0	8	Asbestos Cement	0.013	3.3935	62.57	
520	590	99	583	87.42	177.8	6.513	6	Vitrified Clay	0.013	4.3852	0.682	
1347	744	0	313	0	177.6	0	8	Concrete	0.013	1.1579	21.35	
2239	MH-7671	257.09	653	256.38	178	0.4	6	Vitrified Clay	0.013	0.118	0.074	
622	MH-7669	0	492	83.53	177.7	Min. Slope	8	PVC	0.013	1.8984	0.051	
427	87	142.64	157	123.66	178.3	10.646	8	PVC	0.013	2.3597	0.133	
3907	MH-7670	92.99	345	92.28	177.9	0.4	8	PVC	0.013	1.4872	0.434	
6272	MH-7672	188.34	1293	187.63	178	0.4	6	PVC	0.013	0.8572	0.538	
2932	805	260.23	795	260.37	178.5	Min. Slope	8	PVC	0.013	1.3908	0.916	
1261	129	0	126	137.95	178.6	Min. Slope	8	PVC	0.013	13.1826	0.277	
6318	MH-7673	0	1306	227.09	178.5	Min. Slope	8	PVC	0.013	1.3737	0.022	
3777	311	0	309	0	179	0	8	Concrete	0.013	2.1161	39.018	
2476	1110	178.9	461	175.47	178.5	1.921	8	PVC	0.013	5.5263	0.735	
4002	1085	0	1084	0	178.8	0	8	PVC	0.013	1.6168	29.812	
7844	MH-7674	5.36	1395	4.64	179	0.4	8	PVC	0.013	0.4035	0.118	
2183	555	83.23	554	66.74	178.9	9.217	6	Concrete	0.013	12.0146	1.572	

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803	568	0	559	0	179.7	0	8	PVC	0.013	2.8083	51.781	
2233	742	0	741	0	179.7	0	8	Concrete	0.013	1.3382	24.674	
4551	MH-7677	106.23	1198	105.51	179.8	0.4	6	PVC	0.013	0.3048	0.191	
2003	MH-7675	0	495	100.19	179.5	Min. Slope	8	PVC	0.013	2.3422	0.058	
1605	MH-7676	0	408	232.78	179.7	Min. Slope	8	PVC	0.013	2.8561	0.046	
1328	239	89.01	241	82.76	180.5	3.464	8	PVC	0.013	9.6101	0.952	
3969	168	232.2	166	233.24	180.4	Min. Slope	8	PVC	0.013	3.996	0.97	
4391	MH-7543	0	1172	0	181.1	0	6	PVC	0.013	0.8822	35.032	
2284	MH-7678	0	567	0	181.8	0	8	PVC	0.013	0.4038	7.445	
3436	976	0	980	11.89	182	Min. Slope	6	Vitrified Clay	0.013	2.44	0.379	
4569	MH-7679	0	245	31.7	182.6	Min. Slope	8	PVC	0.013	0.732	0.032	
2790	MH-7680	188.23	MH-7681	187.49	183.1	0.4	6	Concrete	0.013	1.9995	1.255	
1331	238	89.74	239	89.01	183.1	0.399	8	PVC	0.013	8.7237	2.547	
4428	MH-7682	1.47	870	0.73	183.2	0.4	8	PVC	0.013	1.6661	0.486	
3430	MH-7490	0	272	0	183.1	0	8	PVC	0.013	1.1869	21.884	
405	1117	0	1118	0	182.4	0	8	PVC	0.013	1.0388	19.155	
4785	MH-7683	0	1212	204	183.7	Min. Slope	8	PVC	0.013	0.1915	0.003	
433	MH-7684	0	137	0	184	0	6	PVC	0.013	0.9116	36.201	
3926	1285	12.17	910	10.89	184	0.696	10	PVC	0.013	170.9552	20.844	
3129	541	20.24	252	19.72	184	0.283	10	Concrete	0.013	107.1009	20.49	
125	MH-7685	239.24	25	237.34	184.1	1.032	8	PVC	0.013	1.4762	0.268	
1023	188	0	189	0	184.2	0	8	PVC	0.013	31.9033	588.249	
3449	221	39.44	231	38.29	184.8	0.622	10	PVC	0.013	82.2679	10.606	
5105	1263	0	483	87.05	185.2	Min. Slope	6	Concrete	0.013	10.5617	0.612	
1768	502	0	508	0	185.2	0	8	Asbestos Cement	0.013	22.328	411.694	
625	552	0	546	0	185.5	0	8	Asbestos Cement	0.013	4.2088	77.605	
3051	830	5.74	831	5	185.5	0.4	8	Asbestos Cement	0.013	204.329	59.567	
3598	266	0	267	0	185.3	0	6	Concrete	0.013	0.5162	20.498	
6264	1290	0	1292	0	186.2	0	8	PVC	0.013	3.3241	61.291	
4171	MH-7686	0	1127	0	186.4	0	6	PVC	0.013	1.8166	72.137	
1166	202	216.89	101	214.9	186.5	1.067	8	Concrete	0.013	1.8326	0.327	
2802	709	238.29	710	234.93	186.6	1.801	8	PVC	0.013	253.3014	34.806	
4116	1156	0	1106	244.91	186.6	Min. Slope	8	PVC	0.013	1.8863	0.03	
2288	547	0	1148	0	187	0	8	PVC	0.013	3.5063	64.651	
865	MH-7687	0	59	72.38	187.2	Min. Slope	8	PVC	0.013	1.491	0.044	
2803	710	234.93	711	230.34	187.4	2.449	8	PVC	0.013	258.155	30.415	
4181	1133	227.8	1132	225.7	187.6	1.12	8	PVC	0.013	12.659	2.206	
30	MH-7688	0	190	171.7	187.4	Min. Slope	6	PVC	0.013	0.9353	0.039	
7635	1367	49.42	1368	47.44	188.7	1.049	8	PVC	0.013	2.5116	0.452	
6982	MH-7690	41.83	1406	41.07	188.7	0.4	8	Vitrified Clay	0.013	0.2005	0.058	
1149	MH-7689	0	134	167.93	188.6	Min. Slope	6	PVC	0.013	2.7174	0.114	
4341	1160	31.2	MH-7500	0	189.2	16.492	8	PVC	0.013	7.4428	0.338	
3796	324	0	322	16.48	188.7	Min. Slope	8	PVC	0.013	12.4951	0.78	
4334	MH-7691	0	1158	43.3	189.3	Min. Slope	6	PVC	0.013	2.8974	0.241	
4161	1124	62.2	1123	52.04	189.8	5.354	6	PVC	0.013	1.2035	0.207	
8094	1496	116.62	1424	115.86	189.8	0.4	8	PVC	0.013	0.7417	0.216	

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20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
1187	150	153.74	152	145.37	190.4	4.397	8	Concrete	0.013	321.4861	28.27	
4363	1167	249.1	1166	247.99	189.4	0.586	8	PVC	0.013	2.4445	0.589	
2467	MH-7692	132.99	629	132.17	204	0.4	6	Vitrified Clay	0.013	0.4978	0.313	
1426	MH-7693	29.54	780	28.78	190	0.4	8	PVC	0.013	1.6892	0.492	
3830	294	0	328	0	190.7	0	8	PVC	0.013	12.0535	222.248	
2210	681	105.09	263	102.77	191	1.215	6	PVC	0.013	10.3	3.711	
6431	1311	214.57	1312	213.62	191.5	0.496	8	PVC	0.013	1.5352	0.402	
1123	170	213.9	171	212.59	191.2	0.685	8	Concrete	0.013	28.3867	6.323	
1116	98	0	126	137.95	191.8	Min. Slope	8	PVC	0.013	1.4501	0.032	
7592	1359	256	1360	255.1	191.6	0.47	8	PVC	0.013	114.0413	30.685	
2734	274	23.79	273	23.25	192	0.281	10	Concrete	0.013	68.7082	13.174	
5249	MH-7696	4.18	876	3.4	194.2	0.4	6	Vitrified Clay	0.013	0.2465	0.155	
1948	MH-7697	0	773	0	193	0	8	PVC	0.013	1.5935	29.381	
2253	622	0	612	0	192.9	0	8	PVC	0.013	3.4262	63.174	
7682	1374	240.8	1378	238.6	192.5	1.143	8	PVC	0.013	4.6004	0.794	
4289	1107	0	1108	0	192.7	0	8	PVC	0.013	4.4436	81.933	
7456	MH-7292	0	68	0	192.7	0	8	Asbestos Cement	0.013	33.1505	611.246	
2156	509	33.34	517	27.4	193.5	3.07	6	PVC	0.013	13.8283	3.134	
3972	1072	0	578	0	193.6	0	6	Concrete	0.013	6.504	258.273	
3520	977	35.66	978	0	193.2	18.455	8	PVC	0.013	3.0631	0.131	
2433	613	0	1264	0	193.4	0	6	Concrete	0.013	19.4813	773.593	
3382	915	37.3	967	32.63	193.7	2.411	8	PVC	0.013	0.9248	0.11	
1188	152	145.37	155	130.39	194.4	7.704	8	Concrete	0.013	322.8332	21.446	
3150	262	23.71	522	23.41	194.6	0.154	18	Concrete	0.013	2,063.48	111.466	
4122	1109	253.42	57	0	194.9	130.004	8	PVC	0.013	3.474	0.056	
3405	MH-7698	0	977	35.66	195.1	Min. Slope	8	PVC	0.013	0.691	0.03	
6306	154	126.8	156	124.8	194.9	1.026	8	PVC	0.013	7.5651	1.377	
7681	1373	242.7	1374	240.8	195.2	0.974	8	PVC	0.013	3.5385	0.661	
3106	1065	253.49	1061	245.38	196	4.138	8	PVC	0.013	4.5487	0.412	
3270	889	2.38	891	1.6	196.1	0.4	8	Asbestos Cement	0.013	4.1322	1.205	
1171	106	212.61	107	0	196	108.498	8	Concrete	0.013	2.8066	0.05	
4901	1240	236	MH-7367	0	195.9	120.476	8	PVC	0.013	0.7979	0.013	
2739	MH-7399	0	515	0	196	0	6	PVC	0.013	3.6094	143.326	
4796	MH-7699	0	1233	165.9	197	Min. Slope	6	PVC	0.013	2.1839	0.094	
3409	MH-7274	0	943	45.91	197.4	Min. Slope	6	PVC	0.013	0.5715	0.047	
1478	MH-7700	92.25	679	91.46	197.7	0.4	8	PVC	0.013	3.1952	0.931	
4329	MH-7701	0	730	199.65	198.2	Min. Slope	6	Concrete	0.013	1.8806	0.074	
4239	MH-7425	0	599	0	198.1	0	6	Concrete	0.013	1.8141	72.036	
6654	MH-7702	0	1330	146.72	198.3	Min. Slope	6	Vitrified Clay	0.013	0.6402	0.03	
2848	799	0	800	255.05	198.4	Min. Slope	8	PVC	0.013	1.3908	0.023	
2357	MH-7480	0	564	0	198.9	0	6	Asbestos Cement	0.013	2.3023	91.424	
4180	1132	225.7	1131	218.5	199	3.617	8	PVC	0.013	17.2903	1.676	
3443	MH-7703	0	917	30.66	199.2	Min. Slope	8	PVC	0.013	0.6802	0.032	
2423	250	0	261	22.82	198.9	Min. Slope	8	PVC	0.013	17.8575	0.972	
3194	868	1.49	865	0.69	199.5	0.401	8	PVC	0.013	2.0832	0.607	
3889	334	62.6	349	61.8	199.4	0.4	8	PVC	0.013	3.3532	0.978	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
3897	335	55.74	336	55	199.4	0.371	10	PVC	0.013	41.5701	6.939	
943	840	201.29	77	0	200.1	100.597	8	PVC	0.013	297.2713	5.465	
2100	759	0	760	248.56	199.8	Min. Slope	8	PVC	0.013	1.9828	0.033	
1165	177	217.98	101	214.9	199.8	1.542	8	Concrete	0.013	256.3986	38.076	
1141	109	0	110	0	200	0	8	Concrete	0.013	3.837	70.749	
429	MH-7705	0	1109	253.42	200.5	Min. Slope	8	PVC	0.013	2.545	0.042	
3001	MH-7704	0	807	0	200.2	0	6	PVC	0.013	2.8753	114.175	
3816	308	0	310	0	200.3	0	8	Concrete	0.013	0.6612	12.192	
3278	MH-7706	67.71	874	66.91	200.8	0.4	6	Vitrified Clay	0.013	1.1126	0.699	
4281	MH-7708	0	1151	10.62	201.4	Min. Slope	8	PVC	0.013	0.7101	0.057	
8071	1417	242.24	1418	240.14	200.9	1.045	8		0.013	2.1238	0.383	
1133	94	203.24	99	200.73	278.4	0.902	15	PVC	0.013	995.3274	36.155	SM 3
617	585	70.46	MH-7341	13.16	201.5	28.441	6	PVC	0.013	7.6595	0.57	
3936	MH-7707	5.52	197	4.72	201.3	0.4	6	PVC	0.013	0.1638	0.103	
2287	557	0	547	0	201.9	0	8	PVC	0.013	2.5088	46.258	
4948	1244	62.89	349	61.8	202.1	0.539	8	PVC	0.013	2.6903	0.675	
820	485	132.79	488	117.9	202.6	7.348	8	PVC	0.013	363.6812	24.738	
7983	1401	74.5	1397	66.95	203	3.719	8		0.013	1.9599	0.187	
2065	558	65.29	563	65.25	203	0.02	6	Concrete	0.013	13.6598	38.642	
6668	MH-7428	98.23	1336	97.42	203	0.4	6	Vitrified Clay	0.013	0.5025	0.315	
4224	1141	10.23	1140	9.28	202.8	0.468	30	PVC	0.013	5,116.83	40.614	
3940	MH-7552	0	424	230.12	204	Min. Slope	8	PVC	0.013	16.9409	0.294	
3982	1074	15.9	1070	15.65	204.1	0.123	30	PVC	0.013	4,886.00	75.829	
1724	MH-7709	0	517	27.4	203.8	Min. Slope	4	PVC	0.013	1.1331	0.362	
3609	231	38.29	358	33.4	204.2	2.394	10	PVC	0.013	82.709	5.436	
2090	436	159.78	1319	148.44	204.7	5.539	8	Concrete	0.013	28.6293	2.243	
41	533	0	MH-7291	0	204.2	0	8	Asbestos Cement	0.013	31.2283	575.803	
3440	MH-7710	0	967	32.63	205	Min. Slope	8	PVC	0.013	1.1095	0.051	
966	193	104.52	810	101.88	530.6	0.498	18	PVC	0.013	1,716.78	51.628	SM 4
2104	387	247.06	390	241.4	206.3	2.743	8	PVC	0.013	27.2469	3.033	
3255	MH-7711	84.75	875	83.93	206	0.4	6	Vitrified Clay	0.013	1.3333	0.837	
3623	1057	0	1056	0	206	0	8	PVC	0.013	20.0277	369.28	
3237	880	7.5	885	6.67	206.6	0.4	6	Vitrified Clay	0.013	13.7077	8.607	
1200	130	0	MH-7384	0	207.1	0	8	PVC	0.013	30.2414	557.606	
7823	1394	145.2	1388	123.8	207.1	10.333	8	PVC	0.013	0.4411	0.025	
2265	611	0	1097	0	207.5	0	8	PVC	0.013	2.2688	41.834	
3236	1155	3.62	887	2.79	207.1	0.4	8	Asbestos Cement	0.013	9.5458	2.783	
2102	760	248.56	387	247.06	207.5	0.723	8	PVC	0.013	24.4432	5.301	
4947	1245	63.94	1244	62.89	209	0.502	8	PVC	0.013	2.2492	0.585	
3185	859	6.56	867	5.72	208.9	0.4	8	Asbestos Cement	0.013	0.472	0.138	
4738	MH-7714	0	1228	0	208.6	0	8	PVC	0.013	1.436	26.478	
2321	501	91.32	5	82.87	209.4	4.035	8	Asbestos Cement	0.013	629.208	57.759	
144	527	0	528	0	208.9	0	8	PVC	0.013	8.3268	153.534	
3665	998	17.87	997	17.52	209.5	0.167	12	Asbestos Cement	0.013	169.5781	25.945	
3678	MH-7378	48.91	292	48.07	209.7	0.4	8	PVC	0.013	8.587	2.503	
89	52	16.61	53	16.15	210.5	0.219	12	PVC	0.013	0.8076	0.108	

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2298	MH-7394	0	444	209.12	210.7	Min. Slope	8	PVC	0.013	4.1371	0.077	
7583	1353	282.5	1355	279.4	211.4	1.467	8	PVC	0.013	101.8916	15.513	
88	51	17.08	52	16.61	211.5	0.222	12	PVC	0.013	0.4038	0.054	
6288	MH-7715	144.44	623	143.41	258.6	0.4	6	Vitrified Clay	0.013	0.118	0.074	
4456	1183	43.48	1182	35.04	211.2	3.996	8	PVC	0.013	1.5205	0.14	
7662	MH-7717	0	1370	0	212	0	8	PVC	0.013	1.0316	19.021	
7620	MH-7716	227.17	1272	166.79	211.8	28.507	6	Vitrified Clay	0.013	10.3412	0.769	
5129	MH-7718	134.74	1265	133.89	212	0.4	6	PVC	0.013	1.4093	0.885	
3054	828	4.8	826	3.95	212.5	0.4	8	Asbestos Cement	0.013	2.8317	0.826	
4155	1121	12.47	911	11.92	212.4	0.259	30	PVC	0.013	4,941.14	52.743	
1125	164	223.38	165	222.71	71.2	0.942	15	PVC	0.013	944.8505	33.585	SM 5
330	MH-7719	22.85	227	21.99	214.4	0.401	6	Concrete	0.013	1.4177	0.889	
6294	1301	160.15	1300	0	213.9	74.871	8	PVC	0.013	2.6929	0.057	
6432	1312	213.62	1313	212.57	214.9	0.489	8	PVC	0.013	2.3028	0.607	
8092	1495	0	1423	0	214.8	0	8	PVC	0.013	0.7646	14.098	
2320	495	100.19	501	91.32	214.8	4.129	8	Asbestos Cement	0.013	626.6187	56.858	
5102	MH-7720	108.28	1261	107.42	214.5	0.4	6	Vitrified Clay	0.013	6.0426	3.794	
3241	MH-7721	80.03	881	79.17	214.9	0.4	6	Vitrified Clay	0.013	0.5525	0.347	
2329	655	133.28	1258	121.11	218	5.585	6	Vitrified Clay	0.013	7.8957	1.327	
3634	979	0	982	0	215.1	0	8	PVC	0.013	2.7569	50.833	
2147	MH-7722	38.36	496	37.5	215	0.4	8	PVC	0.013	0.6426	0.187	
3821	321	0	296	0	215.7	0	8	PVC	0.013	32.904	606.701	
2342	669	207.98	MH-7723	190.32	215.9	8.179	6	Vitrified Clay	0.013	1.6215	0.225	
4585	MH-7724	170.02	1201	169.15	216	0.4	6	Vitrified Clay	0.013	2.8051	1.761	
425	MH-7725	0	174	238.7	216.5	Min. Slope	8	PVC	0.013	1.4871	0.026	
1607	372	1.43	783	0.82	216.6	0.282	10	Asbestos Cement	0.013	223.4767	42.826	
3965	211	233.2	210	232.83	86.6	0.427	15	PVC	0.013	916.4694	48.35	SM 5
2217	1320	215.13	677	171.71	217.5	19.959	6	Vitrified Clay	0.013	5.0235	0.447	
340	1309	17.86	30	17.72	217.7	0.064	30	PVC	0.013	4,733.93	101.402	
1953	MH-7596	0	771	0	218.5	0	8	PVC	0.013	4.0418	74.524	
2538	MH-7726	166.59	690	165.72	218.1	0.4	6	Vitrified Clay	0.013	0.8432	0.529	
4003	1084	0	1083	0	218.6	0	8	PVC	0.013	7.863	144.981	
98	57	0	1081	0	218.7	0	8	PVC	0.013	4.1689	76.868	
2370	MH-7727	0	228	0	219.2	0	6	PVC	0.013	1.8684	74.195	
3600	291	90.91	290	84.11	218.7	3.109	8	PVC	0.013	6.016	0.629	
7576	1355	279.4	1354	270.4	219.8	4.095	8	PVC	0.013	103.695	9.448	
815	461	175.47	470	165.46	220.2	4.546	8	PVC	0.013	341.082	29.496	
4689	MH-7728	58.47	MH-7287	57.59	219.7	0.4	8	PVC	0.013	1.0645	0.31	
1311	1418	240.14	174	238.7	220.5	0.653	8	PVC	0.013	149.4296	34.098	
3693	951	23.84	955	20.78	220.6	1.387	8	PVC	0.013	4.3332	0.678	
3446	368	41.3	3	40.51	220.9	0.358	10	PVC	0.013	81.3857	13.841	
1441	MH-7730	0	769	223.73	220.5	Min. Slope	8	PVC	0.013	0.7676	0.014	
2235	738	0	737	0	221.2	0	6	PVC	0.013	0.4944	19.632	
822	406	233.93	412	232.96	221.8	0.437	8	PVC	0.013	7.5701	2.11	
4168	MH-7731	0	18	109.67	221.5	Min. Slope	6	PVC	0.013	0.7646	0.043	
1192	1345	165.16	153	0	222.2	74.314	6	Concrete	0.013	19.6668	0.906	

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2221	MH-7732	154.74	1380	153.85	222.8	0.4	6	Vitrified Clay	0.013	0.3048	0.191	
1335	240	59.6	244	58.33	222.8	0.57	8	PVC	0.013	39.8057	9.721	
2424	628	0	619	0	223.7	0	8	PVC	0.013	0.8096	14.927	
7577	1356	262.1	1349	260.5	223.8	0.715	8	PVC	0.013	106.7898	23.287	
7633	MH-7733	99.37	1366	98.48	223.7	0.4	6	Vitrified Clay	0.013	3.4152	2.144	
3641	954	44.48	957	35.19	223.8	4.151	8	PVC	0.013	13.3137	1.205	
4903	1243	245.5	1242	236.4	224	4.063	8	PVC	0.013	0.6862	0.063	
786	430	189.16	437	183.54	224.7	2.501	6	Concrete	0.013	11.9033	2.989	
2662	1089	0	691	116.55	224	Min. Slope	8	PVC	0.013	2.6192	0.067	
8099	192	131.43	193	104.52	224.8	11.97	8	Concrete	0.013	151.199	8.058	
4900	1241	244.91	1240	236	224.4	3.971	8	PVC	0.013	0.2234	0.021	
3762	310	0	299	0	225.2	0	8	Concrete	0.013	8.2471	152.063	
1136	131	166.8	133	165.9	224.7	0.4	8	Concrete	0.013	138.3974	40.352	
2209	MH-7734	162.9	652	162	225	0.4	6	Vitrified Clay	0.013	0.8396	0.527	
3251	MH-7735	64.35	1197	63.45	225.1	0.4	6	Vitrified Clay	0.013	1.4472	0.909	
2426	MH-7723	190.32	657	189.42	225.5	0.4	6	Vitrified Clay	0.013	2.4941	1.566	
3250	MH-7736	136.63	879	135.73	225.6	0.4	6	Vitrified Clay	0.013	2.4039	1.509	
2050	764	3.39	781	2.48	226	0.403	8	Asbestos Cement	0.013	217.4728	63.187	
3254	MH-7737	86	896	85.1	226.1	0.4	6	Vitrified Clay	0.013	1.2194	0.766	
32	MH-7738	0	329	34.13	227	Min. Slope	8	PVC	0.013	1.5022	0.071	
2427	1293	187.63	686	175.77	227	5.225	8	PVC	0.013	4.9856	0.402	
3366	MH-7739	0	939	0	227.1	0	8	PVC	0.013	0.4411	8.133	
1646	60	0	515	0	227.5	0	8	PVC	0.013	8.2387	151.908	
1965	MH-7740	0	405	234.19	227.7	Min. Slope	8	PVC	0.013	5.2433	0.095	
818	476	148.35	477	147.39	227.2	0.423	8	PVC	0.013	348.9395	98.969	
2910	796	0	794	0	227.3	0	8	PVC	0.013	3.3186	61.189	
2080	767	0	768	234	227.6	Min. Slope	8	PVC	0.013	1.1874	0.022	
709	370	100.91	791	100	227.7	0.4	8	PVC	0.013	2.9621	0.863	
2059	573	40.51	561	39.6	228.3	0.4	8	Vitrified Clay	0.013	50.4109	14.698	
3431	MH-7741	0	270	0	228.2	0	8	PVC	0.013	0.594	10.953	
3885	353	80.97	348	81.38	228.7	Min. Slope	8	PVC	0.013	15.0322	6.546	
2094	440	0	448	156.38	229	Min. Slope	8	PVC	0.013	1.9914	0.044	
7603	504	0	60	0	228.9	0	8	PVC	0.013	1.0316	19.021	
3610	358	33.4	357	32.63	228.5	0.337	10	PVC	0.013	83.1501	14.568	
2035	MH-7745	150.66	1238	149.74	228.8	0.4	6	Vitrified Clay	0.013	1.8911	1.187	
3225	MH-7744	1.66	870	0.73	230.5	0.4	8	Vitrified Clay	0.013	2.0944	0.611	
3613	941	61	939	0	228.5	26.696	8	PVC	0.013	6.2867	0.224	
130	MH-7527	0	393	0	228.8	0	8	PVC	0.013	2.3773	43.833	
3774	316	0	315	0	229.5	0	8	Concrete	0.013	25.7501	474.793	
3640	948	50.41	954	44.48	229.9	2.579	8	PVC	0.013	11.7822	1.353	
262	MH-7481	0	692	0	229.9	0	8	PVC	0.013	3.8372	70.753	
1168	100	213.24	102	210.86	229.8	1.036	8	Concrete	0.013	261.4038	47.357	
1999	MH-7747	0	586	0	230.4	0	6	Concrete	0.013	1.1561	45.906	
93	56	0	790	235.75	230	Min. Slope	8	PVC	0.013	1.0497	0.019	
2072	766	239.24	765	235.35	230.7	1.686	8	PVC	0.013	1.4304	0.203	
1764	MH-7746	0	1062	244.61	232.7	Min. Slope	8	PVC	0.013	1.2572	0.023	

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General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
2223	642	0	645	0	230.6	0	8	Concrete	0.013	3.2968	60.788	
1785	1273	0	485	132.79	231.4	Min. Slope	8	PVC	0.013	4.0033	0.097	
5053	MH-7748	102.75	625	101.82	231.5	0.4	6	PVC	0.013	0.6741	0.423	
3531	330	0	279	0	231.3	0	8	Concrete	0.013	20.0776	370.201	
6327	MH-7750	0	533	0	232	0	6	Concrete	0.013	1.4725	58.471	
4335	1158	43.3	1159	34.13	231.4	3.962	8	PVC	0.013	4.1088	0.381	
819	477	147.39	484	134.98	232.6	5.335	8	PVC	0.013	355.3717	28.37	
2107	391	0	400	0	232.9	0	8	PVC	0.013	25.9892	479.202	
36	MH-7751	0	524	0	232.3	0	6	PVC	0.013	0.4038	16.035	
3629	973	27.56	981	19.17	233.3	3.597	8	PVC	0.013	4.3801	0.426	
2267	MH-7754	0	581	0	233.4	0	6	Concrete	0.013	1.2839	50.984	
2075	1100	0	771	0	232.9	0	6	Concrete	0.013	4.7798	189.803	
2157	MH-7458	0	MH-7293	0	233.6	0	6	PVC	0.013	9.9541	395.271	
4462	1178	23.98	MH-7368	0	233.2	10.284	8	PVC	0.013	6.526	0.375	
4643	MH-7752	0	1217	112	233.2	Min. Slope	8	PVC	0.013	0.7997	0.021	
4246	1147	188.13	MH-7753	0	233.3	80.655	8	PVC	0.013	1.1087	0.023	
3109	34	248.07	1061	245.38	233.7	1.151	6	PVC	0.013	4.5759	1.694	
7588	1363	249.9	1060	248.38	234.7	0.648	8	PVC	0.013	119.3508	27.345	
3603	223	45.97	367	44.95	234.3	0.435	10	PVC	0.013	79.1802	12.204	
1178	117	216.39	116	0	234.5	92.277	8	PVC	0.013	17.5664	0.337	
4131	MH-7755	0	24	0	235.3	0	6	PVC	0.013	1.2294	48.819	
3794	323	0	322	16.48	235.4	Min. Slope	8	PVC	0.013	2.5692	0.179	
4165	1126	0	1125	0	235.7	0	6	PVC	0.013	1.8233	72.403	
2270	581	0	578	0	235.1	0	6	Concrete	0.013	50.801	2,017.29	
2579	MH-7757	257.86	647	256.92	235.7	0.4	6	Asbestos Cement	0.013	0.7971	0.5	
957	84	235.82	85	234.13	236	0.716	8	PVC	0.013	2.719	0.592	
2909	794	0	797	0	235.4	0	8	PVC	0.013	5.5634	102.58	
3893	348	81.38	352	74.4	235.4	2.966	8	PVC	0.013	27.1791	2.91	
2971	795	260.37	800	255.05	236.2	2.253	8	PVC	0.013	4.3707	0.537	
2046	MH-7756	118.14	680	117.2	235.7	0.4	6	PVC	0.013	1.5194	0.954	
3032	809	0	810	101.88	236.3	Min. Slope	8	Asbestos Cement	0.013	12.7154	0.357	
3441	MH-7758	0	979	0	236.5	0	6	PVC	0.013	1.1095	44.057	
3235	883	57.76	MH-7354	56.81	236.5	0.4	6	Vitrified Clay	0.013	28.5374	17.918	
2415	526	0	359	41.93	236.8	Min. Slope	8	PVC	0.013	4.4805	0.196	
4517	1188	31.43	863	3.7	236.3	11.736	10	PVC	0.013	570.8041	16.944	
3981	260	0	1074	15.9	236.1	Min. Slope	8	PVC	0.013	20.6577	1.468	
2041	20	107.33	1276	106.39	236.3	0.4	6	Concrete	0.013	1.7491	1.098	
1153	139	0	140	161.24	236.4	Min. Slope	8	Concrete	0.013	3.0749	0.069	
2083	418	206.25	426	178.41	237.1	11.74	8	PVC	0.013	21.1358	1.137	
3141	905	20.22	902	19.59	236.4	0.266	18	Concrete	0.013	2,169.79	89.155	
2252	1149	0	599	0	237.2	0	6	Concrete	0.013	24.8274	985.886	
1185	148	0	150	153.74	237.1	Min. Slope	8	Concrete	0.013	1.0619	0.024	
3639	946	60.11	948	50.41	237.7	4.08	8	PVC	0.013	7.3407	0.67	
3110	1062	244.61	1064	243.64	237.9	0.408	8	PVC	0.013	15.9644	4.61	
3638	949	37.79	957	35.19	238.2	1.092	8	PVC	0.013	6.1183	1.08	
1177	119	212.58	117	216.39	238.5	Min. Slope	8	PVC	0.013	3.1568	0.461	

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2116	409	221.44	414	206.6	238.6	6.22	8	PVC	0.013	78.2466	5.785	
3276	888	68.07	874	66.91	238.1	0.487	10	Vitrified Clay	0.013	65.6815	9.571	
3607	222	42.22	368	41.3	238.9	0.385	10	PVC	0.013	80.9446	13.264	
2121	474	143.74	473	135.92	238.3	3.281	8	PVC	0.013	8.1585	0.83	
129	1165	247.75	81	0	239.4	103.504	8	PVC	0.013	6.0563	0.11	
1909	776	0	777	99.22	239.3	Min. Slope	6	Concrete	0.013	5.2212	0.322	
7600	575	124.36	20	107.33	238.7	7.135	6	Concrete	0.013	0.5701	0.085	
442	176	219.28	88	218.26	239.8	0.425	8	Concrete	0.013	227.4958	64.317	
4399	1172	0	1111	0	239.7	0	8	PVC	0.013	10.6109	195.649	
2124	MH-7322	0	457	160.44	239.1	Min. Slope	8	PVC	0.013	4.286	0.096	
4223	1140	9.28	1139	8.22	239.1	0.443	30	PVC	0.013	5,117.08	41.744	
214	1112	31.62	940	31.03	240	0.246	12	PVC	0.013	106.4935	13.431	
1652	MH-7759	114.63	373	113.67	240	0.4	6	Vitrified Clay	0.013	0.9447	0.593	
2585	MH-7761	0	474	143.74	240.2	Min. Slope	8	PVC	0.013	2.3266	0.055	
965	820	238.89	84	235.82	239.9	1.28	8	PVC	0.013	1.317	0.215	
2260	607	0	609	134.8	239.8	Min. Slope	8	PVC	0.013	1.2753	0.031	
3646	MH-7363	0	965	21.06	239.9	Min. Slope	8	PVC	0.013	8.9284	0.556	
4005	MH-7760	0	1083	0	240.2	0	8	PVC	0.013	0.7609	14.029	
3680	938	0	939	0	240.8	0	8	PVC	0.013	0.4411	8.133	
3184	860	7.52	859	6.56	241	0.4	8	Asbestos Cement	0.013	0.354	0.103	
7587	1358	257.4	1352	256.2	240.5	0.499	8	PVC	0.013	111.9478	29.22	
1012	MH-7762	0	181	207.93	241.2	Min. Slope	8	PVC	0.013	1.3786	0.027	
1992	689	0	619	0	240.6	0	8	PVC	0.013	4.7984	88.475	
1491	MH-7763	85.73	556	84.76	241.6	0.4	6	PVC	0.013	0.2005	0.126	
35	848	0	259	0	241	0	8	PVC	0.013	17.8612	329.334	
2327	660	121.75	MH-7445	120.79	241.5	0.4	8	Vitrified Clay	0.013	53.9474	15.726	
3967	207	235.69	208	235.01	130.2	0.522	15	PVC	0.013	900.781	42.989	SM 5
4175	1129	227.4	1128	203.1	242.5	10.021	8	PVC	0.013	0.9857	0.057	
635	975	0	MH-7764	0	242.6	0	6	Vitrified Clay	0.013	7.0585	280.291	
3084	837	0	838	0	242.8	0	8	PVC	0.013	28.6902	529.005	
1132	93	204.2	94	203.24	242.4	0.396	8	Concrete	0.013	10.6916	3.132	
787	420	204.32	MH-7249	189.16	251.6	6.026	6	PVC	0.013	4.2752	0.692	
4499	593	141.94	1186	136.12	242.8	2.397	6	Vitrified Clay	0.013	2.6311	0.675	
2232	747	0	739	0	243.3	0	8	Concrete	0.013	5.41	99.752	
2175	MH-7767	93.91	646	92.94	243.2	0.4	6	Vitrified Clay	0.013	1.0123	0.636	
5294	MH-7765	0	776	0	242.9	0	8	PVC	0.013	0.9754	17.985	
3545	283	0	281	0	243.7	0	8	Concrete	0.013	32.1203	592.249	
3337	912	61.79	1050	60.71	243.9	0.443	8	PVC	0.013	1.7743	0.492	
2152	MH-7768	0	506	0	244	0	8	PVC	0.013	2.2054	40.664	
1314	205	228.88	164	223.38	244.1	2.253	8	Concrete	0.013	11.8444	1.455	
3532	968	27.14	969	25.13	243.5	0.826	8	PVC	0.013	7.6515	1.553	
3931	908	9.54	1051	8.54	244.2	0.409	18	Concrete	0.013	179.0284	5.934	
5081	1256	63.14	1255	55.28	243.6	3.227	8	PVC	0.013	2.9169	0.299	
2269	592	0	581	0	244.5	0	8	PVC	0.013	2.6832	49.474	
3968	213	236.33	207	235.69	131.8	0.486	15	PVC	0.013	899.0828	44.495	SM 5
2129	453	0	464	0	244.8	0	6	PVC	0.013	3.36	133.423	

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3687	MH-7331	0	327	0	245.4	0	8	PVC	0.013	4.9778	91.783	
3536	961	0	962	0	245.6	0	8	PVC	0.013	25.5602	471.291	
3108	1061	245.38	79	245.17	246.4	0.085	8	PVC	0.013	10.78	6.808	
2482	688	15.49	1068	14.95	246.1	0.219	12	PVC	0.013	1.6152	0.216	
872	61	240	388	236.16	246.5	1.558	8	PVC	0.013	3.1361	0.463	
3539	270	0	271	0	245.9	0	8	PVC	0.013	8.737	161.097	
6291	1298	0	445	210.15	246.3	Min. Slope	8	PVC	0.013	32.1501	0.642	
6643	MH-7770	0	138	0	246	0	8	PVC	0.013	0.7676	14.153	
404	1116	0	MH-7339	0	246.6	0	8	PVC	0.013	3.6483	67.27	
942	77	0	1059	191.69	246.9	Min. Slope	8	PVC	0.013	301.4242	6.308	
3894	340	78.69	337	77.59	274.5	0.4	8	PVC	0.013	12.3689	3.606	
80	49	226.02	50	215.21	247.4	4.37	8	PVC	0.013	7.1435	0.63	
3083	763	5.96	817	4.97	247.2	0.4	8	PVC	0.013	0.9077	0.265	
3151	234	173.42	232	168.8	246.9	1.871	6	Concrete	0.013	24.8942	7.226	
7685	1375	242.1	1376	240.2	201.5	0.943	15	PVC	0.013	853.2185	30.31	SM 5
1786	MH-7772	0	1273	0	248	0	6	PVC	0.013	1.8605	73.882	
3620	965	21.06	963	16.79	247.4	1.726	8	PVC	0.013	13.7715	1.933	
284	MH-7771	0	748	0	254	0	8	PVC	0.013	1.4202	26.186	
2224	645	0	649	0	247.7	0	8	Concrete	0.013	6.0214	111.025	
1264	173	229.4	164	223.38	241.7	2.491	15	PVC	0.013	931.4395	20.357	SM 5
2162	MH-7773	161.94	658	160.95	248.5	0.4	6	Vitrified Clay	0.013	288.3217	181.026	
2001	596	0	377	0	248.8	0	8	PVC	0.013	7.6529	141.108	
4245	MH-7753	0	451	185.69	248.2	Min. Slope	8	PVC	0.013	3.135	0.067	
2033	1262	174.73	656	126.67	248.4	19.346	6	Vitrified Clay	0.013	10.4304	0.942	
806	359	0	220	41.57	248	Min. Slope	8	PVC	0.013	5.243	0.236	
1186	142	167.92	150	153.74	249.4	5.686	8	Concrete	0.013	319.3623	24.695	
1313	206	222.8	163	221.8	249.4	0.4	8	Concrete	0.013	13.3972	3.906	
2336	1425	129.73	632	128.73	249.3	0.4	6	PVC	0.013	1.6761	1.052	
834	701	0	515	24.5	248.9	Min. Slope	8	PVC	0.013	20.2261	1.189	
2271	578	0	572	0	249.6	0	6	Concrete	0.013	57.761	2,293.66	
3030	807	0	808	0	249.8	0	8	PVC	0.013	5.8451	107.774	
1154	140	161.24	146	148.88	249.9	4.947	8	Concrete	0.013	1,184.84	98.225	
1270	179	229.03	178	227.58	250	0.58	8	PVC	0.013	4.093	0.991	
3725	16	0	41	0	250	0	8	PVC	0.013	0.5905	10.889	
2099	471	105.31	478	90.95	250	5.744	10	Concrete	0.013	74.6278	3.167	
3895	346	57.16	347	56.18	249.7	0.392	8	PVC	0.013	40.6879	11.976	
1142	110	0	111	181.73	249.5	Min. Slope	8	Concrete	0.013	6.0315	0.13	
1190	137	0	138	0	250.4	0	6	Concrete	0.013	4.2559	168.999	
1126	165	222.71	172	217.91	254.3	1.888	15	PVC	0.013	945.9123	23.747	SM 5
1979	371	231.48	714	229.99	250.4	0.595	8	PVC	0.013	114.843	27.453	
1122	169	0	170	213.9	249.9	Min. Slope	8	Concrete	0.013	11.9928	0.239	
504	625	101.82	616	100.86	241.3	0.4	6	Vitrified Clay	0.013	3.1704	1.991	
3096	MH-7774	101.91	370	100.91	250.1	0.4	8	PVC	0.013	1.0784	0.314	
636	MH-7764	0	926	11.48	250	Min. Slope	6	Vitrified Clay	0.013	7.9887	1.48	
2477	566	41.54	573	40.51	255.9	0.4	8	Concrete	0.013	18.5936	5.42	
594	839	0	35	0	250.6	0	8	Asbestos Cement	0.013	33.0717	609.793	

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4417	1176	179	234	173.42	251	2.223	8	PVC	0.013	7.7622	0.96	
3622	963	16.79	964	13.74	250.3	1.218	8	PVC	0.013	17.6651	2.951	
2166	1201	169.15	693	168.15	250.6	0.4	6	Vitrified Clay	0.013	3.8489	2.417	
2062	600	110.06	590	99	251.1	4.405	6	Vitrified Clay	0.013	3.9479	0.747	
2141	449	0	450	0	250.6	0	8	PVC	0.013	11.8776	219.005	
2149	219	25.08	842	14.96	250.7	4.037	8	PVC	0.013	3.6782	0.338	
2732	276	0	277	0	250.7	0	8	PVC	0.013	4.6653	86.022	
2144	MH-7383	39.09	490	38.08	251.6	0.4	8	PVC	0.013	1.8164	0.53	
1196	180	215.1	182	209.5	251.7	2.225	8	Asbestos Cement	0.013	2.2429	0.277	
17	38	0	39	131.7	250.8	Min. Slope	8	PVC	0.013	1.3006	0.033	
2258	589	0	377	0	250.9	0	6	Concrete	0.013	31.1487	1,236.90	
5101	1260	0	569	0	251.7	0	6	Concrete	0.013	9.0356	358.799	
1121	163	221.8	170	213.9	251.9	3.136	8	Concrete	0.013	15.3319	1.596	
6062	465	0	1099	90.04	251.9	Min. Slope	6	Concrete	0.013	3.0064	0.2	
7809	1387	0	MH-7872	0	256.3	0	8	PVC	0.013	1.842	33.963	
3637	944	46.54	949	37.79	251.7	3.476	8	PVC	0.013	3.9292	0.389	
2111	392	0	403	0	252.3	0	8	PVC	0.013	3.4652	63.893	
8049	861	9.81	1407	8.8	251.9	0.4	8	Asbestos Cement	0.013	0.118	0.034	
3690	950	16.01	960	15.07	252.3	0.373	8	Asbestos Cement	0.013	2.37	0.716	
2247	1325	0	615	0	252.5	0	6	Concrete	0.013	4.84	192.195	
2030	484	134.98	485	132.79	251.9	0.869	8	PVC	0.013	357.2322	70.649	
2245	MH-7776	223.24	670	222.23	252.8	0.4	6	Vitrified Clay	0.013	1.0234	0.643	
1128	95	0	96	203.5	252.4	Min. Slope	8	PVC	0.013	5.3775	0.11	
665	331	84.33	332	62.87	253.2	8.475	8	PVC	0.013	2.9003	0.184	
1315	204	231.18	173	229.4	275.7	0.646	15	PVC	0.013	920.5337	39.517	SM 5
1316	178	227.58	218	224.89	253.5	1.061	8	PVC	0.013	23.1102	4.137	
2122	466	146.56	473	135.92	254.3	4.183	8	PVC	0.013	173.5661	15.647	
2262	586	0	584	0	253.4	0	6	Concrete	0.013	41.7537	1,658.02	
2168	693	168.15	620	159.92	253.9	3.241	6	Vitrified Clay	0.013	5.0303	1.11	
2481	687	14.79	746	14.45	253.9	0.134	30	PVC	0.013	4,892.14	72.619	
600	MH-7777	0	36	0	253.9	0	8	PVC	0.013	0.9317	17.179	
7683	1376	240.2	1378	238.6	291.9	0.548	15	PVC	0.013	854.2804	39.798	SM 5
5906	992	10.16	994	9.47	254.1	0.271	8	Asbestos Cement	0.013	59.7311	21.137	
506	MH-7778	132.89	697	131.87	254.9	0.4	6	Vitrified Clay	0.013	0.7417	0.466	
7860	1397	66.95	1398	59.2	255.2	3.037	8	PVC	0.013	2.2923	0.243	
2173	621	133.79	1259	123.85	255.2	3.895	6	Vitrified Clay	0.013	2.3629	0.475	
2600	704	0	702	26.24	255.2	Min. Slope	8	PVC	0.013	6.8006	0.391	
3604	367	44.95	366	44.37	255.5	0.227	10	PVC	0.013	79.6213	16.994	
2118	1249	0	434	174.61	255.8	Min. Slope	8	PVC	0.013	128.6216	2.87	
486	698	99.54	597	89.36	255.7	3.982	6	Vitrified Clay	0.013	5.9731	1.189	
2254	637	172.86	MH-7521	171.84	255.3	0.4	6	PVC	0.013	12.1497	7.628	
2355	579	107.1	576	106.35	255.3	0.294	6	Concrete	0.013	4.4141	3.233	
6437	1318	229.04	1317	216.12	255.5	5.056	6	PVC	0.013	1.3726	0.242	
3261	898	163.4	877	162.38	255.9	0.4	6	Vitrified Clay	0.013	36.9383	23.194	
2153	506	0	248	24.9	255.8	Min. Slope	8	PVC	0.013	6.1321	0.362	
817	470	165.46	476	148.35	256.8	6.664	8	PVC	0.013	346.5858	24.755	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
2148	496	26.1	219	25.08	256.1	0.4	8	PVC	0.013	2.6514	0.773	
2234	741	0	740	0	256.8	0	8	Concrete	0.013	2.47	45.543	
4226	1143	11.26	1142	10.62	256.1	0.25	30	PVC	0.013	4,941.63	53.693	
3549	273	23.25	271	22.53	256.9	0.28	10	Asbestos Cement	0.013	69.6085	13.372	
3538	272	0	270	0	257.1	0	8	PVC	0.013	7.0052	129.165	
1156	151	136.04	154	126.8	257.1	3.594	8	PVC	0.013	5.6629	0.551	
3635	982	0	983	0	256.5	0	8	PVC	0.013	3.7767	69.637	
4356	1163	46	1162	0	256.5	17.935	8	PVC	0.013	5.9683	0.26	
4630	1214	62.82	1213	50.37	257.4	4.836	8	PVC	0.013	1.8835	0.158	
3775	313	0	314	0	256.7	0	8	Concrete	0.013	3.4509	63.63	
1259	184	0	185	197.59	256.9	Min. Slope	8	PVC	0.013	40.0387	0.842	
3689	970	13.8	972	12.96	257.7	0.326	8	Asbestos Cement	0.013	45.1022	14.567	
4506	1187	29.54	13	0	257.2	11.485	8	PVC	0.013	2.0774	0.113	
1203	187	186.1	190	171.7	258.3	5.574	8	Concrete	0.013	107.4061	8.388	
3555	275	22.8	1002	22.13	241.7	0.277	10	Asbestos Cement	0.013	73.956	14.286	
2079	770	175	772	164.46	258.6	4.075	6	Concrete	0.013	5.8527	1.151	
4055	1093	92.61	1092	88.54	257.8	1.579	8	PVC	0.013	4.3646	0.641	
2227	750	0	751	0	258.7	0	8	Concrete	0.013	2.1456	39.562	
20	43	0	327	0	258.2	0	8	PVC	0.013	3.1721	58.489	
4640	1219	106.2	1220	96.8	258.3	3.64	8	PVC	0.013	4.545	0.439	
1184	135	181.83	142	167.92	259.2	5.367	8	Concrete	0.013	317.2385	25.25	
3632	983	0	981	19.17	258.3	Min. Slope	8	PVC	0.013	5.4133	0.366	
4642	1217	112	1218	108.9	258.3	1.2	8	PVC	0.013	2.5641	0.432	
958	825	2.45	86	1.41	259.2	0.4	8	Asbestos Cement	0.013	3.9308	1.146	
512	790	235.75	768	234	259.4	0.675	8	PVC	0.013	7.9967	1.795	
2095	446	0	447	144.47	258.7	Min. Slope	6	Concrete	0.013	5.7148	0.304	
4398	1173	35.4	1172	0	259.4	13.648	8	PVC	0.013	9.2876	0.464	
2242	668	230.02	676	214.73	258.9	5.906	6	Vitrified Clay	0.013	5.9692	0.975	
3890	350	62.83	349	61.8	258.7	0.398	8	PVC	0.013	28.5024	8.328	
7634	1369	52.12	1367	49.42	259.5	1.04	8	PVC	0.013	1.4202	0.257	
3547	279	0	278	0	259.6	0	8	Concrete	0.013	62.3514	1,149.67	
1205	190	171.7	191	155.73	259.8	6.147	8	Concrete	0.013	143.9739	10.707	
3543	1054	0	1053	0	259.7	0	8	Concrete	0.013	29.326	540.726	
4396	1175	47.1	1174	37.1	259	3.861	8	PVC	0.013	5.12	0.48	
3188	1202	3.81	858	1.7	259.7	0.812	8	PVC	0.013	180.1572	36.856	
7011	MH-7780	144.45	623	143.41	259.4	0.4	6	Vitrified Clay	0.013	2.8185	1.77	
4611	1207	212.33	1205	210.25	260	0.8	8	PVC	0.013	1.9067	0.393	
1206	191	155.6	192	131.43	260.2	9.289	8	Concrete	0.013	149.5972	9.05	
349	19	0	649	0	260.2	0	8	PVC	0.013	6.6491	122.6	
42	70	0	71	20.17	260.3	Min. Slope	8	PVC	0.013	2.7786	0.184	
2218	670	222.23	677	171.71	259.7	19.451	6	Vitrified Clay	0.013	5.3233	0.479	
4023	337	77.59	353	80.97	260.2	Min. Slope	8	PVC	0.013	13.374	2.163	
3544	1053	0	283	0	260.2	0	8	Concrete	0.013	31.4013	578.992	
3817	302	0	303	0	259.5	0	8	PVC	0.013	1.8517	34.142	
2126	480	115.53	486	98.91	260.5	6.381	8	PVC	0.013	184.2822	13.451	
2981	803	0	761	0	260.5	0	8	PVC	0.013	2.0811	38.372	

