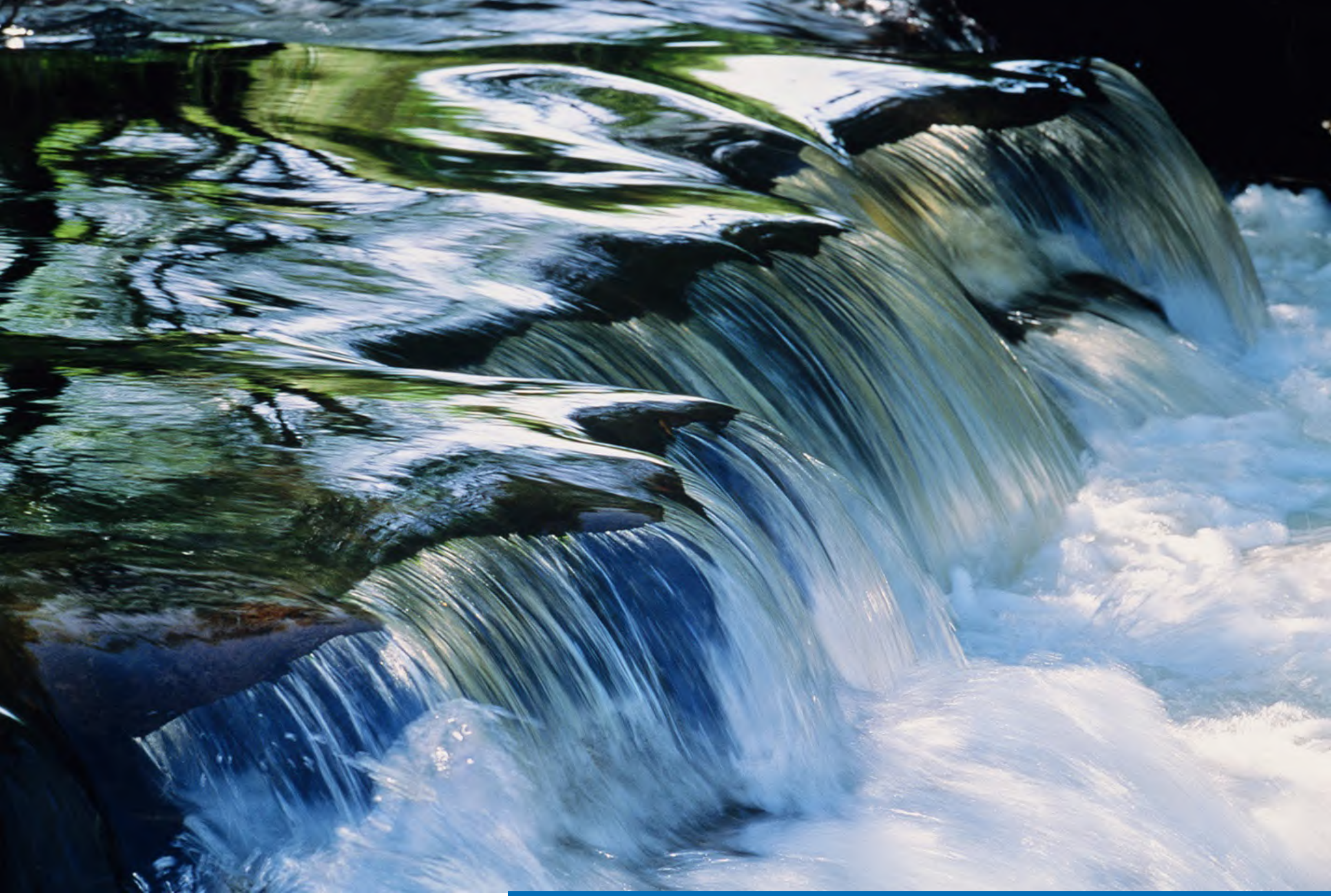

City of Camas

GENERAL SEWER PLAN

DRAFT | June 2022

City of Camas

GENERAL SEWER PLAN

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This document is released for the purpose of information exchange review and planning only under the authority of Joshua R. Miner, June 23, 2022, State of Washington PE No. 22015138.

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Abbreviations

°F	degrees Fahrenheit
AACE	American Associate of Cost Estimators
AAF	average annual flow
AB	aeration basin
AC	alternating current
ACH	changes per hour
ADWF	Average Dry Weather Flow
AKART	all known, available and reasonable methods of prevention, control and treatment
Anx	Anoxic Zone
aSRTs	aerobic solids retention times
ATS	automatic transfer switch
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
CARA	Critical Aquifer Recharge Area
Carollo	Carollo Engineers, Inc.
CCTV	closed-circuit television
CFD	computational fluid dynamics
CFM	cubic feet per minute
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIP	Capital Improvement Plan
City	City of Camas
CMC	Camas Code of Ordinances / Municipal Code
CMMS	Computerized Maintenance Management System
CWA	Clean Water Alliance
d	depth
D	diameter
d/D	depth versus diameter
DMR	discharge monitoring report
DMZ	demilitarized zone
DNS	determination of non-significance
DO	dissolved oxygen
DOE	Department of Ecology
DWF	dry weather flow
E&IC	electrical instrumentation and control
EA	Environmental Assessment
Ecology	Washington State Department of Ecology

ENR	Engineering News Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FOG	fats, oil and grease
FONSI	finding of no significant impact
ft	feet
ft/sec	feet per second
ft^3	cubic feet
gal	gallon
GIS	geographic information system
GMA	Washington Growth Management Act
gpad	gallons per acre per day
gpcd	gallons per capita day
gpd	gallons per day
gpd/sq ft	gallons per day per square foot
gpm	gallons per minute
GSP	general sewer plan
GWI	groundwater infiltration
HDPE	high-density polyethylene
HGL	Hydraulic Grade Line
HMI	human-machine interface
hp	horsepower
hr	hour
I/I	Inflow and Infiltration
IDWF	Influent Dry Weather Flow
in	inch(es)
lbs/day	pounds per day
LEL	Lower Explosive Limit
LF	linear feet
LOS	level of service
LS	lift station(s)
MG	million gallons
$Mg(OH)_2$	Magnesium Hydroxide
mg/L	milligrams per liter
mgd	million gallons per day
MH	manhole
mi	mile
mL	milliliter

mL/g	milliliters per gram
MLSS	mixed liquor suspended solids
mm	millimeter
MMF	maximum monthly flow
MS4	Municipal Separate Storm Sewer System
n	Manning's Coefficient
N/A	Not applicable
NASSCO	National Association of Sewer Service Companies
NEPA	National Environmental Policy Act
NH4	ammonia
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
O&M	operation and maintenance
Orange Book	Ecology's Criteria for Sewage Works Design book
Ox	Aerobic Zone
PC	primary clarifier
PCB	polychlorinated biphenyl
PDCs	power distribution centers
PDF	peak day flow/load
PDX	Portland Airport
Penn Valley	Penn Valley Pump Company, Inc.
PHD	peak hour demand
PHDF	peak hour demand flow
PHF	peak hour flow
Plan	City of Camas General Sewer Plan
PLC	programmable logic controller
ppcd	pounds per capita day
ppd	pounds per day
ppm	parts per million
PS	Pump Station???
psi	pounds per square inch
PVC	polyvinyl chloride
PWWF	peak wet weather flow
QA/QC	quality assurance and quality control
RAS	Return Activated Sludge
RCW	Revised Code of Washington
RDI/I	rainfall dependent infiltration and inflow
RIOs	remote input/output

R&R	repair and replacement
SAx	Anaerobic Selector Zone
SC	secondary clarifier
SCADA	supervisory control and data acquisition
SEPA	State Environmental Policy Act
SPA	state point analysis
SR	State Route
SSO	sanitary sewer overflow
STE	septic tank effluent
STEF	septic tank effluent filter
STEG	septic tank effluent gravity
STEP	septic tank effluent pump
SU	standard units
SVI	sludge volume index
SWCAA	Southwest Clean Air Agency
SWPPP	stormwater pollution prevention plan
TCLP	toxic characteristic leachate procedure
TM	technical memorandum
TP	treatment plant
TSS	Total Suspended Solids
UGA	Urban Growth Area
UGB	Urban Growth Boundary
UV	ultraviolet
VCP	vitrified clay pipe
VFD	variable frequency drive
WAC	Washington Administrative Code
WAS	Waste Activated Sludge
WRF	water reclamation facility
WSE	water surface elevations
WTP	water treatment plant
WWTF	wastewater treatment facility
WWTFO	Washington Wastewater Treatment Facility Operator

EXECUTIVE SUMMARY

ES.1 Introduction

The City of Camas (City) is located in Clark County, Washington near the border of Washington and Oregon along the Columbia River near Vancouver, Washington. The City owns and operates most of the sewer collection system within the City limits and its urban growth boundary (UGB). The collection system is a combination of gravity sewers, pump stations, force mains, and septic tank effluent pump (STEP) systems. Wastewater is collected and treated by the City at the Camas Wastewater Treatment Plant and then discharged to the Columbia River.