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Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
2034	686	175.77	1262	174.73	259.9	0.4	6	Vitrified Clay	0.013	5.8818	3.693	
7700	694	123.68	1379	118.56	260	1.971	6	Vitrified Clay	0.013	4.2548	1.203	
2436	MH-7355	119.88	MH-7624	118.84	260.4	0.4	6	Vitrified Clay	0.013	2.6675	1.675	
2435	677	171.71	684	170.67	260.4	0.4	6	Vitrified Clay	0.013	12.3133	7.731	
1191	138	0	144	0	260.8	0	6	Concrete	0.013	6.2948	249.964	
3125	730	199.65	83	193.75	260.7	2.263	8	Concrete	0.013	3.1881	0.391	
2358	569	0	564	0	260	0	8	Asbestos Cement	0.013	71.9477	1,326.61	
3533	994	9.47	991	8.62	259.9	0.327	8	Asbestos Cement	0.013	60.4521	19.492	
2244	MH-7782	239.7	676	214.73	261.1	9.564	6	Vitrified Clay	0.013	8.4208	1.081	
2817	MH-7304	0	722	224.94	260.1	Min. Slope	8	PVC	0.013	2.4894	0.049	
3152	441	174.03	232	168.8	260.9	2.004	10	PVC	0.013	137.0624	9.845	
2145	490	38.08	360	37.04	260.2	0.4	8	PVC	0.013	2.7762	0.809	
4321	1154	35.8	1153	28.2	260	2.923	8	PVC	0.013	2.4771	0.267	
2733	278	0	277	0	260.8	0	8	Concrete	0.013	62.5986	1,154.22	
2225	649	0	654	0	260.2	0	8	Concrete	0.013	13.6549	251.775	
6252	886	77.57	MH-7781	76.53	260.5	0.4	10	Vitrified Clay	0.013	136.7941	21.994	
19	42	0	43	111.8	260.3	Min. Slope	8	PVC	0.013	1.3377	0.038	
2071	78	239.39	765	235.35	260.4	1.552	8	PVC	0.013	39.0615	5.782	
4644	1216	118.6	1217	112	261.1	2.528	8	PVC	0.013	1.3233	0.153	
2088	381	0	454	135.91	260.5	Min. Slope	8	Concrete	0.013	31.151	0.795	
3836	303	0	276	0	260.4	0	8	PVC	0.013	4.4181	81.464	
3795	325	0	324	18.03	261.2	Min. Slope	8	PVC	0.013	4.5305	0.318	
2073	765	235.35	836	231.3	260.8	1.553	8	PVC	0.013	44.1177	6.528	
1127	172	217.91	96	203.5	261.9	5.503	8	Concrete	0.013	946.9742	74.434	
3898	336	55	339	54.34	261.6	0.252	10	PVC	0.013	46.8214	9.48	
2555	1379	118.56	937	117.51	261.3	0.4	6	Vitrified Clay	0.013	5.3009	3.328	
2097	454	135.91	463	120.87	262	5.742	8	Concrete	0.013	68.8624	5.299	
2133	452	0	465	0	262	0	6	PVC	0.013	1.7995	71.456	
2731	1009	23.53	275	22.8	257.3	0.284	10	Asbestos Cement	0.013	73.7088	14.073	
250	14	0	15	0	262.5	0	8	PVC	0.013	3.5126	64.767	
916	68	16.7	69	16.38	262.5	0.122	30	Concrete	0.013	4,843.48	75.352	
2170	396	144.34	1103	143.29	262.6	0.4	8	Vitrified Clay	0.013	12.7908	3.729	
2131	464	0	472	0	262.8	0	6	Concrete	0.013	6.4359	255.566	
3815	314	0	312	0	262.7	0	8	Concrete	0.013	4.88	89.98	
3826	295	0	1054	0	262.7	0	8	Concrete	0.013	28.2826	521.489	
2077	773	0	774	153.47	262.3	Min. Slope	8	PVC	0.013	2.7034	0.065	
2171	1330	146.72	593	141.94	262.5	1.821	6	Vitrified Clay	0.013	1.179	0.347	
3825	299	0	281	0	262.3	0	8	Concrete	0.013	9.6591	178.099	
1738	235	0	449	0	263.1	0	8	PVC	0.013	9.4531	174.3	
1042	90	0	160	122.44	263.8	Min. Slope	8	PVC	0.013	1.8764	0.051	
2729	922	25.06	MH-7784	24.33	263.7	0.277	10	Asbestos Cement	0.013	73.2144	14.152	
2313	MH-7478	0	467	0	263.1	0	8	PVC	0.013	3.5339	65.16	
2117	414	206.6	415	205.41	263.2	0.452	8	PVC	0.013	86.4879	23.716	
3363	940	31.03	913	30.43	264	0.227	12	PVC	0.013	117.1448	15.366	
3692	945	29.65	951	23.84	264	2.201	8	PVC	0.013	3.1902	0.397	
1349	740	0	304	0	264	0	8	Concrete	0.013	3.3364	61.518	

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4641	1218	108.9	1219	106.2	263.5	1.025	8	PVC	0.013	4.1039	0.748	
816	451	185.69	461	175.47	264.7	3.86	8	PVC	0.013	314.7502	29.538	
4380	1171	0	1170	220.4	264.1	Min. Slope	8	PVC	0.013	2.6136	0.053	
3763	312	0	310	0	264.8	0	8	Concrete	0.013	6.513	120.091	
3031	808	0	809	0	264.9	0	8	PVC	0.013	9.5772	176.589	
2360	548	0	541	0	264.4	0	8	Concrete	0.013	78.1633	1,441.21	
3995	1076	6.08	1075	5.28	264.7	0.302	8	Vitrified Clay	0.013	176.575	59.222	
18	39	0	41	0	264.4	0	8	PVC	0.013	2.9073	53.607	
4357	1162	0	1111	0	264.4	0	8	PVC	0.013	8.4417	155.653	
951	1119	100.44	MH-7485	77.61	265	8.617	6	PVC	0.013	1.5669	0.212	
4379	1170	220.4	95	0	265.8	82.91	8	PVC	0.013	3.6755	0.074	
954	85	234.13	175	232.45	265.2	0.634	8	PVC	0.013	11.4421	2.651	
2074	775	0	776	0	266	0	8	PVC	0.013	2.3444	43.227	
2123	457	0	466	146.56	266	Min. Slope	8	PVC	0.013	172.2446	4.279	
1157	146	148.88	147	148.49	27.1	1.44	15	PVC	0.013	1,187.82	34.143	SM 6
2132	472	0	1263	0	266.2	0	6	Concrete	0.013	9.0171	358.064	
7916	1399	148.08	660	147.02	266	0.4	8	Vitrified Clay	0.013	10.6881	3.116	
487	761	0	755	0	265.5	0	8	PVC	0.013	4.3231	79.712	
1129	96	203.5	94	203.24	46.2	0.562	15	PVC	0.013	953.4136	43.854	SM 6
2276	736	30.7	537	0	265.6	11.559	8	PVC	0.013	8.0581	0.437	
4698	1225	256	1224	254.56	265.9	0.542	8	PVC	0.013	0	0	
4358	1164	0	1163	46	265.9	Min. Slope	8	PVC	0.013	4.9647	0.22	
2085	426	178.41	436	159.78	266.8	6.983	8	PVC	0.013	26.1597	1.825	
3964	233	178.3	234	173.42	266.1	1.834	6	Concrete	0.013	15.5849	4.57	
7632	1257	110.55	1365	80.3	266.8	11.341	6	Vitrified Clay	0.013	9.0952	1.072	
4322	1153	28.2	1152	23.88	266.1	1.623	8	PVC	0.013	7.3289	1.061	
3117	780	28.78	853	8.5	267.3	7.586	8	PVC	0.013	9.553	0.64	
3605	366	44.37	2	43.41	267.3	0.359	10	PVC	0.013	80.0624	13.585	
4140	26	0	272	0	267.8	0	8	PVC	0.013	3.0473	56.188	
4699	1224	254.56	1223	253.1	267.3	0.546	8	PVC	0.013	0.9352	0.233	
2076	771	0	772	164.46	267.5	Min. Slope	6	Concrete	0.013	9.9751	0.505	
3286	267	0	998	0	267.4	0	8	Concrete	0.013	3.9694	73.19	
3835	306	0	330	0	267.6	0	8	Concrete	0.013	18.3469	338.288	
3694	955	20.78	960	15.07	267.6	2.134	8	Asbestos Cement	0.013	36.5083	4.609	
3113	1064	243.64	78	239.39	268.6	1.582	8	PVC	0.013	32.4068	4.751	
4340	1159	34.13	1160	31.2	267.8	1.094	8	PVC	0.013	6.2467	1.101	
4007	MH-7785	0	1085	0	268	0	8	PVC	0.013	0.8877	16.367	
2315	MH-7786	0	467	0	268.7	0	6	PVC	0.013	1.7533	69.624	
4221	1138	7	1137	6.74	268.5	0.097	30	PVC	0.013	5,118.57	89.358	
7580	1357	258.8	1358	257.4	268.9	0.521	8	PVC	0.013	110.9162	28.345	
3133	531	20.6	1309	19.58	269.7	0.378	10	Asbestos Cement	0.013	702.6439	116.191	
3224	890	5.52	900	4.44	269.8	0.4	8	Vitrified Clay	0.013	31.6544	9.228	
1351	737	0	302	0	269	0	8	PVC	0.013	0.7416	13.674	
3114	81	0	1064	243.64	269.4	Min. Slope	8	PVC	0.013	15.3805	0.298	
3922	343	53.24	1	50.02	270.3	1.191	10	PVC	0.013	59.9225	5.584	
3667	999	19.6	355	18.7	270.3	0.333	12	Asbestos Cement	0.013	161.7244	17.528	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
4219	1136	6.48	1135	6.12	269.8	0.133	30	PVC	0.013	5,119.95	76.144	
4220	1137	6.74	1136	6.48	270	0.096	30	PVC	0.013	5,119.41	89.618	
1959	835	0	837	0	271	0	8	PVC	0.013	26.1769	482.662	
3535	947	22.22	952	20.38	270.9	0.679	8	PVC	0.013	122.8402	27.485	
2098	463	120.87	471	105.31	271	5.741	10	Concrete	0.013	70.5355	2.994	
3814	315	0	295	0	270.2	0	8	Concrete	0.013	27.6521	509.863	
2431	388	236.16	399	227.39	271.1	3.235	8	PVC	0.013	4.1072	0.421	
1182	124	191.96	128	188.87	271.1	1.14	8	Concrete	0.013	310.0496	53.544	
2142	778	50.62	779	49.54	270.4	0.4	8	PVC	0.013	1.1497	0.335	
4397	1174	37.1	1173	35.4	270.4	0.629	8	PVC	0.013	6.6299	1.542	
2115	404	234.07	409	221.44	271.4	4.653	8	PVC	0.013	75.2985	6.436	
2061	937	117.51	582	96.33	271.3	7.806	8	Vitrified Clay	0.013	28.819	1.902	
4553	1199	96.87	1066	67	271.4	11.004	8	PVC	0.013	0.9492	0.053	
4578	1200	0	510	42.99	271.6	Min. Slope	6	Concrete	0.013	28.2975	2.824	
2086	774	153.47	381	143.74	271.2	3.588	8	Concrete	0.013	23.7207	2.309	
2441	588	0	1260	0	271.8	0	6	Concrete	0.013	5.5428	220.101	
1980	408	232.78	371	231.48	271.1	0.48	8	PVC	0.013	109.7474	29.22	
3153	854	2.81	843	2.21	271.4	0.221	12	Asbestos Cement	0.013	0.8697	0.116	
2231	748	0	747	0	272.1	0	8	Concrete	0.013	3.4962	64.465	
5215	403	0	1270	0	271.7	0	8	PVC	0.013	5.7135	105.348	
2067	1336	97.42	582	96.33	272	0.4	6	Vitrified Clay	0.013	0.8045	0.505	
2432	515	0	525	32.88	272.9	Min. Slope	8	PVC	0.013	33.301	1.769	
2000	620	159.92	1310	150.56	272.4	3.436	6	Vitrified Clay	0.013	6.3471	1.36	
2096	448	156.38	446	150.53	272.3	2.148	6	Concrete	0.013	3.9518	1.071	
2154	1400	0	505	48.54	273.2	Min. Slope	8	PVC	0.013	7.877	0.345	
2290	536	0	535	0	272.4	0	8	PVC	0.013	10.1378	186.926	
263	22	90.35	293	89.26	273.2	0.4	8	PVC	0.013	2.5033	0.73	
2105	390	241.4	401	234.64	273.4	2.472	8	PVC	0.013	31.078	3.645	
1151	134	167.93	140	161.24	248.7	2.69	15	PVC	0.013	1,178.10	24.775	SM 6
3283	870	0.73	864	0.35	273.4	0.142	10	Asbestos Cement	0.013	82.4444	22.229	
3602	354	46.76	223	45.97	273.6	0.289	10	PVC	0.013	78.7391	14.903	
3670	914	59.55	948	50.41	272.9	3.349	8	PVC	0.013	3.6608	0.369	
3050	832	6.09	831	5	273.4	0.4	8	Asbestos Cement	0.013	3.3125	0.966	
4719	MH-7788	0	459	197.28	274	Min. Slope	8	PVC	0.013	2.4331	0.053	
2031	450	0	462	0	274.1	0	8	PVC	0.013	17.0044	313.536	
2375	572	0	569	0	273.6	0	8	Asbestos Cement	0.013	61.5991	1,135.80	
2078	772	164.46	774	153.47	274.4	4.005	8	Concrete	0.013	17.5001	1.612	
2539	690	165.72	634	160.58	273.9	1.877	6	Vitrified Clay	0.013	1.7879	0.518	
4452	1177	111.73	471	0	273.9	40.792	8	PVC	0.013	2.3289	0.067	
593	35	0	183	202.43	274	Min. Slope	8	Vitrified Clay	0.013	42.6633	0.915	
1	36	0	618	182.45	274	Min. Slope	8	PVC	0.013	1.24	0.028	
2081	768	234	769	223.73	275.3	3.731	8	PVC	0.013	11.1653	1.066	
2331	639	149.18	1399	148.08	275	0.4	8	Vitrified Clay	0.013	6.9201	2.017	
1134	99	200.73	103	198.69	250.4	0.815	15	PVC	0.013	996.3894	38.078	SM 6
2268	584	0	581	0	274.9	0	6	Concrete	0.013	45.9358	1,824.09	
1118	115	193.94	123	190.85	275.9	1.12	15	PVC	0.013	998.5797	32.544	SM 6

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SewerGEMS Results

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1130	171	212.59	94	203.24	276.3	3.384	8	Concrete	0.013	30.0655	3.013	
1348	739	0	304	0	275.2	0	8	Concrete	0.013	6.7482	124.426	
2226	654	0	751	0	275.2	0	8	Concrete	0.013	20.0214	369.165	
2237	663	255.14	673	228.28	275.9	9.737	6	PVC	0.013	4.6647	0.594	
3891	351	73.66	350	62.83	275.4	3.933	8	PVC	0.013	28.0613	2.609	
3601	1	50.02	354	46.76	276.1	1.181	10	PVC	0.013	66.9901	6.27	
4222	1139	8.22	1138	7	275.5	0.443	30	PVC	0.013	5,117.57	41.772	
3925	910	10.89	909	10.51	275.5	0.138	18	Concrete	0.013	174.0959	9.944	
2091	447	144.4	454	135.91	276.7	3.069	8	Concrete	0.013	36.0574	3.795	
3162	232	168.8	457	160.44	276.8	3.02	8	PVC	0.013	165.6141	17.571	
967	834	244.54	1268	243.37	276.2	0.424	8	PVC	0.013	139.7284	39.583	
1354	245	31.7	736	30.7	276.1	0.362	8	PVC	0.013	6.0697	1.86	
4942	MH-7790	0	1154	35.8	277	Min. Slope	8	PVC	0.013	1.6964	0.087	
2989	MH-7789	0	801	250.23	277.2	Min. Slope	8	PVC	0.013	3.2441	0.063	
2037	462	0	461	175.47	276.4	Min. Slope	8	PVC	0.013	18.9202	0.438	
2216	673	228.28	MH-7716	227.17	277.3	0.4	6	Vitrified Clay	0.013	6.3356	3.978	
1135	103	198.69	115	193.94	300.3	1.582	15	PVC	0.013	997.4512	27.356	SM 6
2730	MH-7784	24.33	1009	23.53	285.7	0.28	10	Asbestos Cement	0.013	73.4616	14.117	
2161	1416	64.78	661	63.67	278.6	0.4	6	Vitrified Clay	0.013	6.067	3.809	
1170	104	204.73	112	197.86	279.2	2.46	8	Concrete	0.013	264.6481	31.11	
4844	1236	86.56	556	84.76	279	0.645	6	Concrete	0.013	9.9032	4.896	
2324	365	45.5	851	25.18	279.7	7.265	10	Asbestos Cement	0.013	659.5042	24.883	
3556	1002	22.13	1001	21.3	295.7	0.281	10	Asbestos Cement	0.013	74.2032	14.243	
1608	843	2.21	372	1.43	279.9	0.279	10	Asbestos Cement	0.013	223.2762	43.012	
2556	1324	125.52	694	123.68	279.6	0.658	6	Vitrified Clay	0.013	2.1262	1.041	
5425	MH-7791	0	MH-7308	0	279.6	0	6	Concrete	0.013	0.6891	27.362	
3316	990	11.09	992	10.16	279.8	0.332	8	Asbestos Cement	0.013	59.0102	18.873	
4373	1169	56.98	944	46.54	280.8	3.718	8	PVC	0.013	3.4773	0.333	
1183	128	188.87	135	181.83	281.1	2.505	8	Concrete	0.013	311.1115	36.246	
1263	111	181.73	122	177.84	281.3	1.383	8	Concrete	0.013	12.0485	1.889	
1179	116	0	112	197.86	280.6	Min. Slope	8	Concrete	0.013	35.8638	0.787	
3064	1063	246.71	833	245.19	281.6	0.54	8	PVC	0.013	135.4808	34.002	
2257	615	0	613	0	280.8	0	6	Concrete	0.013	15.9668	634.034	
1363	1365	80.3	881	79.17	281.4	0.4	6	Vitrified Clay	0.013	11.4918	7.216	
1380	369	219.22	418	206.25	282.1	4.598	8	PVC	0.013	6.2856	0.541	
511	1331	79.13	382	72.53	282.1	2.339	6	Vitrified Clay	0.013	5.3009	1.376	
2038	1261	107.42	675	106.29	281.8	0.4	6	Vitrified Clay	0.013	10.604	6.658	
4133	MH-7286	244	17	242.87	282	0.4	6	PVC	0.013	1.7924	1.125	
3621	959	0	963	16.79	282.5	Min. Slope	8	PVC	0.013	1.5768	0.119	
1323	1060	248.38	1063	246.71	282.7	0.591	8	PVC	0.013	126.1135	30.254	
4176	1130	204.6	1128	203.1	282.1	0.532	8	PVC	0.013	35.4965	8.975	
3095	5	82.87	4	79.38	282.2	1.237	8	Asbestos Cement	0.013	631.367	104.686	
3933	1066	67	946	60.11	283	2.435	8	PVC	0.013	2.0885	0.247	
811	735	0	251	0	283.1	0	8	PVC	0.013	12.0578	222.328	
2158	499	0	498	76.94	282.7	Min. Slope	6	Vitrified Clay	0.013	4.1202	0.314	
1197	182	209.5	181	207.93	282.8	0.555	8	Asbestos Cement	0.013	4.961	1.228	

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3627	964	13.74	971	12.63	283.6	0.391	8	PVC	0.013	169.1908	49.863	
4051	1092	88.54	1091	74.56	281.8	4.96	8	PVC	0.013	6.9277	0.574	
3282	894	9.23	862	5.83	283.6	1.198	10	Vitrified Clay	0.013	20.3798	1.893	
2140	429	195.31	430	189.16	282.8	2.174	8	PVC	0.013	5.0725	0.634	
2207	1186	136.12	605	131.24	283.7	1.72	8	Vitrified Clay	0.013	4.2837	0.602	
3771	319	0	320	18.52	284	Min. Slope	8	PVC	0.013	7.1248	0.514	
3761	296	0	MH-7435	0	284	0	8	PVC	0.013	33.3451	614.834	
1365	1366	98.48	682	97.34	283.9	0.4	6	Vitrified Clay	0.013	4.2765	2.685	
2261	609	134.8	596	0	284.4	47.392	8	PVC	0.013	6.0177	0.161	
336	30	17.72	29	17.57	283.7	0.053	30	PVC	0.013	4,734.96	111.852	
1148	127	176.8	134	167.93	284.8	3.115	8	Concrete	0.013	1,023.08	106.889	
3238	876	3.4	887	3.4	284.6	0	10	Asbestos Cement	0.013	49.5896	504.3	
3186	863	3.7	866	2.9	284.5	0.28	10	Vitrified Clay	0.013	570.9221	109.729	
4435	1421	78.12	89	76.98	284.5	0.4	8	PVC	0.013	0.3276	0.096	
4227	911	11.92	1143	11.26	284.7	0.232	30	PVC	0.013	4,941.39	55.746	
790	410	232.39	416	231.45	285.8	0.329	8	PVC	0.013	11.5718	3.72	
2326	665	113.91	675	106.29	285.6	2.668	8	Vitrified Clay	0.013	84.1861	9.503	
3189	864	0.35	869	-0.8	286.4	0.4	10	Asbestos Cement	0.013	82.5624	13.274	
810	220	0	530	0	286.5	0	8	PVC	0.013	6.1548	113.486	
1162	174	238.7	175	232.45	287.3	2.175	8	PVC	0.013	151.9786	19	
3272	885	6.67	890	5.52	287.9	0.4	8	Vitrified Clay	0.013	30.0364	8.757	
3970	901	24.5	904	23.82	287.9	0.236	18	Concrete	0.013	2,043.17	89.174	
1767	500	0	502	0	288.4	0	8	Asbestos Cement	0.013	20.4636	377.318	
2813	731	0	77	0	288.5	0	8	PVC	0.013	2.4582	45.325	
3691	MH-7795	0	950	16.01	289.8	Min. Slope	8	Concrete	0.013	1.0514	0.082	
2155	505	48.54	509	33.34	289.9	5.243	8	PVC	0.013	9.4636	0.762	
3240	897	4	876	3.4	289.9	0.207	10	Asbestos Cement	0.013	34.1501	7.633	
2289	538	0	535	0	290.1	0	8	PVC	0.013	16.2396	299.434	
2167	643	163.57	634	160.58	290	1.031	6	Vitrified Clay	0.013	2.1262	0.832	
6525	MH-7328	22.77	MH-7472	22.7	80	0.087	30	PVC	0.013	2,113.54	38.813	SM 7
2422	MH-7796	150.34	639	149.18	290.5	0.4	6	Vitrified Clay	0.013	2.6625	1.672	
3228	892	62.27	895	55.41	290.2	2.365	10	Vitrified Clay	0.013	535.6961	35.422	
4845	1237	240.86	MH-7782	239.7	290.6	0.4	6	Vitrified Clay	0.013	5.9719	3.749	
3778	309	0	307	0	290.8	0	8	Concrete	0.013	2.3633	43.576	
960	823	2.57	86	1.41	290.3	0.4	8	PVC	0.013	62.2511	18.148	
3550	271	22.53	920	21.72	290.2	0.279	10	Asbestos Cement	0.013	86.0324	16.559	
1181	114	194.7	124	191.96	291.4	0.94	8	Concrete	0.013	303.8318	57.775	
2109	389	240.33	394	237.31	291.3	1.037	8	PVC	0.013	1.6986	0.308	
3142	906	20.32	905	20.22	159.1	0.063	30	PVC	0.013	2,160.77	46.824	SM 7
6241	1288	0	1287	0	291.1	0	8		0.013	4.5449	83.801	
2264	617	0	611	0	291.8	0	8	PVC	0.013	1.8173	33.507	
4075	1096	57.53	1095	55.55	291.6	0.679	8	PVC	0.013	3.2784	0.734	
2058	561	4.5	6	3.68	292	0.28	10	PVC	0.013	51.2129	9.843	
1963	MH-7797	0	1100	0	292.8	0	6	PVC	0.013	1.5379	61.068	
3257	896	85.1	875	83.93	292.5	0.4	8	Vitrified Clay	0.013	122.0409	35.578	
2135	478	90.95	479	90.04	174.8	0.521	24	PVC	0.013	1,814.60	24.768	SM 7

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3273	1321	10.4	894	9.23	293.1	0.4	8	Vitrified Clay	0.013	20.2618	5.907	
2172	1103	143.29	605	131.24	293.1	4.111	8	Vitrified Clay	0.013	16.3641	1.488	
3908	339	54.34	343	53.24	293.7	0.375	10	PVC	0.013	52.8382	8.779	
2367	525	23.48	903	22.8	217.3	0.313	15	PVC	0.013	694.4141	42.815	SM 7
2068	605	131.24	937	117.51	293.7	4.675	8	Vitrified Clay	0.013	21.9984	1.876	
3256	875	83.93	886	77.57	293.8	2.165	8	Vitrified Clay	0.013	129.3259	16.206	
3242	881	79.17	885	6.67	293.4	24.707	6	Vitrified Clay	0.013	15.7549	1.259	
2069	393	0	78	239.39	293.3	Min. Slope	8	PVC	0.013	3.4392	0.07	
2026	1189	95.28	696	75.81	294.1	6.619	6	Vitrified Clay	0.013	5.0254	0.776	
3239	364	33.4	MH-7508	32.22	294.5	0.4	6	PVC	0.013	7.2992	4.583	
2087	380	148.98	381	143.74	294.8	1.777	6	Concrete	0.013	5.7222	1.704	
2169	634	160.58	1310	150.56	294.5	3.402	6	Vitrified Clay	0.013	5.2308	1.126	
2137	481	89.04	483	87.05	290.6	0.685	24	PVC	0.013	1,822.17	21.686	SM 7
3253	1364	78.75	886	77.57	294.5	0.4	6	Vitrified Clay	0.013	5.2532	3.298	
2273	577	0	570	0	295.1	0	8	Concrete	0.013	13.0657	240.912	
3090	MH-7798	0	1100	0	294.6	0	6	Concrete	0.013	1.1978	47.564	
507	661	63.67	671	62.48	295.5	0.4	6	Vitrified Clay	0.013	8.8684	5.568	
3616	952	20.38	958	15.03	295.9	1.808	8	PVC	0.013	123.2813	16.906	
2353	574	105.95	565	87.46	295.4	6.259	6	Concrete	0.013	8.2844	1.315	
2797	721	205.4	429	195.31	296.1	3.407	8	PVC	0.013	1.6769	0.168	
2125	473	135.92	480	116.16	296.3	6.668	8	PVC	0.013	182.4922	13.031	
3537	1000	20.5	999	19.6	296.3	0.304	12		0.013	160.9772	18.267	
2490	845	2.18	855	1	295.8	0.4	8	Asbestos Cement	0.013	0.2005	0.058	
3190	862	5.83	866	2.9	296.8	0.987	10	Vitrified Clay	0.013	21.3909	2.19	
3271	887	2.79	891	1.6	296.9	0.4	10	Asbestos Cement	0.013	66.0369	10.619	
92	MH-7799	0	54	146.1	297.7	Min. Slope	8	PVC	0.013	1.6972	0.045	
2056	MH-7570	2.85	MH-7469	2.05	288.5	0.28	10	Vitrified Clay	0.013	65.9052	12.665	
3053	829	5.99	828	4.8	298	0.4	8	Asbestos Cement	0.013	1.365	0.398	
3073	MH-7800	0	833	245.19	297.7	Min. Slope	8	PVC	0.013	1.0619	0.022	
2434	1272	166.79	685	165.6	297.9	0.4	6	Vitrified Clay	0.013	12.4748	7.832	
3124	844	193.76	1059	191.69	297.8	0.695	8	PVC	0.013	4.5684	1.01	
1317	349	61.8	242	60.8	298.2	0.334	8	PVC	0.013	35.1276	11.211	
2462	565	87.46	1236	86.56	298.1	0.302	6	Concrete	0.013	8.7894	6.352	
6278	MH-7801	0	258	0	299	0	8	PVC	0.013	1.3118	24.187	
4535	1192	62.89	1193	38.3	299.2	8.217	8	PVC	0.013	3.7205	0.239	
90	53	16.15	688	15.49	299.6	0.22	12	PVC	0.013	1.2114	0.161	
1978	729	215.17	732	207.11	299.8	2.689	8	PVC	0.013	6.1376	0.69	
7818	1390	121.8	1389	120.3	299.2	0.501	8	PVC	0.013	1.3233	0.345	
2138	483	87.05	487	84.9	301.1	0.714	24	PVC	0.013	1,833.94	21.377	SM 7
3154	852	-0.2	854	-1.4	299.8	0.4	8	Asbestos Cement	0.013	0.6692	0.195	
3546	281	0	279	0	300.5	0	8	Concrete	0.013	42.0265	774.906	
4608	1209	233	1205	210.25	299.7	7.591	8	PVC	0.013	1.8831	0.126	
3534	991	8.62	993	7.64	299.6	0.327	8	Asbestos Cement	0.013	60.8658	19.622	
808	519	0	520	0	299.9	0	8	PVC	0.013	1.1065	20.402	
2220	675	106.29	682	97.34	300.8	2.976	8	Vitrified Clay	0.013	101.0149	10.797	
2491	855	1	852	-0.2	300.6	0.4	8	Asbestos Cement	0.013	0.401	0.117	

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
3187	866	2.9	858	1.7	300.5	0.4	10	Vitrified Clay	0.013	653.9198	105.152	
503	697	131.87	625	101.82	310.1	9.688	6	Vitrified Clay	0.013	1.4158	0.181	
2042	23	0	513	0	300.7	0	8	PVC	0.013	6.8295	125.926	
3245	899	58.96	883	57.76	301.4	0.4	6	Vitrified Clay	0.013	27.0142	16.962	
1334	242	60.8	240	59.6	301.2	0.4	8	PVC	0.013	35.8358	10.448	
2039	MH-7507	115.11	665	113.91	301.2	0.4	6	Vitrified Clay	0.013	19.7255	12.384	
3140	902	19.59	252	19.72	315.1	Min. Slope	30	PVC	0.013	2,172.52	58.099	SM 7
109	8	91.54	237	90.33	300.9	0.401	8	PVC	0.013	1.9467	0.567	
3036	812	7.69	814	6.49	302	0.4	8	PVC	0.013	54.2749	15.824	
3161	437	183.54	233	178.3	302	1.735	6	Concrete	0.013	13.6346	4.111	
620	MH-7488	14.82	6	13.62	302.4	0.4	6	Vitrified Clay	0.013	5.6294	3.534	
1360	683	4.7	897	4	302.5	0.231	10	Asbestos Cement	0.013	22.4027	4.736	
3702	943	45.91	945	29.65	302.6	5.374	8	PVC	0.013	1.143	0.091	
2475	MH-7802	0	1110	178.9	302.3	Min. Slope	8	PVC	0.013	1.7006	0.041	
3668	1001	21.3	1000	20.5	303.2	0.264	12		0.013	160.73	19.569	
4134	646	92.94	55	87.91	303.1	1.659	6	Asbestos Cement	0.013	2.4982	0.77	
2043	672	5.5	683	4.7	303.4	0.264	10	Asbestos Cement	0.013	19.6883	3.899	
2310	460	198.98	459	197.28	302.7	0.562	8	Asbestos Cement	0.013	210.4864	51.792	
2134	1099	0	479	90.04	304.1	Min. Slope	6	Concrete	0.013	4.6549	0.34	
2743	384	0	500	0	304.1	0	8	PVC	0.013	18.1889	335.376	
3618	958	15.03	964	13.74	304.5	0.424	8	PVC	0.013	123.7224	35.049	
3445	960	15.07	918	13.84	305.3	0.403	8	Asbestos Cement	0.013	41.1181	11.944	
2159	498	76.94	1228	42.99	305.5	11.113	6	Concrete	0.013	16.9629	2.021	
2190	507	0	511	0	305.6	0	6	Asbestos Cement	0.013	15.1091	599.977	
3277	MH-7781	76.53	MH-7295	75.67	305	0.28	10	PVC	0.013	140.2346	26.951	
3230	872	63.58	892	62.27	326.6	0.4	10	Vitrified Clay	0.013	75.0615	12.07	
2469	570	0	MH-7610	0	305.9	0	6	Concrete	0.013	14.1226	560.801	
3169	856	6.95	867	5.72	305.4	0.4	8	Vitrified Clay	0.013	151.2532	44.095	
37	524	0	848	0	306	0	8	PVC	0.013	10.8988	200.957	
2312	459	197.28	458	192.87	305.3	1.444	8	Asbestos Cement	0.013	215.1859	33.014	
4135	55	87.91	1331	79.13	306	2.869	6	Vitrified Clay	0.013	3.9842	0.934	
4177	1131	218.5	1130	204.6	306.5	4.535	8	PVC	0.013	24.9639	2.161	
2311	456	201.47	455	199.74	305.6	0.566	8	Asbestos Cement	0.013	199.3432	48.85	
628	344	93.5	345	92.28	306	0.4	8	PVC	0.013	1.1024	0.321	
91	54	0	482	146.25	307.8	Min. Slope	8	PVC	0.013	3.242	0.087	
4602	1203	5.08	1202	3.81	306.5	0.414	10	PVC	0.013	176.811	27.932	
1318	244	58.33	346	57.16	306.9	0.381	8	PVC	0.013	40.2468	12.019	
1326	MH-7803	0	1060	248.38	306.7	Min. Slope	8	PVC	0.013	1.6111	0.033	
3258	MH-7804	80.28	MH-7459	79.05	307.6	0.4	6	Vitrified Clay	0.013	1.9409	1.219	
7414	MH-7805	108.93	MH-7806	107.69	307.8	0.4	6	Vitrified Clay	0.013	1.778	1.116	
2314	467	0	468	175.36	307.9	Min. Slope	8	PVC	0.013	6.3189	0.154	
7677	1372	245	1373	242.7	309.2	0.744	8	PVC	0.013	1.4147	0.302	
3226	891	1.6	870	0.73	309.1	0.28	10	Asbestos Cement	0.013	71.8279	13.803	
666	MH-7807	85.56	331	84.33	308.4	0.4	8	PVC	0.013	0.9492	0.277	
4536	1193	38.3	1194	36.5	309.6	0.581	8	PVC	0.013	4.1243	0.997	
3779	307	0	306	0	309.6	0	8	Concrete	0.013	4.1462	76.45	

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General Sewer Plan
SewerGEMS Results

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2303	422	0	421	228.26	309.5	Min. Slope	8	PVC	0.013	1.3236	0.028	
7822	1392	92	1393	61.2	310	9.937	8	PVC	0.013	3.0877	0.181	
2557	MH-7808	167.57	695	166.33	310	0.4	6	Vitrified Clay	0.013	0.2682	0.168	
3666	355	18.7	998	17.87	311.1	0.267	12	Asbestos Cement	0.013	163.8857	19.844	
2812	725	0	1299	201.29	310.4	Min. Slope	8	PVC	0.013	13.7171	0.314	
3074	1395	4.64	764	3.39	311.4	0.4	8	Asbestos Cement	0.013	215.3128	62.769	
3686	328	0	1057	0	310.9	0	8	PVC	0.013	19.0187	350.676	
2438	MH-7809	87.75	MH-7810	86.51	311.4	0.4	6	Vitrified Clay	0.013	0.6497	0.408	
3145	1059	191.69	451	185.69	312.5	1.92	8	PVC	0.013	309.105	41.134	
2818	MH-7432	0	728	214.12	313.4	Min. Slope	6	PVC	0.013	7.0288	0.338	
5012	MH-7811	0	1251	225.4	313.3	Min. Slope	8	PVC	0.013	1.8572	0.04	
2189	497	0	507	0	314.6	0	6	Asbestos Cement	0.013	1.5659	62.182	
3072	MH-7812	0	834	244.54	313.9	Min. Slope	8	PVC	0.013	1.0619	0.022	
2351	614	135.17	629	132.17	314.8	0.953	8	Vitrified Clay	0.013	2.0727	0.391	
2222	MH-7813	99.98	678	98.72	314.6	0.4	6	Vitrified Clay	0.013	3.4002	2.135	
4151	1113	0	7	0	314.3	0	8	PVC	0.013	2.108	38.869	
3675	293	89.26	290	88	315.5	0.4	8	PVC	0.013	3.1835	0.928	
5011	1251	225.4	1250	223.56	315	0.584	8	PVC	0.013	3.7497	0.905	
3955	161	109.03	162	107.29	317.7	0.548	18	PVC	0.013	1,558.81	44.681	SM 7
1169	102	210.86	104	204.73	315.8	1.941	8	Concrete	0.013	263.4977	34.87	
3679	289	51.28	1	50.02	315.9	0.4	8	PVC	0.013	6.3874	1.862	
3523	1090	95.74	288	94.47	317	0.4	8	PVC	0.013	1.4636	0.427	
1282	216	0	214	0	317.2	0	8	PVC	0.013	2.2117	40.78	
2443	674	107.93	681	105.09	318.2	0.893	6	PVC	0.013	9.2584	3.891	
3281	895	55.41	MH-7317	54.14	317.8	0.4	10	Vitrified Clay	0.013	567.0321	91.173	
3143	362	20.86	906	20.32	483.2	0.112	30	PVC	0.013	2,159.31	35.087	SM 7
2047	699	131.65	680	117.2	318.6	4.537	6	Vitrified Clay	0.013	2.3668	0.441	
3274	1403	56.68	895	55.41	318.5	0.4	6	Vitrified Clay	0.013	30.0612	18.876	
2211	680	117.2	1257	110.55	318.9	2.085	6	Vitrified Clay	0.013	5.5111	1.515	
2808	719	215.05	840	201.29	319.6	4.306	8	PVC	0.013	279.3461	24.823	
2308	431	218.45	442	206.2	319.6	3.833	8	Asbestos Cement	0.013	150.7235	14.195	
682	342	94.72	341	83.56	318.7	3.502	8	PVC	0.013	3.7514	0.37	
3548	277	0	274	0	319.9	0	8	Concrete	0.013	67.5111	1,244.80	
683	341	83.56	343	62.29	319.4	6.66	8	PVC	0.013	5.3282	0.381	
3183	1407	8.8	860	7.52	319.7	0.4	8	Asbestos Cement	0.013	0.236	0.069	
403	1115	0	1116	0	319.6	0	8	PVC	0.013	2.2019	40.6	
664	332	62.87	338	61.59	319.8	0.4	8	PVC	0.013	4.8358	1.41	
2352	623	143.41	630	142.13	320.5	0.4	6	Vitrified Clay	0.013	4.7946	3.011	
1283	217	0	209	0	320.4	0	8	PVC	0.013	4.2765	78.852	
3886	MH-7814	70.63	333	69.34	322.6	0.4	8	PVC	0.013	0.6192	0.181	
681	MH-7815	96.01	342	94.72	323.4	0.4	8	PVC	0.013	1.9952	0.582	
3674	923	25.98	922	25.06	326	0.282	10	Asbestos Cement	0.013	72.9672	13.969	
2300	443	207.81	442	206.2	325.1	0.495	8	Asbestos Cement	0.013	41.1953	10.794	
3595	269	0	268	0	325.1	0	8	PVC	0.013	2.5874	47.707	
522	597	89.36	585	70.46	326	5.798	6	Vitrified Clay	0.013	7.256	1.197	
7820	1388	119.5	1392	92	325.9	8.439	8	PVC	0.013	2.6466	0.168	

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1124	166	233.24	167	230.66	326.3	0.791	8	Concrete	0.013	6.9853	1.448	
2814	715	229.22	720	0	327	70.098	8	PVC	0.013	129.0922	2.843	
784	732	207.11	455	199.74	327.4	2.251	8	Asbestos Cement	0.013	8.3506	1.026	
952	MH-7816	0	179	229.03	326.6	Min. Slope	8	PVC	0.013	1.0619	0.023	
3677	292	48.07	354	46.76	327.2	0.4	8	PVC	0.013	10.7998	3.149	
2206	616	100.86	698	99.54	329.3	0.4	6	Vitrified Clay	0.013	4.5548	2.86	
6298	MH-7370	40.92	561	39.6	329.5	0.4	8	Vitrified Clay	0.013	0.6015	0.175	
2334	631	129.09	641	127.77	330.2	0.4	8	PVC	0.013	12.088	3.524	
3664	995	16.65	988	15.76	330.5	0.269	12	Asbestos Cement	0.013	174.4522	21.025	
3262	1334	85.25	875	83.93	330.1	0.4	6	Vitrified Clay	0.013	2.6816	1.684	
2795	MH-7817	0	711	230.34	330	Min. Slope	8	PVC	0.013	1.925	0.042	
3093	246	22.6	363	21.95	330.4	0.197	18	Concrete	0.013	2,115.61	101.171	
3597	229	35.9	355	18.7	330.2	5.209	8	PVC	0.013	1.6451	0.133	
3248	MH-7818	118.15	1277	116.83	330.7	0.4	6	Vitrified Clay	0.013	0.7135	0.448	
3676	MH-7819	92.23	291	90.91	330.9	0.4	8	PVC	0.013	1.0499	0.306	
521	1259	123.85	600	110.06	332.9	4.142	6	Vitrified Clay	0.013	3.2061	0.626	
2369	529	22.09	531	20.6	335.7	0.444	10	Asbestos Cement	0.013	701.6123	107.101	
814	261	0	260	20.03	334.7	Min. Slope	8	PVC	0.013	18.9441	1.428	
2343	MH-7283	0	595	0	335.1	0	8	Concrete	0.013	5.2816	97.385	
2794	MH-7820	0	710	234.93	335.5	Min. Slope	8	PVC	0.013	2.0706	0.046	
1208	162	107.29	193	104.52	513.3	0.54	18	PVC	0.013	1,563.27	45.139	SM 7
2040	MH-7821	145.8	MH-7780	144.45	337.2	0.4	6	Vitrified Clay	0.013	2.7005	1.696	
2341	632	128.73	644	127.38	338.7	0.4	6	PVC	0.013	15.5303	9.751	
2678	241	82.76	348	81.38	344	0.4	8	PVC	0.013	10.7933	3.147	
821	488	117.9	489	116.09	338.2	0.535	8	PVC	0.013	364.8191	91.945	
4537	1194	36.5	1195	34.7	339.6	0.53	8	PVC	0.013	4.5281	1.147	
4182	1134	241.4	1133	227.8	340.2	3.998	8	PVC	0.013	5.4726	0.505	
1907	MH-7268	85.85	487	84.9	340.2	0.28	10	Concrete	0.013	3.2764	0.63	
3075	810	101.88	777	99.22	532.7	0.499	18	PVC	0.013	1,731.57	51.977	SM 7
4332	1157	44.19	1153	28.2	343.1	4.66	8	PVC	0.013	3.9923	0.341	
2029	MH-7822	135.09	398	133.72	343	0.4	6	Vitrified Clay	0.013	2.8534	1.791	
2055	603	74.81	1101	55.5	343.5	5.622	6	Vitrified Clay	0.013	8.6375	1.447	
2584	695	166.33	700	164.16	343.6	0.631	6	Vitrified Clay	0.013	0.6378	0.319	
3474	969	25.13	955	20.78	344.7	1.262	8	PVC	0.013	9.6048	1.576	
2304	413	232.63	421	228.26	345	1.267	8	PVC	0.013	7.0444	1.154	
3088	MH-7823	0	82	249.08	344.1	Min. Slope	8	PVC	0.013	2.8247	0.061	
961	1396	7.37	829	5.99	344.7	0.4	8	Asbestos Cement	0.013	1.2012	0.35	
4054	1094	96.74	1093	92.61	344.3	1.199	8	PVC	0.013	1.1512	0.194	
1103	97	0	129	0	345.5	0	8	PVC	0.013	1.2524	23.091	
3720	972	12.96	980	11.89	345.7	0.309	8	Asbestos Cement	0.013	46.5105	15.416	
3071	82	249.08	1063	246.71	345.6	0.686	8	PVC	0.013	6.7915	1.512	
2437	678	98.72	682	97.34	345.9	0.4	6	Vitrified Clay	0.013	7.5059	4.713	
2805	1338	0	716	215.84	347.3	Min. Slope	8	PVC	0.013	272.6737	6.378	
2416	469	0	470	165.46	346.4	Min. Slope	8	PVC	0.013	2.3579	0.063	
1155	143	150.42	151	136.04	347.4	4.14	8	PVC	0.013	3.9523	0.358	
4121	1104	259.37	1109	253.42	348	1.71	8	PVC	0.013	0.4881	0.069	

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2045	671	62.48	MH-7637	61.09	348.7	0.4	6	Vitrified Clay	0.013	15.6298	9.814	
1353	300	30.3	251	25.11	348.8	1.488	8	PVC	0.013	4.5883	0.694	
2318	482	146.25	489	116.09	350.2	8.613	8	Asbestos Cement	0.013	253.4063	15.921	
7590	1361	254.2	1362	250.5	349.2	1.06	8	PVC	0.013	117.227	20.999	
626	MH-7824	0	514	0	350.4	0	8	PVC	0.013	6.004	110.704	
2323	4	79.38	365	45.5	350.1	9.678	10	Asbestos Cement	0.013	656.4471	21.459	
3156	226	32.76	257	30.09	350.5	0.762	12	Asbestos Cement	0.013	11.253	0.806	
3091	MH-7825	26.15	849	22.79	394.6	0.851	10	Asbestos Cement	0.013	13.4594	1.483	
1143	113	0	111	181.73	351	Min. Slope	8	Concrete	0.013	2.688	0.069	
2428	MH-7806	107.69	675	106.29	351.2	0.4	6	Vitrified Clay	0.013	5.2545	3.299	
1368	MH-7810	86.51	896	85.1	351.4	0.4	6	Vitrified Clay	0.013	2.2074	1.386	
621	556	84.76	555	83.23	352.7	0.434	6	Concrete	0.013	10.3042	6.213	
2430	407	229.17	399	227.39	353.3	0.504	8	PVC	0.013	0.5522	0.143	
785	442	206.2	456	201.47	353.4	1.339	8	Asbestos Cement	0.013	194.2267	30.954	
332	28	17.31	MH-7270	17.11	352.8	0.058	30	PVC	0.013	4,751.29	107.572	
3144	1058	198.66	458	192.87	354	1.635	8	Asbestos Cement	0.013	17.9603	2.59	
2982	802	251.55	753	250.23	353.7	0.373	8	PVC	0.013	11.3558	3.428	
3619	953	26.49	965	21.06	354.9	1.53	8	PVC	0.013	2.4137	0.36	
2815	720	0	727	219.47	355	Min. Slope	8	PVC	0.013	131.0588	3.073	
1725	510	42.99	1323	0	355.8	12.083	8	Concrete	0.013	31.7519	1.684	
2305	421	228.26	432	219.23	356.8	2.531	8	PVC	0.013	11.275	1.307	
1352	301	0	735	0	356.7	0	8	PVC	0.013	10.3182	190.252	
1119	92	205.7	93	204.2	357.1	0.42	8	Concrete	0.013	6.1005	1.736	
148	544	0	MH-7471	0	358.3	0	6	Concrete	0.013	25.532	1,013.87	
280	594	0	40	0	359.9	0	8	Concrete	0.013	11.5124	212.272	
2450	1294	0	645	0	360.1	0	8	Asbestos Cement	0.013	0.9694	17.874	
2325	851	25.18	525	23.48	360.7	0.471	10	Asbestos Cement	0.013	659.5042	97.696	
1280	209	0	208	235.01	362.3	Min. Slope	8	PVC	0.013	7.2306	0.166	
2178	383	2.97	787	2.35	364.3	0.17	14	Asbestos Cement	0.013	880.2501	88.516	
2064	582	96.33	573	40.51	365.1	15.289	8	Vitrified Clay	0.013	30.4667	1.437	
2319	489	116.09	495	100.19	366	4.345	8	Asbestos Cement	0.013	622.663	55.08	
2054	786	1.72	784	1.09	366.5	0.17	14	Asbestos Cement	0.013	889.852	89.474	
2177	648	3.59	383	2.97	367.3	0.17	14	Asbestos Cement	0.013	876.9714	88.186	
2317	468	175.36	482	146.25	369	7.889	8	Asbestos Cement	0.013	246.1092	16.156	
2980	798	0	755	0	369	0	8	PVC	0.013	13.5223	249.33	
2740	1098	0	626	0	369.7	0	8	PVC	0.013	6.066	111.847	
3608	3	40.51	221	39.44	368.7	0.29	10	PVC	0.013	81.8268	15.446	
3917	290	84.11	340	78.79	370	1.438	8	PVC	0.013	10.8295	1.665	
1209	MH-7404	78.46	89	76.98	369.6	0.4	6	PVC	0.013	1.6443	1.032	
1281	214	0	213	236.33	370.2	Min. Slope	8	PVC	0.013	4.9122	0.113	
2243	MH-7451	242.59	MH-7263	241.1	372.3	0.4	6	Vitrified Clay	0.013	4.0261	2.528	
2816	722	224.94	729	215.17	373.3	2.617	8	PVC	0.013	4.9114	0.56	
5226	685	165.6	1271	164.11	372.5	0.4	6	Vitrified Clay	0.013	15.088	9.473	
1362	1234	60.46	899	58.96	373.6	0.4	6	Vitrified Clay	0.013	22.0289	13.831	
2165	MH-7827	147.28	651	145.79	372.9	0.4	6	Vitrified Clay	0.013	0.8016	0.503	
2648	224	37.3	300	30.3	372.6	1.879	8	PVC	0.013	3.0815	0.415	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
2179	787	2.35	786	1.72	373.9	0.17	14	Asbestos Cement	0.013	889.6515	89.459	
3921	345	92.28	291	90.91	373.7	0.367	8	PVC	0.013	3.6582	1.114	
2176	667	4.23	648	3.59	374.2	0.17	14	Asbestos Cement	0.013	876.6694	88.152	
3827	268	0	298	0	373.6	0	8	PVC	0.013	5.6251	103.718	
4764	1232	230.47	1230	228.5	373.7	0.527	8	PVC	0.013	2.2186	0.563	
2272	580	0	577	0	373.7	0	8	Concrete	0.013	10.6433	196.246	
2120	475	0	474	143.74	374.6	Min. Slope	8	PVC	0.013	4.3222	0.129	
3040	826	3.95	825	2.45	375.5	0.4	8	Asbestos Cement	0.013	3.767	1.098	
1472	MH-7828	93.75	MH-7700	92.25	375.4	0.4	8	Vitrified Clay	0.013	1.4061	0.41	
769	521	0	527	0	449	0	8	PVC	0.013	3.397	62.635	
3524	288	94.47	289	51.28	375.5	11.5	8	PVC	0.013	3.6504	0.198	
2150	487	84.9	493	58.21	377.5	7.07	12	Concrete	0.013	2,027.27	47.681	
2819	728	214.12	733	202.85	378	2.981	8	Asbestos Cement	0.013	10.118	1.08	
777	518	0	MH-7297	0	380.1	0	6	PVC	0.013	29.8374	1,184.83	
1139	132	0	134	167.93	380.5	Min. Slope	8	Concrete	0.013	148.6481	4.126	
4534	1191	111.58	1192	62.89	381.7	12.757	8	PVC	0.013	3.0332	0.157	
1688	MH-7829	0	580	0	382	0	6	Concrete	0.013	1.3422	53.297	
4148	7	0	328	0	382	0	8	PVC	0.013	4.1929	77.311	
3818	298	0	301	0	382.7	0	8	PVC	0.013	8.5568	157.774	
3280	900	4.44	866	2.9	384.1	0.4	8	Vitrified Clay	0.013	51.0766	14.891	
1355	746	14.45	318	13.94	385.1	0.132	30	PVC	0.013	4,892.55	73.034	
4137	MH-7681	187.49	MH-7296	185.94	388.6	0.4	6	Concrete	0.013	3.9475	2.479	
3828	265	0	297	0	387.2	0	8	PVC	0.013	4.6822	86.333	
2316	458	192.87	468	175.36	388.9	4.503	8	Asbestos Cement	0.013	237.1231	20.604	
3092(1)	522	23.41	MH-7869	22.88	341	0.155	24	PVC	0.013	2,064.90	51.588	SM 7
2473	789	209.04	788	0	390.5	53.526	8	PVC	0.013	3.3145	0.084	
1653	373	113.67	397	106.81	391.1	1.754	6	Vitrified Clay	0.013	2.3291	0.698	
3606	2	43.41	222	42.22	390.5	0.305	10	PVC	0.013	80.5035	14.829	
3998	1080	0	1079	0	392.5	0	8	PVC	0.013	10.6987	197.268	
3999	1079	0	1078	0	394.3	0	8	PVC	0.013	12.0308	221.83	
3116	247	6.92	853	5.19	395	0.438	8	PVC	0.013	8.5158	2.373	
947	195	10.93	1346	9.34	396.2	0.4	8	PVC	0.013	12.1286	3.536	
3089	836	231.3	821	225.36	396.7	1.497	8	Concrete	0.013	52.0648	7.846	
1117	147	148.49	156	124.8	398.5	5.945	8	Concrete	0.013	1,191.47	90.098	
962	821	225.36	176	219.28	397.7	1.529	8	Concrete	0.013	57.4247	8.564	
2591	703	0	701	25.64	399.8	Min. Slope	8	PVC	0.013	8.5551	0.623	
2240	653	256.38	666	254.78	399.7	0.4	6	Vitrified Clay	0.013	2.5275	1.587	
3035	815	4.88	816	3.27	400.3	0.4	8	PVC	0.013	61.9235	18.053	
944	MH-7830	0	186	193	400	Min. Slope	8	Vitrified Clay	0.013	2.6845	0.071	
3833	287	0	319	24.41	400.2	Min. Slope	8	PVC	0.013	1.5691	0.117	
3037	814	6.49	815	4.88	402.3	0.4	8	PVC	0.013	54.6029	15.918	
2806	717	0	716	215.84	403	Min. Slope	8	PVC	0.013	3.5421	0.089	
1212	201	3.54	199	1.93	404.6	0.4	8	Asbestos Cement	0.013	15.8335	4.616	
1146	123	190.85	122	177.84	408.3	3.186	8	Concrete	0.013	1,005.61	103.872	
2478	63	15.52	1069	15.16	409.5	0.088	30	PVC	0.013	4,889.31	89.58	
2296	428	227.99	1298	210.15	410.4	4.347	8	PVC	0.013	30.0303	2.656	

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20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
1193	153	0	161	109.03	414.4	Min. Slope	6	Concrete	0.013	20.6911	1.602	
1346	751	0	317	0	414.7	0	8	Concrete	0.013	23.8109	439.037	
2275	546	0	544	0	415.3	0	8	Asbestos Cement	0.013	7.1225	131.329	
4113	297	0	1120	13.64	423.1	Min. Slope	8	PVC	0.013	8.9764	0.922	
4117	MH-7832	0	1107	0	424	0	1	PVC	0.013	1.0733	5,066.39	
4112	120	13.71	1120	12.76	423	0.225	30	PVC	0.013	4,897.74	56.142	
1137	MH-7833	0	133	165.9	426	Min. Slope	8	PVC	0.013	5.0818	0.15	
2106	757	0	391	0	431.3	0	8	PVC	0.013	24.3674	449.298	
1370	1271	164.11	877	162.38	432.4	0.4	6	Vitrified Clay	0.013	16.6872	10.477	
3259	882	71.71	888	68.07	435.4	0.836	10	Vitrified Clay	0.013	64.2933	7.151	
1781	718	226.52	724	218.49	439.1	1.829	8	PVC	0.013	3.7535	0.512	
2442	659	113.21	674	107.93	440.9	1.197	6	Vitrified Clay	0.013	4.8313	1.753	
43	545	0	66	0	444.3	0	8	PVC	0.013	5.9493	109.695	
2236	647	256.92	663	255.14	444.1	0.4	6	Vitrified Clay	0.013	2.8391	1.782	
1976	713	231.68	714	229.99	443.5	0.381	8	PVC	0.013	7.6416	2.283	
3596	230	37.8	229	35.9	443.9	0.428	8	PVC	0.013	0.7723	0.218	
141	10	0	527	0	448.3	0	8	PVC	0.013	2.3255	42.879	
2471	MH-7834	217.93	1317	216.12	451.5	0.4	6	Vitrified Clay	0.013	0.8348	0.524	
3625	962	0	964	13.74	450.8	Min. Slope	8	PVC	0.013	26.7434	2.824	
2359	564	0	548	0	460.1	0	8	Concrete	0.013	75.5118	1,392.32	
3157	227	21.99	362	20.86	459.7	0.246	18	Concrete	0.013	2,158.55	92.345	
2796	MH-7835	0	712	222.88	461.4	Min. Slope	8	PVC	0.013	2.0451	0.054	
3158	257	30.09	MH-7825	26.15	462.6	0.852	12	Asbestos Cement	0.013	12.0176	0.814	
3624	1056	0	961	0	464.3	0	8	PVC	0.013	24.0845	444.082	
2363	MH-7836	0	512	0	465.7	0	8	PVC	0.013	2.793	51.498	
3927	907	11.45	910	10.89	466.1	0.12	18	Concrete	0.013	2.6996	0.165	
1195	MH-7837	0	162	107.29	468	Min. Slope	8	Vitrified Clay	0.013	0.7676	0.03	
3137	254	19.21	253	18.56	467.9	0.139	18	Concrete	0.013	2,282.56	129.905	
1359	MH-7267	9.37	880	7.5	469.4	0.4	6	Vitrified Clay	0.013	11.7668	7.388	
1361	679	91.46	1274	43.5	469.5	10.215	6	Vitrified Clay	0.013	6.5694	0.816	
6331	MH-7838	0	510	42.99	470	Min. Slope	8	Concrete	0.013	1.9484	0.119	
3120	493	58.21	248	24.9	471.7	7.061	12	Concrete	0.013	2,030.83	47.795	
2793	MH-7839	0	429	195.31	470.5	Min. Slope	8	PVC	0.013	0.7676	0.022	
1766	83	193.75	235	178.3	481.7	3.207	6	Concrete	0.013	4.3149	0.957	
3813	329	34.13	245	31.7	480.6	0.506	8	PVC	0.013	2.47	0.64	
3092(2)	MH-7869	22.88	849	22.79	59.1	0.152	24	PVC	0.013	2,098.55	52.98	SM 7
2048	662	93.4	679	91.46	485.7	0.4	6	Vitrified Clay	0.013	1.2953	0.813	
2465	635	165.52	643	163.57	486.6	0.4	6	Vitrified Clay	0.013	1.0123	0.636	
3669	1052	0	264	0	488.3	0	8	PVC	0.013	0.4411	8.133	
3932	909	10.51	908	9.54	489.8	0.198	18	Concrete	0.013	176.1808	8.398	
1675	MH-7840	0	595	0	493.7	0	8	PVC	0.013	3.618	66.711	
1606	785	63.88	1410	0.26	498.3	12.769	6	Vitrified Clay	0.013	7.758	0.862	
4147	1111	32.72	1112	31.62	500.6	0.22	12	PVC	0.013	21.3468	2.846	
1364	684	170.67	MH-7348	168.73	483.8	0.4	6	Vitrified Clay	0.013	30.9478	19.431	
5196	1269	176.51	655	174.47	510	0.4	6	Vitrified Clay	0.013	0.4978	0.313	
2163	658	160.95	664	140.67	214.2	9.465	8	Vitrified Clay	0.013	294.0686	17.625	SM 9

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City of Port Townsend
General Sewer Plan
SewerGEMS Results

20-Year (2043) with Proposed Improvements - Peak Hour Flow - Pipe Capacity Table

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Node Invert Elevation (ft)	Length (ft)	Slope (Calculated) (%)	Diameter (in)	Material	Manning's n	Flow (gpm)	Flow / Capacity (Design) (%)	CIP
4237	1144	158.3	1103	143.29	519.8	2.888	6	Vitrified Clay	0.013	2.5948	0.606	
2219	676	214.73	684	170.67	519.9	8.475	6	Vitrified Clay	0.013	17.383	2.371	
3626	264	0	971	12.63	520.7	Min. Slope	8	PVC	0.013	0.8822	0.104	
4120	MH-7841	0	448	156.38	529.3	Min. Slope	6	Concrete	0.013	0.7676	0.056	
3252	879	135.73	1197	63.45	292.7	24.692	8	Vitrified Clay	0.013	315.4645	11.706	SM 9
3275	1197	63.45	892	62.27	293.5	0.4	8	Vitrified Clay	0.013	317.7134	92.632	SM 9
3229	874	66.91	872	63.58	533.3	0.624	10	Vitrified Clay	0.013	70.6821	9.096	
1528	769	223.73	418	206.25	542.4	3.223	8	PVC	0.013	13.7424	1.411	
7993	664	140.67	1402	139.49	294.8	0.4	6	Vitrified Clay	0.013	299.1288	187.817	SM 9
505	MH-7842	136	621	133.79	553.3	0.4	6	Vitrified Clay	0.013	1.6212	1.018	
3115	853	9.92	812	7.69	557	0.4	8	PVC	0.013	19.2178	5.603	
2208	1265	133.89	699	131.65	559	0.4	6	Vitrified Clay	0.013	2.2488	1.412	
1908	1384	99.1	478	91.31	627	1.242	12	Concrete	0.013	1,738.92	97.566	
CO-14	824	1.13	W-Port	0	7.5	14.984	8		0.013	82.5068	3.93	
CO-18	395	0	W-31st St	212.35	7.9	Min. Slope	8		0.013	5.9062	0.021	
CO-20	MH-7299	0.8	W-Gaines St	0.77	20	0.15	15		0.013	1,209.43	107.699	
CO-25	MH-7315	5.95	O-2	5.95	5.5	0.079	24	PVC	0.013	5,374.76	187.995	
2044	1402	139.49	1332	137.93	389.9	0.4	6	Vitrified Clay	0.013	308.0774	193.433	SM 9
1358	1332	137.93	879	135.73	550.7	0.4	8	Vitrified Clay	0.013	310.5501	90.536	SM 9
121(1)	792	1.42	MH-7870	1.31	48.7	0.22	12	Vitrified Clay	0.013	86.8686	11.587	
121(2)	MH-7870	1.31	9	0.85	211.3	0.22	12	Vitrified Clay	0.013	95.0276	12.669	
CO-29	882	71.71	1409	74.51	122.2	2.288	6	Vitrified Clay	0.013	7.7595	2.037	
CO-30	1409	74.51	884	74.13	94.1	Min. Slope	6	Vitrified Clay	0.013	6.3713	4.001	
2361(1)	571	0	MH-7871	0	397.2	0	8	Concrete	0.013	20.3012	374.323	
2361(2)	MH-7871	0	541	0	221	0	8	Concrete	0.013	24.3361	448.72	
343(1)	40	0	MH-7872	0	166.4	0	8	Concrete	0.013	12.7659	235.385	
343(2)	MH-7872	0	571	0	132.2	0	8	Concrete	0.013	15.1979	280.226	
CO-35	MH-7882	28.03	968	27.14	222.7	0.4	12		0.013	0	0	

1. Calculated slopes are based on invert elevations provided by the City. Where adverse slopes were present due to a lack of data a minimum slope was assumed.

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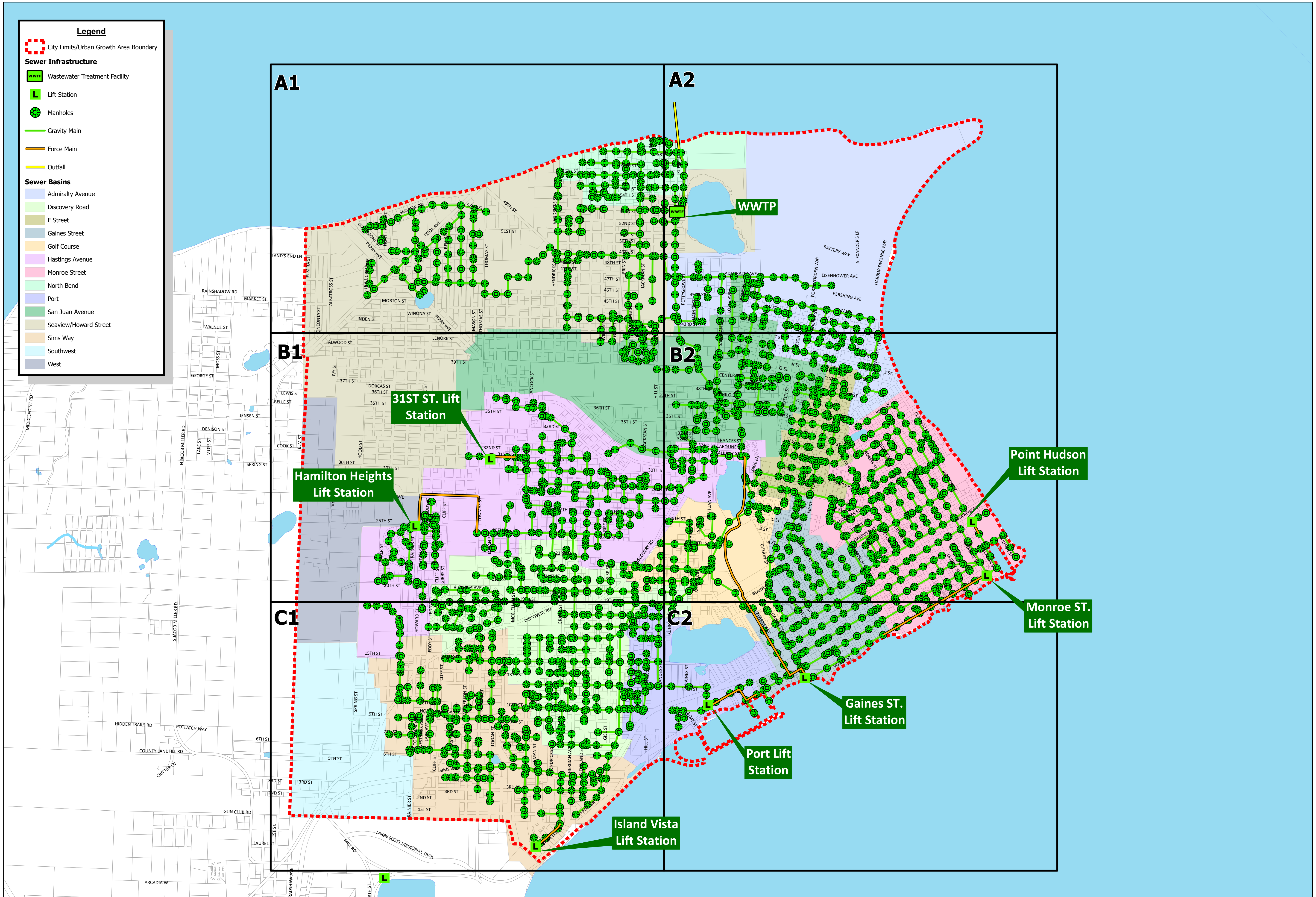

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Vicinity Map

Esri, HERE, Garmin, USGS, EPA, NPS

Appendix I
Hydraulic Model Node Diagram Overview
City of Port Townsend General Sewer Plan

City of Port Townsend

1 inch : 1,000 Feet

0 500 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

RH2

NORTH

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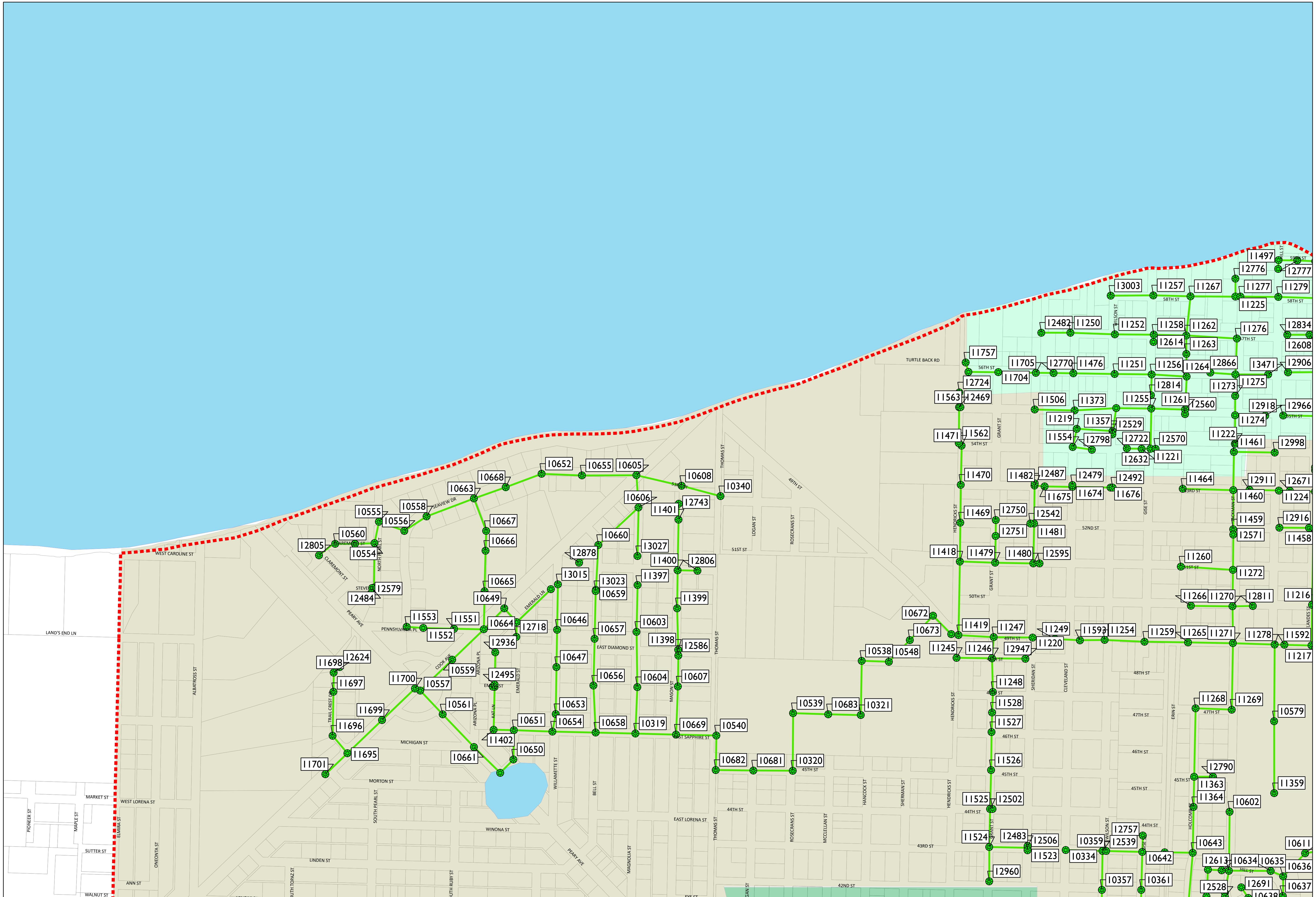

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Vicinity Map

Esri, HERE, Garmin, USGS, EPA, NPS

Appendix I
Hydraulic Model Node Diagram
City of Port Townsend General Sewer Plan

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City of Port Townsend

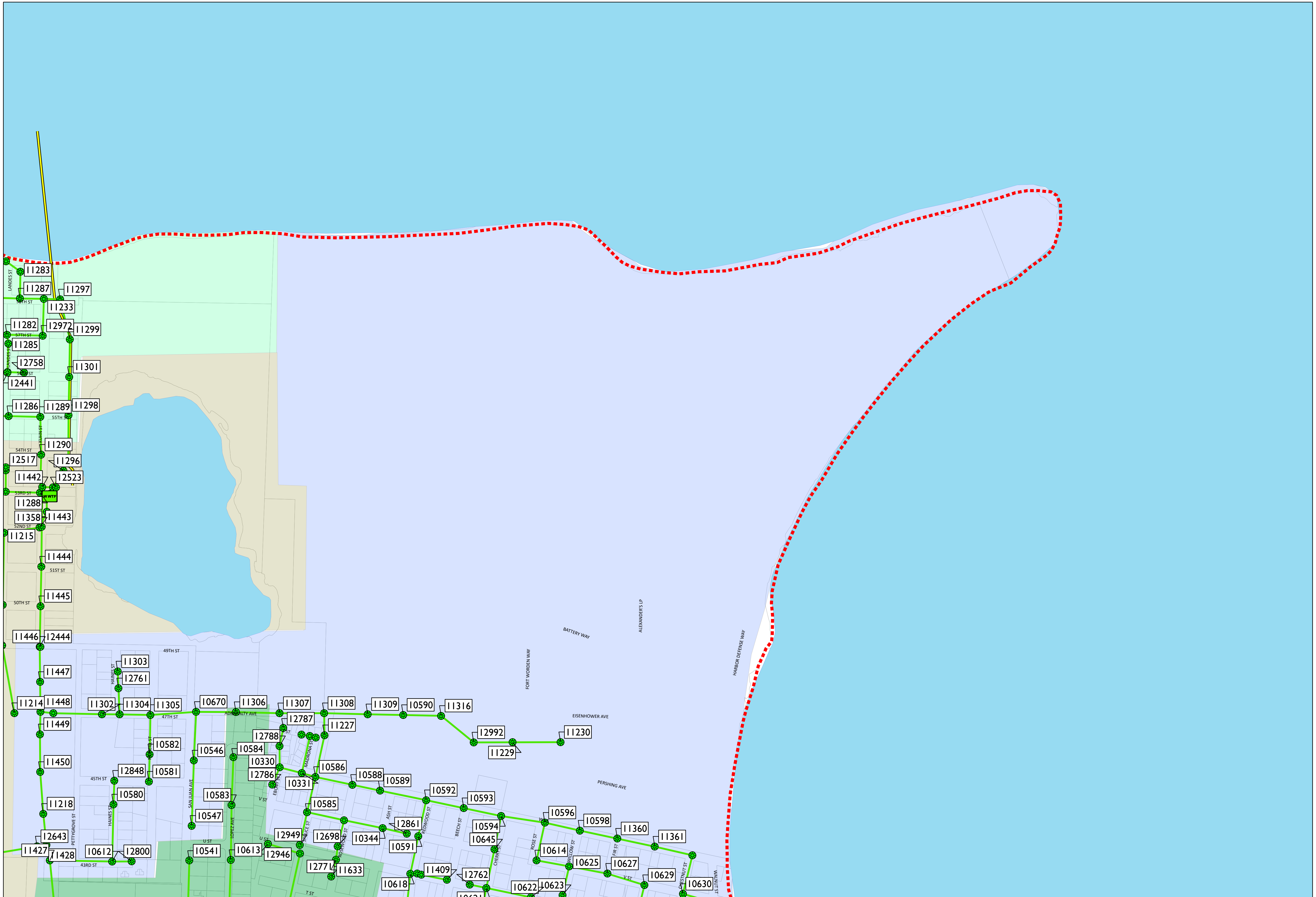
1 inch : 300 Feet

0 300 600 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

RH2

NORTH



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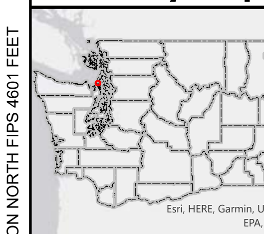
Vicinity Map



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Appendix I
Hydraulic Model Node Diagram

City of Port Townsend General Sewer Plan

City of Port Townsend

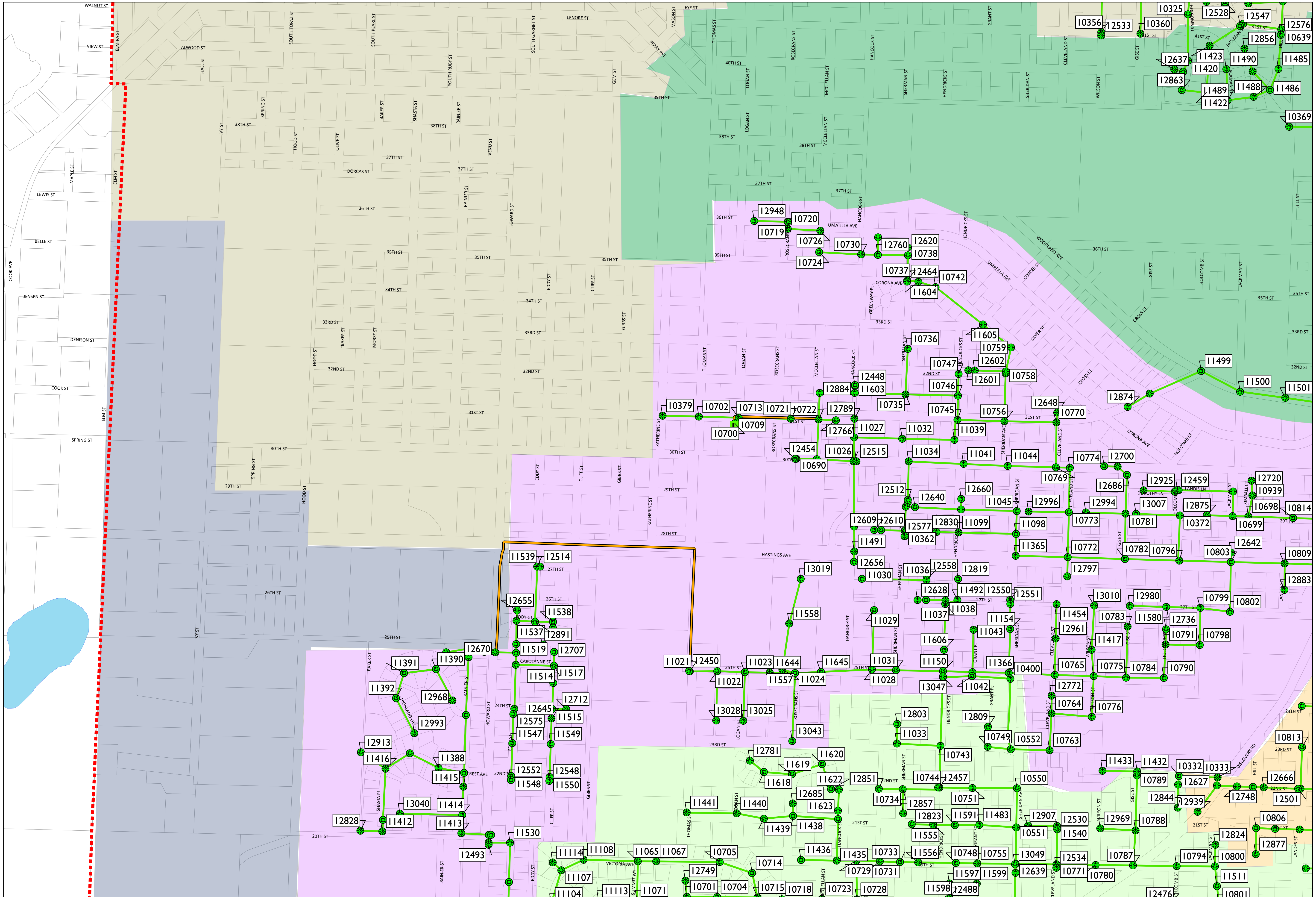
1 inch : 300 Feet

0 300 600 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

RH2

NORTH



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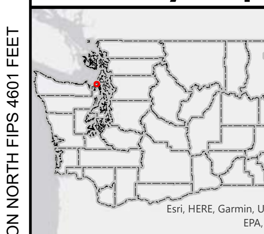
Vicinity Map



Appendix I
Hydraulic Model Node Diagram
City of Port Townsend General Sewer Plan

COORDINATE SYSTEM: NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

PLOT DATE: JAN 5, 2024 BY: EDANIEL

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City of Port Townsend

1 inch : 300 Feet

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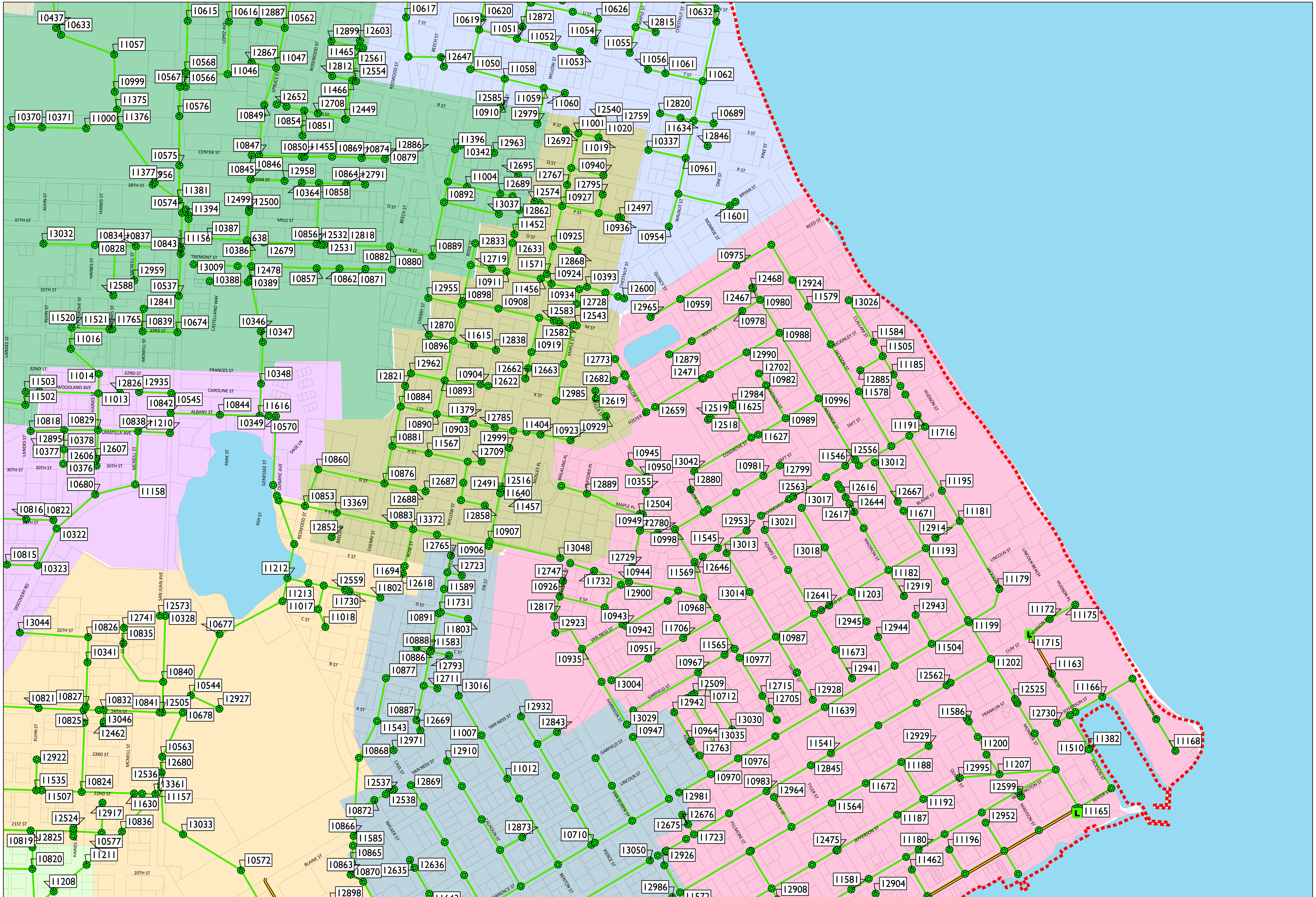
DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

RH2

NORTH



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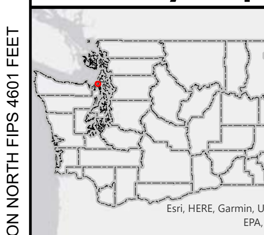
Vicinity Map



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COORDINATE SYSTEM: NAD 1983 HARN STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

PLOT DATE: JAN 5, 2024

BY: EDANIEL

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City of Port Townsend

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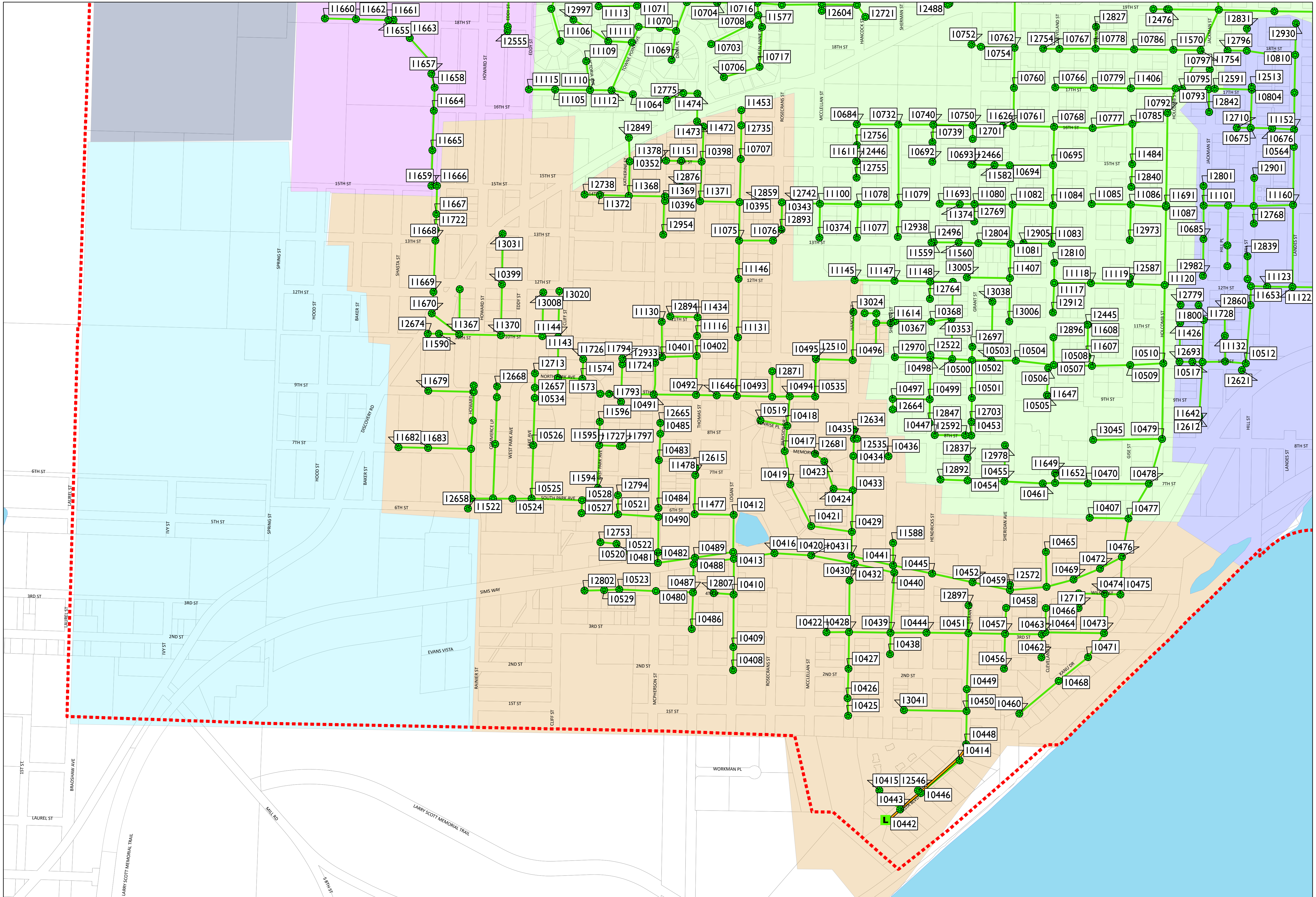

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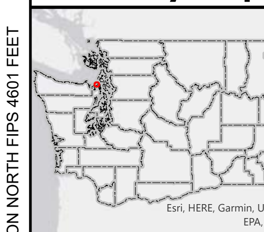

Appendix I
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City of Port Townsend

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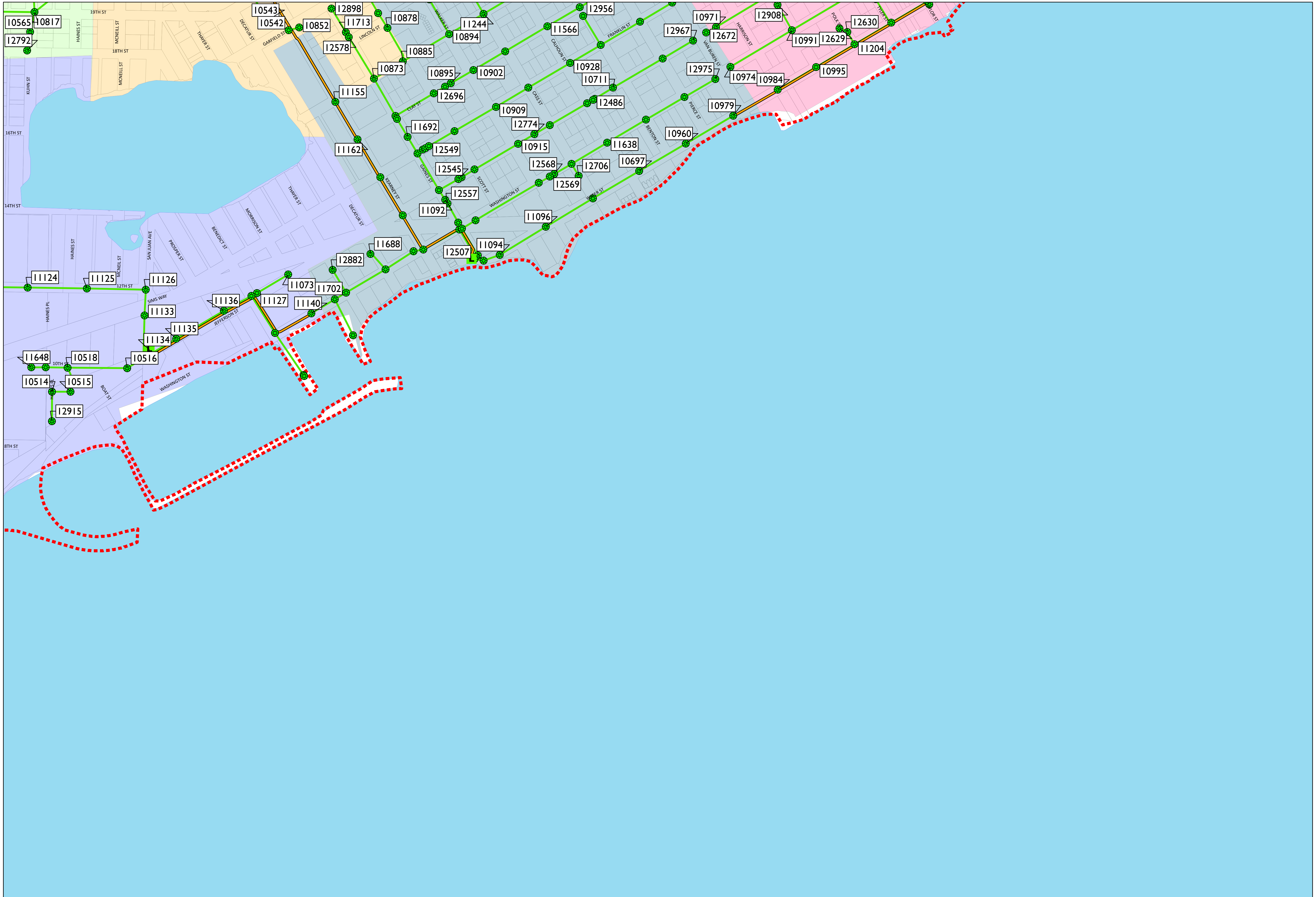

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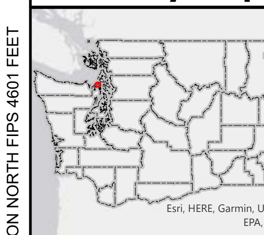

Appendix I
Hydraulic Model Node Diagram

City of Port Townsend General Sewer Plan

City of Port Townsend

1 inch : 300 Feet

0 300 600 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 2"

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Appendix J

Mill Site Lift Station Sizing Analysis

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Flow estimates for Mill Road Lift Station and associated sewer epansion area.