The purpose of the City's General Sewer Plan (Plan) is to develop a clear and logical path to manage the collection system over the next 20 years. The Plan results from an evaluation of the sanitary sewer system which identified deficiencies and concerns that must be addressed to provide service to existing users, as well as improvements needed to accommodate growth. Key elements addressed in the Plan include:

- The need and timing of the replacement of older, deteriorating sanitary sewer facilities within large, neighborhood-size areas within the City.
- The evaluation of system capacity to address both existing deficiencies and potential development.
- The identification of sanitary sewer lift stations and force mains requiring removal, rehabilitation, and replacement.
- The City's Infiltration and Inflow (I/I) program to evaluate options and needs for I/I reduction.
- Implementation of recommended improvements by priority which maintains affordable rates for the system users.

ES.1.1 Sewer Service Area

A map of the sewer service area is presented in Figure ES.1.

ES.2 Policies

The City is responsible for managing and operating its wastewater system in accordance with all local, state, and federal regulations. To best manage the wastewater system and comply with regulations, the City has adopted wastewater system policies and criteria. These policies guide the development and financing of the infrastructure required to provide wastewater service and document the City's commitments to current wastewater system customers as well as those considering service from the City. The following policies and criteria are summarized in Chapter 2 - Policies:

- Environmental Stewardship.
- Design Criteria and Standards.
- Financial Policies.
- Regulatory Requirements.

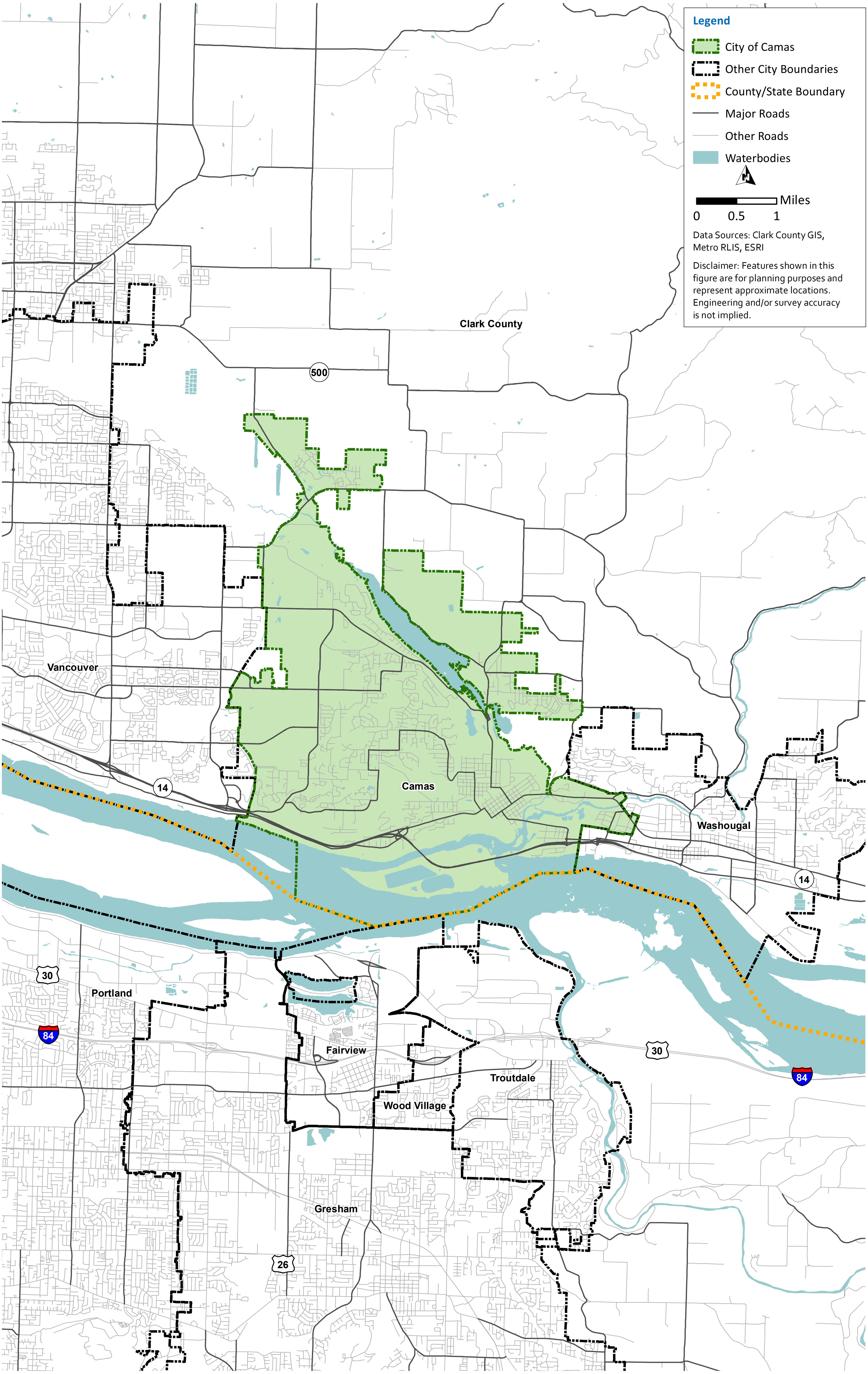

Figure ES.1 Vicinity Map

ES.3 Basis of Planning

Chapter 3 of the Plan presents flow projections for the collection system and wastewater treatment facility (WWTF) based on demographic growth projections from the *2035 Comprehensive Plan*. Slightly different methodologies are used to project wastewater flows in the collection system and WWTF due to the requirements of the analyses and availability of data. Two major factors drive these differences. First, the collection system analysis considered flow monitoring data collected during a four-month period in the winter of 2018 and 2019, while the WWTF analysis uses historical influent data from 2015 through 2018. Second, the WWTF was assessed using flows projected for 2035, while collection system flows consider both 2035 and buildout of the service area. Collection system piping is typically sized using the buildout period projections since these pipes have a 75-year service life.

ES.3.1 Collection System Flow Projections

The collection system flow projections were developed for use in the City's calibrated hydraulic model of the sewer system. The modeled system corresponds with the study area of the 2019 flow monitoring program, which focused on the lower basins in the collection system closest to the WWTF. The data collected during the flow monitoring program was used along with population growth projections, land use development projections, and wastewater flow factors to develop the flow projections presented in Table ES.1.

Table ES.1 Hydraulic Model Flow Projections Summary

Planning Horizon	ADWF (mgd)	PWWF (mgd)	Peaking Factor (PWWF : ADWF)
2018	0.80	5.45	6.8
2035	1.63	13.33	8.2
Buildout	2.63	14.86	5.7

Notes:
Abbreviations: ADWF - average dry-weather flow; mgd - million gallons per day; PWWF - peak wet weather flow.

ES.3.2 WWTF Flow and Load Projections

The City's WWTF receives flows from the gravity collection system, septic tank effluent, and the septage receiving station. The sum of these flows is greater than the collection system flow projections because the analysis performed for this Plan only focused on the portion of the system included in the hydraulic model and did not include septic tank flows, which constitute up to 50 percent of the total influent flow. Thus, load and peak hour flow projections were developed independently for the WWTF based on measured influent flows and wastewater characteristics, typical septage and STEP system characteristics, and population growth projections. The City expects that half of additional plant flow from population growth within the service area will come from the gravity sewer system, while the other half of the additional flow will come from the STEP system. The influent flow projections developed for the WWTF are summarized in Table ES.2.

Table ES.2 Current and Projected WWTF Flows

Flow Parameter	2021 Flow (mgd)	2035 Flow (mgd)
ADWF	2.2	3.4
AAF	2.8	4.0
MMF	4.8	6.2
PDF	8.4	10.8
PHF	10.0	13.5

Notes:
Abbreviations: AAF - average annual flow; MMF - maximum monthly flow; PDF - peak day flow/load; PHF - peak hour flow.

Wastewater loading data which are related to effluent limitations contained in the City's WWTF National Pollution Discharge Elimination System (NPDES) permit were also projected to evaluate treatment capacity for future conditions. Historical values for 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), and ammonia (NH_3) and projections to 2035 are detailed in Table ES.3.

Table ES.3 Current and Projected WWTF Loads

Load Parameter	2021 Load (ppd)	2035 Load (ppd)
Sewered Population(1)	18,900	36,000
BOD_5 (ppd)		
Average Annual	2,400	6,000
Max Month	3,300	8,200
Max Week	4,300	10,600
Peak Day	5,300	13,000
TSS (ppd)		
Average Annual	2,400	6,300
Max Month	3,300	10,500
Max Week	4,300	17,000
Peak Day	5,300	19,300
Ammonia (ppd)		
Average Annual	900	1,400
Max Month	1,100	2,000
Peak Day	1,800	4,300

Notes:
(1) Current sewered population is based on 2035 Comprehensive Plan.

ES.4 Existing System

Chapter 4 describes the sewer system within the City's service area, which is owned, maintained, and operated by the City. A map of the existing system is shown in Figure ES.2. The City's conventional system (modeled for this Plan) includes 236,200 linear feet of gravity mains, 29 lift stations, and 38,260 linear feet of force main, which convey nearly half of the total influent flow to the City's WWTF. The septic tank effluent systems convey the remainder of the total flow treated by the City's WWTF through 263,110 linear feet of dedicated sewer mains. The septic tanks provide preliminary wastewater treatment, solids settling, and some digestion such that the effluent is not as strong as raw sewage collected in the conventional system. Each septic tank in the City's service area is pumped out on a five-year cycle and the solids are trucked to the WWTF for treatment.