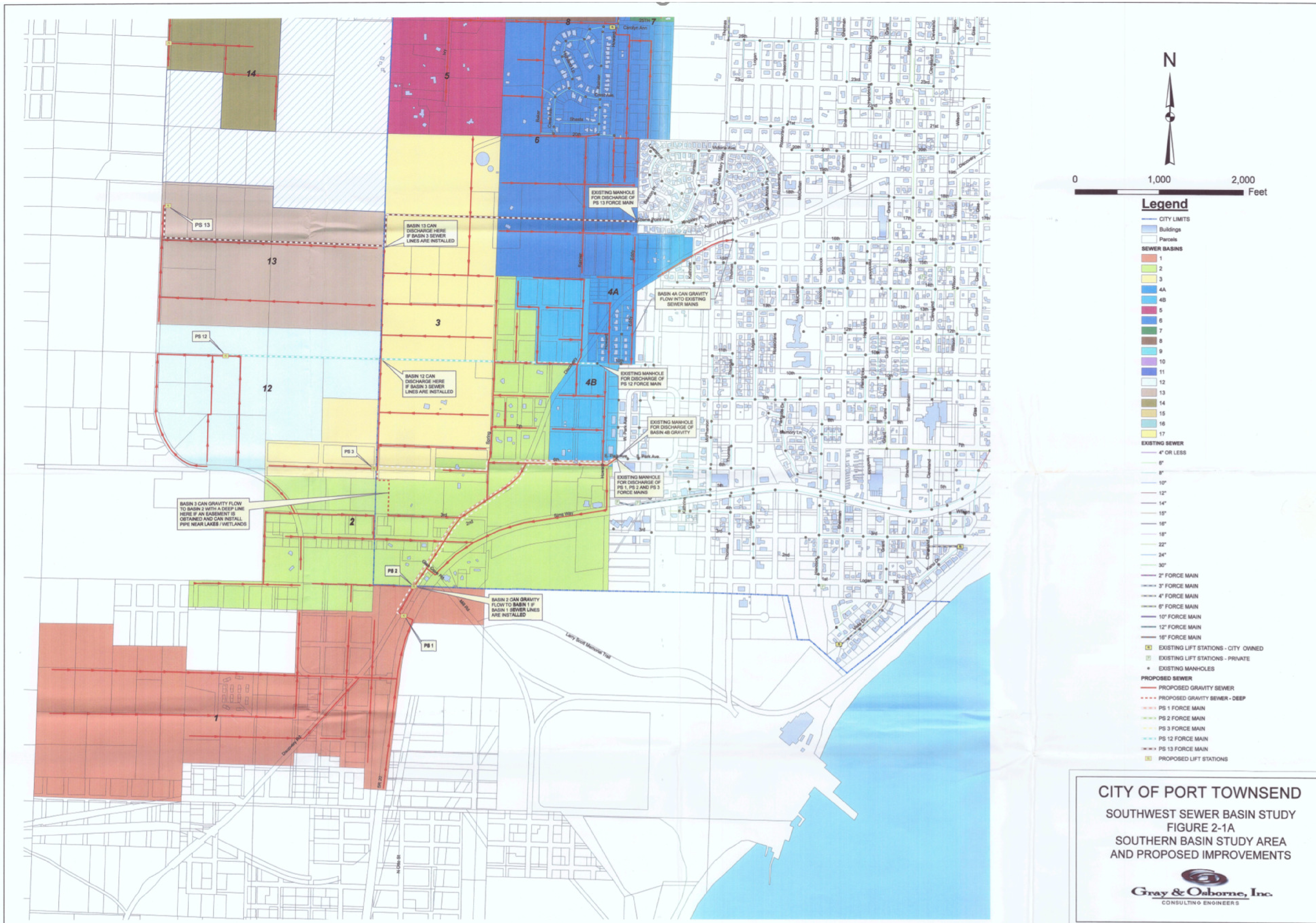
Objective:

Create estimates for 10 yr, 20 yr., and buildout estimates for flow feeding the Mill Road Lift Station based on the 2009 Basin Study and the 2012 Lift Station Analysis.

Assumptions

1 For buildingout to occur, there must be a UGA expansion to encompass the entire basin
2 Estimates are developed for 10 and yr building out only based on Glen Cove and the existing City Limits
3 It will take 20 years to absorb 50% of the existing structures within the Glen Cover and the existing City Limits
4 The Mill domestic wastewater will flow to the lift station enabling the Mill to get rid of their plant
5 The area within the City limits will achieve 50% of building out within 20 years
6 The 20 acre County property next to the LS will building out within 10 years
7 Assume 120 gpd/unit

							Flow (GPD)				
Basin	Basin Area (acres)	Acres In City Limits	Type of Dev.	Zoned density	Density Red. For wetlands units/acre	Ave. Day Flow. GPD/Acre at Buildout	Total Buildout Peak Flow (gpd)	Area Likely to Connect	20 yr	10 yr	Notes
Paper Mill							6,125		6,125	6,125	Based on NPDES Permit for Domestic WW Discharge
1	180	0	Residential	0							None of Basin 1 in CL- See Glen Cove Basin below which overlaps
2	175	105	Residential	8	5	600	105,000	105	63,000	31,500	60% of basin in CL; GPD/acre reduced for wetands
3	140	105	Residential	8	4	480	67,200	105	50,400	25,200	75% of basin in CL; GPD/acre reduced for wetlands
4A	25										This basin does not flow to the Mill Road LS
4B	40										This basin does not flow to the Mill Road LS
Compost/Septic Fac.		0	Public Srv.				10,000		10,000	10,000	Assumes solids removal and decanting liquid to sewer system
Glen Cove	800	0	Light Industrial	6	6	720	576,000	100	72,000	36,000	Only area within the existing developed light industry area.
						Total Ave. Day Flow	764,325		201,525	108,825	
						Peak HR Factor (large population)	2		2	2	Peak hour factor based on negligible inflow (new system) - RH2 Analysis
						Peak Hour Flow (GPD)	1,528,650		403,050	217,650	
						Peak Hour Flow (gpm)	1,062		280	151	



CITY OF PORT TOWNSEND

SOUTHWEST SEWER BASIN STUDY

FIGURE 2-1A

SOUTHERN BASIN STUDY AREA AND PROPOSED IMPROVEMENTS

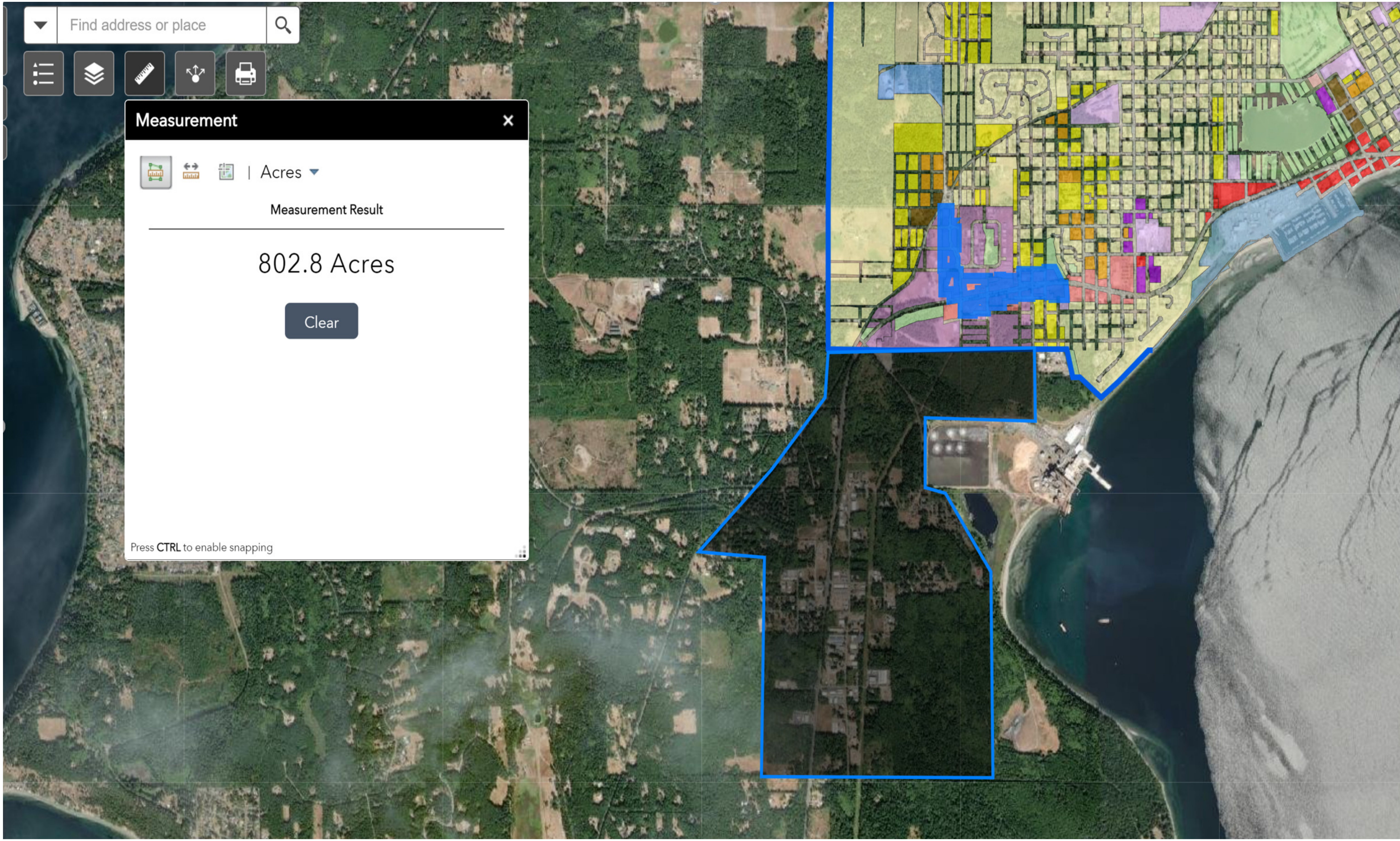
Gray & Osborne, Inc.

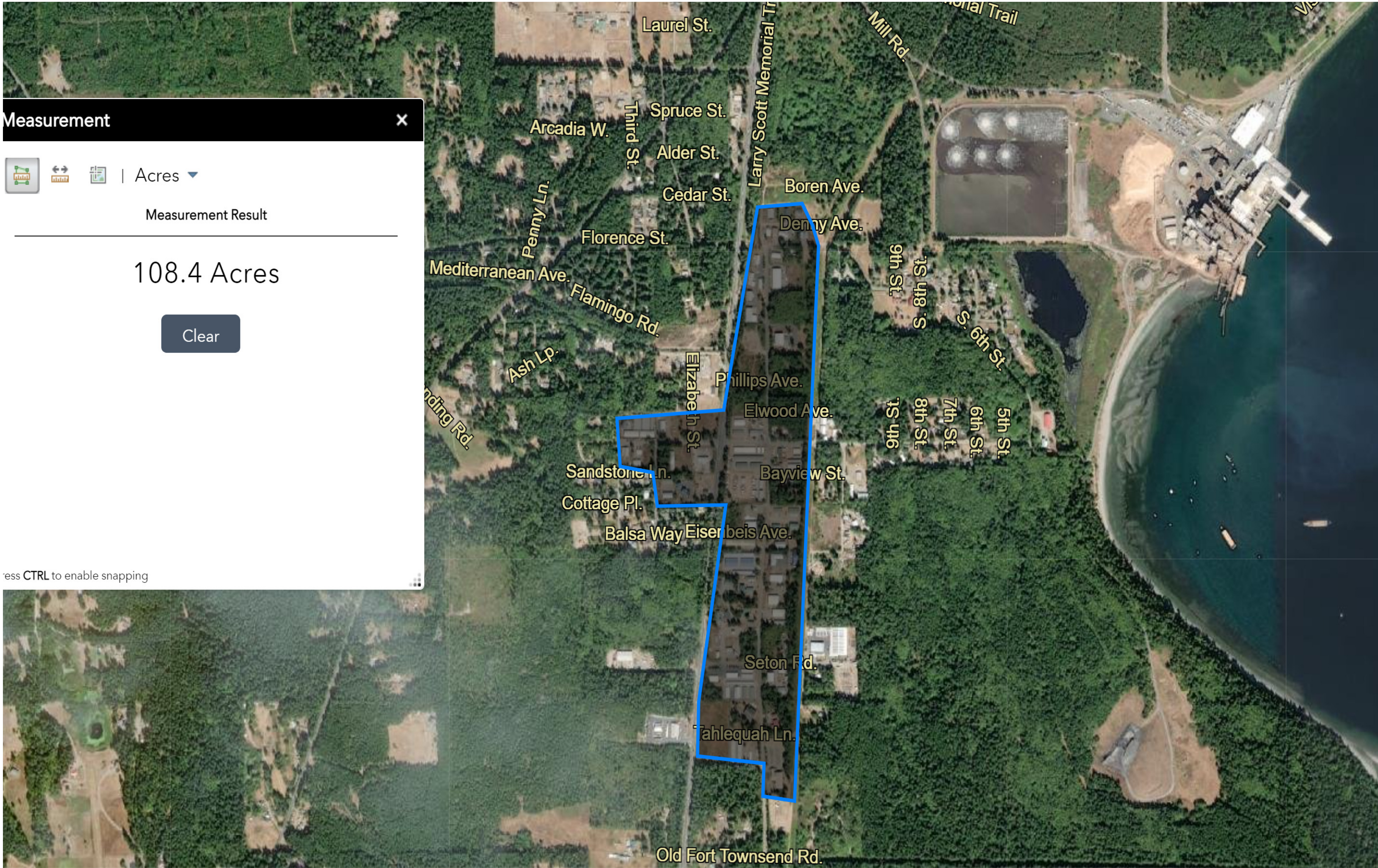
CONSULTING ENGINEERS

TABLE 2-1

Proposed Sewer Basins and Developable Area

Basin	Developable Area, Acres
1	180
2	175
3	140
4A	25
4B	40
5	85
6	125
7	45
8	15
9	30
10	380
11	125
12	45
13	95
14	50
15	145
16	90
17	25


Find address or place
Measurement
Acres
Measurement Result
802.8 Acres
Clear
Press CTRL to enable snapping


Measurement
Acres
Measurement Result
108.4 Acres
Clear
ess CTRL to enable snapping
Laurel St.
Spruce St.
Arcadia W.
Third St.
Alder St.
Larry Scott Memorial Tr
Mill Rd.
Cedar St.
Boren Ave.
Denny Ave.
Florence St.
Penny Ln.
Mediterranean Ave.
Flamingo Rd.
9th St.
S. 8th St.
S. 6th St.
Ash Lp.
Elizabeth St.
Phillips Ave.
Elwood Ave.
9th St.
8th St.
7th St.
6th St.
5th St.
Sandstone Ln.
Bayview St.
Cottage Pl.
Balsa Way
Eisenbeis Ave.
Seton Rd.
Tahlequah Ln.
Old Fort Townsend Rd.

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Appendix K

2022 City of Port Townsend Sea Level Rise and Coastal Flooding Risk Assessment

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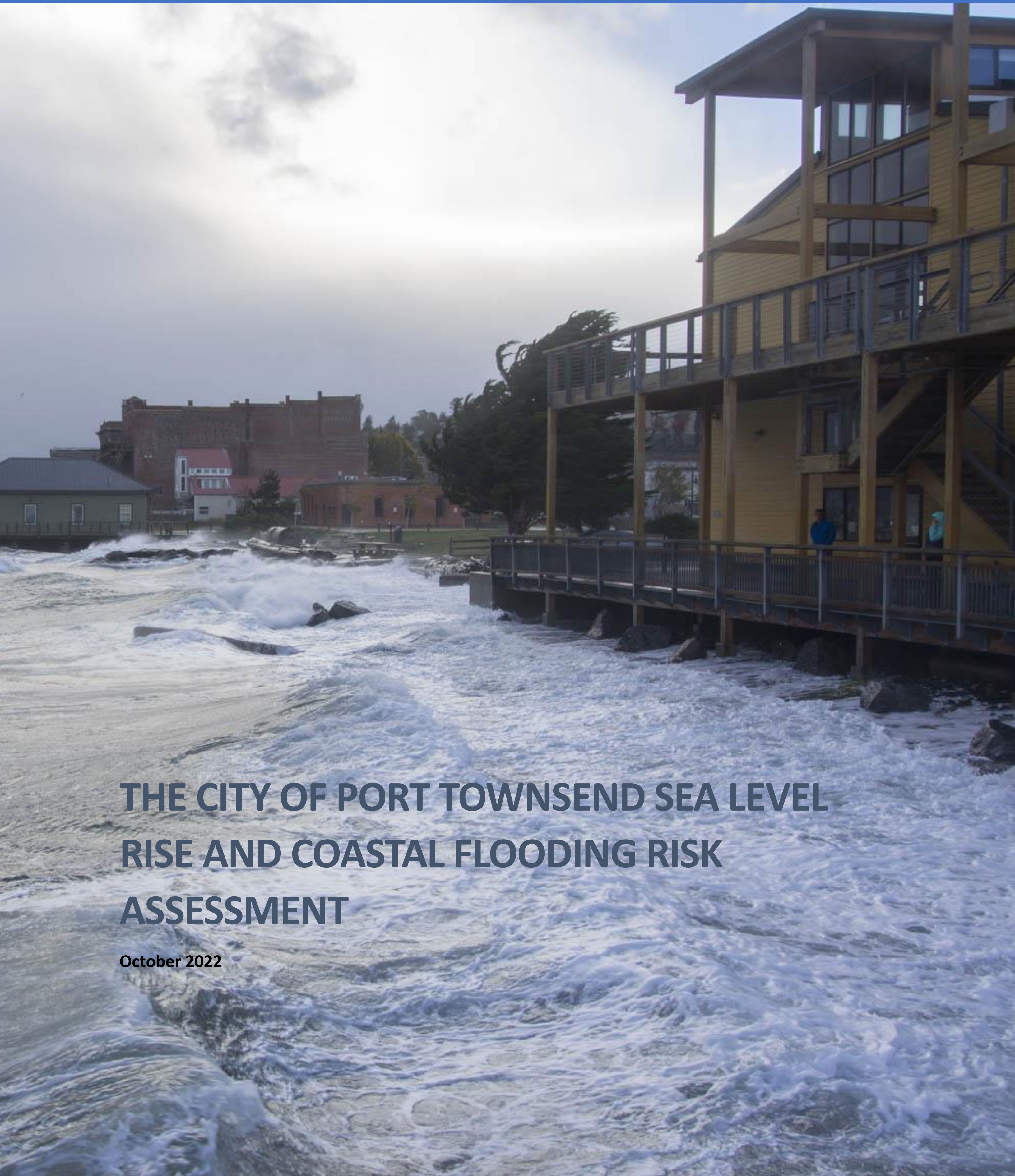

THE CITY OF PORT TOWNSEND SEA LEVEL RISE AND COASTAL FLOODING RISK ASSESSMENT

October 2022

Photo by Barney Burke

ACKNOWLEDGMENTS

The City of Port Townsend thanks the North Olympic Peninsula Resource Conservation & Development Council for providing financial support for technical assistance.

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Cindy Jayne, Chair, Climate Action Committee
Dave Wilkinson, Local 20/20

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Cover Photo Credit: Barney Burke

TABLE OF CONTENTS

ACKNOWLEDGMENTS **2**

PROJECT STEERING COMMITTEE 2
CONSULTING TEAM: CASCADIA CONSULTING GROUP 2
SUGGESTED CITATION 2

INTRODUCTION **4**

PROJECT BACKGROUND 4

FLOOD EXPOSURE AND MAPPING APPROACH **4**

COASTAL FLOODING PROBABILITIES AND PROJECTIONS 5
Sea Level Rise Projections *5*
Current Coastal Flooding Processes *6*
Sea Level Rise and Coastal Flooding in Port Townsend *7*
APPROACH TO ASSESS FUTURE COASTAL FLOODING LEVELS IN PORT TOWNSEND 8
Inundation Mapping for Future Water Levels *8*

PORT TOWNSEND ASSETS AND FLOOD RISK **11**

ASSET RISK ASSESSMENT METHODOLOGY 11
Assessing Exposure *12*
Assessing Sensitivity *13*
Assessing Consequence *14*

RESULTS **14**

SUMMARY OF COASTAL FLOODING RISK TO KEY ASSETS 14
High Exposure *14*
Highly Sensitive Assets *15*
High Consequence Assets *15*
Asset Values at Risk *15*

LIMITATIONS **17**

REFERENCES **18**

APPENDIX A: FLOODING AND INUNDATION MAPS **20**

APPENDIX B. DETAILED ASSET TABLE **28**

DETAILED ASSET TABLE 28
DETAILED ASSET TABLE, BY EXPOSURE 33

INTRODUCTION

Project Background

The North Olympic Peninsula Resource Conservation & Development Council (NODC) secured technical assistance funding to support four local jurisdictions across the North Olympic Peninsula to better prepare for the future impacts of climate change. Clallam County, the Jamestown S'Klallam Tribe, the City of Port Angeles, and the City of Port Townsend received funding for technical assistance to advance their climate resilience and mitigation planning. The City of Port Townsend used the support to identify asset risks from sea level rise and other coastal flooding impacts.

Figure 1. Map of the Olympic Peninsula in Washington State with location of Port Townsend.

The City of Port Townsend is the county seat of Jefferson County with a population of 10,148 (U.S. Census Bureau, 2021). Located on the Quimper Peninsula, the town is surrounded by water and many areas of the shoreline occur at low lying elevations and already experience coastal flooding from storm surge, wave run-up, and extreme high tides (**Figure 1**). This study examines sea level rise and coastal flooding risks to coastal assets in the City of Port Townsend, with the goals listed below.

- Model and map the extent of coastal flooding scenarios
- Analyze City of Port Townsend coastal asset exposure to coastal flooding
- Establish risk classifications to evaluate impacts of asset exposure to coastal flooding

Studies that share related goals are currently being conducted, such as the Jefferson County Sea Level Rise Study, which is currently underway in fall 2022. Both studies involve an analysis of sea level rise models and other scientific information, identification of areas exposed to future sea level rise, and an assessment of at-risk community assets and infrastructure. Additionally, the approach of the Port Townsend analysis was similar to the sea level rise matrix conducted as part of the City of Tacoma's Comprehensive Climate Adaptation Strategy.

FLOOD EXPOSURE AND MAPPING APPROACH

While much of the Port Townsend coast occurs along bluffs at high elevation many coastal areas of the city that are at much lower elevations are already susceptible to current coastal flooding. Rising sea levels due to climate change means that coastal inundation impacts will extend and intensify across many low-elevation areas of the City.

This study focuses on the impacts of coastal flooding that threaten city assets at low elevations. Mapping the relationship between assets and coastal inundation scenarios leads to a better understanding of the risks and vulnerabilities of key assets and resources to current and future exposure to coastal flooding, which will be exacerbated by sea level rise.

Coastal Flooding Probabilities and Projections

Coastal flooding probabilities and projections were developed using sea level rise projections and current coastal flooding impacts, such as storm surge, wave run-up, and 100-year floods. The subsequent sections discuss each impact.

Sea Level Rise Projections

The Washington Coastal Resilience Project (WRCP) developed community-scale sea level rise projections in 2018 across 171 locations along Washington's coastline based on global and regional sea level rise projections that account for vertical land movement (Miller et al. 2018). These projections are accompanied by an interactive website developed by the University of Washington's Climate Impacts Group that includes sea level rise data visualizations for each of the 171 locations. The sea level rise data is presented based on two global greenhouse gas emissions scenarios, a high emissions scenario and a low emissions scenario.[1] The analysis in this report uses sea level rise scenarios based on the RCP 8.5 scenario because it aligns with current the global emissions trajectory.

In addition to using different emissions scenarios, the 2018 sea level rise projections are based on probabilistic projections of sea level rise exceedance. The WRCP produced a report with recommendations for how to apply the projections, with guidance on applying the probabilistic projections (Raymond et al. 2020). These projection scenarios are listed below.

- ***High Probability Projections (>83%):*** This represents a lower rate of sea level rise with a high probability of occurring, meaning that it is very likely that the sea level will rise to the level associated with this projection. It suggests that there is an 83% chance that the sea-level rise will be greater than the identified rate with this threshold. The recommendation is to use this projection for risk-tolerant situations where infrastructure can accommodate sea level rise impacts or projects have flexibility or adaptability and where the consequences of flooding would be minimal.
- ***Low-Range Probability Projections (<17%):*** This represents a higher rate of sea level rise with a lower probability of occurring. It suggests that there is a 17% chance that the sea-level rise will be greater than the value identified for this probability, or amount of sea level rise. The recommendation is to use this level for assets that are risk-averse and where sea level rise will

[1] A high emissions scenario (RCP 8.5) assumes a global future in which we do not significantly reduce or limit emissions. It also assumes high population and lower income growth with moderate technological change and energy improvement, resulting in long-term to high energy demand and greenhouse gas emissions. A low emissions scenario (RCP 4.5) assumes a more aggressive global response to emissions reduction actions based on the 2015 Paris Agreement and limits mean global warming to less than 2°C and achieves net-zero greenhouse gas emissions by 2050. This scenario is considered politically challenging and would require concerted action by all countries to shift to lower emissions.

have substantial consequences. For example, using the estimated sea level rise associated with this probability should be used for critical infrastructure, such as sewage treatment plants or emergency response infrastructure, or others that would be seriously compromised by flooding and that the loss of that function would be a major disruption to the community.

- ***Extreme Low Probability Projections (0.1%):*** This represents the highest rate of sea-level rise with the lowest probability of occurring. This projection represents the physical upper limit for sea level rise and is a worst-case scenario for extremely conservative decisions. This level of sea-level rise is unlikely to change with future scientific updates.

The National Oceanic and Atmospheric Administration (NOAA) also updated its sea level rise projections in 2022, which are based off extrapolated tide gauge record data, to reflect the most recent climate change scenarios (Sweet et al. 2022). NOAA's updated projects include 5 scenarios that generally correspond to a global climate model scenario (Low, Intermediate-Low, Intermediate, Intermediate-High, and High). The NOAA 2022 High Projection scenario was used as a visual reference layer in this spatial analysis, but the WRCP projections were used for the asset analysis since they are more locally tailored.

Current Coastal Flooding Processes

Sea level rise can exacerbate existing coastal flooding, which is affected by a variety of processes, events, and factors. This analysis uses storm surge, wave runup, and the FEMA 100-year flood zone to represent current drivers of coastal flooding, described below.

- ***Storm surge:*** Storm surge creates water levels that are higher than the predicted astronomical tides, due to a combination of high tide events, low atmospheric pressure, and wind-driven waves. Because of the intensified impacts of these events, this study additively combines storm surge with WCRP sea level rise projections. Storm surge for Port Townsend was estimated by examining the extreme water level historic data from the nearby Friday Harbor tide gauge and comparing it to MHHW levels. There is 1% chance of a storm surge event for any given year in Port Townsend that would raise the tide levels by an additional 3.1 feet (Petersen et al. 2015). For the purposes of this report, the 3.1 feet of water level rise attributable to storm surge was used to represent current flooding in Port Townsend.
- ***Wave runup:*** Wave runup is the height difference between the elevation of still water and the elevation that is reached by the uprush of a wave on beaches and shore barriers such as seawalls. At a local monitoring site (Salmon Club Boat Ramp, **Figure 2**) with a gently sloping shoreline, wave

Figure 2. Wave runup at a city park and the Salmon Boat Club ramp.

runup has been measured to increase tide levels by an additional 2.0 to 2.5 feet (Local 20/20 2018). For all inundation scenarios that were within 100 feet of the coast, an additional 2.5 feet was added to the total elevation to represent wave runup. In the case of this report, the purpose of evaluating wave runup was to better understand how properties along the shoreline are directly impacted due to wave action and serve as a planning tool for mitigation measures against wave runup.

- ***100-year flood:*** The National Flood Insurance Program provides geographic areas and subdivisions at risk of flooding and the associated base flood elevation. For this analysis, the base elevations of the 1% annual flood event—or a 100-year flood—for designated high-risk areas within Port Townsend were used. Depending on the subdivisions the base flood elevations ranged from 7 feet to 17 feet (FEMA 2019). These flood maps were included in the asset inundation analysis because it is representative of where historical flooding has occurred. However, the FEMA flood map does not consider future sea level rise.

Sea Level Rise and Coastal Flooding in Port Townsend

Sea level rise projections for the coastal area around the City of Port Townsend are summarized in **Table 1**. For the purposes of this analysis, we used WRCP's 17% and 1% probability of exceedance value with a planning horizon of 2100 (3-feet and 5-feet of sea level rise, respectively). We also mapped the NOAA 2022 High Projection scenario with a planning horizon of 2100 (6.52-feet of sea level rise) to compare across datasets. The sea level rise projections and current coastal flooding levels selected for this analysis are summarized on **Table 2**. To represent the impacts of current coastal flooding impacts in Port Townsend we used the FEMA 100-year coastal flood elevation, the observed tidal elevation from the 1% storm surge event (3.1 feet), and 2.5 feet of wave run-up.

Table 1. Projected Sea Level Change for Port Townsend (in feet).

Time period	Greenhouse Gas Scenario	Central Estimate (50%)	17% probability of exceedance	Higher magnitude, but lower likelihood possibilities			NOAA 2022 High projections
				10% probability of exceedance	1% probability of exceedance	0.1% probability of exceedance	
2050 (2040-2059)	**High**	0.8	1.0	1.1	1.5	2.1	1.47
2100 (2090-2109)	**High**	2.2	3.0	3.3	5.0	8.5	6.52
2150 (2140-2159)	**High**	3.7	5.2	5.9	10.2	18.8	16.2

This table summarizes the 2018 assessment projections from the WCRP projections and NOAA 2022 High Projection scenario for the City of Port Townsend. For the WCRP projections, projected changes are assessed relative to contemporary sea level, which WCRP defines as the average sea level over the 19-year period 1991-2009. For the NOAA 2022, projected changes are added on top of MHHW elevation. Projections highlighted in orange were used for this analysis and the projections highlighted in yellow was used as a reference.

Table 2. Scenarios and their associated elevations (feet).

Projection	Inundation Scenario	Feet of Sea-level Rise	Source
Washington State Unified projections	2100 Low-Range Probability Projections (<17%)	3 feet	Miller et al. 2018
Washington State Unified projections	2100 Low Probability Projections (1%)	5 feet	Miller et al. 2018
2022 NOAA Projection	2100 High projection	6.52 feet	Sweet et al. 2022
Storm Surge	100 Year Storm event	3.1 feet	Petersen et al. 2015
FEMA Flood Hazards	100-year Flood	Base elevations from 7-15 feet	FEMA 2019
Wave Run-up	Current observations	2.5 feet, on top of storm surge	Local 20/20 2018

Approach to Assess Future Coastal Flooding Levels in Port Townsend

This section outlines how we assessed future coastal flooding based on different sea level rise projections and coastal flooding scenarios.

Inundation Mapping for Future Water Levels

Tidal Datums

The National Oceanic and Atmospheric Administration (NOAA) maintains a tide gauge along Water Street near Point Hudson (Station ID: 9444900). **Table 3** details the tidal datums and their current elevations (feet) that the gauge tracks. For this analysis, MHHW (8.52 feet) was used as a reference base elevation with all inundation projections added on top of the 8.52 feet (in reference to Mean Lower Low Water, or MLLW).

Table 3. Tidal datums and their current elevations (feet) relative to MLLW.

Datum		Current Elevation
Mean higher high water	MHHW	8.52
Mean high water	MHW	7.84
Mean tide level	MTL	5.17
Mean sea level	MSL	5.00
Mean low water	MLW	2.50
Mean lower low water	MLLW	0.00

For instance, the 1% annual storm surge event was observed to increase the elevation of MHHW during low atmospheric events by 3.1 feet. Cumulatively, this would mean that the water level during a 1% storm surge event will be 11.62 feet (**Table 4**).

Table 4. Projected water level during 1% storm surge event (feet).

MHHW Elevation	1% Storm Surge Event Increase	Total Water Level During 1% Storm Surge Event
8.52	3.1	11.62

The total water level that accounts for sea level rise by 2100 was calculated by totaling MHHW with the elevation of WCRP sea level rise projections and storm surge. This would model not only the total water level increase brought on by sea level rise, but also the additional elevation driven by 1% storm surge events (**Table 5**).

Table 5. 2100 Total water level (feet) according to WRCP Washington State projections.

Projection	2022 MHHW Levels	1% Storm Surge	Sea Level Rise	2100 Projected Water Level
17% Likelihood SLR Event	8.52	3.1	3	14.62
1% Likelihood SLR Event	8.52	3.1	5	16.62

Because areas of the shoreline within proximity to the current water level would be additionally impacted by wave runup, the total water level for areas within 100 feet of the shoreline included an additional 2.5-feet of elevation that accounts for wave runup (**Table 6**).

Table 6. 2100 Projected (WRCP) total water level coupled with wave runup (feet).

Projection	2100 Projected Water Level	Wave Runup	2100 Water Level with Wave Runup
17% Likelihood SLR Event	14.62	2.5	17.12
1% Likelihood SLR Event	16.62	2.5	19.12

As a comparison, the 2022 NOAA High Projection scenario was 6.52-feet of sea level rise by 2100, which would place the total projected water level at 15.05 feet by 2100 (**Table 7**).

Table 7. Total water level (feet) in 2100 according to NOAA 2022 projections.

2022 MHHW Level	Sea Level Rise	2100 Projected Water Level
8.52	6.52	15.05

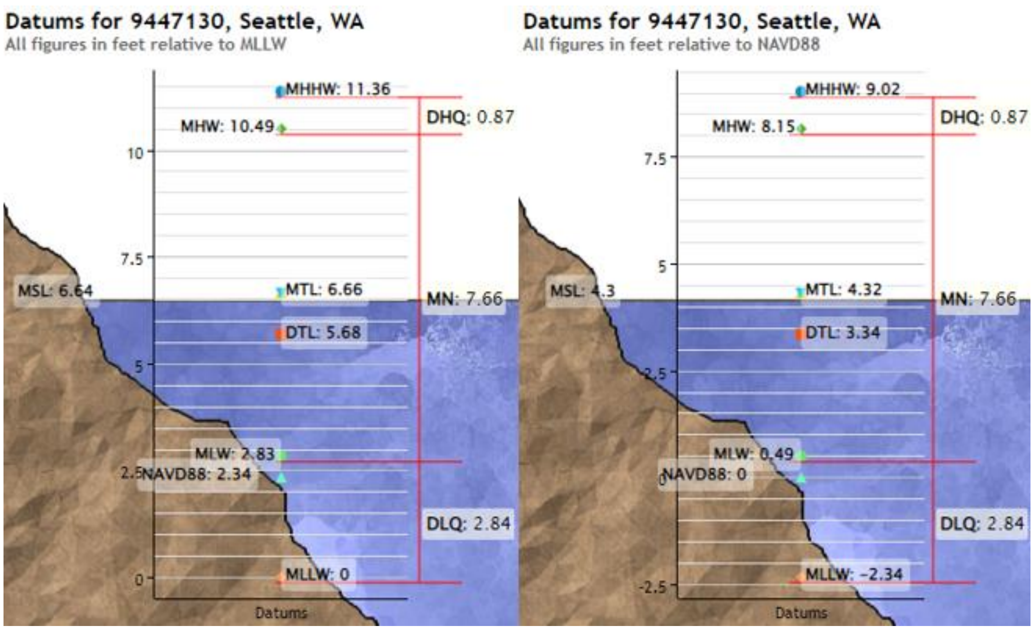
Vertical Datum Conversions

The Digital Elevation Model (DEM) for Jefferson County was obtained from the [NOAA Sea Level Rise Viewer] tool and downloaded into ArcGIS. The DEM used was in meters and had a spatial reference coordinate system of NAVD88. The DEM had a horizontal resolution of 3-meters and a 0.328 RMSE of vertical accuracy. Additionally, the elevation data source of the DEM met the standards of the USGS Quality Level 2 as defined by the Lidar Base Specification of the national interagency 3D Elevation Program. Using Online VDatum, the reference conversion from MLLW to NAVD88 for the Port Townsend area was calculated to be -1.1 feet. By applying this offset, water levels could be converted to NAVD88. For example, if MHHW of 8.52 feet was applied the conversion offset would have an elevation of 7.42 feet in reference to NAVD88 (**Table 8**). A visual representation of this offset illustrates how the conversion can be applied and can be seen in **Figure 3**.

Table 8. Water level (feet) in reference to MLLW and NAVD88.

Inundation Scenario	Elevation in reference to MLLW	Elevation in reference to NAVD88
MHHW	8.52	7.42
Storm Surge	11.62	10.52
17% Likelihood SLR Event	14.62	13.52
NOAA High 2022 Event	15.04	13.94
1% Likelihood SLR event	16.62	15.52

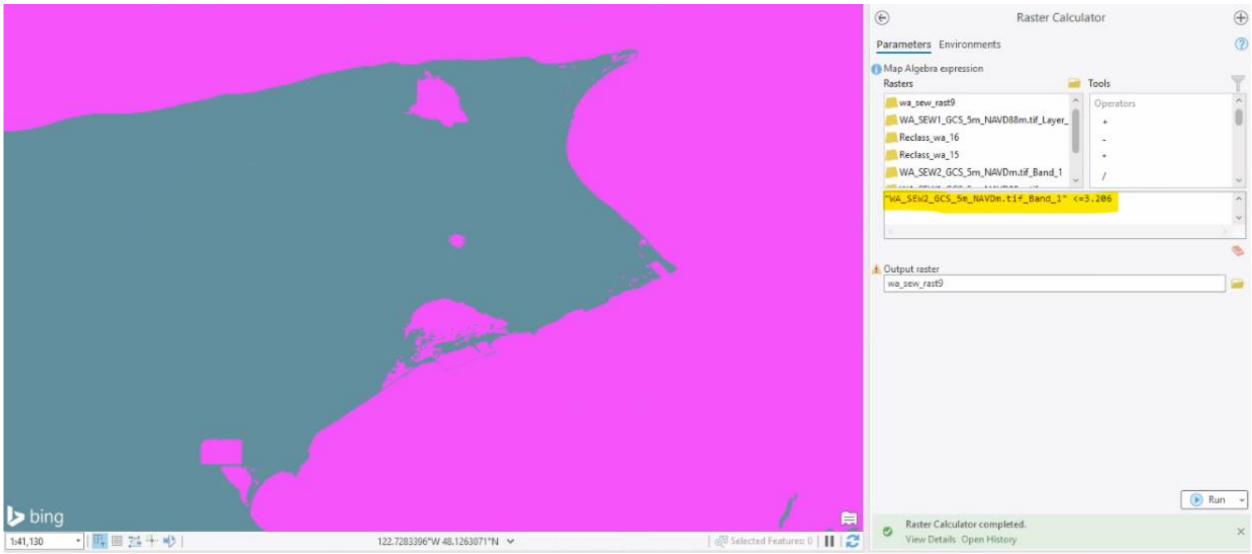
Figure 3. Tidal datum elevation offset in reference to MLLW and NAVD88.



Sea Level Rise and Storm Surge Mapping

This section outlines a case study of how these various models and data were used to estimate the total water level that accounts for sea level rise and storm surge within ArcGIS. To calculate storm surge, 3.1-feet was added on top of the MHHW (8.52 feet). This elevation of 12.62 feet was then offset by -1.1 feet to ensure total water elevation was based off the NAVD88 reference layer, leading to a total water level of 10.52 feet (in reference to NAVD88). This elevation was then converted from feet to meters (3.21). Finally, all areas of the DEM that were under 3.21 meters of elevation were selected using the Raster Calculate tool (**Figure 4**).

Figure 4. Example of how inundation layers were created using the Raster Calculate tool. In this scenario, the graphic depicts all areas equal to or below 3.21 meters (pink), which is the 3.1-feet storm surge scenario.



The Reclassify tool was used to replace the raster values that were over the specified elevation (3.21 meters) with "No Data" so that only the raster values representing sea level rise remained. The raster was then converted to a polygon using the Raster to Polygon tool to smooth the layer into simpler shapes and allow for further analysis.

Areas of the polygon that were under the elevation of water level that were not hydrologically connected to the coast or were deemed as "Areas unlikely to Flood". These areas were eventually represented in a different color.

Wave Run-Up Mapping

The wave runup maps were calculated by adding total water level observation (Salmon Club Boat Ramp, Local 20/20 2018) and the NAVD88 offset and then subtracting the elevation from the tidal gauge observation (Point Hudson). Wave run-up height was modeled by adding an additional 2.5-feet of elevation for each inundation scenario.

The Erase tool was then used to delete all parts of the wave runup layer that overlapped with a corresponding inundation layer, leaving a layer that represents areas 2.5-feet higher than the given inundation scenario. Since wave runup only impacts shoreline areas, The Buffer tool was used to establish a zone of Port Townsend that was within 100 feet of the shoreline. Areas 2.5-feet higher than the given inundation scenario were attached to this 100-foot buffer zone using the Clip tool.

PORT TOWNSEND ASSETS AND FLOOD RISK

Asset Risk Assessment Methodology

Generally, climate vulnerability is defined as the climate risks and impacts moderated by the capacity to adapt and cope to those impacts. For example, the extent of coastal flooding impacts on sewer infrastructure is dependent on the location of sewer infrastructure in relation to expected sea level rise and whether the infrastructure can function with that inundation. A total of eighty-five (85) assets were identified through city documents and city staff consultation with an emphasis on coastal assets. For this assessment we focused on climate risks to coastal assets and categorized assets by various characteristics (**Table 9**).

Table 9. Asset type and characteristics.

Asset Type	Asset Characteristics
• Accommodations (Temporary Housing) • Dock or Marina • Education Facility • Fabrication or Working Boatyards • Financial Facility • Food, Restaurants, or Retail • Fuel • Offices and Buildings • Open Outdoor Spaces and Parks • Parking Lots • Power Structures • Residences (Housing) • Safety Facilities • Stormwater Infrastructure • Transportation • Wastewater Infrastructure • Water Infrastructure	• Ownership (e.g., City owned, privately owned, etc.) • Year Built • Expected Asset Lifespan • Estimated Cost (i.e., assessed parcel value or estimated replacement cost of public infrastructure)

We then looked at three components of risks to assets—exposure, sensitivity, and consequence—to assess sea level risk to these assets. These terms are further defined in subsequent sections.

Assessing Exposure

Exposure includes the physical factors that put assets in harm’s way from sea level rise and coastal flooding. Extent of an asset’s exposure to coastal flooding includes an asset’s location, elevation, location, and whether it overlaps with anticipated future coastal flooding. We measured exposure by identifying the spatial locations of assets into ArcGIS Pro as points or polylines and overlayed with inundation layers. If an asset was within the boundary or intersected (partly within) with an inundation layer, it was deemed to be exposed to that flooding scenario.

We categorized asset exposure level as high, medium, or low based on the likelihood of that asset experiencing coastal flooding (**Table 10**). A high exposure asset would intersect with one of the current flooding risks (i.e., an asset overlapped with current wave run-up, storm surge, or 100-year flood). A medium exposure asset intersects with the 17% sea level rise threshold and a low exposure asset intersects with the 1% sea level rise threshold. We identified exposure for both private and public assets, however, only provide results for the public assets in this document.

Table 10. Exposure categories defined as high, medium, or low exposure levels

Exposure Level	Short Description	Current Coastal Flooding Risk			Future Flooding Risk, related to SLR Projections	
		1% storm surge	Wave runup	FEMA 100-year flood	17% SLR+ 1% storm surge	1% SLR+ 1% storm surge
High	Assets that are already exposed to current flooding from storm surge + wave run-up or 100-year floods.	*Any asset exposed to any current coastal flooding impact is considered to have high exposure.*				
Medium	Assets that will be exposed to future flooding due to SLR by 2100 at the 17% probability of exceedance.				X	
Low	Assets that will be exposed to future flooding due to SLR by 2100 at the 1% probability of exceedance or will experience no future flooding.					X

Assessing Sensitivity

Sensitivity is the degree to which the asset is affected by sea level rise and coastal flooding. For example, a new asset built with newer materials and built up to current design standards would be relatively less affected by temporary inundation as compared to infrastructure or assets that are built with older materials and to outdated design standards.

Within this analysis, sensitivity is defined as the asset age relative to expected design life. We identified less conservative and more conservative asset design life estimates using different sources related to asset types (**Table 11**). High sensitivity assets were assets whose current age exceeded less conservative design life estimates. We only identified sensitivity for public assets due to data availability and limitations.

Table 11. Design lifespan of key asset types.

Asset Type	Design Life (Less Conservative)	Design Life (More Conservative)	Source(s)
Accommodations (Temporary Housing)	30	100	Portland Cement Association (PCA), n.d. David and Sons, 2017
Dock / Marina	40	50	Michigan Sea Grant, 2015
Education	30	100	PCA, n.d. David and Sons, 2017
Fabrication / Working Boatyards	30	100	Eurostat, 2003
Financial	30	100	PCA, n.d. David and Sons, 2017
Food, Restaurants, Retail	30	100	PCA, n.d.

Asset Type	Design Life (Less Conservative)	Design Life (More Conservative)	Source(s)
			David and Sons, 2017
Fuel	20	30	ServoPro, 2021
Offices and Buildings	30	100	PCA, n.d. David and Sons, 2017
Open outdoor space and parks	20	50	City of Hamilton, Public Works, 2009
Parking lot	20	20	CA Department of Transportation, 2017
Power	50	50	Union of Concerned Scientists, 2017
Residences (Housing)	30	100	PCA, n.d. David and Sons, 2017
Safety	30	100	*No data found. Using lifespan of concrete structures as proxy.*
Stormwater	50	100	ASCE, 2021a
Transportation	10	100	Union of Concerned Scientists, 2017
Wastewater	25	50	ASCE, 2021b
Water	60	100	Union of Concerned Scientists, 2017

Assessing Consequence

High consequence assets represent assets that would affect key community functions if it failed due to coastal flooding. For this project, we identified high consequence assets using FEMA's definition of critical facilities — which includes assets, systems, networks, or functions that would have a debilitating effect on security or public health and safety if they were debilitated or incapacitated due to hazards — to identify critical infrastructure on the list of assets. Critical infrastructure was identified by the City of Port Townsend project staff. These assets were subsequently categorized as high consequence assets.

RESULTS

Summary of Coastal Flooding Risk to Key Assets

The eighty-five assets assessed in this study are categorized based on asset type, ownership, exposure, sensitivity, and whether it represents a high consequence asset (public assets are summarized on **Table 12** with the detailed asset descriptions for public and private assets in Appendix B). Of these 85 assets, forty (40) assets were publicly owned or owned by NGOs.

High Exposure

Of the 40 public assets, 32 were identified as having high exposure, meaning that those assets are already located within the 1% chance of storm surge (3.1 feet) area, wave runup (2.5 feet) area, and/or the FEMA 100-year flood zone. There highly exposed assets include assets within wastewater, water, transportation, stormwater, safety, marinas, housing, and business categories. Out of the 29 high consequence assets representing critical infrastructure (which include private assets), 23 are highly exposed to current coastal flooding.

These exposures represent current risk conditions and do not consider future sea level rise. The high exposure assets should be prioritized by the City for adapting to sea level rise as these are already known to experience coastal flooding during extreme high tide events and storm surge events and they will be the first assets to be affected by future sea level rise.

Highly Sensitive Assets

Out of the 40 public assets that were evaluated for sensitivity, six (6) are considered highly sensitive. That means their current age exceeds their anticipated design life, or the estimated length of time that asset is designed to function for. These assets are more likely to fail after a single or repeated flooding events because of their age in relation to their design life. Assets with high sensitivity to sea level rise should also be considered as priorities for the City as they will be the assets least equipped to deal with future coastal flooding worsened by sea level rise.

High Consequence Assets

The high consequence assets are assets that provide critical services – such as food, gas, shelter, power, and health services – to Port Townsend that also have high exposure and high sensitivity. The City will need to prioritize these assets in adapting to sea level rise to avoid failure of these critical facilities. High consequence assets include public and private assets. There are four (4) public assets that have been identified as high consequence assets.

Asset Values at Risk

Asset values were represented as either assessor's parcel value for private assets or represented as estimated replacement cost for public assets (included with detailed asset descriptions in Appendix B). We identified total costs at risk by different exposure levels for both public and private assets.

For public assets, the total estimated replacement costs for assets with high exposure where assets are already located within the 1% chance of storm surge, wave runup, or the FEMA 100-year flood zone is $179,200,000. The total estimated replacement cost for public assets with medium exposure, or where assets intersect with the 17% probability of exceedance, is $2,068,544. Finally, the total estimated replacement cost for assets with low exposure, or where assets intersect with the 1% probability of exceedance, is $12,771,167.

For private assets, the total assessed parcel value for assets with high exposure where assets are already located within the 1% chance of storm surge, wave runup, or the FEMA 100-year flood zone is $44,060,086. The total assessed parcel value for private assets with medium exposure, or where assets intersect with the 17% probability of exceedance, is $2,880,465. Finally, the total assessed parcel value for private assets with low exposure, or where assets intersect with the 1% probability of exceedance, is $1,231,924.

Table 12. Assets categorized by level of exposure and sensitivity and whether it represents a high consequence asset.

ID	Asset	Ownership	Exposure	Sensitivity	High Consequence
Wastewater					
WW- 1	Monroe Street Lift Station	City	High	High	Y
WW- 2	Gaines Street Lift Station	City	High	Low	
WW- 3	Kah Tai Nature Park Restrooms	City	High	Medium	

ID	Asset	Ownership	Exposure	Sensitivity	High Consequence
WW- 4	Wastewater Treatment Plant	City	Low	Medium	
WW- 5	Port Lift Station	City	Medium	Medium	
WW- 6	Point Hudson Lift Station	City	High	Medium	
WW- 7	Kearney Sewer	City	High	Low	
WW- 8	Boat Haven Sewer	City	High	Medium	
WW- 9	Downtown Sewer	City	High	High	Y
Water					
W- 1	Kearney Water	City	High	Low	
W- 2	Boat Haven Water	City	High	Low	
W- 3	Downtown Water	City	High	Low	
Transportation					
T- 1	Washington State Ferry Terminal	Washington State	High	Medium	
Stormwater					
SW- 1	Stormwater Lift Station	City	High	Low	
SW- 2	Kearney Storm	City	High	Low	
SW- 3	Boat Haven Storm	City	High	Medium	
SW- 4	Downtown Storm	City	High	High	Y
Safety					
S- 1	US Coast Guard	Federal	Low	Medium	
S- 2	Point Wilson Lighthouse	Federal	High	High	Y
Parking Lot					
PL- 1	The Back Alley	City	Low	High	
Power					
P- 1	Electric Sub-Station	City	Low	Low	
Open Outdoor Space and Parks					
OP- 1	Pope Marine Park	City	High	Medium	
OP- 2	Adams Street Park	City	High	Medium	
OP- 3	Tyler Street Plaza	City	High	Low	
OP- 4	Wave Viewing Gallery	City	High	Low	
Offices and Buildings					
OB- 1	City Hall	City	Low	Low	
OB- 2	Cotton Building	City	Low	Low	
OB- 3	Pope Marine Building	City	High	Low	
OB- 4	Port of Port Townsend	Port	High	Low	
Education					
E- 1	Marine Science Center- 1	NGO	High	Low	
E- 2	Northwest Maritime Center	NGO	High	Low	
E- 3	Marine Science Center- 2	NGO	High	Low	
E- 4	Marine Science Center- 3	NGO	Medium	Low	
Dock / Marina					

ID	Asset	Ownership	Exposure	Sensitivity	High Consequence
D- 1	Port of Port Townsend Maintenance	Port	High	High	
D- 2	Union Wharf	Public	High	Low	
D- 3	City Dock	Public	High	Low	
D- 4	Boat Haven Marina	Port	High	Low	
D- 5	Point Hudson (Port Property)	Port	High	Low	
Accommodations (Temporary Housing)					
A- 9	American Legion (Homeless Shelter)	NGO	High	High	

LIMITATIONS

While this report attempts to assess the coastal flooding risk of key assets, there are some limitations of this assessment, identified below.

- The inundation modeling was based off elevation data and does not account for the effects of seawalls or other fortification structures. Because of this, the hazard exposure analysis may have resulted in more conservative high estimations of flooding in certain areas.
- The elevation of assets (i.e., building height) was not considered and therefore may overrepresent flooding.
- Site specific variables of wave runup were not assessed.
- The effects of natural processes or human causes geomorphological changes that might lower or raise the sea level elevation are not sufficiently understood and therefore the model does not consider coastal geomorphological processes that might occur in the future.

Furthermore, we recommend expanding on this assessment in the future. These recommendations are also listed below.

- Assessing asset adaptive capacity or ability to cope with inundation is beyond the scope of this project. We recommend reviewing the identified asset list and focusing on assets that are highly exposed, highly sensitive, and would have a high consequence of failure to assess the ability of those assets to cope or withstand impacts of coastal inundation, especially repeatedly. In addition, identifying adaptive capacity of infrastructure and assets could result in policy and planning recommendations for how to adapt key assets. This process is identified in the Climate Action Committee’s Risk Screening Tool (2019) and follows the steps laid out in this project.
- Erosion along bluffs may be impacted by sea level rise and storm surge but is outside the scope of this study.
- Port Townsend’s identify is linked to its historic and cultural resources. The Comprehensive Plan encourages retention of significant buildings (Land Use Element Goal 17). We recommend reviewing US Department of Interior’s Guidelines on Flood Adaptation for Rehabilitating Historic Buildings.

- This study did not account for the tsunami inundation zone. Future expansion of this could include integration of assets exposed to tsunami-related flooding.

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APPENDIX A: FLOODING AND INUNDATION MAPS

This appendix section provides more detailed maps that depict coastal flooding and inundation of assets.

Figure 5. Infrastructure along Kearney Street that are exposed to different inundation scenarios. Storm water pipes are shown in pink, water systems are shown in orange, and sewer lines are shown in purple. Coastal flooding is show in blue, wave runup in green, and areas unlikely to flood in a crosshatch blue pattern for each inundation scenario. Coastal flooding from the 17% sea level rise event and the 1% sea level rise event also take into account flooding brought on from 1% storm surge.

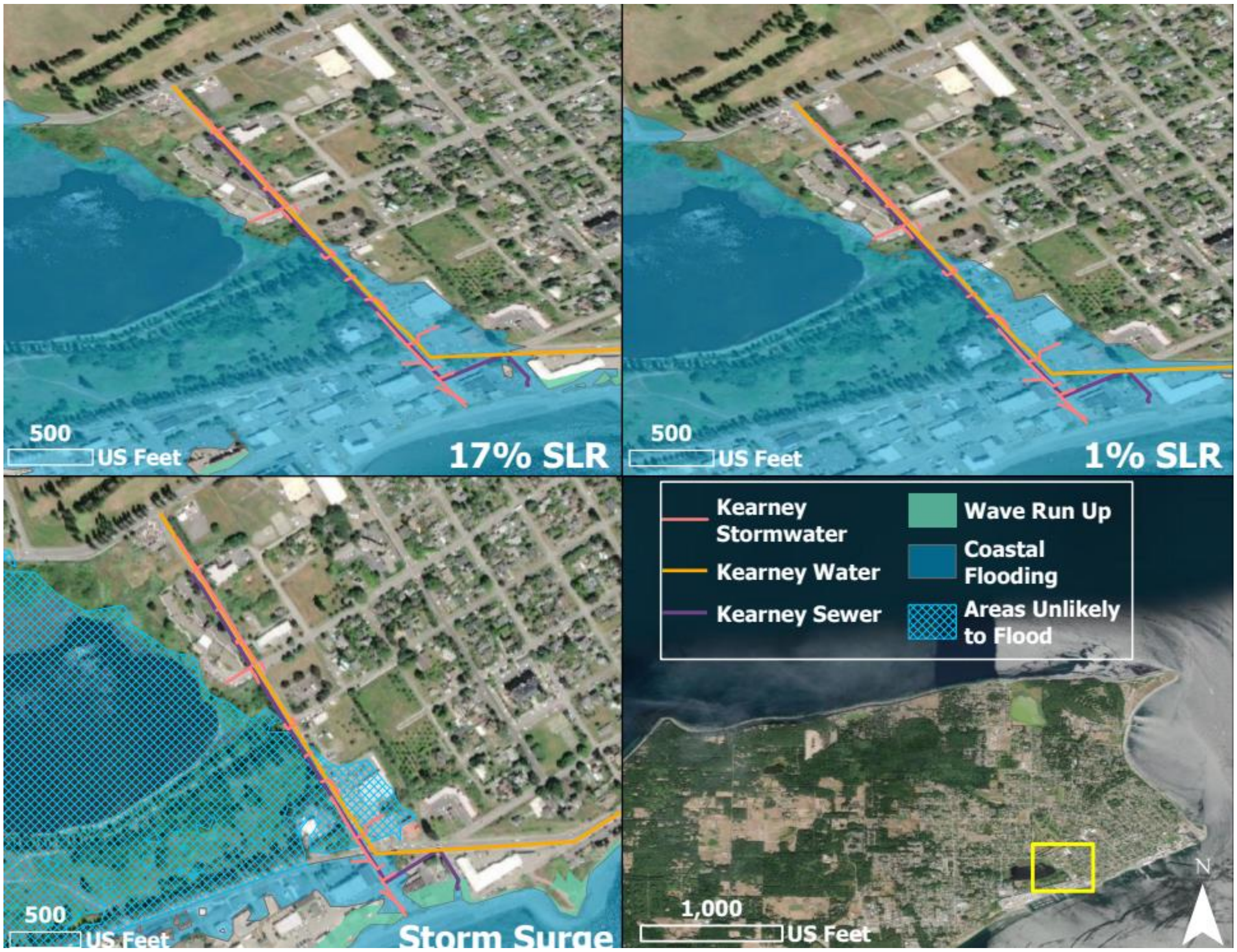


Figure 6. Boat Haven infrastructure exposed to different inundation scenarios. Storm water pipes are shown in pink, water systems are shown in orange, and sewer lines are shown in purple. Coastal flooding is show in blue, wave runup in green, and areas unlikely to flood in a crosshatch blue pattern for each inundation scenario. Coastal flooding from the 17% sea level rise event and the 1% sea level rise event also take into account flooding brought on from 1% storm surge.

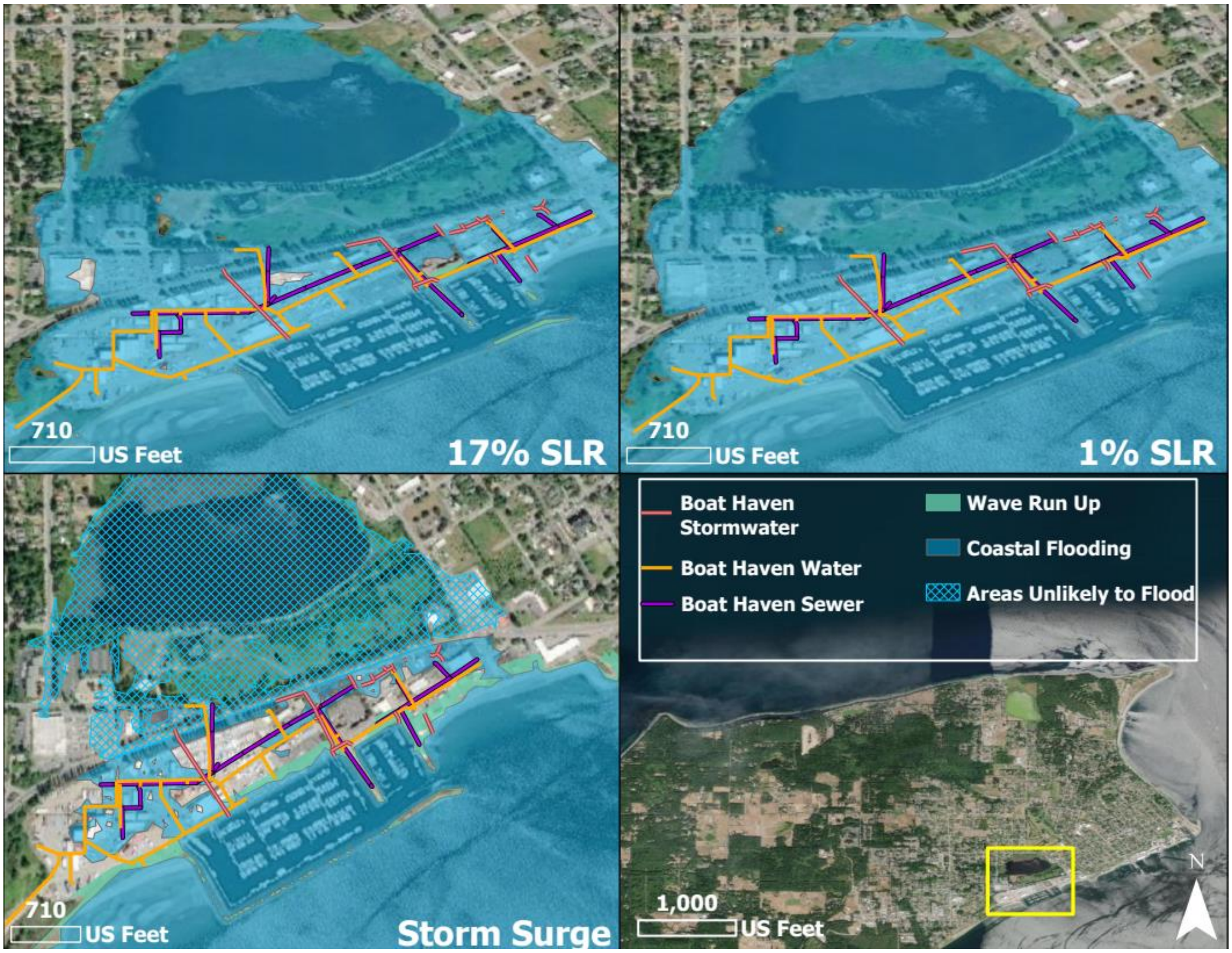


Figure 7. Downtown infrastructure exposed to different inundation scenarios. Storm water pipes are shown in pink, water systems are shown in orange, and sewer lines are shown in purple. Coastal flooding is show in blue, wave runup in green, and areas unlikely to flood in a crosshatch blue pattern for each inundation scenario. Coastal flooding from the 17% sea level rise event and the 1% sea level rise event also take into account flooding brought on from 1% storm surge.

Figure 8. Map of assets categorized by current flood exposure in Port Townsend. Storm surge is depicted in blue and wave runup in green. Areas that are below 1% storm surge event elevation but are hydrologically unconnected are labeled as "areas unlikely to flood" and are depicted in a crosshatch blue pattern. Assets are classified by their exposure types, high exposure assets are shown in red, medium exposure assets in yellow, and low exposure in green.

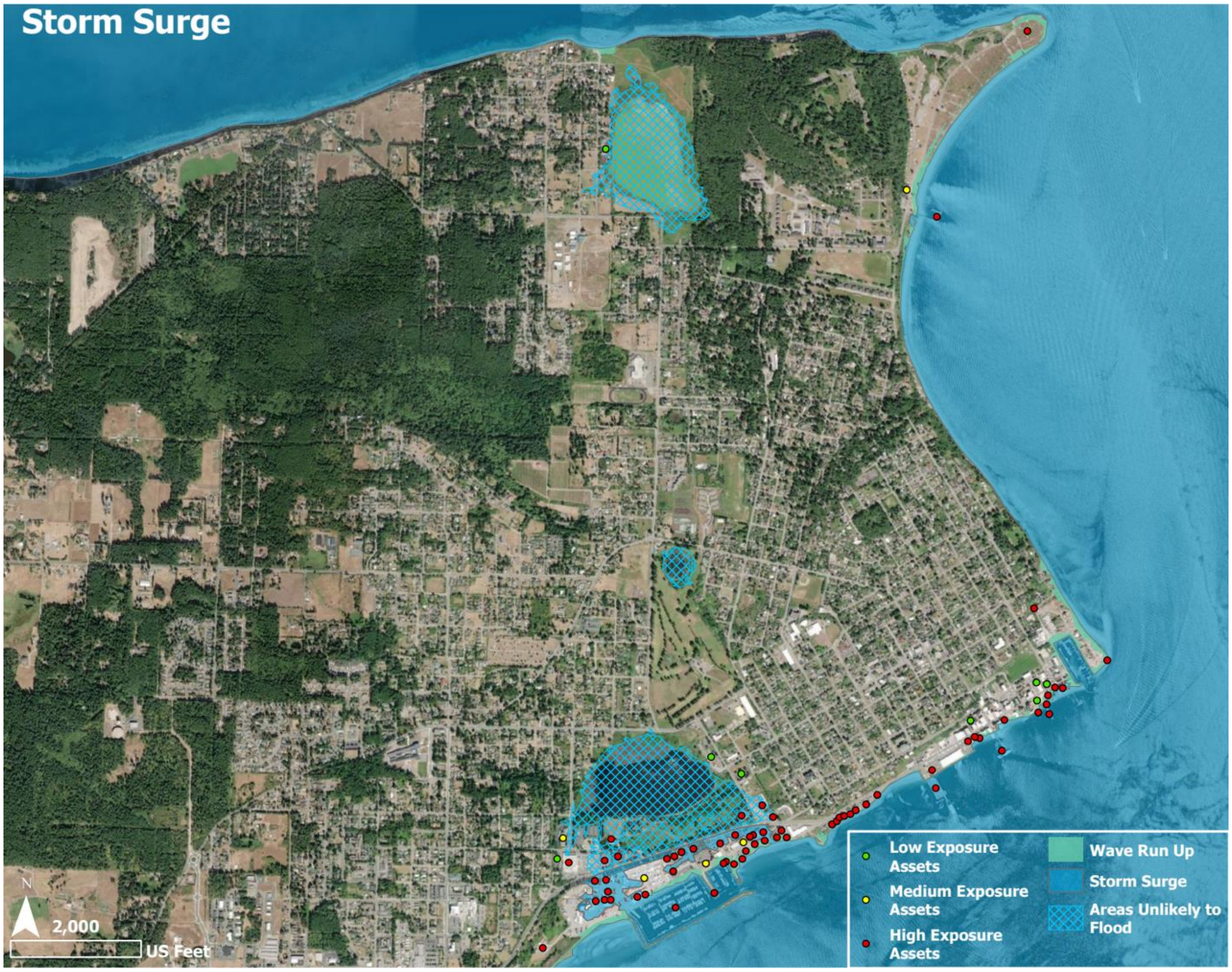


Figure 9. Map of assets categorized by future flood exposure in Port Townsend by 2100 under the 17% likelihood SLR event. Coastal flooding brought on by 17% SLR event and the 1% storm surge is depicted in blue, and wave runup in green. Areas that are below the combined elevation of the 17% SLR event and 1% storm surge but are hydrologically unconnected are labeled as “areas unlikely to flood” and are depicted in a crosshatch blue pattern. Assets are classified by their exposure types, high exposure assets are shown in red, medium exposure assets in yellow, and low exposure in green.

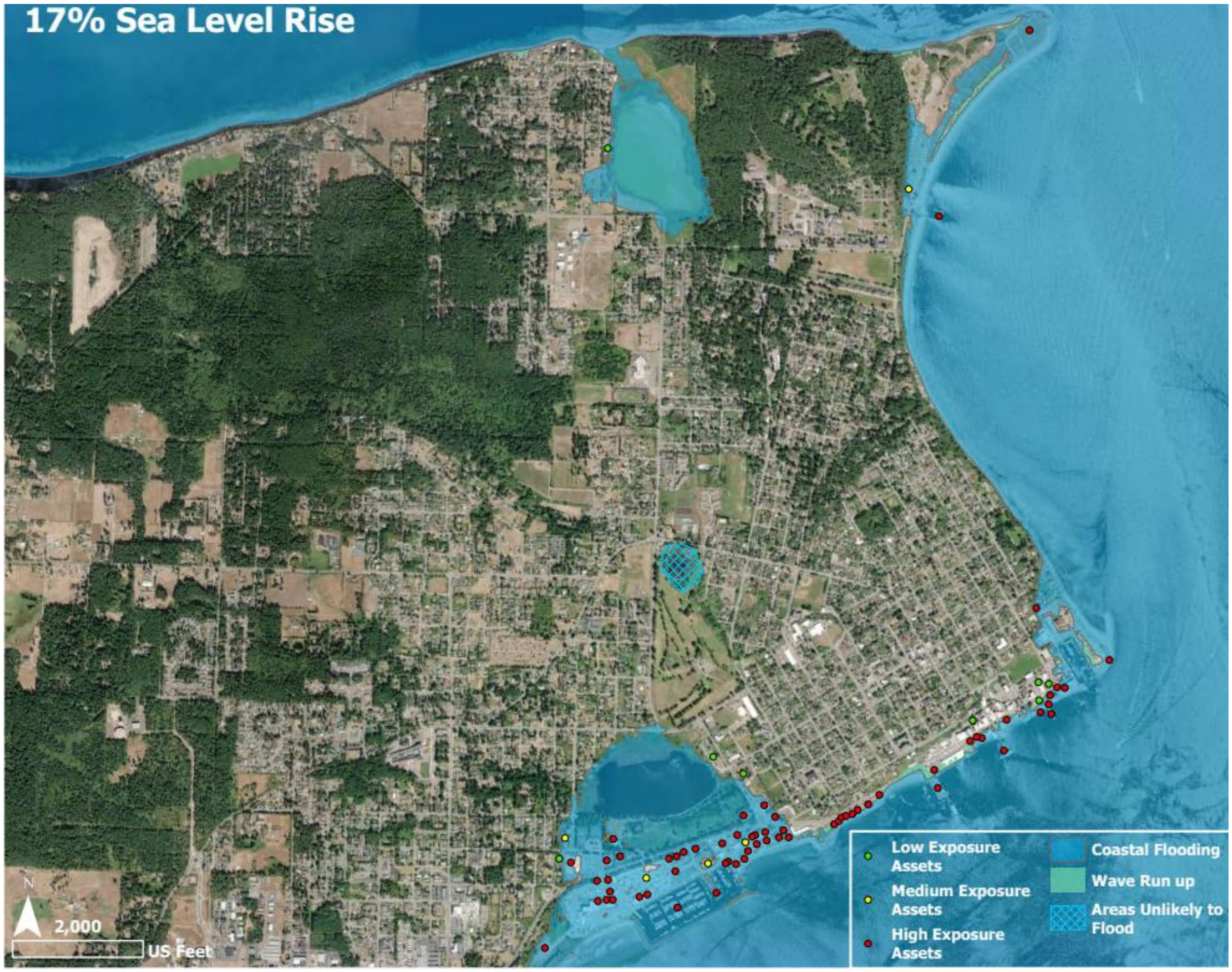


Figure 10. **Map of assets categorized by flood exposure in Port Townsend by 2100 under the 1% likelihood SLR scenario.** Coastal flooding brought on by 1% SLR event and the 1% storm surge is depicted in blue, and wave runup in green. Areas that are below the combined elevation of the 1% SLR event and 1% storm surge but are hydrologically unconnected are labeled as "areas unlikely to flood" and are depicted in a crosshatch blue pattern. Assets are classified by their exposure types, high exposure assets are shown in red, medium exposure assets in yellow, and low exposure in green.

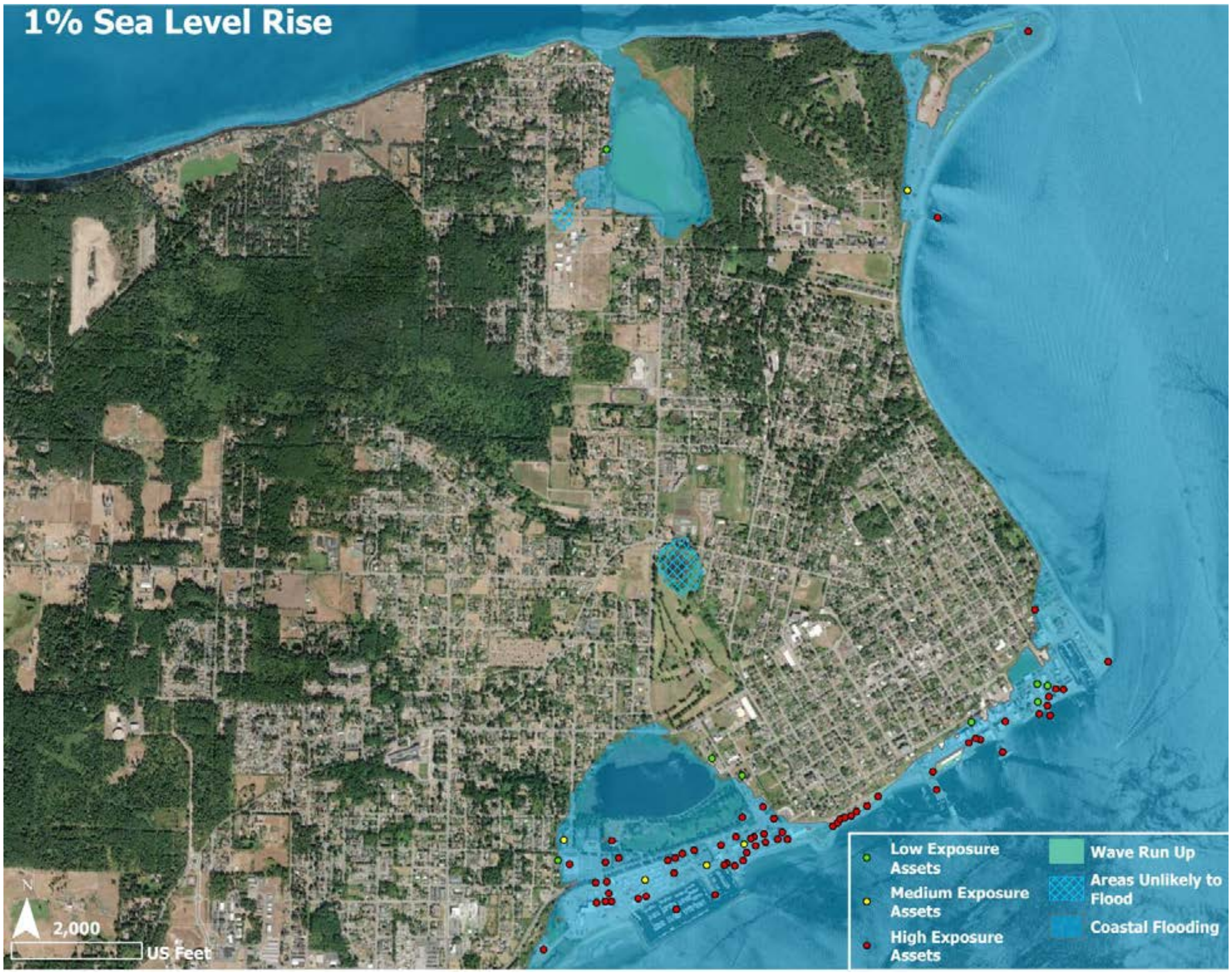
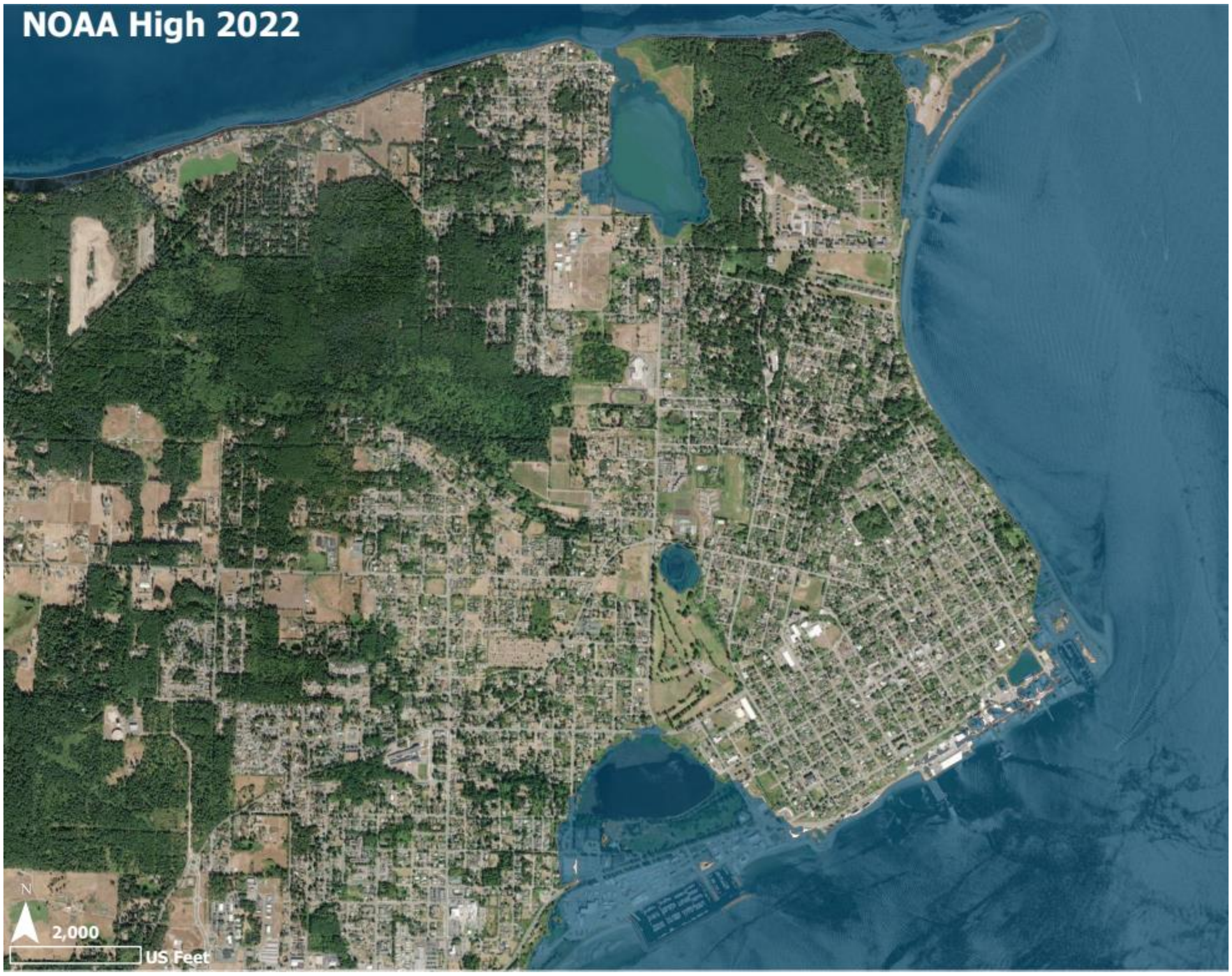


Figure 11**. Map of assets categorized by flood exposure in Port Townsend based on FEMA 100-year flood areas,** which represent historic flooding in Port Townsend (Shown in blue). Assets are classified by their exposure types, high-exposure assets are shown in red, medium-exposure assets in yellow, and low-exposure assets in green.

Figure 12**. Map of flooding impacts that would occur in 2100 under the 2022 NOAA High Projection scenario**. This was used as a reference layer.



APPENDIX B. DETAILED ASSET TABLE

The table below summarizes key assets, asset characteristics, and risk characteristics. Asset data was collected in summer 2022, and information was estimated when data was not explicitly available or accessible. These tables are based on the year 2022.

For a more detailed table that allows for regular updates, please visit https://docs.google.com/spreadsheets/d/15YVIpbCPVBIHBbgnCO5nbK7zZJHxVZyXkzFlzx-J4cw/edit#gid=0.

Detailed Asset Table

Asset	Description	Owned	Critical Facility	Year Built	Lifespan (years)	Value/Cost	Exposure		
							Current	17%	1%
Monroe Street Lift Station	Sewer Pump Station	City	Y	1960	62	$2,000,000	X		
Gaines Street Lift Station	Sewer Pump Station	City	Y	2022	0	$4,000,000	X		
Kah Tai Nature Park Restrooms	Restrooms	City		1993	29	$500,000	X		
Wastewater Treatment Plant	City's sewer plan on Kuhn Street	City	Y	1995	27	$75,000,000			X
Port Lift Station	Sewer Pump Station	City	Y	1985	37	$1,500,000		X	
Point Hudson Lift Station	Sewer Pump Station	City	Y	1990	32	$750,000	X		
Kearney Sewer	Wastewater line (Est. .25 miles)	City	Y	2005	17	$500,000	X		
Boat Haven Sewer	Wastewater line (Est. 1 mile)	City	Y	1990	32	$2,500,000	X		
Downtown Sewer	Sewer lines (Est. 2 miles)	City	Y	1950	72	$2,000,000	X		
Kearney Water	Water lines	City	Y	1975	47	$750,000	X		
Boat Haven Water	Water Lines	City	Y	TBD	TBD	$1,750,000	X		
Downtown Water	Water Lines	City	Y	TBD	TBD	$1,700,000	X		

Asset	Description	Owned	Critical Facility	Year Built	Lifespan (years)	Value/Cost	Exposure		
							Current	17%	1%
Washington State Ferry Terminal	Ferry Terminal	Washington State	Y	1990	32	$60,000,000	X		
Stormwater Lift Station	Stormwater Pump Station	City	Y	1995	27	$100,000	X		
Kearney Storm	Storm pump.... flooded pipes (Est. .25 miles)	City	Y	2000	22	$500,000	X		
Boat Haven Storm	Storm lines (est. .5 miles)	City	Y	1960	62	$1,250,000	X		
Downtown Storm	Storm lines (Est. 1 mile)	City	Y	1900	122	$5,000,000	X		
US Coast Guard	Coast Guard	Federal	Y	1960	62	$15,000,000	X		
Point Wilson Lighthouse	Lighthouse	Federal	Y	1914	108	$10,000,000	X		
Claridge Court	Apartments	Private		1989	33	$2,873,355		X	
Bay Vista II	Condominium	Private		1994	28	$2,531,400	X		
Bay Vista Condominium	Condominium	Private		1990	32	$1,177,343	X		
The Edgewater	Condominium	Private		TBD	TBD	$2,228,768	X		
Electric Sub-Station	Power	City	Y	1990	32	$5,000,000			
The Back Alley	Public outdoor space	City		1950	72	$150,000			X
Pope Marine Park	Public outdoor space	City		1987	35	$500,000	X		
Adams Street Park	Public outdoor space	City		1993	29	$150,000	X		
Tyler Street Plaza	Public outdoor space	City		2017	5	$500,000	X		
Wave Viewing Gallery	Public outdoor space	City		2010	12	$750,000	X		
City Hall	Admin, Finance, Council, HR, Planning,	City	Y	2005	17	$20,000,000			X

Asset	Description	Owned	Critical Facility	Year Built	Lifespan (years)	Value/Cost	Exposure		
							Current	17%	1%
	Engineering and museum								
Cotton Building	Public gatherings	City		2010	12	$1,500,000			X
Pope Marine Building	Public gatherings	City		2010	12	$1,000,000	X		
Port of Port Townsend	Administrative Building	Port		2014	8	$5,000,000	X		
Jefferson Title	Title Company	Private		TBD	TBD	$568,544	X		
Port Townsend Yacht Club	Public gathering space	NGO		1986	36	$5,000,000	X		
Port Townsend Visitor Center	Information for tourists	Private		TBD	TBD	$568,544	X		
Safeway Gas Station	Gas Station	Private	Y	2001	21	$568,544	X		
The Food Coop	Grocery Store	Private	Y	1970	52	$2,626,938	X		
Penny Saver	Grocery Store	Private	Y	1989	33	$396,997	X		
Safeway	Grocery Store	Private	Y	1981	41	$8,560,966	X		
McDonald's	Grocery Store	Private	Y	1988	34	$1,188,949	X		
Fast Shop	Grocery Store	Private	Y	2001	52	$568,544	X		
Bayview	Restaurant	Private		1978	33	$42,968	X		
123 Thai	Restaurant	Private		TBD	41	$912,327	X		
O'Reilly Auto Parts	Auto Parts	Private		TBD	34	$912,327	X		
PhoFilling	Restaurant	Private		1989	21	$680,467		X	
Pan d'Amore Bakery	Bakery	Private		TBD	44	$980,547	X		
Pourhouse	Pub with food service	Private		TBD	TBD	$851,675	X		
New Day Fisheries	Fish Processing	Private		TBD	TBD	$0 (Exempt based off parcel information)	X		
Sea J's Cafe	Restaurant	Private		TBD	33	$0 (Exempt based off parcel information)	X		

Asset	Description	Owned	Critical Facility	Year Built	Lifespan (years)	Value/Cost	Exposure		
							Current	17%	1%
Port Townsend Garden Center	Plant retail	Private		TBD	TBD	$678,055	X		
Goldstar Marine	Marine Service	Private		TBD	TBD	$0 (Exempt based off parcel information)	X		
Sunrise Coffee Company	Coffee Shop	Private		TBD	TBD	$0 (Exempt based off parcel information)	X		
Key City Fish	Grocery - seafood	Private		TBD	TBD	$0 (Exempt based off parcel information)	X		
Port Townsend Brewing Company	Pub	Private		TBD	TBD	$1,287,369	X		
Blue Moose Cafe	Restaurant	Private		TBD	TBD	$1,417,070	X		
Admiral Ship Supply	Marine Service	Port		TBD	TBD	$1,417,070	X		
Shipwright's Co-op	Marine Service	Private		TBD	TBD	$1,287,369	X		
Better Living Through Coffee	Coffee Shop	Private		TBD	TBD	$1,051,583	X		
Henry Hardware	Hardware store	Private		1991	TBD	$1,872,103	X		
Chase	Bank	Private		1984	31	$568,544	X		
Kitsap Credit Union	Credit Union	Private		1992	38	$987,877			X
US Bank	Bank	Private		1975	30	$1,124,141		X	
Wells Fargo	Bank	Private		1977	47	$1,370,471	X		
Kitsap Bank	Bank	Private		1975	45	$1,025,197	X		
Anderson Machine Shop	Machine shop	Private		TBD	TBD	$0 (Exempt based off parcel information)	X		
Armstrong Consolidated Inc.	Boat Manufacturer	Private		TBD	TBD	$1,274,890	X		
Marine Science Center- 1	Interactive museum	NGO		2021	1	$10,000,000	X		

Asset	Description	Owned	Critical Facility	Year Built	Lifespan (years)	Value/Cost	Exposure		
							Current	17%	1%
Northwest Maritime Center	Education facility and gather space	NGO		2009	13	$25,000,000	X		
Marine Science Center-2	Interactive museum	NGO	Y	2010	12	5,000,00		X	
Marine Science Center-3	Interactive museum	NGO		2010	12	$5,000,000	X		
Port of Port Townsend Maintenance	Marine Service	Port		1950	72	$2,000,000	X		
Union Wharf	Public outdoor space	Public	Y	1996	26	$1,500,000	X		
City Dock	Public outdoor space	Public		1990	32	$5,500,000	X		
Boat Haven Marina	Port of Port Townsend	Port	Y	1997	25	$5,000,000	X		
Point Hudson (Port Property)		Port	Y	1990	32	$4,000,000	X		
Life Care Center	Convalescent Center	Private		1980	42	$2,409,149			
Harborside Inn	Hotel	Private		1990	32	$5,338,062		X	
The Tides Inn-1	Hotel	Private		TBD	TBD	$481,924	X		
The Tides Inn-2	Hotel	Private		TBD	TBD	$902,358	X		
The Tides Inn-3	Hotel	Private		TBD	TBD	$902,358	X		
The Tides Inn-4	Hotel	Private		TBD	TBD	$428,232	X		
The Tides Inn-5	Hotel	Private		TBD	TBD	$428,232	X		
Aladdin Inn-	Hotel	Private		1989	33	$1,651,831	X		
American Legion	Homeless Shelter	NGO	Y	1950	72	$2,500,000			X

Detailed Asset Table, by Exposure

Assets that were partially within an inundation layer are denoted with an asterisk. While spatial analysis may not categorize these as at-risk assets, real life ground truthing confirmed that some assets would still be partially or completely flooded despite their asset only partially overlapping an inundation later.

Asset ID	Asset	Current Coastal Flooding Risk			Future Flooding Risk, related to SLR Projections	
		1% storm surge	1% Storm surge+ Wave run-up	FEMA 100-year flood	17% SLR	1% SLR
1	Monroe Street Lift Station		X		X	X
2	City Hall					X
3	Cotton Building					X
4	Pope Marine Building	X	X*	X	X	X
5	Gaines Street Lift Station	X	X*		X	X
6	Kah Tai Nature Park Restrooms			X	X	X
7	Wastewater Treatment Plant					X*
8	Port Lift Station				X	X
9	Pope Marine Park		X	X	X	X
10	Adams Street Park		X*	X*		X
11	Stormwater Lift Station	X		X	X	X
12	The Food Coop			X	X	X
13	Penny Saver			X	X	X
14	Chase			X	X	X
15	Life Care Center					
16	Electric Sub-Station					
17	Safeway			X*	X	X
18	McDonald's			X	X	X
19	Claridge Court				X	X
20	Kitsap Credit Union					X*
21	Safeway Gas Station	X*		X*	X	X

Asset ID	Asset	Current Coastal Flooding Risk			Future Flooding Risk, related to SLR Projections	
		1% storm surge	1% Storm surge+ Wave run-up	FEMA 100-year flood	17% SLR	1% SLR
22	Fast Shop			X*	X	X
23	Port of Port Townsend	X*			X	X
24	Harborside Inn				X*	X
25	US Coast Guard	X*	X*	X*	X	X
26	Point Wilson Lighthouse			X	X	X
27	Point Hudson Lift Station			X	X	X
28	US Bank		X*		X*	X
29	Bayview	X*	X*		X*	X*
30	Bay Vista II	X*	X*	X*	X*	X*
31	Bay Vista Condominium	X*	X*		X*	X
32	The Tides Inn-1		X*		X*	X
33	The Tides Inn-2		X*		X*	X
34	The Tides Inn-3		X*	X*	X*	X*
35	The Tides Inn-4		X*		X*	X
36	The Tides Inn-5		X*		X*	X
37	Wells Fargo		X*			X
38	The Edgewater	X*	X	X	X	X
39	123 Thai	X		X	X	X
40	O'Reilly Auto Parts	X		X	X	X
41	Kitsap Bank	X		X	X	X
42	PhoFilling				X	X
43	Aladdin Inn	X*	X		X	X
44	Pan d'Amore Bakery		X		X	X
45	Pourhouse		X	X*	X	X
46	Jefferson Title	X	X*	X	X	X
47	New Day Fisheries		X		X	X
48	Sea J's Cafe		X	X*	X	X
49	Port Townsend Yacht Club	X	X*	X	X	X

Asset ID	Asset	Current Coastal Flooding Risk			Future Flooding Risk, related to SLR Projections	
		1% storm surge	1% Storm surge+ Wave run-up	FEMA 100-year flood	17% SLR	1% SLR
50	Port Townsend Garden Center	X		X	X	X
51	Port Townsend Visitor Center	X*		X	X	X
52	Anderson Machine Shop	X*		X	X	X
53	Armstrong Consolidated Inc.	X	X*	X	X	X
54	Goldstar Marine	X	X*	X	X	X
55	Sunrise Coffee Company	X		X	X	X
56	Key City Fish	X			X	X
57	Port Townsend Brewing Company	X		X	X	X
58	Blue Moose Cafe	X		X	X	X
59	Admiral Ship Supply	X		X	X	X
60	Shipwright's Co-op	X		X	X	X
61	Port of Port Townsend Maintenance			X	X	X
62	Better Living Through Coffee	X	X*	X	X	X
63	Marine Science Center	X*	X*	X*	X*	X
64	Tyler Street Plaza		X*		X	X
65	Northwest Maritime Center		X	X*	X	X
66	Marine Science Center				X	X
67	Marine Science Center	X		X	X	X
68	Washington State Ferry Terminal	X		X	X	X
69	Henery Hardware			X		X
70	The Back Alley					X

Asset ID	Asset	Current Coastal Flooding Risk			Future Flooding Risk, related to SLR Projections	
		1% storm surge	1% Storm surge+ Wave run-up	FEMA 100-year flood	17% SLR	1% SLR
71	Wave Viewing Gallery	X		X	X	X
72	Union Wharf	X		X	X	X
73	City Dock	X		X	X	X
74	Boat Haven Marina	X		X	X	X
75	American Legion					X
76	Point Hudson (Port Property)	X	X	X	X	X
77	Kearney Sewer	X		X	X	X
78	Kearney Storm	X	X	X	X	X
79	Kearney Water	X		X	X	X
80	Boat Haven Sewer	X	X	X	X	X
81	Boat Haven Storm	X	X	X	X	X
82	Boat Haven Water	X	X	X	X	X
83	Downtown Storm	X	X	X*	X	X
84	Downtown Sewer	X	X	X*	X	X
85	Downtown Water	X*	X	X*	X	X

Appendix L

2019 Port Townsend Condition Assessment Summary Report by Jacobs

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JACOBS

Port Townsend Condition Assessment

Summary Report

September 11, 2019

Contents

1. Introduction 2
2. Observations 3
2.1 Mechanical Systems 3
2.2 Instrumentation and Control 6
2.3 Corrosion 7
3. Summary of Recommended Improvements 11
3.1 Mechanical Systems and Corrosion 11
3.2 Instrumentation and Control 13
4. Summary of Estimated Costs 16

Appendix A. Site Plan 18
Appendix B. Photos 19

1. Introduction

The City of Port Townsend's (City's) Wastewater Treatment Plant (WWTP) was upgraded to secondary treatment in the early 1990s. In the approximately 25 years since completion of that project the WWTP has operated well and has been maintained in good condition. However, as is the case with all WWTP facilities, conditions are harsh on equipment and structures. Additionally, control systems and instruments have a limited useful life and become difficult to maintain, repair, and replace individually. After a period of 25 years, these systems and instruments undergo substantial advancement. Upgrade and replacement of instrumentation and control systems need to be assessed holistically.