The City's WWTF is located along the Columbia River in the southeastern portion of its sewer service area. The WWTF was originally constructed in 1972 and has had several modifications since that time to increase capacity and improve treatment capabilities to continue to meet all effluent permit requirements. The City's NPDES effluent discharge limitations, prohibitions, and requirements are similar to other municipal facilities with standard 30/30 monthly TSS and BOD concentration limits with a mandatory 85 percent reduction in each. However, the WWTF has ammonia limits of 20 milligrams per liter (mg/L) (NH_3 as N) in the summer and 7 mg/L (NH_3 as N) in the winter. An aerial view of the WWTF with each unit process and building identified is shown in Figure ES.3.

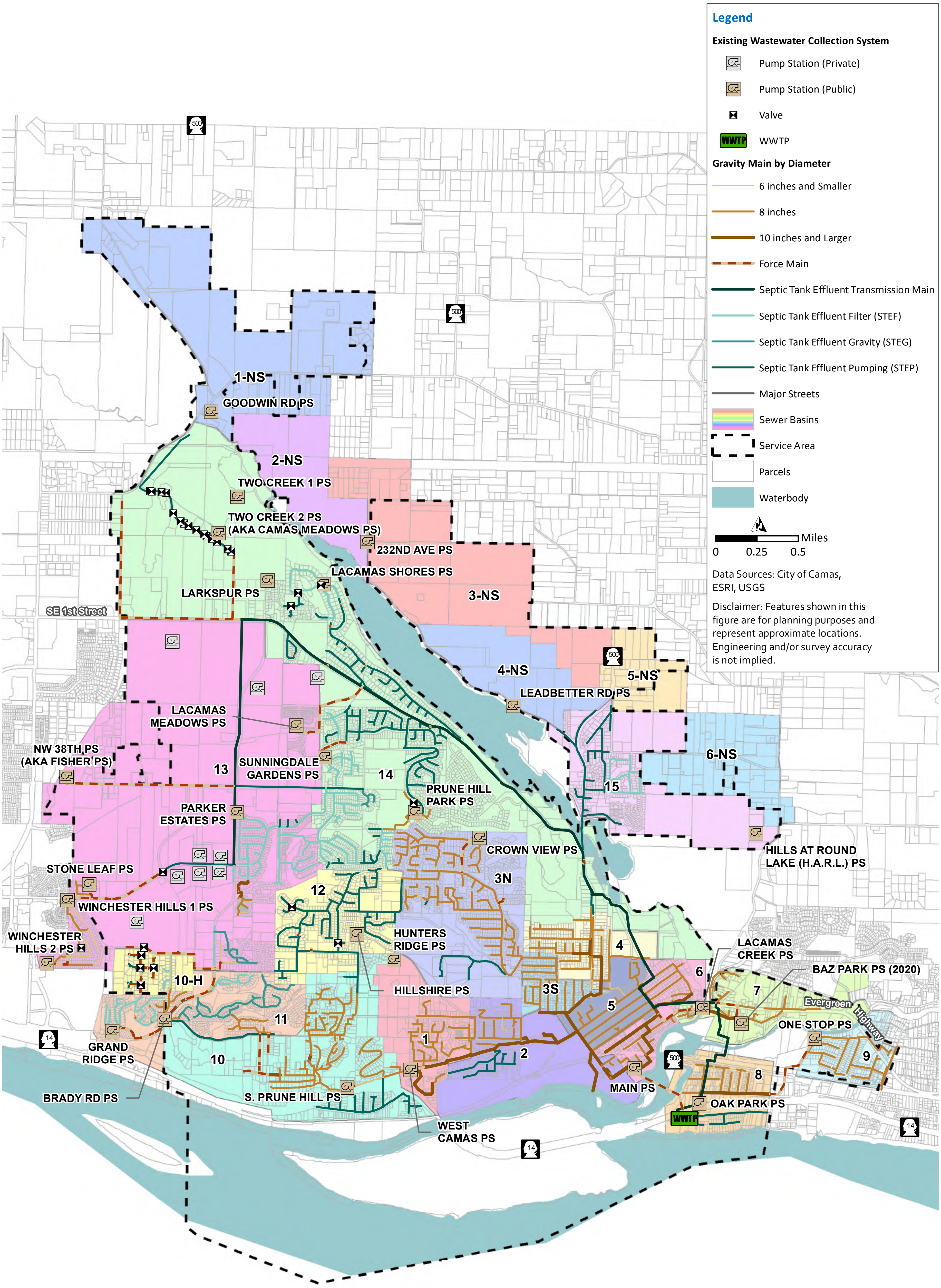

Figure ES.2 Existing Wastewater Collection System

Figure ES.3 WWTF Aerial Image with Site Plan

ES.5 Infiltration and Inflow Program

Chapter 5 of this plan summarizes the City's efforts to reduce I/I from 2016 through 2020 and the quantifiable, positive improvement that has been accomplished in reducing I/I. Infiltration and inflow consist of two components which may combine or act independently to increase flow volume and peak flows in the sewer system. If too much I/I enters the sewer system such that the sewer system is operating at or above its capacity, sanitary sewer overflows (SSO) could occur. More dilute wastewater can also be more difficult to treat under percent removal NPDES permits such as those held by the City.

In 2016, the City commissioned an evaluation of the collection system to document existing infiltration and inflow as a condition of their new stormwater permit. The results of this study showed that there was excessive inflow compared to the EPA's guidelines. Since 2016, the City initiated an I/I reduction program and has completed improvement projects each year, totaling well over $1 million. A follow up study completed in 2020 showed significant improvements in I/I and improved WWTF performance. Table ES.4 summarizes the improvements in per capita I/I observed in the City's collection system. The City is continuing to invest in the collection system to further reduce I/I through a pipeline repair and replacement program along with improvements to two key lift stations: Crown View pump station and Lacamas Creek pump station.

Table ES.4 Per Capita I/I Compared to EPA Criteria

Parameter	EPA Criteria for Excessive I/I (gpcd)	I/I Value for Camas in 2014 (gpcd)	Current I/I Value for Camas (gpcd)
EPA Excessive Infiltration Criteria	120	80	46
EPA Excessive Inflow Criteria	275	348	176

Notes:
Abbreviations: gpcd - gallons per capita day.

ES.6 System Analysis

Chapter 6 describes the hydraulic modeling analysis conducted for gravity pipes and pump stations in the modeled portion of the City's collection system. The modeled collection system is primarily large gravity sewers which represent a skeletonized version of the system that does not include the septic tank effluent infrastructure. The analysis identified capacity deficiencies associated with current and projected future use and recommends improvements to alleviate any identified concerns. The collection system was evaluated applying three planning scenarios:

- **Existing:** Matching existing conditions.
- **2035:** Incorporating flows related to growth through 2035 as identified in the City's comprehensive plan.
- **Build-Out:** Development of the full service area including urban growth boundary.

Performance and design criteria for the conveyance system are outlined below:

- **Performance Criteria:** During PWWF for the design storm, water levels should not exceed a maximum depth to diameter flow ratio (d/D) of 1.2 for build-out conditions, and a d/D of 1.0 for existing conditions. No surcharging (d/D>1.0) is allowed at manholes where the distance between crown of pipe and manhole rim is less than three feet.
- **Design Criteria:** New sewers shall be designed to flow at a maximum d/D of 1.0 at peak flow rates for both existing and build-out conditions.

The City's lift stations should have sufficient firm capacity to pump the PWWF during the design storm with the largest pump out of service. Other pump station and force main design criteria are presented in Chapter 2 of the Plan.

ES.6.1 Gravity Collection System Evaluation

For each planning scenario, the associated PWWF was routed through the hydraulic model. The peak hydraulic grade line in manholes and gravity pipelines was compared to the established performance criteria. Under existing conditions there are seven potential problem areas where the capacity is deficient to convey the PWWF. Two additional deficiency areas were identified in the build-out scenario.

ES.6.2 Lift Station Evaluation

The City's hydraulic model includes five out of the seven lift stations located in the gravity collection system. The estimated current and future PWWFs were compared to the five lift station firm capacities in the hydraulic model. For the two lift stations not in the model, firm capacity was compared to projected influent flows. Four of the seven lift stations did not meet the firm capacity criteria under current conditions and the deficiencies were exacerbated under build-out conditions.

ES.6.3 Recommended Improvements

When an increase in capacity is required, existing sewers can be upsized to a larger diameter pipe, or parallel or relief sewers can be constructed. Table ES.5 summarizes the recommended pipe capacity improvement project details.

It is recommended that the Main, South Prune Hill, West Camas, and Crown View Plaza PSs all be upgraded to provide pump redundancy under existing PWWF conditions. These stations do not meet the required firm capacity, based on the City's performance criteria. Table ES.6 summarizes the recommended lift station improvement project details.