Being aware that it is time to plan for targeted rehabilitation and upgrade at the WWTP, the City initiated a high-level task to assess the condition of its WWTP with a focus on three primary areas: (1) mechanical (both building mechanical and process mechanical); (2) corrosion of structures, equipment, and piping; and (3) instrumentation and control. The focus was on these aspects of the WWTP because these were generally understood to be the areas of greatest concern.

This work included a one-day examination of the WWTP by Jacobs Engineering Inc (Jacobs) technical staff. Jacobs' corrosion specialist, WWTP mechanical engineer, and instrumentation and control engineer participated in the one-day examination. After the one-day examination, observations were documented, deficiencies noted, and recommendations (and associated estimated costs) for mitigation developed. Each of these are presented herein.

Note that the WWTP generally appears to be within its design capacity and within its capacity to meet the needs of the City of Port Townsend. However, in addition to the primary focus of this condition assessment, the City should consider addressing longer-term future needs that are beyond the scope of this work and beyond typical planning horizons. Addressing such longer-term future needs would likely require additional property adjacent to the existing WWTP, beyond what the City currently owns. Additional property would enable the City to flexibly address certain future challenges.

Future challenges that would require additional property could include the eventual degradation and deterioration of the WWTP. WWTP environments are inherently corrosive to concrete and steel despite the best efforts and practices to prolong the useful lives of these materials. At some point, new unit process structures will become necessary. Changes in future, more-stringent regulation, such as the currently-contemplated nutrient reduction, could require new or expanded unit processes. Increases in population could eventually increase WWTP flows, which could require additional property for expanded unit processes.

Directly east and to the south of the WWTP are several properties without existing buildings and one that includes a residence. These lots are between Kuhn Street and Landes Street on the east and west, respectively, and between 50th Street and 53rd Street on the south and north, respectively. The City should pro-actively explore the possibility of purchase of these properties for the long-term future and assess whether or not it is feasible and reasonable to hold these properties for many years (even decades) before they might be needed.

2. Observations

The one-day examination of the WWTP was conducted July 15, 2019. WWTP staff guided Jacob's staff through the plant and provided input on the function and performance of various unit processes and facilities. The observations presented herein are presented on a per-facility basis (except for Instrumentation and Control) in three main sections: (1) Mechanical Systems, (2) Instrumentation and Control, and (3) Corrosion.

A copy of the WWTP Site Plan drawing from the 1991 design – marked up as part of the construction project of 1992 through 1994 – is presented in Appendix A for reference as to the location of key facilities. Photographs collected during the July 15, 2019 site visit of key facilities, equipment, and observed deficiencies are presented numerically in Appendix B. These photographs are referenced from the main body of this report.

2.1 Mechanical Systems

Mechanical system where noted for condition, capacity, and function. WWTP staff provided input on condition, recent rebuilds, equipment capacity limitations, and challenging system-operations. Based on discussion with WWTP staff, it appears the overall WWTP is operating well within its design capacity. No overall capacity enhancement appears to be necessary in the near future. A Facility Plan Amendment is required if the WWTP reaches 85% of its design capacity. That is not the case after over 25 years of operation. Overall, the WWTP's mechanical systems are in good condition – reflecting staff's commitment to regular and pro-active maintenance.

2.1.1 Intake Pump Station

The influent pump station receives sewage by gravity from two influent sewers. The primary portion of flow comes by conveyance from the Gaines Street Lift Station. That line flows by gravity to the plant once it reaches the general area of the golf course. An additional gravity conveyance system conveys sewage to the plant from areas to the south and west. The Influent Pumps deliver raw sewage to the elevated headworks channels, located atop the adjacent Headworks Building. Below are observations related to the mechanical systems of the Intake Pump Station.

- Capacity. Most of the time only one of the two duty pumps are in operation. Occasionally, during an extreme rainfall event, the lag pump will come online for a short period of time. If the lag pump were starting more frequently, then we might conclude that the capacity of the pump station might need to be increased.
- Equipment. The original pumps have been replaced one at a time with Flygt pumps with the N-style impeller. The original pumps had corrosion issues. The N impellers and these pumps have proven very reliable in submersible service and in pumping disposable wipes, which present great challenges for all wastewater treatment systems. The pumps are inspected and serviced regularly but have required no repairs to date.
- Notable features. The pump power and control cables are connected with Meltric connector plugs that sit within the wet well gas space. According to WWTP staff the plugs have been in place for several years without any issues. This method of providing a way to disconnect the pump power and remove pump from the wetwell appears to be efficient. It eliminates any obstruction, such as a junction box above the intake pump station that could obstruct traffic in entrance driveway.

2.1.2 MCC and Generator Rooms

The generator is well maintained and has just received a controls upgrade. The system is load tested periodically, run once a month on a regular schedule, and periodically is called to run after an area power failure. It has ample capacity to power the WWTP.

2.1.3 Headworks

Raw sewage from the Influent Pump Station discharges into a covered, open channel and flows to the influent bar screen. Bar screen effluent flows thru the vortex grit unit, Parshall flume, and onto the box where return activated sludge RAS combines with the screened and degritted-influent and is then split between the two oxidation ditches (Photo 1).

- Capacity. The bar screen is functioning well with no comments associated with high water levels upstream of the screen indicating possible capacity issues (Photos 2 and 3). There is a manual bar rack (Photo 4) that can be installed in a parallel channel if the installed screen fails. The Pistagrit vortex grit removal unit (Photo 5) is also functioning well with no significant accumulations of grit downstream to indicate that the unit is overloaded.
- Equipment. The Parkson bar screen replaced the original screening equipment. It was rebuilt approximately 10 years ago and is still in good condition. The screenings compactor is in good condition. According to WWTP staff, no issues have been observed with the screenings compactor tube (Photo 6). The Pistagrit unit has had some wear but that is not unusual in grit service. The air lift tube wore out and has been replaced. The cyclone at the top of the air lift wore out and has been rebuilt. The grit-classifier is located in the grit and screenings dumpster area on the main level of the headworks building; it was replaced at some time since the mid-1990s. It appears to be working well. The Parshall flume and instrumentation appears to provide accurate plant influent flow information.
- Notable features. As seen by the extensive amount of corrosion and liner damage over the RAS/Influent splitter weirs and under the cover of the influent wet well, it appears there is insufficient air flow/change to prevent build-up of corrosive gases. This issue is likely the result of either or both of inadequate blower capacity or ducting capacity.

2.1.4 Odor Control System

- Capacity. As evidenced by severe corrosion and degradation of the concrete liner, either the odor system has insufficient capacity or the distribution of air changes across the system is not adequate. That said, when the system is running, odor complaints from offsite are infrequent. So, there may be enough air moved to contain odors but not enough to reduce condensation and formation of sulfuric acid on gas environment contact surfaces.
- Equipment. The odor control fan needs to be replaced (Photo 7). An evaluation should be conducted to determine the proper size fan for this application. The carbon scrubber vessel (Photo 8) appears to be in good condition. If the evaluation indicates that more surface area or carbon volume is required, it might make sense to install a second, parallel vessel rather than replace the existing with a larger tank.

2.1.5 Oxidation Ditches

Combined influent and Return Activated Sludge (RAS) is split into either of the two oxidation ditches (Photo 9). Dissolved oxygen for biological consumption and mixing energy/lateral movement in the ditches is supplied by large, deck-mounted vertical mixers which have a type of paddle aerator turning below the water surface. The agitation entrains air into the mixer liquor and the energy imparted by the turning paddles, drives flow around the ditch circle. Flow exits the ditch over manually, adjustable side weirs. As the weir invert is raised, the mixing disks are further submerged driving more dissolved oxygen into the mixer liquor. As the speed of the disks are increased, more oxygen is transferred and the rate at which the mixed liquor travels around the ditch increases.

- Capacity. During the summer months, when water temperature is higher, WWTP staff raise the oxidation weirs to the highest levels. The purpose of this is to introduce enough dissolved oxygen in the mixed liquor to reduce the ammonia levels. Oxygen is the limiting factor here. In addition, the mixers are run at a higher speed twice a day. By October, operation of the ditches returns to the normal mode as the waste water cools.

- Equipment. The aerators and oxidation ditch design was done by Eimco. There are large, gearbox assemblies that drive the mixer shaft (Photo 10) that sit in noise enclosures (Photo 11) on the oxidation ditch deck. This equipment has worked well and there is a spare motor on site.

2.1.6 Secondary Clarifiers

Mixed liquor splits to either of two secondary clarifiers. During summer flows, one clarifier can be down for service (Photo 12). There are no process mechanical issues with the secondary clarifiers.

- Capacity. There appear to be no capacity issues.
- Equipment. The clarifier mechanisms are manufactured by Eimco. The original drives and motors are in service. Typically, well-maintained clarifier drives have long life spans (Photo 13).

2.1.7 RAS/WAS/Scum Pumps

The RAS pumps pull settled mixed liquor from the floor of the secondary clarifiers and return to the mixing and splitter box just downstream of the Parshall flume at Headworks. The Waste Activated Sludge (WAS) pumps pull from the bottom of the clarifier and send waste mixed liquor sludge (theoretically the quantity of biomass grown on a daily basis) to the WAS aerobic digester/holding tanks for later dewatering on the belt filter press. The Secondary Scum pump pulls secondary scum from the scum sump between the secondary clarifiers and pumps to the WAS holding tank. No issues with capacity, functionality, or condition were observed (Photo 14).

2.1.8 Chlorine Contact Basins and W3 Pumps

Secondary clarifier effluent enters the Chlorine Contact Basins, has hypochlorite solution diffused into the stream, passes thru the serpentine flow path that is designed to achieve a design contact time and then discharges to the outfall. There is the wide spot just prior to outfall discharge that provides a wet well for vertical turbine, W3 pumps to pull suction. There are no capacity, functionality, or condition issues with this process or equipment (Photos 15 and 16).

2.1.9 Chemical Systems

Hypochlorite is delivered in 12% concentration and stored in a new 6,200 HDPE tank. This is a black tank. The black tank (increased temperature of the hypochlorite) could possibly be contributing to an increase observed in off-gassing and vapor locking of the hypochlorite metering pumps (Photo 17) from prior operations. It also may have nothing to do with it.

A recirculation pump has been added to ensure continuous hypochlorite flow from the tank suction connection, past the pump suction points, and back to the tank. This is a commonly-implemented strategy designed to prevent chemical from sitting in the pipes and off-gassing to the point of accumulating enough gas to break suction. So, this is not a critical issue at this point, but the City may wish to look into this a bit more to see if there's better strategies to avoid this situation. Typically, ensuring adequate flooded suction and no high points in suction piping is sufficient. But other pump types such as peristaltic and hose pumps are options to consider instead of diaphragm metering pumps (what is currently installed) because these pumps better handle the off-gassing issue.

There are no capacity or equipment issues with the Sodium Bisulfite metering system. Only recently was a chlorine residual limit established but they have been feeding bisulfite for many years as a best practice.

2.1.10 Old Wastewater Plant (Aerobic Digesters)

WAS is pumped to the aerobic digesters (Photo 18) where it is aerated in order to avoid odor issues as well as to facilitate aerobic digestion of the sludge.

- Capacity. There appear to be no capacity issues.
- Equipment. There are likely some missing coarse bubble diffusers in the aeration system. The air is shut off daily for about 4 to 5 hours to allow the sludge to settle and thicken. The tank is decanted back to the

influent pump station and the thickened sludge, around 8,000 mg/L, is pumped to the belt press for dewatering (Photo 19). Approximately 30,000 gallons per day of thickened WAS is delivered to the belt press. The dewatered cake is about 14% solids, suitable for blending with wood chips in the composting process. The cake is hauled out to the landfill where the composting system is located. The composting process generates significant heat rendering a Class A sludge product, available to the public, after a prescribed composting period. These tanks are remnants from the original treatment plant. Likely these tanks would perform poorly in a significant seismic event.

2.1.11 Blower Room

Air is delivered to the aerobic digesters (waste activated sludge [WAS]) via a pair of rotary lobe blowers located in the lower level of the Operations building. They have 60-horsepower motors and produce about 1,200 cfm of air (Photo 20). They operate around 19 hours per day with additional run time in the summer. These blowers are in good condition and have adequate capacity. However, rotary lobe blowers are not particularly efficient from a power-usage standpoint. This could be a consideration with respect to upgrading these blowers, as is discussed in Section 3.

2.1.12 Belt Press

There are no capacity or equipment issues with the belt press or belt press room (Photo 21).

2.2 Instrumentation and Control

The majority of the instrumentation and control systems and instruments remain from the 1990s upgrade of the WWTP to secondary treatment. Equipment, cabinetry, and panels are kept clean and good working order (Photo 22). Control panels are clean, and wiring is still orderly indicating proper care has been taken during maintenance (Photo 23). Overall, the instrumentation and control systems and instruments have been well-maintained and are in good working order.

2.2.1 WWTP SCADA HMI

The WWTP's SCADA HMI system was upgraded within the last two years and does not require any major additional upgrades at this time. Normal maintenance of the application and security updates is important and should be diligently continued.

2.2.2 PLCs, VFDs, and UPSs

However, one of the major issues that is ongoing at the WWTP, and is common to all such facilities, is aging of the instrumentation and control equipment. While many electrical and electronic devices have the capacity to last up to 30 or even 40 years, the accepted lifespan of instruments and controllers is 15 to 20 years. The main reason for this is the rapid pace of technological advancement with these systems and the associated lack of availability of support for systems older than 15 years. The key critical control components for the WWTP are the system programmable logic controllers (PLCs), the variable frequency drives (VFDs), and the control panels' uninterruptable power supply (UPS). All of these have been well maintained but have exceeded their useful expected life (Photos 24, 25, 26). Each of these elements are obsolete and not supported by the original manufacture since about 2010. Each of these elements are considered high value items (over $5,000 each). The PLC and VFD system replacements are not a simple part-swaps and will require engineering to develop the replacement strategy. For these items the replacement should be performed within the next year or two.

2.2.3 Instruments

The more common instrument components are also at end of their useful life spans and some even obsolete. New direct replacement elements are available for most of these with only slight mounting differences. For these types of items, maintenance plans should be created that identify the next repair item to purchase when needed. Then, these items can be changed out with new components when needed. It was noticed that the transmitter for the plant flow flume flow meter FIT-460 has issues with the LCD display. Magnitrol no longer makes replacements for this meter and since plant flowrate is used by other processes it should be considered for a near-term replacement.

2.2.4 Influent Pump Station

The instruments, conduit, and associated support elements inside of the influent structure need to be replaced due to corrosion. The area gas transmitter located inside the wet well shows extreme corrosion and the corresponding reading on the panel meter is off, indicating that it has failed (Photos 27, and 28).

2.2.5 Miscellaneous

- It was observed that the electrical equipment, motor control centers, VFDs, control panels, etc, do not have Arc Flash and PPE requirement labels on them. This was an added requirement in the 2008 NEC.
- Many of the flexible conduit connectors show rust, these should be coated with a rust protectant coating (Photo 30).
- Previous upgrade projects resulted in abandoning some components that are still in place. The network radio antenna’s function has been replaced by a new network service to the facility (Photo 31). The new Sodium Hypochlorite tank uses a visual tank measurement, leaving the Milltronics transmitter located in the containment abandoned in place (Photo 32). The sodium bisulfite is metered with manual settings. A Strantrol Dechlor controller that was apparently previously used for metering is de-energized inside of CP1 (Photo 33). There may be other instruments that due to change in process needs have been abandoned in place.

2.3 Corrosion

Overall the WWTP is in relatively good condition from a corrosion standpoint – better condition than most WWTPs of with this number of years in service. The cathodic protection test stations were checked to determine the status of this corrosion protection system for buried pipe. The anodized aluminum handrails, grating, and covers are in very good condition. WWTP staff have done a good job maintaining protective coatings. That stated, there are some corrosion issues that will need corrective action.

2.3.1 Intake Pump Station

The Intake Pump Station (IPS) is exposed to corrosive conditions caused by release of hydrogen sulfide gas. The odor control system removes some of the corrosive atmosphere, but enough hydrogen sulfide remains to cause deterioration of pump station materials over time.

- Concrete. Corrosion of the concrete walls and ceiling has exposed the aggregate. It is estimated that the depth of concrete deterioration is ¾- to 1-inch. No exposed reinforcing steel was observed (Photos 34 and 35).
- Electrical. Electrical and I&C conduit and junction boxes appear to be PVC coated, but these are severely corroded where the PVC coating has deteriorated. These instruments, conduit, and ancillary equipment need to be replaced.
- Pump Guide Rails. The pump guide rails appear to be stainless steel. The rails are in good condition, with some discoloration and minor corrosion in the head space.
- Hatch Covers. The aluminum hatch covers are in good condition.

2.3.2 MCC and Generator Rooms

These facilities are air conditioned and no corrosion issues were observed.

2.3.3 Headworks

The headworks channels and basins are covered and head space air is removed and exchanged with fresh air by an odor control system. A plastic embedded liner ("T-Lock") provides corrosion protection from residual hydrogen sulfide gas. Bar screens are stainless steel.

- Embedded Liner. The embedded liner is generally in good condition (Photo 36). There are several isolated locations in the channels where the liner has failed and concrete is corroding.
  - ✓ Isolated failures were observed at the Parschall Flume (Photo 37).
  - ✓ The embedded liner has failed on a concrete support column in the RAS return basin. It appears that the liner was not completely installed over the cap of the column, and corrosion of the concrete has occurred from the top of the column down, allowing the embedded liner to peel away from the concrete at the corners (Photo 38). The process is turbulent in the RAS return basin, a condition that liberates hydrogen sulfide gas and creates a more corrosive condition.
  - ✓ Liner failure was also observed in the RAS return basin where the embedded liner was terminated next to stainless steel embeds for temporary gates (Photo 39).
- Stainless Steel Bar Screens. The stainless steel bar screens were found to be in good condition.
- Traveling Screen. The traveling screen is fabricated with stainless steel components; no corrosion issues observed.
- Aluminum Channel and Basin Covers. The aluminum covers had a light covering of aluminum corrosion product, a condition normally observed in this application. The covers were in very good condition.
- Gate operator stems and brackets. These appeared to be in good condition.
- Above-Grade Materials, Miscellaneous.
  - ✓ A short section of ductile iron W3 pipe near the traveling screen is not painted (Photo 40).
  - ✓ Moderate corrosion was observed where the pipe was not provided with thermal insulation.
  - ✓ Conduit fittings are corroding.
  - ✓ The painted air intakes for the MCC and generator rooms are in good condition.
  - ✓ A fiberglass box installed to house I&C equipment is starting to deteriorate from UV exposure (Photo 41).
  - ✓ The stainless steel and painted steel electrical enclosures appear to be in good condition.

2.3.4 Odor Control System

- Odor Control Duct.
  - ✓ The stainless steel odor control duct on the top of the headworks appears to be in good condition.
  - ✓ The vertical stainless steel odor control duct has some external staining, and may have some small wall penetrations at a weld due to internal corrosion.
  - ✓ The horizontal stainless steel odor control duct at grade level has numerous pipe wall penetrations due to internal corrosion (Photos 42 and 43). Most, but not all, of the penetrations are at the bottom of the duct.
- Fan. Some surface corrosion was observed on the fan housing.
- Fiberglass Filter Tank. No corrosion issues were observed.

2.3.5 Oxidation Ditches

- No corrosion issues were observed.

2.3.6 Secondary Clarifiers

- The south secondary clarifier was drained and available for visual observation (Photo 44).
- Clarifier Mechanism.
  - ✓ The paint on the secondary clarifier mechanism is maintained on a regular basis by plant staff. There are some areas where minor corrosion is occurring at coating defects (Photo 45). Overall, the paint system is in good condition considering its age.
  - ✓ Carbon steel fasteners on the mechanisms failed and were replaced with stainless steel hardware.
- Concrete.
  - ✓ No corrosion issues observed on submerged concrete or on concrete floor.
  - ✓ Some leaching of the concrete launder has occurred, and some aggregate is exposed (Photo 46). The amount of leaching does not appear to be excessive and is not anticipated to an issue.
- Walkway. The galvanized steel walkway is in good condition.
- Motor and Drive. The paint on the motor and drive is in good condition.
- Fiberglass Weirs and Baffles.
  - ✓ The fiberglass weirs and baffles are in good condition.
  - ✓ Stainless steel hardware is in good condition.
  - ✓ Carbon steel support brackets are corroding (Photo 47).
- Pump Station. Paint on exposed piping and appurtenances appears to be regularly maintained and is in good condition. No corrosion-related issues observed.

2.3.7 Chlorine Contact Basins

- Overflows. The coating on the overflows appears to be in good condition.
- Gate Operator Stems. The gate operator stems are corroding at the water surface.
- Wood Planks. The wood planks above water are showing signs of rot. The condition of the planks below water was not observed.

2.3.8 Chemical Systems

- Hypochlorite.
  - ✓ The original fiberglass hypochlorite tank was replaced with a 6,200 gallon high density polyethylene tank. No corrosion issues were observed on this tank.
  - ✓ Pump Room. No corrosion issues were observed.
- Sodium Bisulfite. No corrosion issues were observed on the tank or in the pump room.

2.3.9 Grit Removal

- Pump and Suction Piping. Some items of the grit removal pump and suction piping on top of the headworks have eroded or corroded and been replaced or repaired by plant staff.

- Grit Room. The grit classifier was replaced about 10 years ago and appears to be in good condition. The grit room is well-ventilated and no corrosion issues were observed.

2.3.10 Belt Press

- Belt Press. The belt press room is well ventilated, and no significant corrosion of exposed metals was observed on the belt press.
- Miscellaneous.
  - ✓ Light Fixtures. The metal housings on the light fixtures are starting to rust.
  - ✓ Steel Door Frame. The base of the steel door frame is corroding.
  - ✓ Platform Columns. The grout used under the base of the aluminum platform columns has deteriorated.
  - ✓ Platforms and Gratings. The aluminum platforms and grating are in good condition.

2.3.11 Blower Room

- No corrosion issues were observed.

2.3.12 Old Wastewater Plant (Aerobic Digesters)

- No corrosion issues were observed.

3. Summary of Recommended Improvements

A summary of recommended improvements is presented herein on a per-facility basis for Mechanical Systems and Corrosion combined within the same subsections. Recommended improvements for Instrumentation and Control are presented separately.

3.1 Mechanical Systems and Corrosion

The following items are recommended for improving plant performance or increasing reliability and reducing maintenance efforts.

3.1.1 Influent Pump Station

A protective coating is recommended for the interior walls and ceiling of the influent pump station. This protective coating is required to mitigate corrosion of the concrete due to hydrogen sulfide gas. A typical corrosion protection coating for this application would include:

- Dewatering and cleaning with high pressure water to remove surface contaminants and loose concrete.
- Abrasive blasting or high-pressure water wash to reach sound concrete.
- Application of cementitious surface restoration product to restore concrete thickness and provide a smooth surface for coating.
- Application of a high performance, high build epoxy coating designed for exposure corrosive conditions associated with hydrogen sulfide gas.

The concrete will continue to deteriorate under the current operating conditions. A protective coating project should be budgeted and scheduled for implementation within the next three to five years.

The electrical and I&C conduit, fittings, and sensors need to be replaced because of corrosion (see Section 3.2, Instrumentation and Control).

In order to accomplish the bypass pumping around this influent pump station, there will have to be a pump around set up for the wetwell. There is a manhole across the drive from the pump station where temporary pumps could draw suction. (Photo 48). The pumps could discharge thru a hose across the drive and then into a rigid pipe to carry the sewage up to the Headworks Building roof, discharging into a headworks open channel. (Photos 49 and 50). This pump around could last for one month in order to accomplish the coatings prep, concrete repair and new coatings process. During this time, access to the plant offices and lab, sludge cake loadout, and the screenings and grit dumpster would have to be maintained. Possibly a lightweight truss bridge could be constructed to carry the temporary pump discharge above truck height across the drive.

This project would require outside consulting services to develop a bidding document to procure a contractor to do this work.

3.1.2 Headworks

The embedded plastic liner needs to be repaired in several areas of the headworks facility. Significant corrosion of the concrete has occurred on the column in the RAS return basin (the last basin of the headworks). These repairs will need to be performed by a specialty contractor. Smaller repair areas on walls will need to be repaired with plastic liner material. The repairs to the column plastic liner can be repaired by restoring the concrete and replacement of the embedded liner or wrapped with carbon fiber.

The repairs to the concrete column should be made within the next two years. It will be necessary to bypass the channels and RAS return basin to make these repairs.

This project would require outside consulting services to develop a bidding document to procure a contractor to do this work. It is assumed that this work would be completed as part of the same construction contract as the Influent Pump Station coating system work.

3.1.3 Odor Control

It may be possible to revise the odor control system to remove more air, increase air changes, and reduce the concentration of hydrogen sulfide gas in the RAS return basin of the Headworks and to the influent pump station. Duct sizes conveying this system should be checked to confirm the ducts are adequately sized. A desktop evaluation of the odor control system would be necessary to assess the potential for improvements. Revising and upgrading the system could reduce corrosion related to hydrogen sulfide.

Some of the WWTP's odor-scrubbed areas do not appear to be experiencing this same hydrogen sulfide corrosion resulting from inadequate air changes and scouring. These areas include: the grit and screenings dumpster room, the screenings channel, and the grit vortex channel.

In addition to modifying the odor control capacity, the odor control duct from the top of the headworks to the filter tank has been penetrated by corrosion and will need to be replaced. At this point, the holes are small. However, they will become larger as corrosion inside the duct continues. The duct should be scheduled for replacement within one to two years. Polymer-lined, stainless steel duct has been used successfully on several recent wastewater treatment plant projects and would be a suitable option for this installation.

3.1.4 Oxidation Ditches

Given the approach WWTP staff undertake during summer to achieve effective sludge oxidation, it appears that oxygen appears to be a limiting factor in the performance and capacity of the oxidation ditches. Given there is no other apparent, current limitation to the WWTP capacity, oxygenation of the sludge appears to potentially be the limiting factor on WWTP capacity. This should be checked to confirm there isn't already a capacity issue that should be addressed. A biological process capacity evaluation is recommended. This is a desktop modeling analysis and should be incorporated into the City's plans within the next 5 years.

As noted earlier, WWTP flows have not risen beyond the levels that trigger an update to the facility planning documents (85% of WWTP capacity per Ecology). But, it is possible that due to reduction in combined storm flows, reduction in infiltration into the sanitary sewer resulting from new and improved sewer piping, and the ever-increasing numbers of low flow and flush fixtures, that the wastewater load (BOD) is increasing. This is likely driving the need to increase oxygenation of the mixed liquor sludge during the summer. If this were determined to be the case, options for increasing oxygenation could be evaluated, which would increase the capacity of the Oxidation Ditches.

3.1.5 Secondary Clarifiers

- The coating on the secondary clarifier mechanisms is over 25 years old. It appears to be in relatively good condition, but epoxy coatings on steel in this environment generally have a service life of 20 to 25 years. Budget for recoating should be set aside for a project to be implemented in the next 5 to 10 years for both of these mechanisms. The actual date for repainting can be determined based on periodic observation of the mechanisms by City staff. There is no need to undertake the recoating until it is determined to be necessary. This project would require outside consulting services to develop a bidding document to procure a contractor to do this work.
- Leaching has occurred on the concrete launders for each of the two secondary clarifiers. It is possible to coat these items with epoxy coating, but it will introduce potential coating maintenance for plant staff. The amount of concrete leaching currently does not warrant installation of a protective coating. However, WWTP staff should monitor and document the pace of corrosion and consider coating the launders in the future if concrete deterioration significantly increases. This project would require outside consulting services to develop a bidding document to procure a contractor to do this work.

- The carbon steel weir support brackets should be replaced with stainless steel. The brackets do not appear to be in imminent risk of failure, so this activity could be scheduled to occur with a mechanism repainting project – in the next 5 to 10 years. This work could be done by City staff.
- Part of a desktop biological process evaluation of the oxidation ditches typically includes a check on secondary clarifier capacity particularly concerning the surface solids loading rate. Often-times the limiting unit process for overall secondary treatment capacity, assuming that you can supply enough oxygen to the biomass, is the ability of the clarifiers to settle the solids from the effluent. Current plant effluent is very high quality. It would be interesting to know in a clarifier study what the maximum mixed liquor concentration could be to the clarifier and still maintain the current effluent quality. This value would translate then back into the pounds of BOD loading that the plant can handle ultimately representing the population that the plant can treat.

3.1.6 Chemical Systems

In reference to the off-gassing issue for the sodium hypochlorite system, the City may feel comfortable with its current strategy to avoid pump-binding, but it may also wish to explore options either internally or as a byproduct of another project at the WWTP.

3.1.7 WAS Blowers

Since the WAS blowers run a significant portion of the day, and have moderate sized motors, they could be good candidates for an energy upgrade project, partially grant-funded by the Washington State Department of Energy Services where an alternate blower would be selected with a greater energy efficiency. Turbo blowers are often touted in the marketplace and indeed are high efficiency machines. There are also hybrid rotary lobes, such as by Aerzen and Kaiser, which are higher efficiency machines than installed now, but they have a greater tolerance for changing discharge pressure resulting from liquid level changes in the sludge storage tanks. The City should consider undertaking an evaluation to assess the need for this replacement and the payback on the investment resulting from lower power cost.

3.1.8 Miscellaneous Corrosion Recommendations

- Some fiberglass enclosures housing various I&C equipment are deteriorating due to UV exposure. The enclosures can be painted to reduce the rate of deterioration and exposure of glass fibers. The procedure would consist of cleaning with biodegradable detergent, light sanding to remove exposed fibers, and painting with two coats of a high-quality latex paint.
- The short section of W3 pipe on the headworks roof that is not insulated should be painted with epoxy.
- The aluminum light standards are in very good condition, but it was noted that screws on the electrical covers are either galvanized or carbon steel. They should be replaced with stainless steel.

3.2 Instrumentation and Control

Recommended improvements, upgrades, and replacements to the instrumentation and control system are presented herein.

3.2.1 Influent Pump Station

Coordinated with the work to recondition the influent wet well, several instruments need to be replaced because of their corroded condition. These include:

- Replace the existing LE & LIT-210 Wet Well Level instrument with a single-sealed unit appropriate for these conditions. An appropriate unit would be Vega's VegaPULS WL61. This replacement would include, as a byproduct, a HART analog Intrinsic Safety Barrier which will allow remote connection and troubleshooting of this new unit.

- Replace the existing LSH & LSL-210 Wet Well low and high-level float switches with new float switches and Intrinsic Safety Barriers, including new 316L stainless steel mounting pole.
- Replace the existing AE & AIT-240 Wet Well Explosive Gas Sensor instrument with a new remote sensor that includes a sample draw system that returns the sample to the wet well. This is typical of current wet well design.
- Replace all conduit inside the wet well, and extending into the buried condition, as applicable, with a new system that includes a handhole outside the pump station where a sealed transition can be made to protected cables (suitable for the wet well environment).

3.2.2 SCADA Programmable Logic Controller (PLC)

The WWTP has an Allen-Bradley PLC5 based control system with a redundant, backup controller and three I/O panels. The PLC5 series of processors and the redundancy module are obsolete as of 2011 with the ControlLogix family of processors identified as their replacement. Allen-Bradley has a migration plan for this upgrade to the ControlLogix family that includes parts to minimize the rewiring of the Input and Output (I/O) modules. Using these will reduce costs and minimize the control system downtime.

An Ethernet Device Level Ring network would replace the Data Highway Plus RemoteIO network that currently connects the three control panel I/O racks together. The Ethernet Device Level Ring network will provide communication path redundancy if there was a problem with one cable segment.

Sequencing of tasks can be done to reduce down times but require multiple control system outages of affected equipment. Manual control of the WWTP would be implemented during these control system outages. These outages would be up to 8 hours duration. Alternatively, a single longer outage maybe possible if the migration adaptor plates that Allen-Bradley offers fit into the existing enclosures.

Prior to undertaking detailed design of this PLC replacement, a preliminary design would be necessary to plan how this work would be implemented. This same preliminary design would enable planning of the other improvements and replacements identified in this section (UPS replacement, VFP replacement, and other minor instrument replacements). The preliminary design to determine project sequencing, phasing, prioritization, and would identify what activities need to be designed by consultant support and what could be accomplished by City staff.

3.2.3 Uninterruptible Power Supplies (UPSs)

Each of the three control panels are equipped with a UPS. Each of these UPSs should be replaced because they are obsolete. Falcon UPS has a UL508 approved UPS designed for critical industrial applications. Their 1.5 KVA unit and maintenance bypass switch would be a good fit for these three systems.

3.2.4 Variable Frequency Drive Replacement

There are seven variable frequency AC drives (VFD) in the plant that are part of the 1990s secondary WWTP upgrade. They are Reliance Electric drives. Reliance Electric was purchased by Allen-Bradley in 1996. These VFDs are installed in large stand-along enclosures. The existing VFDs are Reliance Electric GP-2000 A-C VS Drives with Control Signal Buffer Kits. These components are obsolete and no longer supported. The seven VFDs control the following pump systems.

- Three Influent Pumps – 35 HP
- Three RAS Pumps – 7.5 HP
- One Belt Press Feed Pump – 10 HP

There are two approaches that should be evaluated: (1) retrofit existing enclosures with new VFD and auxiliary components, (2) or replace the entire cabinet with a wall-mounted VFD enclosure.

3.2.5 Flow Meter

The WWTP flow meter, FIT-460 (flume flow meter), needs to be replaced, as it is obsolete and has a broken faceplate. There are several meter alternatives that could be considered. One of note would be using the same instrument that is chosen to replace the influent wet well level transmitter. As an example, the VegaPULS WL61 is well suited for the influent wet well and when combined with the VegaMET creates an instrument that calculates flume or weir flows.

3.2.6 Arc Flash

An Arc Flash Study and hazard identification is required to be completed for the electrical infrastructure at the WWTP. This activity would result in a report and arc flash warning labels for applicable equipment. These Arc Flash requirements are outlined in section 110.16 of the 2017 National Electrical Code (NEC).

4. Summary of Estimated Costs

A summary of estimated initial capital costs for the recommended improvements presented in Section 3 is presented herein on a per-facility basis for Mechanical Systems and Corrosion. Refer to Table 1 below. A summary of estimated costs for the recommended improvements for Instrumentation and Control are presented separately. Refer to Table 2 below.

The estimated initial capital costs presented herein are intended to be used by City for budgeting purposes. Some of the estimated costs are based on undertaking equipment and/or instrument replacement by City staff. Other estimated costs are based on consultant assistance for planning, design, and construction support, in addition to construction costs. These estimated initial capital costs were developed to the “concept level” or “Class 5” level of accuracy as defined by the Association for the Advancement of Cost Engineering International (AACEI). This level of cost estimating is considered accurate to +100/-50 percent.

The estimated costs were prepared based on information available at the time of the estimate. The final cost of the project will depend upon the actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. The purpose of these estimates is to make the best decisions regarding capital expenditures and to provide concept-level guidance for budgeting implementation of mitigation improvements. As a result, the final project costs for each alternative will vary from the estimates presented herein. Because of this variation, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions.

Table 1. Summary of Estimated Costs for Mechanical and Corrosion Improvements

Item No.	Name	Described in Section	Estimated Cost	Comments
1	New Influent PS Coating System	3.1.1	$225,000	High priority – complete in next 2 years.
2	Headworks Plastic Liner Repair	3.1.2	$150,000	High priority – complete in next 2 years. Estimated cost assumes completing this work as part of the Influent PS Coating work.
3	Odor Control System Evaluation	3.1.3	$30,000	High priority – complete in next 2 years.
4	Odor Control System Duct Repair	3.1.3	$20,000	High priority – complete in next 2 years. This can be completed by City staff directly contacting specialty contractor.
5	Oxidation Ditch Capacity Evaluation	3.1.4	$50,000	Medium priority – compete in next 5 years.
6	Secondary Clarifier Mechanism Recoating	3.1.5	$250,000	Medium priority – complete in next 5 to 10 years.
7	Concrete Launder Coating	3.1.5	$75,000	Medium priority – monitor and complete as needed. Combine with secondary clarifier mechanism recoating.
8	Replace Carbon Steel Weir Supports	3.1.5	$20,000	Medium priority – replace in next 5 to 10 years. Combine with secondary clarifier mechanism recoating.
9	Secondary Clarifier Capacity Evaluation	3.1.5	Included in Item 5	Complete as part of Item 5, Oxidation Ditch Capacity Evaluation
10	Sodium Hypochlorite Off-Gassing	3.1.6	Low – use O&M budget	Low priority – complete if deemed necessary with City staff or as part of another capital project at the WWTP.
11	WAS Blower Evaluation	3.1.7	$20,000	Medium priority – complete when blowers begin to reach their anticipated useful life (next 5 to 10 years).
12	FRP Enclosures of I&C Equipment	3.1.8	Low – use O&M budget	Low priority – complete as desired or contemplate replacement.

13	W3 Pipe on Headworks Roof	3.1.8	Low – use O&M budget	Low priority – complete as desired or contemplate replacement.
14	Screws on Electrical Covers of Aluminum Light Standards	3.1.8	Low – use O&M budget	Low priority – complete when convenient.

Table 2. Summary of Estimated Costs for Instrumentation and Control Improvements

Item No.	Name	Described in Section	Estimated Cost	Comments
1	Influent PS Instrument Replacement	3.2.1	$50,000	High priority – complete within the next 2 years as part of the coating system.
2	PLC Replacement	3.2.2	$450,000	High priority – complete within the next 3 years. This estimate includes predesign, design, installation, equipment, programming, and testing.
3	UPS Replacement	3.2.3	$10,000	This cost is for the equipment, only. Complete this work as part of the PLC replacement project.
4	VFD Replacement	3.2.4	$75,000	High priority – this work needs to be done within the next year because of lack of spare parts and failure experience. This estimate is based on direct contact by City to Rockwell Industrial Engineering Services to rebuild existing VFDs and provide warranty.
5	Flow Meter	3.2.5	$10,000	High priority – complete in next 1 to 2 years. This can be done by City staff.
6	Arc Flash	3.2.6	$30,000	High priority – complete within the next year. This is as safety and code-compliance issue.

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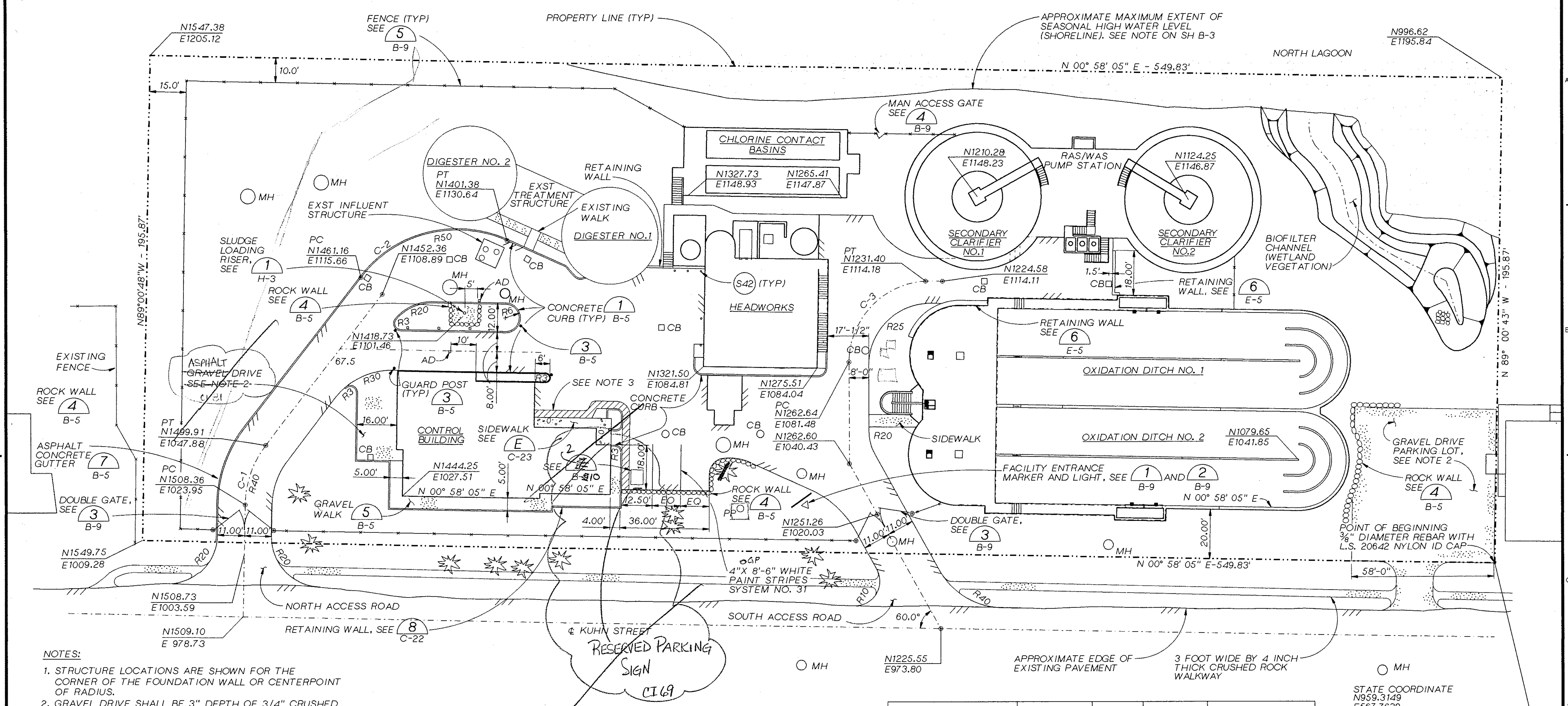
Appendix A. Site Plan



NOTES:

1. STRUCTURE LOCATIONS ARE SHOWN FOR THE CORNER OF THE FOUNDATION WALL OR CENTERPOINT OF RADIUS.
2. GRAVEL DRIVE SHALL BE 3" DEPTH OF 3/4" CRUSHED ROCK, SPECIFIED AS GRANULAR PIPE BASE IN SECTION EARTHWORK, OVER 7" DEPTH COMPACTED CRUSHED SURFACING BASECOURSE.
3. ~~THREE-FOOT WIDE~~ 44" HANDICAPPED ACCESS ROUTE. MARK WITH 4" WHITE SYSTEM NO. 31 PAINT STRIPES.
4. FOR CONTRACTOR'S STAGING AREA, SEE THE SPECIFICATIONS. CI69

C-1 CURVE DATA	C-2 CURVE DATA	C-3 CURVE DATA
Δ=37°	Δ=75.92	Δ=89.35
L=25.83	L=66.25'	L=49.81'
T=12.55'	T=39.07'	T=33.02'

LEGEND

- PCC PAVEMENT AND SIDEWALKS
- ASPHALT CONCRETE PAVEMENT, SEE 4 B-4
- CRUSHED ROCK SURFACE, SEE 5 B-5 (SIM)
- ROCK WALL, SEE 4 B-5

PLAN
1"= 20'

STRUCTURE	OCCUPANCY	AREA (SQ FT)	STORIES	NO. OF OCCUPANT LOAD
CONTROL BUILDING	B-2	4367	2	22
HEADWORKS/ CARBON TOWER/ HYPOCHLORITE TANK	B4/M2/H2	4685	2 + BASEMENT	2
CHLORINE CONTACT BASINS	M-2	1620	BASEMENT	--
SECONDARY CLARIFIER/ PUMP ROOM	M2/B4	3725	1	--
OXIDATION DITCH	M2	13920	1	--

BRIAN J. ELS, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER 25356

CH2M HILL

DSGN J. IRISH
DR P. BAKER
CHK R. FARRELL
APVD D. PETERSON

NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CITY OF PORT TOWNSEND
WASTEWATER TREATMENT PLANT
JEFFERSON COUNTY, WASHINGTON

SITEWORK/CIVIL
SITE PLAN

SHEET B-2
DWG NO. 9 OF 158
DATE NOV 1991
PROJ NO. SEA22388.RD

Appendix B. Photos

Photo 1: Oxidation Ditch Influent/RAS Splitter Box

Photo 2: Bar Screen in Channel

Photo 3: Bar Screen Enclosure and Compactor

Photo 4: Manual Bar Rack

Photo 5: Pista Grit Drive Mechanism and Rebuilt Vortex Separator

Photo 6: End of Screenings Compactor Tube and Odor Control Drawoff for Screenings and Grit Room

Photo 7: Odor Control Fan

Photo 8: Carbon Vessel

Photo 9: Oxidation Ditches

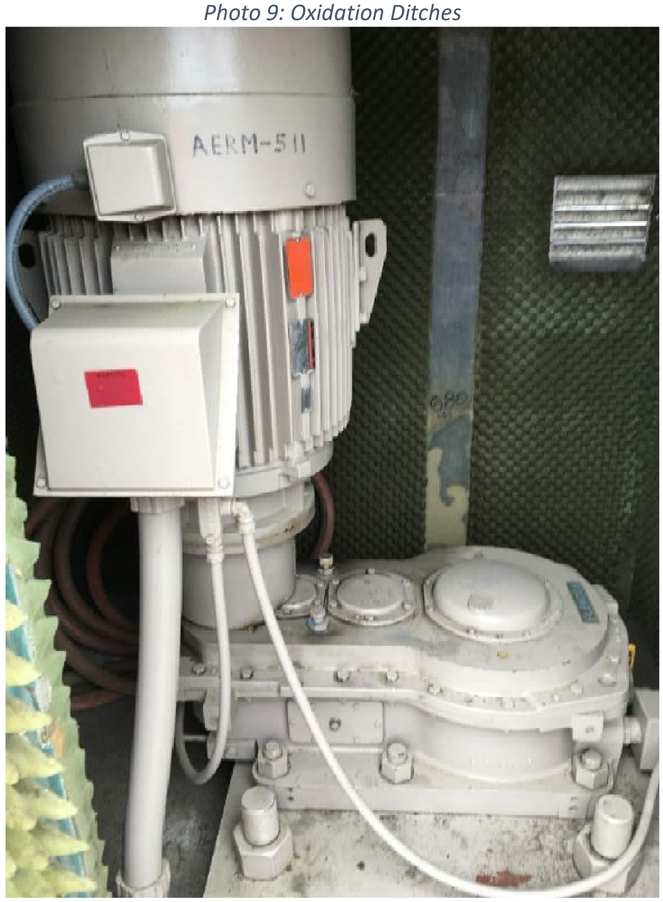


Photo 10: Paddle Aerator Drive

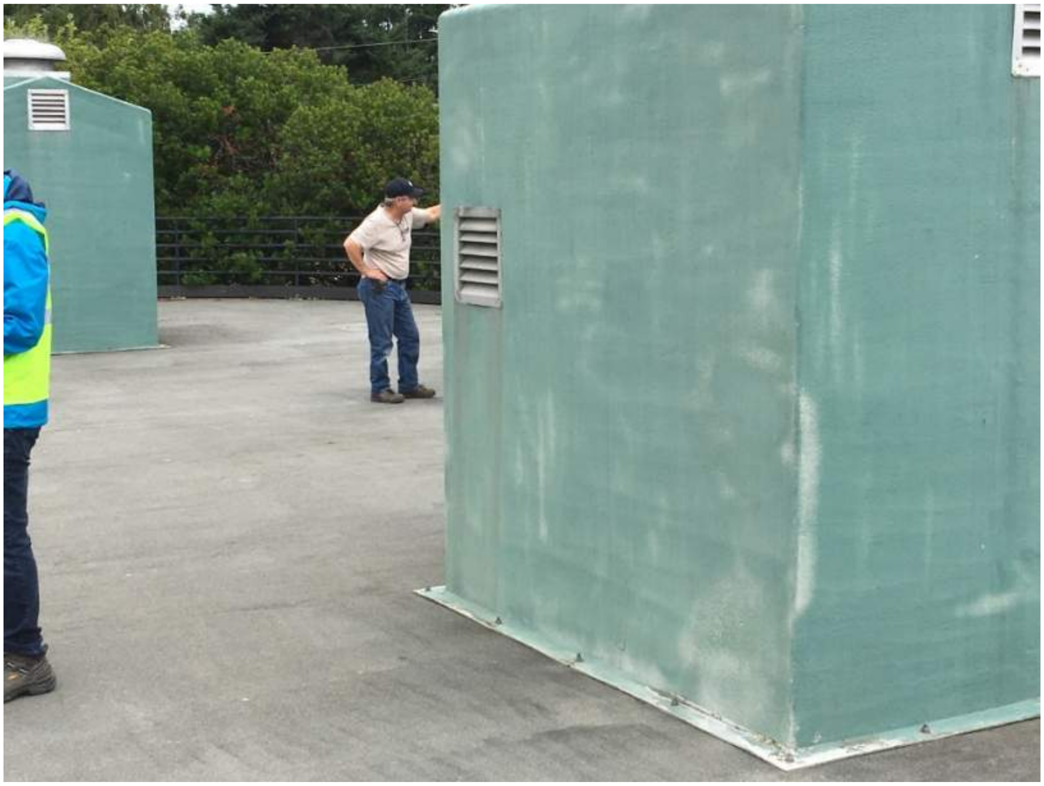


Photo 11: Paddle Drive Enclosures

Photo 12: Secondary Clarifier

Photo 13: Clarifier Drive Mechanism

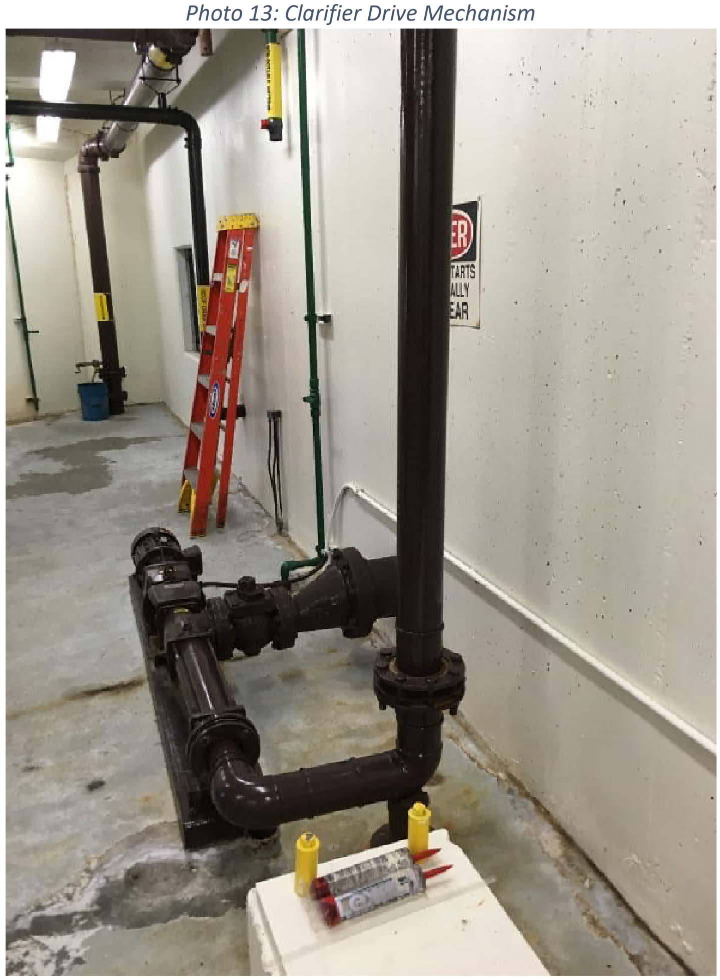


Photo 14: Secondary Scum Pump in RAS/WAS Pump Room

Photo 15: Chlorine Contact Basin

Photo 16: W3 pump and Effluent Sampler

Photo 17: Hypochlorite Metering Pump

Photo 18: WAS Aerobic Digester

Photo 19: Belt Press Feed Pump

Photo 20: Aerobic Digester Blowers

Photo 21: Belt Press

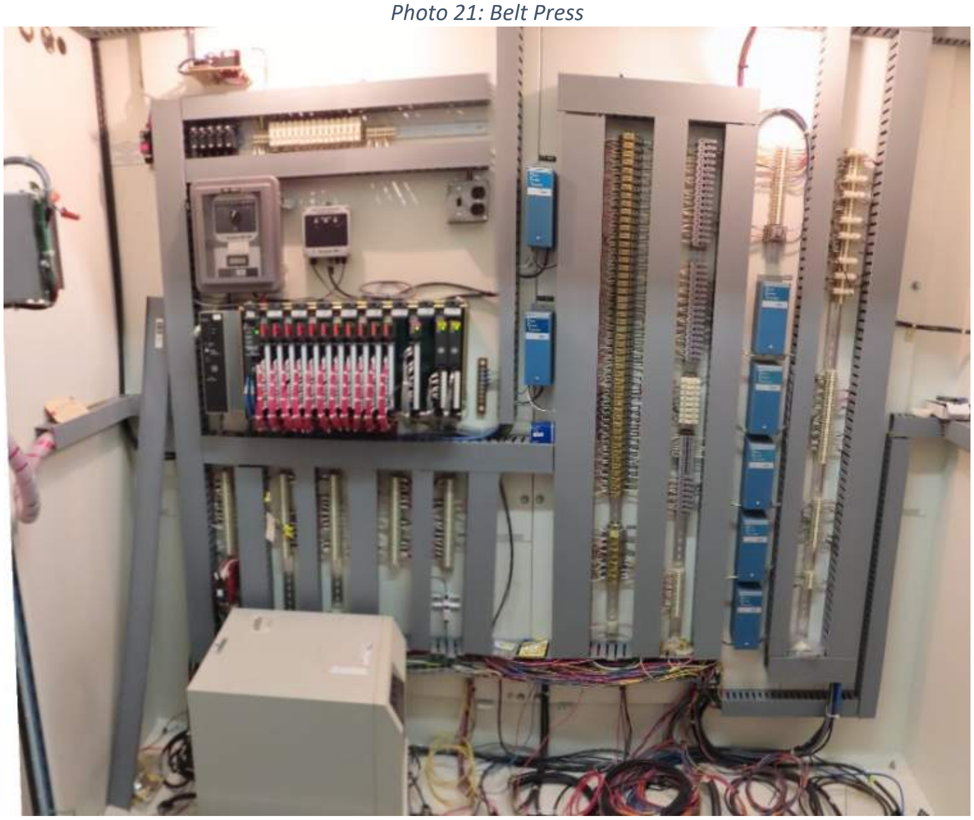


Photo 22. Equipment is clean and in good working conditions

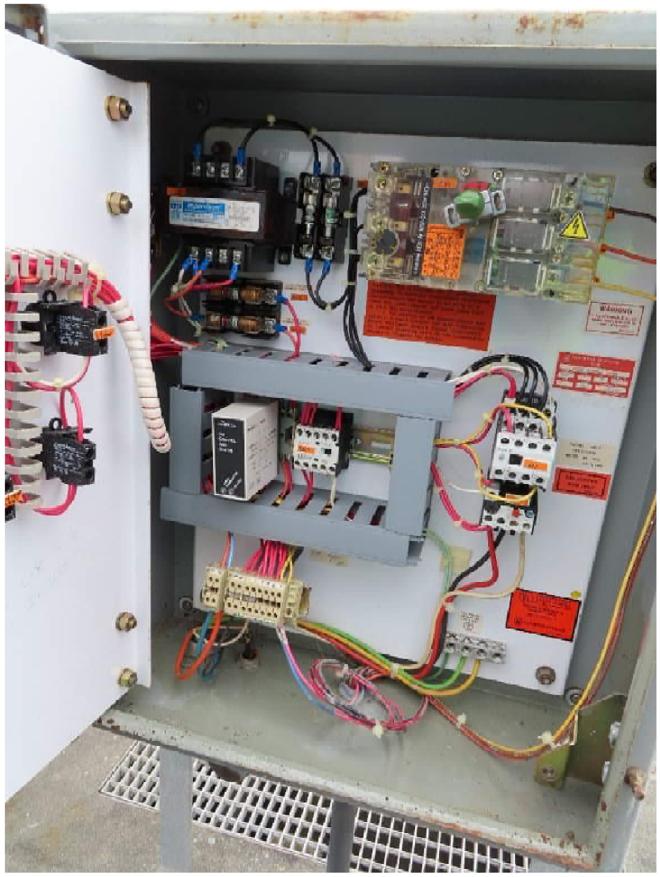


Photo 13. Control panels are clean and in good conditions

Photo 24. Conditions of PLC

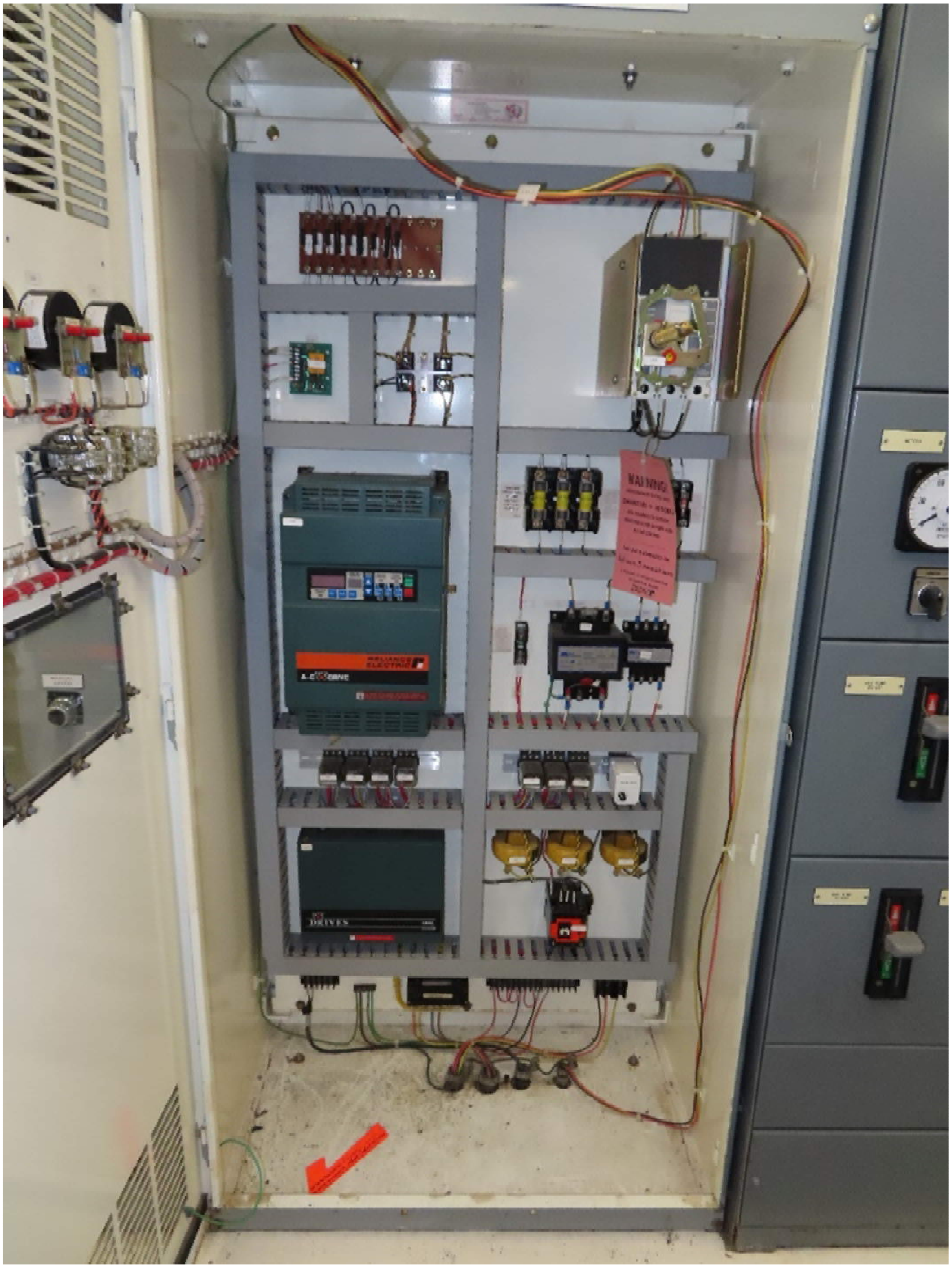


Photo 25. Conditions of VFD

Photo 26. Conditions of UPS

Photo 27. Gas transmitter experiences extreme corrosion

Photo 28. Gas transmitter experiences extreme corrosion

Photo 29. Corrosion of conduits and enclosures located outside

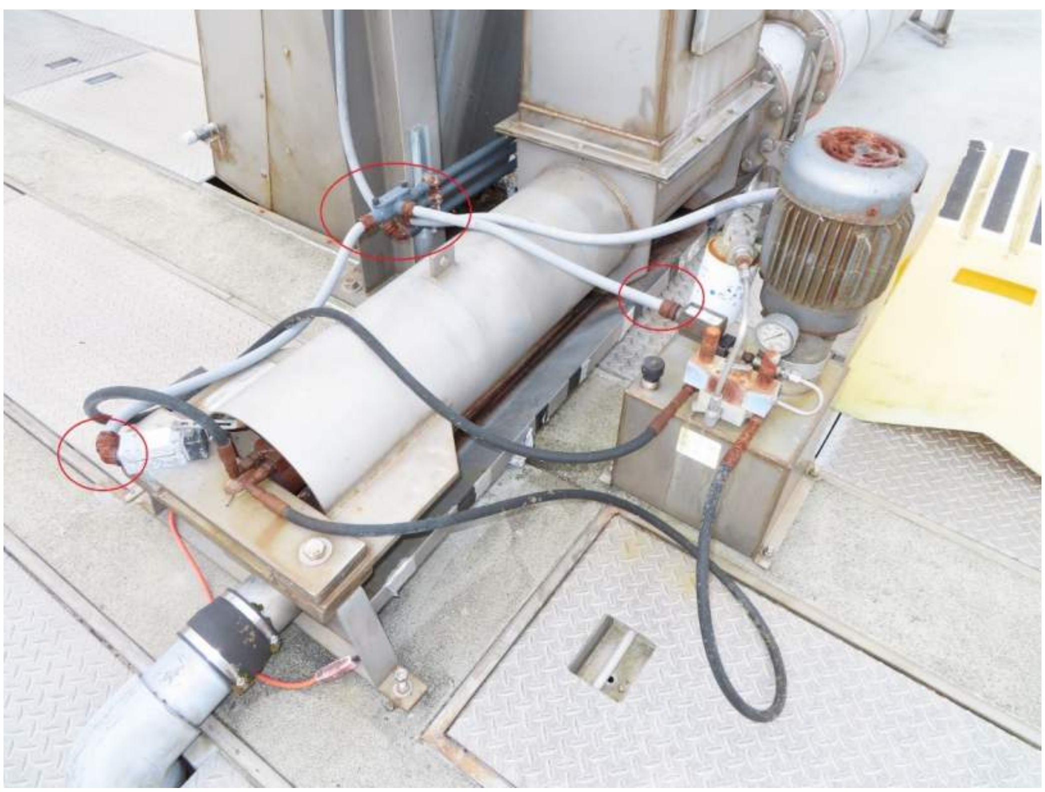


Photo 30. Rusting of flexible conduit connectors

Photo 31. Abandoned network radio antenna

Photo 32. Abandoned the Milltronics transmitter

Photo 33. Deenergized Strantrol Dechlor controller

Photo 34. Influent Pump Station, Port Townsend wastewater treatment plant.

Photo 35. Deteriorated concrete and electrical components, influent wet well. Aluminum covers and stainless steel embeds are in good condition.

Photo 36. Traveling screen and embedded plastic liner in good condition.

Photo 37. Concrete is corroding at base of Parschall Flume where embedded liner is ineffective (arrow).

Photo 38. Embedded liner pulling from concrete at temporary gate groove, RAS return basin.

Photo 39. Failure of embedded liner on corners of concrete support column, RAS return basin.

Photo 40. W3 line corroding wher it is not insulated. Not corrosion on conduit fittings (typical)

Photo 41. Fiberglass box housing instrument panel, subject to UV deterioration (east side of headworks).

Photo 42. Rust staining on concrete floor under stainless steel odor control duct with penetrations caused by internal corrosion.

Photo 43. Typical penetrations in stainless steel odor control duct caused by internal corrosion.

Photo 44. South secondary clarifier, empty at the time of inspection.

Photo 45. Clarifier mechanism rake arm and well. Note coating deterioration on top of well angle (red primer is showing). Some corrosion is occurring on rake arms where coating has failed.

Photo 46. Exposed aggregate in launder, north secondary clarifier.

Photo 47. Corroding carbon steel baffle support bracket, north secondary clarifier.

Photo 48: Potential Influent Pump Station Pump Around Manhole

Photo 49: Influent Pump Station Pump Around Discharge to Pass Over Building Parapet

Photo 50: Route of Pump Around Over Parapet to Channel Upstream of Bar Screen and Odor Control Duct Down to Influent Pump Station.

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Appendix M

City Resolutions and Ordinances

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Chapter 13.21
SEWER SYSTEM - GENERAL PROVISIONS

Sections:

13.21.010 Purpose.

13.21.020 Inspections – Right of entry.

13.21.030 Emergency interruption of service.

13.21.040 City not liable for damages.

13.21.050 Refusal, limitation, or discontinuance of service.

13.21.060 Unlawful acts defined.

13.21.070 Violations – Penalties – Chapter 1.20 PTMC applicable.

13.21.010 Purpose.

A. The purpose of Chapters 13.21 through 13.24 PTMC (hereinafter this "sewer code") is to promote the public health, safety, and general welfare of the users of the Port Townsend sewer system, in accordance with standards established by the city, state and federal laws and regulations. In furtherance of this purpose, the following rates and regulations are established for the service, extension and management of the city's sewer system.

B. Chapter 13.01 PTMC contains definitions and provisions related to engineering design standards manual, administration and enforcement, compliance with federal, state and local requirements, permit requirements, inspection requirements, performance bond requirements, appeals, waivers and variances which are considered part of this sewer code. (Ord. 2579 § 1, 1997).

13.21.020 Inspections – Right of entry.

Any person applying for a service connection to the city's sewer system shall be deemed to have freely and voluntarily consented to entry by authorized city employees, at reasonable hours of the day and upon advance notice to the occupant, onto all parts of the premises or within buildings for the purpose of inspecting the sewer system construction and/or checking conformity to these regulations and the city engineering design standards manual. All other right of entry by city employees shall be governed by the procedures of Chapter 1.20 PTMC. (Ord. 2952 § 1, 2008; Ord. 2579 § 1, 1997).

13.21.030 Emergency interruption of service.

In case of emergency, or whenever the public health or safety so demands, the director may authorize the department to change, reduce or limit the time for, or temporarily discontinue sewer service. Sewer service may be temporarily interrupted for purposes of making repairs, extension or doing other necessary work, or due to sewer main breaks. Before so changing, reducing, limiting or interrupting the use of the sewer system, the department shall, insofar as is possible or practical, notify all sewer customers affected. (Ord. 2579 § 1, 1997).

13.21.040 City not liable for damages.

A. City Nonliability. The city shall not be liable for damages nor will allowances be made for loss of production, sales or service if the city's wastewater system changes, fails or is curtailed, suspended, interrupted or interfered with, or for any cause reasonably beyond its control. Such failure, curtailment, suspension, interruption or interference shall not be held to constitute a breach of contract on the part of the city, or in any way affect any liability for payment for wastewater made available or for money due on or before the date of such occurrence. The customer shall notify the public works department as soon as possible in the event of any such occurrence.

B. Pipes and Equipment on Customer's Premises. In accordance with Chapter 13.23 PTMC, all city pipes and equipment shall be located in the public right-of-way. In the event that city pipes and equipment are located on the customer's premises, the customer agrees, as a condition of service, not to make a claim against nor sue the city for any damages due to leakage and shall hold the city harmless from any and all claims and litigation which allege damages resulting from leakage occurring at such pipes and/or equipment. (Ord. 2579 § 1, 1997).

13.21.050 Refusal, limitation, or discontinuance of service.
A. The city may refuse or discontinue sewer service to any customer through shut-off of water service for violation of any provision of the sewer code or for failure to pay bills when due.

B. The city may refuse service or require pretreatment to any customer who requests to discharge or discharges deleterious or high strength wastewater that impairs or could impair the integrity, operation or performance of the system or consumes a large portion of the capacity of the system.

C. The city may discontinue service to any customer who makes an unauthorized connection to the city's sewer system, bypasses a wastewater meter, or in any way misappropriates use of the city sewer system.

D. Discontinuance of service for any cause stated in this title shall not release the customer from their obligation to the city for the payment of bills or charges. (Ord. 2579 § 1, 1997).

13.21.060 Unlawful acts defined.
A. It shall be unlawful for any person to make an unauthorized connection to the city's sewer system.

B. Any person causing damage to any property belonging to the department shall be liable for any and all damages resulting either directly or indirectly therefrom.

C. It is unlawful for any person to willfully disturb, break, deface, damage or trespass upon any property belonging to or connected with the sewer system of the city, in any manner whatsoever.

D. It is unlawful to deposit any salt water, toxic, potentially hazardous or other material that may cause interference or inhibit the normal metabolic function of an aerobic biological waste treatment system, or the biosolids composting facility or which may be limiting or in any way harmful to plant personnel, or which may result in the city's treated effluent or biosolids exceeding its NPDES limitations including but not limited to the prohibitions identified in the city's permit with the Department of Ecology as follows:

1. Pollutants that create a fire or explosion hazard in the treatment facility (including, but not limited to, waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or

60 degrees centigrade using the test methods specified in 40 CFR 261.21);

2. Pollutants that will cause a hazard to personnel or equipment or corrosive structural damage to the sewer collection system and treatment facility, but in no case discharges with pH lower than 5.5 standard units or higher than 8.5 standard units;

3. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the treatment facility or biosolids composting facility;

4. Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the treatment facility or biosolids composting facility;

5. Heat in amounts that will inhibit biological activity in the treatment facility resulting in interference, but in no case heat in such quantities such that the temperature at the treatment facility exceeds 40 degrees centigrade (104 degrees Fahrenheit);

6. Petroleum oil, nonbiodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through;

7. Pollutants which result in the presence of toxic gases, vapors, or fumes within the treatment facility and/or wastewater collection system in a quantity which may cause acute worker health and safety problems;

8. Any trucked or hauled pollutants, except at discharge points designated by the city;

9. Any water or waste which contains more than 100 parts per million by weight of fat, oil or grease;

10. Any garbage that has not been properly shredded as herein defined; or

11. Any noxious or malodorous gas or substance capable of creating a public nuisance.

E. It is unlawful for any person to place, deposit, or permit to be discharged in any unsanitary manner upon public or private property within the city or in any area under the jurisdiction of the city, any human or animal excrement, garbage or other objectionable waste.

F. It is unlawful to divert or cause to be diverted any stormwater, surface runoff or underground drainage to any sewer, maintenance hole or other appurtenant structure or portion of the sewer system.

G. It is unlawful for any person to refuse or fail to comply with any provision of this sewer code or the city engineering design standards manual. (Ord. 2579 § 1, 1997).

13.21.070 Violations – Penalties – Chapter 1.20 PTMC applicable.
A. Director's Authority. Whenever the public works director or his or her designee ("director") determines that a condition exists in violation of this chapter or any standard required to be

adhered to by this chapter, or in violation of any permit issued hereunder, he or she is authorized to enforce the provisions of this chapter.

B. Chapter 1.20 PTMC Applicable. All violations of any provision of this chapter or incorporated standards, or of any permit or license issued hereunder, are declared nuisances and made subject to the administration and enforcement provisions of Chapter 1.20 PTMC, including any amendments, and including but not limited to abatement, criminal penalty, and civil penalty as set forth in Chapter 1.20 PTMC, which are incorporated by reference as if set forth herein. (Ord. 2952 § 3, 2008; Ord. 2579 § 1, 1997).

Chapter 13.22
SEWER CONNECTIONS

Sections:

13.22.010 General requirements.

13.22.020 On-site septic system to comply with city, county and state regulations.

13.22.030 Application for sewer service – Payment of fees.

13.22.040 Service connections – Specific requirements.

13.22.050 Main extensions, replacements, pump stations and other system improvements required.

13.22.060 Service connection sizing – Other requirements.

13.22.070 City and customer responsibilities.

13.22.080 Use of the service.

13.22.090 Temporary connections for construction and other uses.

13.22.100 Transfer of sewer taps not allowed.

13.22.010 General requirements.

A. All new development must connect to the city’s wastewater collection and treatment system when the development is located within 260 feet of a wastewater collection line, measured from the nearest portion of the subject parcel; provided, however, that accessory dwelling units within the city approved pursuant to PTMC 17.16.020 are not required to separately connect to the city’s wastewater system, and may connect through the primary residence located on the property.

B. All new development that is subject to one or more of the following approvals must connect to the city’s wastewater collection and treatment system, regardless of its location:

1. Subdivision, short subdivision and planned unit development (PUD) approvals subject to the subdivision ordinance, PTMC Title 18;

2. Land use or building permit approvals subject to review and threshold determination under the State Environmental Policy Act implementing ordinance, Chapter 19.04 PTMC; and

3. Land use or building permit approvals subject to the permit requirements of the critical areas ordinance, Chapter 19.05 PTMC.

4. Exceptions. New single-family residences located at a distance greater than 260 feet from an existing wastewater collection line that are subject to review under Chapter 19.05 PTMC (Critical Areas), are exempt from this section; provided, that the impacts of the on-site wastewater disposal system are adequately mitigated and conditioned through critical area review.

C. New development which is not required to connect to the city's wastewater collection and treatment system under subsections A and B of this section, or because a waiver has been granted, may install an individual on-site septic system; provided, that the following conditions are met:

1. The on-site septic system meets Jefferson County health department requirements and is approved by the Jefferson County environmental health department;

2. The system is designed to be efficiently converted to the city's sewer system; and

3. The developer enters into a "no-protest" agreement with the city requiring connection to the city's sewer system within two year(s) of when a sewer main is within 260 feet of the property line, and/or participation in a local improvement district ("LID") which may include installation of sewer mains, interceptors, pump stations and/or latecomer agreement paybacks, all to be filed on record title, as a condition of any building or development permit.

D. Existing development containing an on-site septic system will be required to connect to the city's sewer system within two years of notification by the city that a sewer main is located or extended to within 260 feet of the nearest portion of the subject parcel.

E. Notwithstanding any requirements or exceptions stated in this section, if an on-site septic system fails, connection is required unless the nearest portion of the subject parcel is greater than 260 feet from the nearest sewer main, in which case the septic system may be repaired to serve the subject property; provided it can be upgraded to Jefferson County health department requirements. (Ord. 2736 § 2, 2000; Ord. 2659 § 2, 1998; Ord. 2579 § 1, 1997).

13.22.020 On-site septic system to comply with city, county and state regulations.

A. When on-site septic systems are allowed as defined in PTMC 13.22.010, the type, capacities, location and layout of the system shall comply with all recommendations and regulations of the Jefferson County environmental health department, the Washington State Department of Health, or other state regulatory agency, and with the regulations of the city. No septic tank or cesspool shall be permitted to discharge to any public sewer or natural outlet or to ground surface. The owner shall operate and maintain the private wastewater disposal facilities in a sanitary manner at all times at no expense to the city.

B. On-site septic systems shall be inspected and pumped periodically, and in no case less than once every five years.

C. When an on-site system is abandoned, the property owner shall pump out the tank and fill it with sand or other appropriate materials and provide documentation to the Port Townsend public works department that the system has been properly abandoned. Abandonment of on-site systems shall comply with all Jefferson County health department requirements. (Ord. 2736 § 3, 2000; Ord. 2579 § 1, 1997).

13.22.030 Application for sewer service – Payment of fees.
A. It shall be unlawful for any person to make any connection with any sewer main or side sewer without complying with the provisions of this chapter and having first received an approved utility development permit as identified in Chapter 13.01 PTMC for sewer service from the public works department and paying all applicable fees and charges as identified in Chapter 13.05 PTMC and council resolution.

B. Sewer Service Application Required. An application shall be made for sewer service to any premises, or for a change in use of a premises or for a temporary connection.

C. Form of Application. All applications for sewer service shall be submitted to the city department identified in the engineering design standards manual on forms provided by the city. Information required for the sewer service application shall include:

1. The name of the owner or agent and his or her mailing address, the street address or name of the premises to be served, and the legal description of the premises to be served.

2. The type of development proposed and the number of living units and/or the type of activity that will occur within the premises to be served.

3. A site plan showing the proposed location of the service connection.

4. Upon request by the director and in accordance with the engineering design standards manual, a hydraulic analysis and assessment of the ability of the collection system and treatment facilities to handle the wastewater discharges and mitigation measures if the assessment shows that the city system does not have sufficient capacity.

5. Pretreatment facilities and best management practices to be used for commercial and industrial services.

6. The design drawings and specifications of the sewer system improvements required under Chapter 13.23 PTMC.

7. Any other information deemed reasonably necessary by the director for action upon the application, or required by other provisions of the sewer code, SEPA, the critical areas ordinance or other city ordinance.

D. Complete Application Required. The city will not process any application unless and until the information required by subsections B and C of this section is substantially complete. The public works director may reject an application as incomplete within a reasonable time of review, in which case the director shall return it to the applicant with an indication of the additional information needed to make the application complete.

E. Payment of Fees and Charges Required. All fees and charges shall be paid at the time of building permit approval except as otherwise noted in this code. The fees for service connections are as established in the schedule of fees and charges set out by council resolution.

F. Contract With the City. The approved application shall constitute a contract whereby the applicant agrees as a condition of sewer service to comply with the rules and regulations of this chapter and the engineering design standards manual.

G. Approved permits must be posted at all times during the performance of the work, and until completion thereof in some conspicuous place at or near the work and must be readily and safely accessible to city staff. (Ord. 3051 § 1 (Exh. A), 2010; Ord. 2579 § 1, 1997).

13.22.040 Service connections – Specific requirements.
A. Initial service connections shall be installed at the expense of the property owner.

B. Each served premises must have a separate connection to a main, except two adjacent single-family residential units may have a single connection in accordance with the requirements specified in the engineering design standards manual. In no case shall more than two single-family residential units be served by a single connection to a main.

C. When buildings are replaced by new buildings, the existing sewer service connection may be used unless determined by the director to be unacceptable due to size, condition or materials of construction, in which case the customer shall be required to install a new sewer service connection and pay all applicable fees and charges in accordance with Chapter 13.05 PTMC and council resolution. (Ord. 3051 § 1 (Exh. A), 2010; Ord. 2579 § 1, 1997).

13.22.050 Main extensions, replacements, pump stations and other system improvements required.
A sewer main extension, main replacement, pump station and/or other system improvements may be required as further set forth in Chapter 13.23 PTMC. (Ord. 2579 § 1, 1997).

13.22.060 Service connection sizing – Other requirements.
A. Sizing. The size of service connection to the premises served shall be based on the Uniform Plumbing Code (as adopted by the city in Chapter 16.04 PTMC) and the engineering design standards manual, using the information supplied in the application for service in PTMC 13.22.020.

B. Change in Use. A change in use may require a new service connection or other sewer system requirements, as determined by the director, and fees and charges shall be paid as set forth in Chapter 13.05 PTMC and council resolution.

C. Backflow Valves. The public works director may require a customer to install a backflow valve on the sewer service connection to prevent wastewater from moving from the sewer main to the premises.

D. Other Regulatory Approval. The director may require the applicant to obtain approval to discharge to the city's system from the Department of Ecology Pretreatment Program when the type of activity at the proposed location is a commercial or industrial service. (Ord. 3051 § 1 (Exh. A), 2010; Ord. 2579 § 1, 1997).

13.22.070 City and customer responsibilities.
A. City Responsibility. The city shall own all sewer mains, pump stations and appurtenances in public streets or utility rights-of-way or easements to the property owner's side of the sewer main.

B. Customer Responsibility. The ownership and responsibility for the maintenance of individual service pipe extensions from the main to the premises served shall be that of the owner of the premises served and the city shall not be liable for any part thereof. (Ord. 2579 § 1, 1997).

13.22.080 Use of the service.
The service shall be considered to be in use when both a sewer service connection is made and the water meter is placed by city crews. Monthly billings for sewer service shall begin when the service is considered to be in use. (Ord. 2579 § 1, 1997).

13.22.090 Temporary connections for construction and other uses.
A. Application – Conditions. Sewer service may be supplied to a premises on a temporary basis. Application for temporary service shall only be approved by the public works director and upon payment of all fees and assessments required by council resolution. The application shall state fully the circumstances which require service by temporary means, and the duration for which temporary service is necessary. All costs necessary to install and remove the temporary service shall be paid by the applicant.

B. Payment – Delinquent Charges. All sewer service for building and construction purposes shall be charged at the rate set forth by council resolution. All sewer use shall be charged against the property owner, and all delinquent and unpaid charges shall become a lien upon the premises supplied, and shall be collected in the same manner as other delinquent and unpaid charges for sewer service. (Ord. 3051 § 1 (Exh. A), 2010; Ord. 2579 § 1, 1997).

13.22.100 Transfer of sewer taps not allowed.
No transfer of sewer taps is allowed from an existing premises to another premises; in other words, sewer taps stay with the premises. (Ord. 2579 § 1, 1997).

Chapter 13.23
SEWER MAIN EXTENSIONS, REPLACEMENTS, PUMP STATIONS AND OTHER SYSTEM IMPROVEMENTS

Sections:

13.23.010 General requirements.

13.23.020 Sewer system improvements – Installation method.

13.23.030 Preparation of plans and specifications – Surveys and engineering.

13.23.040 Pipe size and location.

13.23.050 Pump stations and force mains.

13.23.060 Other appurtenances.

13.23.070 Oversizing.

13.23.080 Construction of improvements – Testing/certifications.

13.23.090 Notification of city upon completion of work.

13.23.100 Prevention of damage to public sewer.

13.23.110 Acceptance of improvements.

13.23.010 General requirements.

A. When Required. A main extension, main replacement, pump station, maintenance hole, force main or other system improvement may be required for any of the following reasons to mitigate the direct impacts of the proposed development:

1. Whenever a customer requests service and the premises to be served does not abut a sewer main;

2. Whenever the existing sewer main(s) is not adequate to provide the necessary service;

3. Whenever the development cannot be served by a gravity system;

4. Where other components of the sewer system are inadequate to handle the increased wastewater discharges;

5. Whenever necessary to handle wastewater from the development; or

6. Whenever necessary to protect public health and safety.

B. Extension Requirements Where Customer Owns Multiple Contiguous Lots or Parcels. Multiple lots or parcels which meet the definition of "premises" set forth in PTMC 13.01.020 and which do not fall under subsections (A)(1) through (A)(6) of this section will not require a main extension; provided, that the following conditions are met. First, some portion of the property to be developed must abut a main, which may require binding the lots or parcels with a restrictive covenant to run with the land. Any such restrictive covenant must be in a form acceptable to the city attorney and must ensure that, in the event of any further development of the lots or parcels, all premises to be served will abut a main. Second, the customer/developer must be able to meet all Uniform Plumbing Code, engineering design standards and/or Department of Health and Department of Ecology requirements without a main extension.

C. Right-of-Way Acquisition. When sufficient right-of-way does not exist, the customer shall provide sufficient right-of-way or utility easements where necessary to serve the needs of the development and for the maintenance and orderly growth of the system.

D. Mitigation Costs.

1. The customer shall be required to bear the full costs of all main extensions, replacements, hydrants, valves and other system improvements required by this chapter where reasonably necessary to mitigate the direct impacts of the development.

2. Development Occurring in Tier 1 Areas. Where the installation of these facilities will benefit existing structures and customers already connected to the system, the developer will only be required to pay a proportionate share of the cost of the utility system improvements, defined as that portion fronting the lot(s) owned by the developer and any lots currently unserved and not participating in the construction of the improvements. It will be the city's obligation to fund a pro rata share of utility improvements based on the percentage of lot frontage properties already connected to the system. Undeveloped lots may be included in a benefit assessment area subject to a utility latecomer agreement pursuant to Chapter 13.04 PTMC. However, in the case of developed properties, there is no duty on the part of the city to make connections to the new system.

3. Development Occurring in Tier 2 Areas. Where the installation of these facilities will benefit existing structures and customers already connected to the system, the city will contribute to the cost of the improvements consistent with the city's currently adopted six-year capital improvement plan ("CIP"). In determining proportionate share, the developer will only be required to pay a proportionate share of the cost of the utility system improvements, defined as that portion fronting the lot(s) owned by the developer and any lots currently unserved and not participating in the construction of the improvements. It will be the city's obligation to fund a pro rata share of utility improvements based on the percentage of lot frontage of properties already connected to the system. Undeveloped lots may be included in a benefit assessment area subject to a utility latecomer agreement pursuant to Chapter 13.04 PTMC. However, in the case of developed properties, there is no duty on the part of the city to make connections to the new system.

4. Development in Tier 3 Areas. The developer shall pay for the full costs of the installation of these facilities.

5. Oversizing Costs. Oversizing costs must be paid in accordance with the criteria established in PTMC 13.14.060. (Ord. 2609 § 5, 1997; Ord. 2579 § 1, 1997).

13.23.020 Sewer system improvements – Installation method.

A. Except as noted in Chapter 13.22 PTMC, whenever an applicant requests sewer service to premises with no sewer main in the adjacent street, a main must be installed as a prerequisite to connection to the city sewer system. The main must conform with the city's wastewater master plan and city engineering design standards manual.

B. Sewer mains must be extended as far as possible to flow by gravity. Force mains shall be allowed only when flow by gravity is impractical.

C. Sewer system improvements may be installed by any of the following methods or as specified in PTMC Title 18 for subdivisions:

1. At the expense of the owner, with the improvements installed by a licensed and bonded contractor. Eligible property owners may apply to the city for a utility latecomer agreement pursuant to Chapter 13.04 PTMC;

2. The owner may also elect to have the improvements installed by the formation of a local improvement district (LID) as prescribed by state law and the ordinances of the city; or

3. City crews or contractors for projects and repairs initiated by the city. (Ord. 2579 § 1, 1997).

13.23.030 Preparation of plans and specifications – Surveys and engineering.
A. All applicants shall furnish design and construction plans and specifications for all proposed sewer system improvements. All design and construction plans and specifications shall be prepared in accordance with the city's engineering design standards manual. If base maps prepared by a licensed land surveyor are available, the design and construction plans shall be submitted on such maps. If base maps are unavailable, and the public works director determines that a survey is necessary to avoid conflicts with existing infrastructure, to determine contours, and/or to determine the limits of the right-of-way for utility placement, the applicant shall have the right-of-way surveyed, including elevations along the proposed utility route, by a licensed land surveyor and the plans shall be prepared and submitted on such surveyed base maps.

B. All plans required under this section must be prepared, signed and stamped by a Washington State licensed civil engineer. All plans shall be prepared at the developer's sole cost and expense.

C. All plans under this subsection must be reviewed and approved by the director prior to proceeding with construction of the proposed improvements. (Ord. 3051 § 1 (Exh. A), 2010; Ord. 2579 § 1, 1997).

13.23.040 Pipe size and location.
A. Size. Every new sewer main placed into service shall be eight inches in diameter, unless a larger size is indicated by hydraulic needs or the wastewater system plan or city engineering design standards manual. Hydraulic calculations shall take into account demands placed on the city's system, size and slope of pipe.

B. Location. Sewer mains shall be installed along the complete frontage of the premises and shall be extended to the next street intersection beyond the property; provided, however, that this requirement may be waived pursuant to Chapter 13.01 PTMC. (Ord. 2579 § 1, 1997).

13.23.050 Pump stations and force mains.
All side sewers shall flow by gravity into the city's system whenever possible. Individual side sewer pumps or public service pump stations will only be considered if no area gravity system can be constructed. Pump stations which will be turned over to the city must be sized to serve the entire region or basin which it serves. Gravity lines will be brought as far as possible (i.e., force mains shall be no longer than absolutely necessary). When allowed, pump stations and force mains shall comply with the requirements contained in the engineering design standards manual. Alternatively, private systems which are neither accepted nor maintained by the city may be installed to other standards; in such case, a private maintenance agreement shall be required in a form approved by the city attorney. The city can require pump stations and force mains to be private (i.e., not accepted and maintained by the city). Any pump stations that will serve 20 or more residences will be required to meet all city engineering design standards and shall be owned and operated by the city. (Ord. 2579 § 1, 1997).

13.23.060 Other appurtenances.
Main extension and replacements shall include all maintenance holes, cleanouts and other appurtenances as required by the engineering design standards manual and as determined to be necessary by the director for the integrity and orderly growth and needs of the sewer system. (Ord. 2579 § 1, 1997).

13.23.070 Oversizing.
A. The director shall determine the size of interceptor mains and pump stations based on projected future wastewater demands. For the purpose of determining oversizing of mains, the standard-size main required of the development shall be eight inches, unless the hydraulic demand of the development or pipe slope necessitates a larger size, as determined by the director, in which case the customer shall bear the full cost of the oversizing. For the purpose of determining oversizing of pump stations, oversizing will be considered the difference between the minimum size necessary to serve the development (or the minimum size pump station available whichever is greater) and the size required to serve the benefit area determined by the city.

B. If oversizing of a main or pump station is required for a project in Tier 1 areas (as identified in the Port Townsend Comprehensive Plan – see Chapter 13.01 PTMC, Definitions), the city will pay for the cost of oversizing. Oversizing costs shall be submitted for approval prior to the beginning of construction, and a bill of sale and deed of conveyance shall be submitted prior to reimbursement.

C. If oversizing of a main or pump station is required for a project in Tier 2, the city will reimburse the oversizing costs consistent with the city's currently adopted six-year capital improvement program ("CIP"). Oversizing costs shall be submitted for approval prior to the beginning of construction, and a bill of sale and deed of conveyance shall be submitted prior to reimbursement.

D. Consistent with the policy directive in the comprehensive plan, if oversizing is required for a project in Tier 3, the developer shall bear the full cost of the oversizing. (Ord. 2579 § 1, 1997).

13.23.080 Construction of improvements – Testing/certifications.
A. All main extensions, replacements, pump stations and other system improvements must be situated in public rights-of-way or utility easements.

B. Private Contractors Must Be Licensed and Bonded. Any main installations done other than by city forces shall be performed by a licensed and bonded contractor of the state of Washington.

C. All work within the limits of any public area shall be completed with due diligence. It shall be the responsibility of the developer to secure the safety of all work areas. If the developer fails to do so, and if any excavation is left open beyond a reasonable time necessary to complete the work, the public works director may cause the same to be backfilled and the public area restored at the expense of the owner.

D. Testing/Certifications. All new mains and other sewer system improvements must be tested in accordance with city engineering design standards manual. (Ord. 2579 § 1, 1997).

13.23.090 Notification of city upon completion of work.

Any person, including but not limited to any contractor, performing work under this chapter shall also notify the public works department in writing no later than seven days after the connection is made that the connection has been made. The notice shall include the property owner's name, the address of the premises, and the file number of the permit. The public works department shall then notify the city utility billing office for purposes of commencement of sewer service charges. (Ord. 2579 § 1, 1997).

13.23.100 Prevention of damage to public sewer.
The sewer contractor or other persons doing the work shall prevent any damage to the sewer main, tee or stub out, and also conduct his/her trenching operations as to prevent the possibility of damage to the system occurring. (Ord. 2579 § 1, 1997).

13.23.110 Acceptance of improvements.
The city reserves the right to reject any installation not inspected, tested and approved by the department. Upon satisfactory completion of all required tests and acceptance of the improvements, the department shall cause the improvements to be connected to the city system. All costs incurred in such connection(s) shall be the responsibility of the customer. As a condition of acceptance of the improvements by the city, the permit holder shall provide the city with (1) a statement of the actual cost of design and construction of the sewer improvements; (2) a properly executed bill of sale for all improvements; and (3) as-built drawings prepared in accordance with the engineering design standards manual. (Ord. 2579 § 1, 1997).

Chapter 13.24
CLASSIFICATION OF HIGH-STRENGTH WASTEWATER, CHARGES ASSOCIATED WITH SUCH DISCHARGES, AND PRETREATMENT REQUIREMENTS

Sections:
13.24.010 Purpose.