Table ES.5 Recommended Pipe Capacity Improvements Projects

Project ID	Improvement Type	Location	Existing Size (inch)	Proposed Size (inch)	Length (feet)	Phase
P-1	Gravity	NW Fargo Street between NW 23rd and NW 19th Avenue	8	12	1,007	Short-term
P-2	Gravity	Division Street between NW 18th and NW 11th Avenue	8	12	2,043	Short-term
P-3	Gravity	NW 6th Place, just upstream of South Prune Hills PS	8 10	12 12	188 616	Short-term
P-4	Gravity	NW 6th Place between South Prune Hills PS and West Camas PS	10	12	588	Short-term
P-5	Gravity	NW 6th Avenue downstream of West Camas PS and through Forest Home Park	12 12	15 18	311 1,340	Short-term
P-6	Gravity	NW 6th Avenue between NW 7th Avenue and SE Adams Street	12 8	18 21	817 401	Short-term
P-7	Gravity	NE and SE Adams Street between SE 3rd Avenue and NW 6th Avenue	21 24	24 27	773 925	Short-term
P-8	Gravity	NW 18th Loop	8	12	609	Long-term
P-9	Gravity	NE 15th Avenue between NE Garfield Street and NE Franklin Street	8	18	256	Long-term

Table ES.6 Recommended Lift Station Improvement Projects

Project ID	Improvement Type	Location	Description	Phase
PS-1	Gravity	South Prune Hills	Add pump capable of pumping 664 gpm.	Existing
PS-2	Gravity	West Camas	Add pump capable of pumping 723 gpm.	Existing
PS-3	Gravity	Crown View Hill	Add pump capable of pumping 382 gpm.	Existing
PS-4	Gravity	Main	Add pump capable of pumping 1,831 gpm.	Existing
PS-5	Gravity	Lacamas Shores, Sunningdale Gardens, Winchester Hills 2	Add flow monitors and pressure sensors to get a better understanding of what happens during peak flows and their capacity to aid in future capital improvement planning.	Existing

Notes:
Abbreviations: gpm - gallons per minute.

ES.7 Wastewater Treatment Facility

Chapter 7 summarizes efforts to identify shortfalls in WWTF capacity that will prevent the City from reliably treating and disposing of projected flow and loads in compliance with their NPDES permit at the end of the planning period (i.e., year 2035). To address the identified deficiencies, an alternatives analysis of the most viable improvement options was conducted, which resulted in the development of 14 projects to be incorporated into the Plan's capital improvement program (CIP). Table ES. 7 summarizes the recommended WWTF improvement project details.

Table ES.7 Recommended WWTF Improvement Projects

Project ID	Description	Improvement Type	Phase
TP-1	This project will improve the aeration basin's performance and increase treatment capacity.	Capacity	Short-Term
TP-2	This project includes the replacement of an aging secondary clarifier and replacement of RAS pumps for another secondary clarifier.	Capacity/Condition	Short-Term
TP-3	This project replaces two of the existing aeration blowers with larger high-speed turbo blowers to meet projected aeration demands	Capacity	Short-Term
TP-4	This project enhances plant hydraulics in several areas and includes the replacement of obsolete UV disinfection equipment.	Condition/ Capacity	Short-Term
TP-5	This project increases the effluent pump station's capacity, as required, to pump 100% of 2035's projected PHFs to the outfall in the Columbia River by replacing the existing effluent pumps with larger units.	Capacity	Short-Term
TP-6	This project replaces the existing grit-separation equipment, including hydrocyclones and grit classifiers, and increases the capacity of the odor control systems servicing the grit-handling area and dewatering building, which will extend the life and reduce maintenance of new installed equipment.	Condition	Short-Term
TP-7	This replaces the existing thickened primary sudge pumps with new progressive cavity pumps.	Condition	Long-Term
TP-8	This project replaces the existing digested sludge pumps with new double-disc piston-style pumps.	Condition	Long-Term
TP-9	This project rehabilitates the existing dewatering centrifuge and modifies the space to accommodate a standby unit for redundancy.	Condition	Short-Term
TP-10	This project repairs the existing plant drain pump station No. 1's structure and replaces its pumps.	Capacity/ Condition	Short-Term
TP-11	This project prepares a SCADA master plan that will provide the City with a roadmap to prioritize and implement planned system upgrades designed to address system deficiencies and enhance facility operation. This project includes an in-depth investigation of the existing SCADA control system for the City's WWTF and associated remote sites.	Planning	Short-Term

Project ID	Description	Improvement Type	Phase
TP-12	This project upgrades the existing SCADA system to provide redundancy and take advantage of modern features, including advanced data analysis, report generation, and secure remote accessibility	Network	Short-Term
TP-13	This project includes replaces existing Modicon Quantum hardware with new, standardized PLCs and RIO cabinets for all process areas at the WWTF.	Network	Short-Term
TP-14	This project plans for a future secondary treatment expansion to accommodate flows and loads outside the planning windows.	Planning	Long-Term

ES.8 Operations and Maintenance

Chapter 8 provides an overview of the City's wastewater utility organization, staffing, and operations and maintenance (O&M) program. City staff for the drinking water system and sewer system are combined. The staff works to provide effective and efficient service for utility rate payers through regular operation and maintenance activities on these systems as outlined in the program included in this Chapter.

ES.9 Capital Improvement Plan

The CIP presented in Chapter 9 includes projects needed to accommodate growth, repair and replace aged infrastructure, and attain level of service goals. The CIP is organized and prioritized in two separate project categories short-term (2022-2031) and long term (2032-2041) periods. Projects are grouped into pipeline, pump station, STEP, I/I, maintenance, treatment plant, and general types of infrastructure work. The CIP consists of the cost estimates and schedules for the recommended improvements. Table ES.8 summarizes the recommended CIP projects and estimated project costs. Approximately $41,000,000 of capital improvement projects have been identified for the short-term and an additional $21,435,00 in improvement projects have been identified for the long-term.

ES.10 Financial Analysis

Chapter 10 presents the financial analysis performed as part of this Plan to assess program needs that will allow the City's sewer utility to remain financially viable throughout the planning period. This financial viability analysis considered the historical financial conditions, current and identified future financial and policy obligations, O&M needs, and the financial impacts of the capital projects identified in this Plan. The results of this analysis indicate that rates must increase to provide revenue sufficient to cover all utility financial obligations, including the addition of new debt and partial cash funding of the capital program through 2031. In addition to the adopted annual increases of 3.30 percent in 2022 and 2023, annual 1.75 percent adjustments from 2024 through 2026 should provide for continued financial viability while maintaining generally affordable rates.

Table ES.8 Capital Improvement Plan Summary

City of Camas
General Sewer Plan
Capital Improvement Plan

Capital Improvement Plan Summary

Project		CIP Project Subtotal[1]	Total CIP Cost Estimate	CIP Phasing 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Short-term (2022-2031)	Long-term (2032-2041)	Project Type Growth	Repair & Replacement	Level of Service
Gravity Pipeline																		
P-01	NW Fargo St Upsize	$ 354,000	$ 644,000	$ -	$ 644,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 644,000	$ -	0%	0%	100%
P-02	Division St Upsize	$ 717,000	$ 1,306,000	$ -	$ 1,306,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,306,000	$ -	0%	0%	100%
P-03	NW 6th Pl West Upsize	$ 282,000	$ 514,000	$ -	$ 514,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 514,000	$ -	0%	0%	100%
P-04	NW 6th Pl East Upsize	$ 207,000	$ 376,000	$ -	$ 376,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 376,000	$ -	0%	0%	100%
P-05	NW 6th Ave West Upsize	$ 454,000	$ 825,000	$ -	$ 825,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 825,000	$ -	0%	0%	100%
P-06	NW 6th Ave East Upsize	$ 339,000	$ 617,000	$ -	$ 617,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 617,000	$ -	0%	0%	100%
P-07	Adams St Upsize	$ 678,000	$ 1,235,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 554,000	$ 681,000	$ -	$ 1,235,000	$ -	50%	0%	50%
P-08	NW 18th Loop Upsize	$ 214,000	$ 389,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 389,000	50%	0%	50%
P-09	NE 15th Ave Upsize	$ 98,000	$ 179,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 179,000	50%	0%	50%
	Gravity Subtotal		**$ 6,085,000**	**$ -**	**$ 4,282,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 554,000**	**$ 681,000**	**$ -**	**$ 5,517,000**	**$ 568,000**			
Pump Station																		
PS-01	South Prune Hills Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	0%	0%	100%
PS-02	West Camas Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ -	$ -	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	50%	0%	50%
PS-03	Crown View Hill Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	0%	0%	100%
PS-04	Main Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	$ 510,000	$ -	50%	0%	50%
PS-05	Upgrade Pump Station Telemetry	$ 320,000	$ 14,560,000	$ -	$ -	$ -	$ 1,747,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,747,000	$ 12,813,000	50%	0%	50%
	Pump Station Subtotal		**$ 16,600,000**	**$ -**	**$ 510,000**	**$ 510,000**	**$ 1,747,000**	**$ 510,000**	**$ -**	**$ -**	**$ -**	**$ 510,000**	**$ -**	**$ 3,787,000**	**$ 12,813,000**			
General																		
G-01	Gravity Collection System Model	$ 270,000	$ 491,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 491,000	75%	0%	25%
	General Subtotal		**$ 491,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 491,000**			
STEP																		
S-01	STEP Main Flows	$ 126,000	$ 229,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 229,000	75%	0%	25%
S-02	STEP Main Modeling	$ 53,000	$ 96,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 96,000	75%	0%	25%
S-03	STEP Main Condition Assessment/ Cleaning	$ 451,000	$ 821,000	$ -	$ -	$ 821,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 821,000	$ -	0%	0%	100%
	STEP System Subtotal		**$ 1,146,000**	**$ -**	**$ -**	**$ 821,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 821,000**	**$ 325,000**			
Inflow and Infiltration																		
I&I-01	Ongoing I&I Program	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	50%	0%	50%
	Inflow and Infiltration Subtotal		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**			
Maintenance																		
M-01	WWTP R&R	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,000,000	$ -	0%	100%	0%
M-02	Pump Station R&R	$ 12,000,000	$ 12,000,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 6,000,000	$ 6,000,000	0%	100%	0%
M-03	Sewer Main R&R	$ 3,000,000	$ 3,000,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 1,500,000	$ 1,500,000	0%	100%	0%
M-04	STEP Tank R&R	$ 2,800,000	$ 5,095,000	$ -	$ 1,019,000	$ 1,019,000	$ 1,019,000	$ 1,019,000	$ 1,019,000	$ -	$ -	$ -	$ -	$ 5,095,000	$ -	0%	100%	0%
	Maintenance Subtotal		**$ 22,095,000**	**$ 2,750,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 750,000**	**$ 750,000**	**$ 750,000**	**$ 750,000**	**$ 14,595,000**	**$ 7,500,000**			
Treatment Plant																		
TP-01	Aeration Basin Improvements	$ 189,223	$ 376,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 376,000	$ -	$ -	$ -	$ 376,000	$ -	80%	20%	0%
TP-02	Secondary Clarifier Improvements	$ 2,785,535	$ 5,539,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,539,000	$ -	$ -	$ 5,539,000	$ -	50%	50%	0%
TP-03	Aeration Blower Replacement	$ 936,557	$ 1,862,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,862,000	$ -	$ 1,862,000	$ -	100%	0%	0%
TP-04	Disinfection Building / Hydraulic Improvements	$ 629,472	$ 1,252,000	$ -	$ 1,252,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,252,000	$ -	20%	80%	0%
TP-05	Effluent Pump Station Improvements	$ 641,550	$ 1,276,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,276,000	$ -	$ -	$ -	$ 1,276,000	$ -	100%	0%	0%
TP-06	Grit Separation / Odor Control Improvements	$ 507,998	$ 1,010,000	$ -	$ -	$ -	$ 1,010,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,010,000	$ -	0%	100%	0%
TP-07	TPS Pump Replacement	$ 77,520	$ 154,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 154,000	0%	100%	0%
TP-08	Sludge Recirculation Pump Replacement	$ 256,077	$ 509,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 509,000	0%	100%	0%
TP-09	Mechanical Dewatering Improvements	$ 828,992	$ 1,648,000	$ -	$ -	$ -	$ -	$ 1,648,000	$ -	$ -	$ -	$ -	$ -	$ 1,648,000	$ -	0%	100%	0%
TP-10	Plant Drain Pump Station No. 1 Improvements	$ 260,057	$ 517,000	$ -	$ 517,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 517,000	$ -	50%	50%	0%
TP-11	SCADA Master Plan	$ 208,964	$ 209,000	$ -	$ -	$ 209,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 209,000	$ -	50%	50%	0%
TP-12	SCADA Improvements	$ 324,439	$ 645,000	$ -	$ -	$ -	$ 645,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 645,000	$ -	50%	50%	0%
TP-13	PLC & RIO Improvements	$ 978,424	$ 1,946,000	$ -	$ -	$ -	$ 1,946,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,946,000	$ -	50%	50%	0%
TP-14	Secondary Treatment Expansion Planning	$ 75,000	$ 75,000			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 75,000	100%	0%	0%
	Treatment Plant Subtotal		**$ 17,018,000**	**$ -**	**$ 1,769,000**	**$ 209,000**	**$ 3,601,000**	**$ 1,648,000**	**$ -**	**$ 1,652,000**	**$ 5,539,000**	**$ 1,862,000**	**$ -**	**$ 16,280,000**	**$ 738,000**			
CIP Total			**$ 63,435,000**	**$ 2,750,000**	**$ 8,330,000**	**$ 3,309,000**	**$ 7,117,000**	**$ 3,927,000**	**$ 1,769,000**	**$ 2,402,000**	**$ 6,843,000**	**$ 3,803,000**	**$ 750,000**	**$ 41,000,000**	**$ 22,435,000**	**$ 17,495,700**	**$ 30,920,800**	**$ 15,018,500**
Annual Cost			$ 3,172,000	$ 2,750,000	$ 8,330,000	$ 3,309,000	$ 7,117,000	$ 3,927,000	$ 1,769,000	$ 2,402,000	$ 6,843,000	$ 3,803,000	$ 750,000	$ 4,100,000	$ 2,244,000	$ 875,000	$ 1,546,000	$ 751,000

Notes:

1. CIP Project Subtotal is project cost before contingency costs are added. CIP Project Cost = Estimated Construction Cost. Total CIP Project Cost = Estimated Construction Cost plus merkups for contingency, construction overhead (as applicable), engineering, and administration.
2. Part of existing City CIP Project.

Chapter 1

INTRODUCTION

1.1 Introduction

The purpose of the City of Camas's (City) General Sewer Plan (Plan) is to present policies and an assessment of the system to recommend facility improvements. The Plan is intended to provide a road map for accommodating growth and maintaining a high level of service for existing customers. The existing system is aging and will continue to require investment to maintain a high level of service.

The Plan results from an evaluation of the existing sanitary sewer system which provides the groundwork for recommendations to resolve existing deficiencies and concerns, as well as accommodating growth. This chapter presents the objectives of this Plan, and a brief overview of the City's wastewater collection system. A list of abbreviations is provided in the Table of Contents to assist the reader in understanding the information presented in this Plan.

This Plan and recommended improvements were prepared in accordance with requirements of Washington Administrative Code (WAC) 173-240-050, which is administered by the Washington State Department of Ecology (Ecology) and meets the requirements of the Washington Growth Management Act (GMA).

This Plan addresses the following key issues:

- The need and timing of the replacement of older, deteriorating sanitary sewer facilities within large, neighborhood-size areas within the City.
- The evaluation of the City's system capacity to address both system deficiency and potential development.
- The evaluation of sanitary sewer lift stations and force mains for removal, rehabilitation, and replacement.
- The City's Infiltration and Inflow (I/I) program to evaluate options and needs for I/I reduction.
- Implementation of recommended improvements by priority which maintains affordable rates for the system users.

1.2 Background and Goals

The City is located in Clark County, Washington near the border of Washington and Oregon. It is next to Vancouver, Washington along the Columbia River as shown in Figure 1.1. The City owns and operates most of the sewer collection system within the City limits and its urban growth boundary (UGB). The collection system is a combination of gravity sewers, pump stations, force mains, and septic tank effluent Pump (STEP) systems. Wastewater is collected and treated by the City at the Camas Wastewater Treatment Plant and then discharged to the Columbia River.

The City completed its last General Sewer Plan in 2010. The Plan provides a recognized framework for making decisions about Camas's sanitary sewer service area which includes properties both inside the City and UGB limits. It is intended to aid decision-makers as well as users, including Wastewater Utility, City Council members, the Mayor, City staff, builders, developers, community groups, and other government agencies.

1.3 Referenced Documents

The following documents were referenced in the preparation of this Plan:

- City of Camas 2010 General Sewer Plan.
- Camas 2035 Comprehensive Plan.
- Camas Code of Ordinances.
- Washington Administrative Code, Title 173. Defines the structure of general sewer plans.
- Criteria for Sewage Works Design (Ecology, 2008). Provides guidance for the design of municipal sewer systems and establishes minimum requirements in the State of Washington.
- Camas 2016 Water System Plan.

1.4 Washington State Requirements

The goals of this Plan, to meet the requirements from the Washington State Criteria for Sewage Works Design, include:

- Prepare the Plan in compliance with WAC Chapter 173-240-050.

Each WAC requirement is detailed in Table 1.1 as well as the location within the plan.

Table 1.1 WAC Plan Requirements

Requirement	Location in Plan
Purpose and need for the proposed plan	Chapter 1
Discussion of who will own, operate, and maintain the system	Chapter 2
Existing and proposed service boundaries	Chapter 4
Layout map including:	
• Proposed sewers and areas proposed to be served by each.	Figures 4.1 and 4.2
• Boundary lines of municipality or district and vicinity.	Figure 1.1
• Existing sewers and areas served by each.	Figure 4.2
• Topography and elevations of existing and proposed ground.	Figure 4.3
• Information on streams, lakes, other bodies of water, and discharges.	Figure 4.6 and 4.8
• Information on water systems.	Figure 4.8
Population trends and methods used to determine those trends	Chapter 3
Information on existing wastewater facilities in the area	Chapter 4, Chapter 7
Discussion of infiltration and inflow problems	Chapter 5
Discussion of the provisions for treatment, discharge, and reuse	Chapter 6, Chapter 7
Information on facilities producing industrial wastewater	Chapter 4
Information on existing wells or other water supply sources	Chapter 4
Discussion of alternatives evaluated, and alternatives chosen	Chapter 6, Chapter 7
Information on existing and proposed cost per service	Chapter 10
Statements regarding compliance with SEPA and, if applicable, NEPA	Appendix A

Notes:
Abbreviations: SEPA – Washington State Environmental Policy Act; NEPA – National Environmental Policy Act.