13.24.020 Permission to discharge high-strength waste – Pretreatment requirements – Grease traps required.

13.24.030 Standard Industry Code classifications.

13.24.040 Commodity charge.

13.24.050 Alternate approach to determination of rates.

13.24.010 Purpose.
The purpose of this chapter is to classify high-strength wastewater and establish special wastewater rates for users of the city's sewer system which generate certain high-strength wastes or have high variability in waste loadings and identify pretreatment requirements. It is intended that such special rates will provide a system of charges which equitably reflect the costs to the city of treating such wastes. (Ord. 2579 § 1, 1997; Ord. 2343 § 1, 1993).

13.24.020 Permission to discharge high-strength waste – Pretreatment requirements – Grease traps required.

A. Any person or business proposing to discharge high-strength wastes to the city's sewer system shall apply to the public works director for approval to discharge. The public works director may establish conditions for discharge and monitoring requirements as further established in this chapter.

B. Whenever preliminary treatment is necessary to reduce the strength of the waste to within the maximum limits prescribed by Chapter 13.21 PTMC, such preliminary treatment shall be at the sole expense of the owner of the premises and shall be installed when the director determines that the same is necessary to comply with the standards prescribed. In such cases, all plans, specifications and other pertinent information relating to such proposed preliminary treatment facilities shall be submitted to the director prior to commencement of construction and no construction thereof shall be commenced until the director's approval is noted on the plan. In the event of such installations, they shall be maintained continuously in efficient operation by the owner at his or her own expense.

C. Grease traps will be required on all restaurants or other establishments as determined necessary by the public works director. All costs associated with design, installation and maintenance to insure a working, reliable grease trap system will be the responsibility of the owner. (Ord. 2579 § 1, 1997).

13.24.030 Standard Industry Code classifications.
A. The following types of business activities shall be assigned Standard Industry Code ("SIC") classifications as indicated below:

Business Activity	**Classification**
Brewery	SIC #4
Restaurants/taverns full-service	SIC #3
Fast food	SIC #3
Prepackaged servers	SIC #1
Supermarkets:	
with deli, bakery, etc.	SIC #3
without deli, bakery, etc.	SIC #1
Convenience stores	SIC #1
Canneries (food processors)	SIC #4
Convalescent homes	SIC #3
Marinas	SIC #3
Washington State Ferries	SIC #4

B. Each commercial and industrial account shall be assigned to a SIC by the director of public works based on a review of the wastewater discharges from each account. (Ord. 2579 § 1, 1997; Ord. 2343 § 1, 1993).

13.24.040 Commodity charge.
A. A commodity charge shall be based on water use and wastewater strength. Charges shall be on a block rate, with the block rate increasing based on strength of the waste, as follows:

Classification	Surcharge above commodity charge as identified in Chapter 13.05 PTMC
SIC #1	
< 300 mg/l BOD or TSS	$0.00/1,000 gallons
SIC #2	
301 – 500 mg/l BOD or TSS	$0.00/1,000 gallons
SIC #3	
501 – 700 mg/l BOD or TSS	$0.00/1,000 gallons
SIC #4	
>700 mg/l BOD or TSS or	$0.88/1,000 gallons
variability in loadings *	plus $0.98/lb BOD
	plus $0.62/lb TSS

*Such as Washington State Ferries or other users with instantaneous discharges or other use that causes wide swings in either wastewater quantity or strength that may cause collection or interceptor sewer concerns or potential adverse impacts on the wastewater treatment plant process. The city has the option to monitor and/or test the quality of these wastes or assume that the strength is 700 mg/l for BOD and/or TSS.

B. Water use may be measured at the customer's water meter, or by installation of a wastewater meter per PTMC 13.24.050. (Ord. 2579 § 1, 1997; Ord. 2343 § 1, 1993).

13.24.050 Alternate approach to determination of rates.

When the director deems necessary, or when any sewer customer believes they have been assigned a Standard Industrial Code classification which is not appropriate, the sewer rate may be determined as follows and the customer shall pay the city a monthly fee based upon the actual use of the city wastewater treatment facility as measured by parameters which shall be determined in accordance with the following procedures:

A. Metering. The wastewater flow into the sewerage system will be metered at the point where the facility discharges wastewater into the city system. The cost of installation and maintenance of the meter shall be paid by the customer. The flow metering installation at the facility shall be calibrated quarterly and equipped with a totalizer. Daily maintenance by the facility shall include at least a check of the primary element of the flow meter for obstructions and a visual check of all other elements of the installation for normal operation. A daily log shall be kept by the facility in which all maintenance operations performed and any abnormalities observed shall be noted. The totalizer reading shall also be recorded daily in the log. At the end of each month, the average daily flow during the month shall be determined by using all the valid data collected during the month (total flow divided by days of operation).

B. BOD and Suspended Solids. The monitoring facility shall be equipped with an automatic liquid sampling device which shall be integrated with the flow-metering installation in such a manner that wastewater samples can be collected on a flow-weighted basis and stored. A composite sample shall be prepared weekly, as directed by the city, from all samples collected during a uniform 24-hour period. The BOD and SS of each sample shall be determined and recorded in the log. At the end of each month, the average BOD and TSS during the month shall be determined by using all the valid data collected during the month. After a period of one year, the city may reduce the frequency of monitoring (provided there are no other constraints such as a Department of Ecology permit precluding less frequent monitoring).

C. Records. The facility shall maintain records of all information resulting from any monitoring activities. Such records for all samples shall include:

1. The date, exact place, method and time of sampling;

2. The names of persons taking the sample;

3. The date the analysis was done;

4. The names of persons doing the analysis;

5. The analytical techniques used;

6. The results of the analysis.

D. Calculation of Maintenance and Operation Expenses. The data collected shall be used by the city to calculate the share of the total maintenance and operation expenses which shall be charged to the facility. The method of calculation of maintenance and operation expenses to be charged shall be as follows:

1. O&M charge to the facility during billing period = cost factor x monthly city treatment facility O&M cost.

2. Cost factor = (Vf/Vc)(0.2 + 0.4 BODf/BODc + 0.4 TSSf/TSSc).

where:

Vf =	average daily wastewater flow (in gallons) from the facility during billing period.
Vc =	average daily wastewater flow for the city of Port Townsend wastewater treatment facility plant during billing period (gallons).
BODf =	average daily five-day BOD concentration of wastewater from the facility during billing period.
BODc =	average daily five-day BOD concentration of total plant wastewater during billing period.
TSSf =	average daily TSS concentration of wastewater from the facility during billing period.

TSSc =	average daily TSS concentration of wastewater of total plant during billing period.

E. Lab Testing. One set of BOD, FOG (fat, oil and grease), TSS (total suspended solids), VSS (volatile suspended solids) and pH tests will be required on a composite sample collected by the sewer customer on a weekly basis, or other tests and/or testing intervals as determined by the director, while the facility discharges to the city sewer system. Fees for the required tests shall be paid by the facility. The facility shall have all testing done by a lab that is certified by the Washington State Department of Ecology to perform the required analysis.

F. Operation. The city shall have free access to the facility and the records of operation and maintenance. The records of operation and maintenance shall be kept at the facility and shall be made available to the city during the site visit by the city. The city shall have access to the facility at reasonable hours without prior notice. (Ord. 2579 § 1, 1997; Ord. 2343 § 1, 1993).

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Appendix N

Funding Program Summary

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Funding Programs for Drinking Water and Wastewater Projects

Updated 3-5-24

Type of Program	Pages
Planning/ Pre-Construction	2 - 5
Pre-Construction Only	6 - 7
Construction	8 - 14
Emergency	15-17

You can find the latest version of this document at http://www.infrafunding.wa.gov/resources.html

Please contact Claire Miller at claire.miller@commerce.wa.gov if you would like to update your program information

PLANNING **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
DWSRF Drinking Water State Revolving Fund Planning and Engineering Loans Department of Health	Preparation of planning documents, engineering reports, construction documents, permits, cultural reports, environmental reports.	Group A (private and publicly-owned) community and not-for-profit non-community water systems, but not federal or state-owned systems. Small systems serving fewer than 10,000 people.	Loan • $500,000 maximum per jurisdiction • 0% annual interest rate • 2% loan service fee • 2-year time of performance • 10-year repayment period	On-line applications accepted year-round until funding exhausted. Approximately $3 million available to award each year. **Contact:** Jocelyne Gray 564-669-4893 Jocelyne.gray@doh.wa.gov For information and forms visit: http://www.doh.wa.gov/DWSRF
DWSRF Drinking Water State Revolving Fund Consolidation Grant Department of Health	Development of a feasibility study, engineering evaluation, design of a infrastructure project to consolidated one or more Group A water systems	Group A not-for-profit community water system, county, city, public utility district, or water district in Washington State Tribal systems are eligible provided the project is not receiving other national set-aside funding for the project.	Grant • Up to $50,000 per project • Minimum of $10,000 • 2-year time of performance	Online applications accepted year round until funding exhausted. **Contact:** Jocelyne Gray 564-669-4893 Jocelyne.gray@doh.wa.gov For information and forms visit: http://www.doh.wa.gov/DWSRF
DWSRF Drinking Water State Revolving Fund Lead Service Line Inventory Loan Department of Health	Develop lead service line inventory. There is principal forgiveness for disadvantaged communities.	Group A (private and publicly-owned) community and not-for-profit non-community water systems, but not federal or state-owned systems.	Loan • Minimum $25,000 • No maximum • 0% annual interest rate • 2% loan service fee • 2-year time of performance • 10-year repayment period • First come, first served based on application submittal date.	Online applications available and accepted October 1 through November 30, 2024. **Contact:** Jocelyne Gray 564-669-4893 Jocelyne.gray@doh.wa.gov For information and forms visit: http://www.doh.wa.gov/DWSRF

PLANNING **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
SOURCE WATER PROTECTION GRANT PROGRAM Department of Health	Source water protection studies (watershed, hydrogeologic, feasibility studies). Eligible activities can lead to reducing the risk of contamination of a system's drinking water sources(s), or they can evaluate or build resiliency for a public water supply. They must contribute to better protecting one or more public water supply sources.	Non-profit Group A water systems. Local governments proposing a regional project. Project must be reasonably expected to provide long-term benefit to drinking water quality or quantity.	Grants • Funding is dependent upon project needs, but typically does not exceed $30,000.	Applications accepted anytime; grants awarded on a funds available basis. **Contact:** Nikki Guillot 360-236-3114 Nikki.guillot@doh.wa.gov http://www.doh.wa.gov/ CommunityandEnvironment/DrinkingWater/ SourceWater/SourceWaterProtection.aspx Grant guidelines https://www.doh.wa.gov/Portals/1/Documents/ Pubs/331-552.pdf
ECOLOGY: WATER QUALITY COMBINED FUNDING PROGRAM State Water Pollution Control Revolving Fund (SRF) Centennial Clean Water Fund Stormwater Financial Assistance Program (SFAP) Department of Ecology	Planning projects associated with publicly-owned wastewater and stormwater facilities. The integrated program also funds planning and implementation of nonpoint source pollution control activities.	Counties, cities, towns, conservation districts, or other political subdivision, municipal or quasi-municipal corporations, and federally recognized tribes	Loan: $10,000,000 reserved for preconstruction statewide Interest rates (SFY 2025) • 6-20 year loans: 1.2% • 1-5 year loans: 0.6% Preconstruction set-aside (Distressed Communities) 50% forgivable principal loan and 50% loan	Applications due October 15, 2024. **Contact:** Eliza Keeley 360-628-1976 Eliza.keeley@ecy.wa.gov https://ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Water-Quality-grants-and-loans
RD PRE-DEVELOPMENT PLANNING GRANTS (PPG) U.S. Dept. of Agriculture Rural Development – Rural Utilities Service – Water and Waste Disposal Direct Loans and Grants	Water and/or sewer planning; environmental work; and other work to assist in developing an application for infrastructure improvements.	• Low-income, small communities and systems serving areas under 10,000 population. • Population determined by U.S. Census 2020. • Income determined by the American Community Survey 2017-2021 (5-year).	Planning grant to assist in paying costs associated with developing a complete application for RD funding for a proposed project. Maximum $60,000 grant. Requires minimum 25% match.	Applications accepted year-round, on a fund-available basis. **Contact:** Marti Canatsey 509-367-8570 marlene.canatsey@usda.gov http://www.rd.usda.gov/wa

PLANNING **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
RD 'SEARCH' GRANTS: SPECIAL EVALUATION ASSISTANCE FOR RURAL COMMUNITIES U.S. Dept. of Agriculture Rural Development – Rural Utilities Service – Water and Waste Disposal Direct Loans and Grants	Water and/or sewer planning; environmental work; and other work to assist in developing an application for infrastructure improvements.	• Low-income, small communities and systems serving areas under 2,500 population. • Population determined by U.S. Census 2020. • Income determined by the American Community Survey 2017-2021 (5-year).	Maximum $30,000 grant. No match required.	Applications accepted year-round, on a fund-available basis. **Contact:** Marti Canatsey 509-367-8570 marlene.canatsey@usda.gov http://www.rd.usda.gov/wa
CERB PLANNING AND FEASIBILITY GRANTS Community Economic Revitalization Board – Project-Specific Planning Program	Project-specific feasibility and pre-development studies that advance community economic development goals for industrial sector business development.	Eligible statewide • Counties, cities, towns, port districts, special districts. • Federally recognized tribes • Municipal corporations, quasi-municipal corporations w/ economic development purposes.	Grant • Up to $100,000 per project. • Requires 20% (of total project cost) matching funds • CERB is authority for funding approvals.	Applications accepted year-round. The Board meets six times a year. **Contact:** Janea Stark 360-252-0812 janea.stark@commerce.wa.gov
RCAC Rural Community Assistance Corporation Feasibility and Pre-Development Loans	Water, wastewater, stormwater, and solid waste planning; environmental work; and other work to assist in developing an application for infrastructure improvements.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less, or 10,000 or less if proposed permanent financing is through USDA Rural Development.	• Typically up to $50,000 for feasibility loan. • Typically up to $350,000 for pre-development loan. • Typically up to a 1-year term. • 5.5% interest rate. • 1% loan fee.	Applications accepted anytime. **Contact**: Jessica Scott 719-458-5460 jscott@rcac.org Applications available online at http://www.rcac.org/lending/environmental-loans/

PLANNING **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
Economic Development Administration (EDA) United States Department of Commerce **EDA Public Works & Economic Adjustment Assistance Program:** Planning, Feasibility Studies, Preliminary Engineering Reports, Environmental Consultation for distressed and disaster communities.	Drinking water infrastructure; including pre-distribution conveyance, withdrawal/harvest (i.e. well extraction), storage facilities, treatment and distribution. Waste water infrastructure; including conveyance, treatment facilities, discharge infrastructure and water recycling.	Municipalities, counties, cities, towns, states, not-for-profit organizations, ports, tribal nations.	Grants: • EDA investment share up to $500,000 • Cost sharing required from applicant • Standard grant rate of 50% of total project cost and up to 80%. o Up to 100% for Tribal Nations	**Information:** EDA.gov **Contact:** Laura Ives 206-200-1951 lives@eda.gov **Apply at:** grants.gov

PRECONSTRUCTION ONLY **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
ECOLOGY: WATER QUALITY COMBINED FUNDING PROGRAM State Water Pollution Control Revolving Fund (SRF) Centennial Clean Water Fund Stormwater Financial Assistance Program (SFAP)	Design projects associated with publicly-owned wastewater and stormwater facilities. The integrated program also funds planning and implementation of nonpoint source pollution control activities.	Counties, cities, towns, conservation districts, or other political subdivision, municipal or quasi-municipal corporations, and federally recognized tribes. Stormwater Financial Assistance Program (SFAP) is limited to cities, counties, and public ports.	Loan: $10,000,000 reserved for preconstruction statewide Interest rates (SFY 2025) • 6-20 year loans: 1.2% • 1-5 year loans: 0.6% Preconstruction set-aside (Distressed Communities) 50% forgivable principal loan and 50% loan	Applications due October 15, 2024. A cost effectiveness analysis must be complete at the time of application. **Contact:** Eliza Keeley 360-628-1976 Eliza.keeley@ecy.wa.gov https://ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Water-Quality-grants-and-loans
PWB PRE-CON Public Works Board Pre-Construction Program	Pre-construction activities to bring projects to a higher degree of readiness that prepare a specific project for construction. Roads, streets and bridges, domestic water, sanitary sewer, stomwater, and solid waste/recycling/organics facilities.	Counties, cities, special purpose districts, and quasi-municipal organizations that meet certain requirements. Ineligible applicants: school districts, port districts, and tribes, per statute.	Pre-construction awarded quarterly.	**Contact:** Sheila Richardson 564-999-1927 Sheila.richardson@commerce.wa.gov Check the Public Works Board website periodically at http://www.pwb.wa.gov to obtain the latest information on program details or to contact Public Works Board staff.

PRECONSTRUCTION ONLY **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
RCAC Rural Community Assistance Corporation Feasibility and Pre-Development Loans	Water, wastewater, stormwater, or solid waste planning; environmental work; and other work to assist in developing an application for infrastructure improvements.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less, or 10,000 or less if proposed permanent financing is through USDA Rural Development.	• Typically up to $50,000 for feasibility loan. • Typically up to $350,000 for pre-development loan. • Typically a 1-year term. • 5.5% interest rate. • 1% loan fee.	Applications accepted anytime. **Contact**: Jessica Scott 719-458-5460 jscott@rcac.org Applications available online at http://www.rcac.org/lending/environmental-loans/
Economic Development Administration (EDA) United States Department of Commerce **EDA Public Works & Economic Adjustment Assistance Program:** Design and/or Construction for distressed and disaster communities.	Drinking water infrastructure; including pre-distribution conveyance, withdrawal/harvest (i.e. well extraction), storage facilities, treatment and distribution. Waste water infrastructure; including conveyance, treatment facilities, discharge infrastructure and water recycling.	Municipalities, counties, cities, towns, states, not-for-profit organizations, ports, tribal nations.	Grants: • EDA investment share up to $500,000 • Cost sharing required from applicant • Standard grant rate is 50% of total project cost, and up to 80%. o Up to 100% for Tribal Nations	**Information:** EDA.gov **Contact:** Laura Ives 206-200-1951 lives@eda.gov **Apply at:** grants.gov

CONSTRUCTION AND DESIGN/CONSTRUCTION Programs	Eligible Projects	Eligible Applicants	Funding Available	How To Apply
DWSRF Drinking Water State Revolving Fund Construction Loan Program Department of Health	Drinking water system infrastructure projects aimed at increasing public health protection. There is principal forgiveness for disadvantaged communities.	Group A (private and publicly-owned) community and not-for-profit non-community water systems, but not federal or state-owned systems. Tribal systems are eligible provided the project is not receiving other national set-aside funding for the project.	Loan • Maximum $12 million per jurisdiction. • 2.25% annual interest rate (Final rate is set September 1, 2024). • 1.0% loan service fee (water systems receiving subsidy are not subject to loan fees). • 4-year time of performance, encouraged 2-year time of performance • Loan repayment period: 20 years or life of the project, whichever is less. • No local match required.	Online applications available and accepted October 1 through November 30, 2024. **Contact:** Jocelyne Gray 564-669-4893 Jocelyne.gray@doh.wa.gov For information and forms visit: http://www.doh.wa.gov/DWSRF
DWSRF Drinking Water State Revolving Fund Lead Service Line (LSL) Replacement Loan Department of Health	Lead service line replacement. Galvanized service lines to be replaced per Lead and Copper Rule. Service water meters older than 1986 lead ban, as part of LSL replacement. There is principal forgiveness for disadvantaged communities.	Group A (private and publicly-owned) community and not-for-profit non-community water systems, but not federal or state-owned systems. Tribal systems are eligible provided the project is not receiving other national set-aside funding for the project.	Loan • Minimum $25,000 • No maximum • 2.25% annual interest rate (Final rate is set September 1, 2024). • 1% loan service fee (water systems receiving subsidy are not subject to loan fees) • 4-year time of performance, encouraged 2-year time of performance • 20-year repayment period	Online applications available and accepted October 1 through November 30, 2024. **Contact:** Jocelyne Gray 564-669-4893 Jocelyne.gray@doh.wa.gov For information and forms visit: http://www.doh.wa.gov/DWSRF

CONSTRUCTION AND DESIGN/CONSTRUCTION Programs	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
ECOLOGY: Water Quality Combined Funding Program State Water Pollution Control Revolving Fund (SRF) Centennial Clean Water Fund Stormwater Financial Assistance Program (SFAP)	Construction projects associated with publicly-owned wastewater and stormwater facilities. The integrated program also funds planning and implementation of nonpoint source pollution control activities.	Counties, cities, towns, conservation districts, or other political subdivision, municipal or quasi-municipal corporations, and federally recognized tribes. Stormwater Financial Assistance Program (SFAP) is limited to cities, counties, and public ports. Hardship Assistance Jurisdictions listed above with a service area population of 25,000 or less.	Loan: $200,000,000 available statewide. Interest rates (SFY 2025) • 21-30 year loans: 1.6% • 6-20 year loans: 1.2% • 1-5 year loans: 0.6% Hardship assistance for the construction of wastewater treatment facilities may be available in the form of a reduced interest rate, and up to $5,000,000 grant or loan forgiveness. SFAP grant maximum award per jurisdiction: $10,000,000, with a required 15% match, with match reduced to 5% for hardship.	Applications due October 15, 2024. A cost effectiveness analysis must be complete at the time of application. **Contact:** Eliza Keeley 360-628-1976 Eliza.keeley@ecy.wa.gov https://ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Water-Quality-grants-and-loans
PWB Public Works Board Construction Program	New construction, replacement, and repair of existing infrastructure for roads, streets and bridges, domestic water, sanitary sewer, stormwater, and solid waste/recycling/organics.	• Counties, cities, special purpose districts, and quasi-municipal organizations. • Ineligible applicants: school districts, port districts, and tribes, per statute.	FY2024 Cycle: $235 million available. Interest rate: Projects with 5-20 year term: 1.2% Projects with 1-5 year term: 0.85% Maximum award per jurisdiction per biennium: $10 million Maximum project award: $10 million per jurisdiction per biennium. Construction and pre-construction are competitive cycles. Two construction cycles per biennium. Pre-construction awarded quarterly. Emergency open until funds allocated.	FY2025 cycle opens in Spring 2024 **Contact:** Sheila Richardson 564-999-1927 Sheila.richardson@commerce.wa.gov Check the Public Works Board website periodically at http://www.pwb.wa.gov to obtain the latest information on program details or to contact Public Works Board staff.

CONSTRUCTION AND DESIGN/CONSTRUCTION **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
RD U.S. Dept. of Agriculture Rural Development - Rural Utilities Service Water and Waste Disposal Direct Loans and Grants	Pre-construction and construction associated with building, repairing, or improving drinking water, wastewater, solid waste, and stormwater facilities.	• Cities, towns, and other public bodies, tribes and private non-profit corporations serving rural areas with populations under 10,000. • Population determined by U.S. Census 2020. • Income determined by the American Community Survey 2017-2021 (5-year).	Loans; Grants in some cases • Interest rates change quarterly; contact staff for latest interest rates. • Up to 40-year loan term. • No pre-payment penalty.	Applications accepted year-round on a fund-available basis. **Contact:** Marti Canatsey 509-367-8570 marlene.canatsey@usda.gov http://www.rd.usda.gov/wa
CERB Community Economic Revitalization Board Construction Program	Public facility projects required by private sector expansion and job creation. Projects must support significant job creation or significant private investment in the state. • Bridges, roads and railroad spurs, domestic and industrial water, sanitary and storm sewers. • Electricity, natural gas and telecommunications • General purpose industrial buildings, port facilities. • Acquisition, construction, repair, reconstruction, replacement, rehabilitation	• Counties, cities, towns, port districts, special districts • Federally-recognized tribes • Municipal and quasi-municipal corporations with economic development purposes.	Loans; grants in unique cases • Projects without a committed private partner allowed for in rural areas. • $5 million maximum per project, per policy. • Interest rates: 1-3% Based on Debt Service Coverage Ratio (DSCR), Distressed County, and length of loan term. • 20-year maximum loan term • Match for committed private partners: 20% (of total project cost). • Match for prospective development partners: 50% (of total project cost). • Applicants must demonstrate gap in public project funding and need for CERB assistance. • CERB is authority for funding approvals.	Applications accepted year-round. The Board meets six times a year. **Contact:** Janea Stark 360-252-0812 janea.stark@commerce.wa.gov

CONSTRUCTION AND DESIGN/CONSTRUCTION Programs	Eligible Projects	Eligible Applicants	Funding Available	How To Apply
CDBG-GP Community Development Block Grant General Purpose Grants	• Planning, design, and construction of wastewater, drinking water, side connections, stormwater, streets, and community facility projects. • Infrastructure in support of affordable housing.	Projects must principally benefit low- to moderate-income people in non-entitlement cities and counties. List and map of local governments served by state CDBG program	Maximum grant amounts: • $2,000,000 for construction and acquisition projects. • $500,000 for local housing rehabilitation programs. • $250,000 for local microenterprise assistance programs.	Applications accepted year-round on a fund-available basis beginning Spring 2024. **Contact:** Jon Galow 509-847-5021 Jon.galow@commerce.wa.gov Visit www.commerce.wa.gov/cdbg for more information.
RCAC Rural Community Assistance Corporation Intermediate Term Loan	Water, wastewater, solid waste and stormwater facilities that primarily serve low-income rural communities.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less.	• For smaller capital needs, normally not to exceed $100,000. • Typically up to a 20-year term • 5% interest rate • 1% – 1.125% loan fee	Applications accepted anytime. **Contact**: Jessica Scott 719-458-5460 jscott@rcac.org Applications available online at http://www.rcac.org/lending/environmental-loans/
RCAC Rural Community Assistance Corporation Construction Loans	Water, wastewater, solid waste and stormwater facilities that primarily serve low-income rural communities. Can include pre-development costs.	Non-profit organizations, public agencies, tribes, and low-income rural communities with a 50,000 population or less, or 10,000 populations or less if using USDA Rural Development financing as the takeout.	• Typically up to $3 million with commitment letter for permanent financing • Security in permanent loan letter of conditions • Term matches construction period. • 5.5% interest rate • 1.125% loan fee	Applications accepted anytime. **Contact**: Jessica Scott 719-458-5460 jscott@rcac.org Applications available online at http://www.rcac.org/lending/environmental-loans/

CONSTRUCTION AND DESIGN/CONSTRUCTION Programs	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
Energy Retrofits for Public Buildings Program: Energy Efficiency Grant Washington State Department of Commerce	Retrofit projects that reduce energy consumption (electricity, gas, water, etc.) and operational costs on existing facilities and related projects owned by an eligible applicant. Projects must utilize devices that do not require fossil fuels whenever possible.	• Washington State public entities, such as cities, towns, local agencies, public higher education institutions, school districts, federally recognized tribal governments, and state agencies. • Some percentage of funds are reserved for projects in small towns or cities with populations of 5,000 or fewer. • Priority will be given to applicants who have not received funding previously, certain priority communities, and school districts that reduce PCB's through lighting upgrades.	2023: $22,500,000 • Maximum grant: $350,000 • Minimum match requirements will apply. • Other State funds cannot be used as match. • Tentative: Applications due winter 2023.	**Contact:** Kristen Kalbrener 360-515-8112 energyretrofits@commerce.wa.gov Visit https://www.commerce.wa.gov/growing-the-economy/energy/energy-efficiency-and-solar-grants/ for more information.
Energy Efficiency Revolving Loan Fund Washington State Department of Commerce	Energy audits, installation of energy saving equipment, conversion to electrification	• Low to moderate income homeowners, homeowners with little credit history	2023: $1,700,000	**Contact:** Kristen Kalbrener 360-515-8112 energyretrofits@commerce.wa.gov
Energy Efficiency and Conservation Block Grant Washington State Department of Commerce	Energy audits and energy conservation planning projects including financing, infrastructure, public education	• Local governments (cities, counties, federally-recognized tribes) • Priority for disadvantaged communities	2023: $2,000,000	**Contact:** Kristen Kalbrener 360-515-8112 energyretrofits@commerce.wa.gov

CONSTRUCTION AND DESIGN/CONSTRUCTION Programs	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
Energy Retrofits for Public Buildings: Solar Grants Washington State Department of Commerce	Purchase and installation of grid-tied solar photovoltaic (electric) arrays net metered with existing facilities owned by public entities. Additional points for 'Made in Washington' components.	• Washington State public entities, such as cities, towns, local agencies, public higher education institutions, school districts, federally recognized tribal governments, and state agencies. See above.	Approximately $21.8 million will be available in 2023-2025.	**Contact:** energyretrofits@commerce.wa.gov Visit https://www.commerce.wa.gov/growing-the-economy/energy/solar-grants/ for more information.
Solar plus Storage for Resilient Communities Washington State Department of Commerce	The Solar plus Storage program funds solar and battery back-up power so community buildings can provide essential services when the power goes out, including both planning and installation grants.	Local governments, State governments, Tribal governments and their affiliates, Non-profit organizations and Retail electric utilities.	Approximately $30 million will be available.	**Contact:** solar@commerce.wa.gov **Visit:** **https://www.commerce.wa.gov/growing-the-economy/energy/solar-plus-storage/**

CONSTRUCTION AND DESIGN/CONSTRUCTION **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
Economic Development Administration (EDA) United States Department of Commerce **EDA Public Works & Economic Adjustment Assistance Program:** Design and/or Construction for distressed and disaster communities.	Drinking water infrastructure; including pre-distribution conveyance, withdrawal/ harvest (i.e. well extraction), storage facilities, treatment and distribution. Waste water infrastructure; including conveyance, treatment facilities, discharge infrastructure, water recycling.	Municipalities, counties, cities, towns, states, not-for-profit organizations, ports, tribal nations.	Grants: • EDA investment share up to $5,000,000. • Cost sharing required from applicant • Standard grant rate is 50% of total project cost, and up to 80%. o Up to 100% for Tribal Nations	**Information:** EDA.gov **Contact:** Laura Ives 206-200-1951 lives@eda.gov **Apply at:** grants.gov
RURAL WATER REVOLVING LOAN FUND	Short-term costs incurred for replacement equipment, small scale extension of services, or other small capital projects that are not a part of regular operations and maintenance for drinking water and wastewater projects.	Public entities, including municipalities, counties, special purpose districts, Native American Tribes, and corporations not operated for profit, including cooperatives, with up to 10,000 population and rural areas with no population limits.	• Loans may not exceed $100,000 or 75% of the total project cost, whichever is less. Applicants given credit for documented project costs prior to receiving the loan. • Interest rates at the lower of the poverty or market interest rate as published by USDA RD RUS, with a minimum of 3% at time of closing. • Maximum repayment period is 10 years. Additional ranking points for a shorter repayment period. The repayment period cannot exceed the useful life of the facilities.	Applications accepted anytime. **Contact**: Tracey Hunter Evergreen Rural Water of WA 360-462-9287 thunter@erwow.org Download application online: http://nrwa.org/initiatives/revolving-loan-fund/
Connecting Housing to Infrastructure Program (CHIP) Washington State Department of Commerce	Housing projects with at least 25% of units affordable for at least 25 years. Funding goes toward water, sewer, and stormwater infrastructure improvements for eligible projects, as well as toward system development charges and impact fees, which are waived to encourage affordable housing.	Cities, counties, and utility districts located in a jurisdiction which has a dedicated sales tax for affordable housing. The local jurisdiction will sponsor/ partner with a housing developer on the project.	$55.5 million in total funds available in 2023-2025 biennium. $19.4 million specifically reserved for jurisdictions with a population of less than 150,000. $2,000,000 maximum award. Funds available as both grants and deferred loans.	Contact: Mischa Venables 360-725-3088 Mischa.venables@commerce.wa.gov Visit www.commerce.wa.gov/CHIP

EMERGENCY **Programs**	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
RD – ECWAG U.S. Dept. of Agriculture Rural Development Emergency Community Water Assistance Grants	Domestic water projects needing emergency repairs due to an incident such as: a drought; earthquake; flood; chemical spill; fire; etc. A significant decline in quantity or quality of potable water supply that was caused by an emergency.	• Public bodies, tribes and private non-profit corporations serving rural areas with populations under 10,000. • Population determined by U.S. Census 2020. • Income determined by the American Community Survey 2017-2021 (5-year).	Grant; pending availability of funds • Water transmission line grants up to $150,000 to construct water line extensions, repair breaks or leaks in existing water distribution lines, and address related maintenance to replenish the water supply • Water source grants up to $1,000,000 for the construction of new wells, reservoirs, transmission lines, treatment plants, and/or other sources of water (water source up to and including the treatment plant)	Applications accepted year-round on a fund-available basis. **Contact:** Marti Canatsey 509-367-8570 marlene.canatsey@usda.gov http://www.rd.usda.gov/wa
DWSRF Department of Health – Drinking Water State Revolving Fund Emergency Loan Program Department of Health	Will financially assist eligible communities experiencing the loss of critical drinking water services or facilities due to an emergency.	• Publicly or privately owned (not-for-profit) Group A community water systems with a population of fewer than 10,000. • Transient or non-transient non-community public water systems owned by a non-profit organization. Non-profit non-community water systems must submit tax-exempt documentation. • Tribal systems are eligible provided the project is not receiving other national set-aside funding for the project.	Loan • Interest rate: 0%, no subsidy available • Loan fee: 1.5% • Loan term: 10 years • $500,000 maximum award per jurisdiction. • Time of performance: 2 years from contract execution to project completion date. • Repayment commencing first October after contract execution.	To be considered for an emergency loan, an applicant must submit a completed emergency application package to the department. **Contact:** Jocelyne Gray 564-669-4893 Jocelyne.gray@doh.wa.gov For information and forms visit: http://www.doh.wa.gov/DWSRF

EMERGENCY Programs	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
PWB Public Works Board Emergency Loan Program: Repair, replace, rehabilitate, or reconstruct eligible systems to current standards for existing users.	Roads, streets and bridges, domestic water, sanitary sewer, stormwater, and solid waste/recycling/organics projects made necessary by a natural disaster, or an immediate and emergent threat to the public health and safety due to unforeseen or unavoidable circumstances.	Counties, cities, special purpose districts, and quasi-municipal organizations. Ineligible applicants: school districts, port districts, or tribes, per statute.	• Cycle open continuously during the biennium until allocated funds exhausted. $7.5 million is available. • Maximum loan amount $1 million per jurisdiction per biennium. • 20-year loan term or life of the improvement, whichever is less. • Interest rates vary.	**Contact:** Sheila Richardson 564-999-1927 Sheila.richardson@commerce.wa.gov Check the Public Works Board website periodically at: http://www.pwb.wa.gov to obtain the latest information on program details or to contact Public Works Board staff.
ECOLOGY Water Quality Emergency Clean Water State Revolving Funding Program	Projects that may result from a natural disaster or an immediate and emergent threat to public health due to water quality issues resulting from unforeseen or unavoidable circumstances. Water quality-related projects considered to be an environmental emergency that meets the WAC 173-98-030(27)5 definition and has received a Declaration of Emergency from the local Government.	Only available to public bodies serving a population of 10,000 or less. Counties, cities, and towns, federally recognized tribes, water and sewer districts, irrigation districts, conservation districts, local health jurisdictions, port districts, quasi-municipal corporations, Washington State institutions of higher education	Loan: $5,000,000 maximum Interest rates (SFY25): 10-year loan, 0.0-1.6%	Available year round. Contact: Eliza Keeley 360-628-1976 Eliza.keeley@ecy.wa.gov https://ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Water-Quality-grants-and-loans

EMERGENCY Programs	**Eligible Projects**	**Eligible Applicants**	**Funding Available**	**How To Apply**
RURAL WATER REVOLVING LOAN FUND Disaster area emergency loans	Contact staff for more information on emergency loans.	Public entities, including municipalities, counties, special purpose districts, Native American Tribes, and corporations not operated for profit, including cooperatives, with up to 10,000 population and rural areas with no population limits.	90-day, no interest, disaster area emergency loans with immediate turn-around. Download application online: http://nrwa.org/initiatives/revolving-loan-fund/	Applications accepted anytime. **Contact**: Tracey Hunter Evergreen Rural Water of WA 360-462-9287 thunter@erwow.org
HAZARD MITIGATION GRANT PROGRAM FEMA/WA Emergency Management Division	Disaster risk-reduction projects and planning after a disaster declaration in the state.	Any state, tribe, county, or local jurisdiction (incl., special purpose districts) that has a current FEMA-approved hazard mitigation plan.	Varies depending on the level of disaster, but projects only need to compete at the state level. Local jurisdiction cost-share: 12.5%	Applications will be opened after a disaster declaration. **Contact**: Tim Cook State Hazard Mitigation Officer 253-512-7072 Tim.cook@mil.wa.gov
PUBLIC ASSISTANCE PROGRAM FEMA/WA Emergency Management Division	Construction, repair to, and restoration of publicly owned facilities damaged during a disaster. Debris-removal, life-saving measures, and restoration of public infrastructure.	State, tribes, counties, and local jurisdictions directly affected by the disaster.	Varies depending on the level of disaster and total damage caused.	Applications are opened after disaster declaration. **Contact:** Gary Urbas Public Assistance Project Manager 253-512-7402 Gary.urbas@mil.wa.gov
WASHINGTON STATE DEPARTMENT OF COMMERCE ERR - Emergency Rapid Response	Projects that provide continuity of essential community services that become diminished during an emergency and recovery assistance after an emergency event. Projects that restore service for a limited duration or through a temporary measure.	Tribes and local governments	Grant; pending availability of funds Up to $5,000,000 Period of performance state fiscal year July-June	Applications accepted year-round until funding exhausted. Approximately $5 million available to award each year. **Contact:** Nicole Patrick 206-713-6997 Nicole.patrick@commerce.wa.gov For information and application visit: EmergencyRapidResponse or https://deptofcommerce.box.com/s/skmab4hq3l4z55jazzc7qlsmbrsgermv

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Appendix O

Port Townsend Sewer Rate Model

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City of Port Townsend

Sewer Rate Model
Summary

Financial Plan Summary	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Revenues										
Rate Revenue Under Existing Rates	$ 3,071,639	$ 3,113,678	$ 3,156,292	$ 3,199,490	$ 3,243,279	$ 3,287,667	$ 3,304,105	$ 3,320,626	$ 3,337,229	$ 3,353,915
Other Non-Rate Revenues	236,880	236,880	236,880	236,880	236,880	236,880	236,880	236,880	236,880	236,880
Use of Debt Sinking Fund (430) for Debt Service	18,369	82,527	873,210	-	-	-	-	-	-	-
Use of Debt Reserves for Debt Service	-	-	-	-	-	-	-	-	-	-
Total Revenues	$ 3,326,888	$ 3,433,085	$ 4,266,382	$ 3,436,370	$ 3,480,159	$ 3,524,547	$ 3,540,985	$ 3,557,506	$ 3,574,109	$ 3,590,795
Expenses										
Cash Operating Expenses	$ 4,417,259	$ 4,061,263	$ 4,209,914	$ 4,364,377	$ 4,524,883	$ 4,691,676	$ 4,812,476	$ 4,985,100	$ 5,164,543	$ 5,351,077
Debt Service										
PWTF Loans	69,284	335,458	334,847	334,236	333,625	333,014	332,403	331,792	331,181	330,570
Other Debt	-	-	1,086,434	1,086,434	1,086,434	1,897,391	1,897,391	1,897,391	2,427,323	2,427,323
Other Rate-Funded Capital	-	-	-	-	-	-	168,602	-	-	2,627,243
Additions to Operating Reserve	-	-	24,436	25,391	26,385	27,418	19,858	28,376	29,497	30,663
Total Expenses	$ 4,486,542	$ 4,396,721	$ 5,655,632	$ 5,810,438	$ 5,971,327	$ 6,949,499	$ 7,230,730	$ 7,242,660	$ 7,952,544	$ 10,766,876
Net Cash Flow Under Existing Rates	$ (1,159,654)	$ (963,636)	$ (1,389,250)	$ (2,374,068)	$ (2,491,168)	$ (3,424,952)	$ (3,689,745)	$ (3,685,154)	$ (4,378,435)	$ (7,176,080)
Coverage Ratio Realized Under Existing Rates	(N/A)	(N/A)	(0.20)	(0.42)	(0.52)	(0.27)	(0.48)	(0.62)	(0.53)	(0.58)
Coverage Ratio Required	*(N/A)*	*(N/A)*	*1.25*	*1.25*	*1.25*	*1.25*	*1.25*	*1.25*	*1.25*	*1.25*
Annual Rate Adjustment Required	*61.4%*	*-1.4%*	*2.0%*	*6.8%*	*-3.9%*	*-0.3%*	*-8.2%*	*-19.0%*	*-20.8%*	*-2.7%*
Annual Rate Adjustment Implemented	39.7%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%	13.0%
Rate Revenue After Rate Adjustments	$ 3,986,056	$ 4,915,034	$ 5,630,001	$ 6,448,972	$ 7,387,074	$ 8,461,638	$ 9,609,459	$ 10,912,982	$ 12,393,328	$ 14,074,483
Net Cash Flow After Rate Adjustments	$ (410,583)	$ 511,996	$ 661,596	$ 313,229	$ 929,725	$ 840,874	$ 1,495,325	$ 2,562,720	$ 3,069,627	$ 1,636,645
Coverage Ratio After Rate Adjustments	(N/A)	(N/A)	1.62	1.98	2.54	1.92	2.19	2.59	2.46	2.96

Sewer Rates	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Base Rate - Multifamily and Commercial										
5/8" to 3/4"	$47.17	$53.31	$60.24	$68.07	$76.92	$86.92	$98.21	$110.98	$125.41	$141.71
1"	$70.75	$79.95	$90.35	$102.09	$115.36	$130.36	$147.31	$166.46	$188.10	$212.55
1 1/2"	$117.91	$133.24	$150.57	$170.14	$192.26	$217.25	$245.49	$277.41	$313.47	$354.22
2"	$180.80	$204.31	$230.87	$260.88	$294.80	$333.12	$376.43	$425.36	$480.66	$543.14
3"	$660.34	$746.19	$843.19	$952.81	$1,076.67	$1,216.64	$1,374.80	$1,553.53	$1,755.48	$1,983.70
4"	$738.96	$835.03	$943.58	$1,066.25	$1,204.86	$1,361.49	$1,538.48	$1,738.48	$1,964.49	$2,219.87
6"	$1,100.58	$1,243.66	$1,405.34	$1,588.03	$1,794.47	$2,027.76	$2,291.36	$2,589.24	$2,925.84	$3,306.20
8"	$1,509.37	$1,705.59	$1,927.31	$2,177.86	$2,460.98	$2,780.91	$3,142.43	$3,550.95	$4,012.57	$4,534.20
Volume Rates - Multi-Family and Commercial										
Multi-Family (3 or more units)	$5.42	$6.12	$6.92	$7.82	$8.84	$9.99	$11.28	$12.75	$14.41	$16.28
Commercial A Meter ≤ 2"	$7.31	$8.26	$9.33	$10.54	$11.91	$13.46	$15.21	$17.19	$19.42	$21.95
Commercial B Meter ≥ 3"	$4.79	$5.41	$6.12	$6.91	$7.81	$8.83	$9.98	$11.27	$12.74	$14.39
Government	$7.15	$8.08	$9.13	$10.32	$11.66	$13.18	$14.89	$16.83	$19.01	$21.49
Residential Rates (Base & Volume)										
Low Income Residential (≤ 3,000 gallons water usage)	$26.61	$30.07	$33.98	$38.40	$43.39	$49.03	$55.40	$62.61	$70.75	$79.94
Low Income Residential (≥ 4,000 gallons water usage)	$32.90	$37.17	$42.01	$47.47	$53.64	$60.61	$68.49	$77.40	$87.46	$98.83
Residential Including Duplexes (≤ 3,000 gallons water usage)	$53.22	$60.14	$67.96	$76.80	$86.78	$98.06	$110.81	$125.21	$141.49	$159.88
Residential Including Duplexes (≥ 4,000 gallons water usage)	$65.80	$74.35	$84.01	$94.94	$107.28	$121.22	$136.98	$154.79	$174.91	$197.65
Capital Surcharge (Per Month)										
Other	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Low-Income	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Fund Summary	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Operating Fund (Fund 411)										
Projected Ending Balance (After Rate Adjustments)	$ 726,125	$ 667,605	$ 692,041	$ 717,432	$ 743,816	$ 771,234	$ 791,092	$ 819,469	$ 848,966	$ 879,629
Projected Ending Balance (Days of Operating Expenses)	60 Days	60 Days	60 Days	60 Days	60 Days	60 Days	60 Days	60 Days	60 Days	60 Days
Minimum Balance Required (Days of Operating Expenses)	*60 Days*	*60 Days*	*60 Days*	*60 Days*	*60 Days*	*60 Days*	*60 Days*	*60 Days*	*60 Days*	*60 Days*
Construction Fund (Fund 415)										
Projected Capital Expenses	$ 5,395,950	$ 12,218,388	$ 10,497,090	$ 2,794,500	$ 2,204,891	$ 2,787,473	$ 10,301,848	$ 6,914,169	$ 1,842,231	$ 8,839,834
Planned Funding Strategy:										
Grants & Contributions	$ 2,533,000	$ 3,100,000	$ 581,500	$ 581,500	$ -	$ -	$ -	$ -	$ -	$ -
Direct Rate Funding	-	-	-	-	-	-	168,602	-	-	2,627,243
Loans	1,050,000	-	-	-	-	-	-	-	-	-
Revenue Bonds	-	14,200,000	-	-	10,100,000	-	-	6,600,000	-	-
Cash Reserves	-	-	9,915,590	2,213,000	-	2,787,473	10,133,246	314,169	1,842,231	6,212,591
Total	$ 3,583,000	$ 17,300,000	$ 10,497,090	$ 2,794,500	$ 10,100,000	$ 2,787,473	$ 10,301,848	$ 6,914,169	$ 1,842,231	$ 8,839,834
Total Debt Issued	$ 1,050,000	$ 15,440,843	$ -	$ -	$ 11,021,169	$ -	$ -	$ 7,201,952	$ -	$ -
Projected Ending Balance	$ 5,019,009	$ 11,309,101	$ 2,782,657	$ 1,502,321	$ 10,948,251	$ 9,786,449	$ 1,648,009	$ 4,273,245	$ 5,923,735	$ 1,802,994
Minimum Balance Required	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Reserve (Funds 419/424/426)										
Projected Ending Fund Balance	$ -	$ 1,086,434	$ 1,102,731	$ 1,119,272	$ 1,947,018	$ 1,976,223	$ 2,005,866	$ 2,565,887	$ 2,604,375	$ 2,643,440
Debt Sinking Fund (430)										
Water Capital Surcharge Revenue	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Transfers from System Development Charge Fund (Fund 495)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Projected Ending Fund Balance	$ 928,898	$ 860,305	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

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Appendix P

Agency Review Correspondence

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