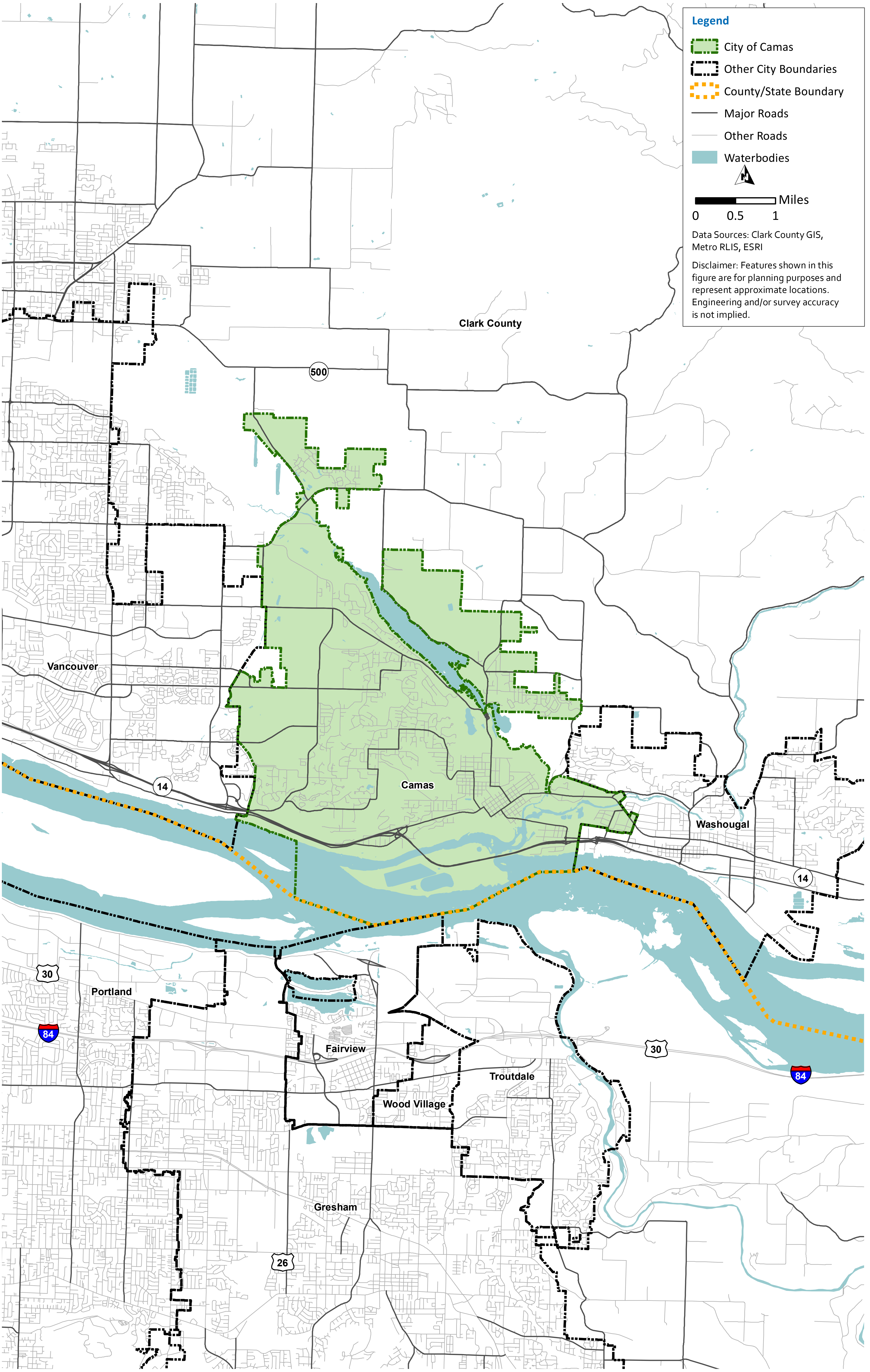

Figure 1.1 Vicinity Map

1.5 Report Organization

This Plan contains ten chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

- **Chapter 1 - Introduction:** This chapter presents the need for this Plan and the objectives of the study. Lists of abbreviations and reference materials are also provided to assist the reader in understanding the information presented.
- **Chapter 2 - Regulations, Policies, and Criteria:** This chapter documents applicable regulations, summarizes City policies impacting long-term sewer system planning, and presents the City's design criteria which are relevant to sewer system planning.
- **Chapter 3 - Basis of Planning:** This chapter presents an evaluation of historical wastewater flows and loads through the City's collection system and entering the wastewater treatment facility (WWTF). This chapter also establishes the WWTF's flow and load projections based upon future population growth for a 2035 projection and build out.
- **Chapter 4 - Existing System:** This chapter describes the City's existing sewer collection system, adjacent sewer service areas, and WWTF.
- **Chapter 5 - I/I Program:** This Chapter focuses on summarizing the City's efforts on I/I reduction from 2016 through 2018. It summarizes the amount of I/I for these years and specific projects completed to address I/I.
- **Chapter 6 - Collection System:** This chapter presents an evaluation of the available capacity of the existing system to convey current and future sewer flows. Recommendations are provided for improvement projects to address capacity deficiencies and level of service goals.
- **Chapter 7 - Wastewater Treatment Facility:** This chapter summarizes the WWTF Engineering report including condition of existing processes, capacity of existing processes and recommendations that will allow the City to reliably and cost-effectively serve their customers now and into the future.
- **Chapter 8 - Operations and Maintenance:** This chapter provides an overview of the City's Wastewater Utility organization, staffing, and operation and maintenance (O&M) program. This chapter documents existing practices and identifies changes that may improve system operation and maintenance.
- **Chapter 9 - Capital Improvement Program:** This chapter describes the improvements necessary to resolve existing and future deficiencies and accommodate growth. The proposed improvements are also listed by priority and project type.
- **Chapter 10 - Financial Analysis:** This chapter evaluates the financial status of the City's wastewater utility and the ability to finance CIP projects.

Additionally, Technical Memoranda (TM) are included in the appendices as follows:

- **Appendix E - TM 01: Hydraulic Model Update and Calibration.**

Other appendices are included as follows:

- **Appendix A - Approvals.**
- **Appendix B - Agency Comment Letters and Responses.**
- **Appendix C - Demographic Projections.**
- **Appendix D - Flow Monitoring Report.**

- **Appendix E - TM 01: Hydraulic Model Update and Calibration.**
- **Appendix F - I/I Program Reports.**
- **Appendix G - Local Limits Program Reports.**
- **Appendix H - Wastewater Treatment Plant Permits.**
- **Appendix I - Wastewater Treatment Engineering Report.**
- **Appendix J - Spill Response Plan.**
- **Appendix K - CIP Project Sheet.**
- **Appendix L - Financial Backup.**
- **Appendix M - O&M APE Examples.**

1.6 SEPA and Approval Process

A SEPA Checklist has been prepared for this Plan and is presented in Appendix A. It is anticipated that this proposed Plan will not have a probable significant adverse impact on the environment and that an environmental impact statement (EIS) will not be required. However, many of the projects proposed herein will require SEPA checklists and an engineering determination will be made with each individual project.

This Plan includes review by adjacent utility systems. All comments are included in Appendix B, Agency Comment Letters and Responses.

1.7 Acknowledgements

Carollo Engineers, Inc. (Carollo) and their team members would like to acknowledge and thank the following individuals for their efforts and assistance in completing this Plan. Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report:

- Bob Busch, City of Camas, Wastewater Treatment Plant Operations Supervisor.
- Sam Adams, City of Camas, Utilities Manager.

Chapter 2
POLICIES AND CRITERIA

2.1 Introduction

The City of Camas (City) is responsible for managing and operating its wastewater system in accordance with all local, state, and federal regulations. To best manage the wastewater system and comply with regulations, the City has adopted wastewater system policies and criteria. These policies guide the development and financing of the infrastructure required to provide wastewater service and document the City's commitments to current wastewater system customers as well as those considering service from the City. The following sections outline the City's policies and design criteria that are relevant to sewer system planning. Existing policies are listed in Table 2.2 through Table 2.5. Proposed new policies are also listed in each table. These policies and criteria will guide the planning process throughout this General Sewer Plan (Plan).

The policies and criteria are organized into the following categories:

- Table 2.1 - Service Policies and Extensions.
- Table 2.2 - Environmental Stewardship.
- Table 2.3 to Table 2.5 - Design Policies and Criteria.
- Table 2.6 - Financial Policies.

2.2 Sewer Service

Table 2.1 summarizes the existing policies regarding the wastewater service area and extension of sewer service to additional customers. The City is committed to serving customers in its sewer service area in accordance with established policies. The current sewer service area includes approximately 7,400 acres within its corporate boundaries. The future service area has been defined as the City's Urban Growth Boundary (UGB).

Table 2.1 Service Policies and Extensions

Subject	Policy	Source
Service Area	Where service is available, require connection to public water for domestic and irrigation needs and connection to sewer systems. The intent is to not wait for the malfunction of a well or septic system if service is available.	Camas 2035 Comprehensive Plan U-1
Service Area	Within UGAs, the City should be the sole provider of urban services.	Camas 2035 Comprehensive Plan U-4
Service Area	Extend public sanitary sewer service, which is required within urban areas, throughout urban areas. Service may be provided outside urban areas to serve areas where imminent health hazards exist.	Camas 2035 Comprehensive Plan SS-1
Utility Extension	Do not extend utilities without annexation or commitments for annexation. Exceptions may be made in cases where human health is threatened. In areas where utilities presently extend beyond City limits, but are within UGAs, the City should plan development jointly with the County. A joint development must be consistent with City standards.	Camas 2035 Comprehensive Plan U-5
System Ownership	The sanitary sewage disposal system of the city, including the treatment plant and all other parts of such system and all additions and improvements thereto and extensions thereof, which may be made hereafter, shall be considered as a part of and belonging to the water works utility of the city. The cost of the construction and installation of the hereinafter provided additions, improvements and extensions and the cost of maintenance and operation of such system as improved shall be charged to the water works utility of the city, and any rates and charges which may be collected hereafter for sewage disposal service shall be paid into the "water and sewer revenue fund" of the city, to be hereafter created.	(CMC) 13.60.010
Ownership of System - Commercial and Industrial	All STEP systems serving commercial, industrial, and other nonresidential properties shall be owned by the owner of the subject property, except for the service box at the point where the STEP system connects to the city sanitary sewer system, which shall be owned by the city. The owner shall be responsible for maintaining all components of the STEP system and its ownership and shall be responsible for pumping the STEP tank as needed and for disposing of the waste in an approved manner. The owner shall further be responsible for paying all electrical costs associated with the operation of the STEP system.	CMC 13.62.060(B)
Ownership of System - Residential	After inspection and acceptance of an installed STEP system on residential property, the city shall be the owner of all components of the STEP system with the exception of the sewer line from the structure to the tank, which shall be owned by the property owner. The city will be responsible for maintaining the components of the STEP system owned by the city, and in addition will be responsible for pumping the STEP tank and disposing of waste material when required. The owner will be responsible for maintaining the sewer line connecting the tank to the structure on the subject property. The owner will further be responsible for paying for all electrical costs associated with the operation of the STEP system.	CMC 13.62.060(A)
Construction	On and after May 1, 1949, it shall be unlawful to construct any means of sewerage or excreta disposal such as septic tanks without having first obtained a permit from the city health officer or his authorized representative.	CMC 13.60.040
Sewer Lien and Ownership	The city shall have a lien against premises to which sewer service is available for delinquent and unpaid charges for sewer services, for penalties levied pursuant to Section 13.60.050(B), for unpaid connection charges, and for unpaid sewer system development charges. All such delinquent charges shall bear interest at the rate of eight percent per annum. Such lien shall be superior to all other liens and encumbrances except general taxes and local and special assessments.	CMC 13.60.055(A)
Connections	All property owners whose property abuts a street or alley in which there is a public sanitary sewer or which is within one hundred fifty feet of a public sanitary sewer may be required to connect their private drains and sewers to the city sanitary sewer system at the direction of the city engineer. Those properties which abut a street or alley in which there is a public sanitary sewer or which are located within one hundred fifty feet of a public sanitary sewer, and which are located within a designated health hazard area or which pose a threat to the general health, shall be connected to the sanitary sewer. Such connection shall be in the most direct manner possible and with a separate connection for each residence or structure.	CMC 13.60.050(A)
Prohibited Connection	Prohibit construction of new private wells and subsurface sewage disposal systems in new developments.	Camas 2035 Comprehensive Plan U-2

Subject	Policy	Source
Application to Connect a STEP System	Any property owner seeking to connect his property to the sanitary sewer system of the city by means of a STEP system shall file an application with the public works department on a form provided by the city. The application shall contain the name and address of the owner, the location of the property to be connected to the sanitary sewer system, the nature of the structure to be constructed on the subject property, the proposed use of the subject property, the proposed location of the STEP system, the design of the STEP system, and such other information as the public works department may require. Upon receipt of any such application, the public works director, or his authorized designee, shall review the application and grant the same if he determines that the subject property is suitable for use of a STEP sanitary sewer system, and if the design, location and other information set forth in the application comply with the standards and specifications adopted by the city for STEP systems and the criteria set forth in this chapter.	CMC 13.62.030
Installation Responsibility of a STEP system	The individual owner shall be responsible for and shall pay for the installation of the STEP/ STE system, including but not limited to, service connection per CMC 13.64.050 if required, the tank, pump apparatus, control box, electrical wiring, conduit, plumbing from the structure to the tank, plumbing from the tank to the service box, excavation and backfill material. The city shall, prior to installation, determine the appropriate size tank.	CMC 13.62.040(A)
Sewer Responsibility	Sanitary sewers shall be provided to each lot at no cost to the city and designed in accordance with city standards: • Detached units shall have their own sewer service and STEP or STEF or conventional gravity system as required. • Duplex units may have up to two sewer services at the discretion of the engineering and public works departments. • Multifamily units shall have one sewer lateral per building. • Commercial or industrial units shall have privately owned and maintained sewer systems acceptable to the city.	CMC 17.19.040(C)
Right-of-Entry Agreement	Any owner seeking to connect his property to the sanitary sewer system of the city by means of a STEP system shall be required to execute a right-of-entry agreement authorizing the city and its employees to have access to the owner's property for the purpose of maintaining and inspecting the STEP system and appurtenances thereto. Such right-of-entry agreement shall be executed upon approval of an application for a STEP system.	CMC 13.62.050
Inspection	The superintendent and other duly authorized employees of the city bearing proper credentials and identification shall be permitted to enter upon all properties for the purpose of inspecting, observing, measuring, sampling, and testing sewer connections, operations, and facilities in accordance and to ensure compliance with the provisions of this chapter. No such entry or inspection shall be made without the consent of the owner or occupant of such building or premises unless the city employee shall have obtained a search warrant, or unless exigent circumstances exist that would justify an inspection and entry without obtaining a warrant.	CMC 13.68.030
Enforcement	It shall be the duty of the city health officer or his authorized agent to enforce the provisions of Sections 13.60.020 through 13.60.110 and in the performance of this duty the health officer or his duly authorized agent is authorized to enter at any reasonable hour any premises as may be necessary in the enforcement of Sections 13.60.020 through 13.60.110.	CMC 13.60.080
FOG and Capacity	Grease, oil and sand interceptors shall be provided, when in the opinion of the superintendent, they are necessary for the proper handling of liquid wastes containing grease in excessive amounts, or any flammable wastes, sand, and other harmful ingredients, except that such interceptors shall not be required for private living quarters. All interceptors shall be of a type and capacity approved by the superintendent and shall be located as to be readily and easily accessible for cleaning and inspection.	CMC 13.68.020(H)
Private System - Flush toilet	Every residence, place of business or other building or place where persons congregate, reside or are employed and which does not abut a street or alley in which there is a public sanitary sewer shall be provided with a private water-flush toilet by the owner or agent of the premises; said water-flush toilet system to be built or rebuilt, constructed and maintained in such a manner as to meet the requirements of construction and maintenance hereinafter described.	CMC 13.60.060

Notes:
Abbreviations: CMC - Camas Code of Ordinances; FOG - fats, oil, and grease; STE - septic tank effluent; STEF - septic tank effluent filter; STEP - septic tank effluent pump; UGA - urban growth area.

2.2.1 Environmental Stewardship

The following section summarizes existing policies regarding environmental stewardship.

Table 2.2 Environmental Stewardship Policies

Subject	Policy	Source
Allowable Discharges	Examples of allowable discharges include the following: • Broken water mains. • Diverted stream flows. • Rising ground waters. • Uncontaminated ground water infiltration, as defined in 40 CFR 35.2005(20). • Uncontaminated pumped ground water. • Foundation drains. • Air conditioning condensation. • Irrigation water from agricultural sources that is commingled with urban stormwater. • Springs. • Water from crawl space pumps. • Footing drains. • Flows from riparian habitats and wetlands. • Discharges from emergency firefighting activities.	CMC 14.04.070
Conditional Discharges	The following types of discharges shall not be considered illegal discharges for the purposes of this chapter if they meet the stated conditions, or unless the Director determines that the type of discharge, whether singly or in combination with others, is causing or is likely to cause pollution of surface water or groundwater: • Potable water, including water from water line flushing, hyperchlorinated water line flushing, fire hydrant system flushing, and pipeline hydrostatic test water. Planned discharges shall be de-chlorinated to a concentration of 0.1 ppm or less, pH-adjusted, if necessary and in volumes and velocities controlled to prevent re-suspension of sediments in the stormwater system. • Lawn watering and other irrigation runoff are permitted but shall be minimized. • De-chlorinated swimming pool discharges. These discharges shall be de-chlorinated to a concentration of 0.1 ppm or less, pH-adjusted, if necessary and in volumes and velocities controlled to prevent re-suspension of sediments in the stormwater system. • Street and sidewalk wash water, water used to control dust, and routine external building wash down that does not use detergents are permitted if the amount of street wash and dust control water used in minimized. At active construction sites street sweeping must be performed prior to washing the street. • Non-stormwater discharges covered by another NPDES permit, provided, that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations; and provided, that written approval has been granted for any discharge to the storm drain system. • Other non-stormwater discharges. The discharges shall be in compliance with the requirements of a SWPPP, reviewed and approved by the city, which addresses control of such discharges by applying AKART to prevent contaminants from entering surface or ground water.	CMC 14.04.080
Septic System Elimination	Coordinate with Clark County to eliminate septic systems.	Camas 2035 Comprehensive Plan U-5
Illicit Connections	The following connections, both past, current, and future, to the stormwater system are expressly prohibited: • The construction, use, maintenance, or continued existence of illicit connections to the storm drain system is prohibited. • This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection. • A person is considered to be in violation of this chapter if the person connects a line conveying sewage to the MS4 or allows such a connection to continue.	CMC 14.04.090
Wastewater Discharges	Except as hereinafter provided, no person shall discharge or cause to be discharged any of the following described water or wastes to any public sewer: • Any liquid or vapor having a temperature higher than 150 °F. • Any water or waste which may contain more than 100 ppm by weight, of FOG. • Any gasoline, benzene, naphtha, fuel oil, motor oil, lubricants or other flammable or explosive liquid, solid or gas. • Any garbage that has not been properly shredded. • Any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure, or any other solid or viscous substance capable of causing obstruction to the flow in sewers or other interference with the proper operation of the sewage works. • Any waters or wastes having a pH lower than 5.5 or higher than 9.0 or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel of the sewage works. • Any waters or wastes containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, or create any hazard in the receiving waters of the sewage treatment plant. • Any waters or wastes containing suspended solids of such character and quantity that unusual attention or expense is required to handle such materials at the sewage treatment plant. • Any noxious or malodorous gas or substance capable of creating a public nuisance.	CMC 13.68.020(C)

Notes:
Abbreviations: °F - degrees Fahrenheit; AKART - all known, available and reasonable methods of prevention, control and treatment; CFR - Code of Federal Regulations; MS4 - Municipal Separate Storm Sewer System; NPDES - National Pollutant Discharge Elimination System, ppm - parts per million; SWPP - stormwater pollution prevention plan

2.2.2 Design Criteria and Standards

The City's wastewater system design standards, design details, specifications, and construction standards are documented in the Camas Design Standards Manual (2019) available from this City's Public Works department website. Additional design requirements and recommendations applicable to the City's sewer system are found in the Washington State Department of Ecology's (Ecology) *Criteria for Sewage Works Design* book, also known as the Orange Book. Current design criteria policies are outlined in Table 2.3.

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

Table 2.3 Design Criteria Policies

Subject	Policy	Source
Design	• Sewer systems shall be designed and constructed to achieve total containment of sanitary wastes and maximum exclusion of I/I. No new combined sewers will be approved.	Orange Book Section C1-1.3
Sewer location	• Siting of public sanitary sewer mains and MHs shall be restricted to the public right-of-way and/or easement dedicated for this utility.	Orange Book SectionC1-1.5
Design Period	• Service laterals shall be designed for the ultimate development of the parcel being served. • Collection sewers (that is, laterals and submains) shall be designed for the ultimate development of the tributary area. • Selection of the design period for trunk and interceptor sewers shall be based on an evaluation of economic, functional, and other considerations.	Orange Book Section C1-3.2
Design Flows	• Sewer systems shall be designed on the basis of per capita flows for the design period in conjunction with a peaking factor or approved alternative methods. • Generally, the sewers shall be designed to carry at least the peak hourly flow when operating at capacity. Peak hourly flow should be the design average daily flow in conjunction with a peaking factor.	Orange Book Section C1-3.3
Lift Station Design Criteria	• The firm capacity of a pumping station shall be equal to or greater than the peak hourly design flow. Because mechanical and electrical equipment is typically designed for a 20-year life, it is recommended that the peak design flow be based on a 20-year forecast or greater. • The number of pumps selected shall allow the station to provide the peak design flow with the largest pump out of order. • The station shall be designed to remain fully operational during the 100- year flood/wave event.	Orange Book Sections C2-1.2.1 C2-1.2.3 C2-1.1
Lift Station Pump	• Pumps should be designed for pumping sewage and capable of passing solids at least three inches in diameter. Pump suction and discharge should be four inches or greater.	Orange Book Section C2-1.2.4
Design Storm	• In accordance with all applicable federal, state, and local regulations, the City should design its wastewater system facilities to adequately and reliably convey peak hour flows associated with a Design Storm event without overflowing or discharging to any water bodies. The Design Storm is defined as a 20-year interval, 24-hour storm recorded at Portland International Airport rain gauge.	Proposed New Policy
Emergency Back-up Power	• All sewage pump stations should be designed with capability for emergency power in case the primary electrical feed is out of service. A portable engine generator unit that is plugged into a pigtail at the pump station commonly provides emergency power for small pump stations. Larger pump stations should have permanent engine generator units with automatic transfer switches to transfer the electrical feed from the primary to the standby unit when a power failure is detected by the instrumentation and control system.	Orange Book Section C2-1.8.3
Surcharging	• The City's design criteria require the depth of flow versus the diameter of the pipe (d/D) ratio to be equal to or less than 1 during the design storm (no surcharging).	Proposed New Policy
Inflow/ Infiltration	• Future development shall be designed for a peak inflow and infiltration rate of 1,100 gpad.	Proposed New Policy

Notes:
Abbreviations: d/D - depth versus diameter; gpad - gallons per acre per day; MH - manhole.

2.2.2.1 Wastewater Treatment Plant Design Criteria

The Ecology maintains requirements for hydraulic and loading capacities as well as the redundancy of treatment processes and equipment. These requirements are presented in the Orange Book, Ecology's guidelines for WWTF design (2008) and are derived from the Federal standards developed by the U.S. Environmental Protection Agency (EPA). Flow requirements are detailed in Table 2.4.

Ecology's criteria for designation of WWTFs are divided into three reliability classes based on the nature of their receiving water. Corresponding redundancy and reliability requirements are presented in Table 2.5 based on Ecology's guidelines and Federal standards. These requirements are the basis of the capacity analysis.

Table 2.4 Flow Requirement

WWTF Component	Flow Requirement	Source
Influent Screens	A backup screen designed for mechanical or manual screening must be provided. Influent screens must accommodate all flows.	(1)
Primary Clarifiers	Units must be sufficient in number and size to allow peak hour design flow including recirculation flow for overflow rate and weir loading rate. Surface overflow rates recommended are 400 to 600 gpd/sq ft at average design flow and 1,200 to 1,500 gpd/sq ft at peak design flow.	(1)
Primary Sludge Pumps	A backup pump must be provided that that matches the largest pump and motor. Pumps must handle peak design flows with the largest units out of service.	(1)
Degritting Cyclone and Grit Classifier	The system must contain components to remove grit and other heavy inorganic solids.	(1), (2)
Aeration Basins	A backup basin will not be required. At least two equal volume basins must be provided. All units in service for peak flow and loading conditions.	(1)
Internal Recycle Pumps	A backup pump must be provided that that matches the largest pump and motor. Pumps must handle peak design flows with the largest units out of service.	(1), (2)
Aeration Systems	A sufficient number of aerators to enable the design oxygen transfer to be maintained with the largest unit out of service.	(1), (2)
Secondary Clarifiers	Units must be sufficient in number and size to allow PHDF including recirculation flow for overflow rate and weir loading rate.	(1)
RAS Pumps	A backup pump must be provided that that matches the largest pump and motor. Pumps must handle peak design flows with the largest units out of service.	(1)
WAS Pumps	A backup pump must be provided that that matches the largest pump and motor. Pumps must handle peak design flows with the largest units out of service.	(1)
Effluent Filters	Secondary effluent polishing filters must pass all flows requiring tertiary treatment.	(1)
UV Channel	Equipment sized to provide maximum day design flow with to meet disinfection requirements and accommodate peak hour design flow hydraulically.	(1)
Effluent Pump Station	A backup pump must be provided that that matches the largest pump and motor. Pumps must handle peak design flows with the largest units out of service.	(1)
Gravity Thickener	Redundant units provided for equipment maintenance. Ability to thicken and dewater maximum sludge production with all units in service.	(1) (2)
Rotary Drum Thickener	Redundant units provided for equipment maintenance. Ability to thicken and dewater maximum sludge production with all units in service.	(1) (2)
Primary Anaerobic Digesters	Redundant units provided for equipment maintenance. Ability to thicken and dewater maximum sludge production with all units in service.	(1) (2)
Digested Sludge Pumps	A backup pump must be provided that that matches the largest pump and motor. Pumps must handle peak design flows with the largest units out of service.	(1)
Dewatering Centrifuge	Redundant units provided for equipment maintenance. Ability to thicken and dewater maximum sludge production with all units in service.	(1) (2)
Biosolids Dryer	Redundant units provided for equipment maintenance. Ability to thicken and dewater maximum sludge production with all units in service.	(1) (2)

Notes:
(1) Criteria for Sewage Works Design (Ecology, 2008).
(2) Design Criteria for Mechanical, Electric, and Fluid Systems and Component Reliability (EPA, 1974).
Abbreviations: gpd/sg ft - gallons per day per square foot; PHDF - peak hour demand flow; RAS - return activated sludge; UV - ultraviolet; WAS - waste activated sludge.

Table 2.5 Wastewater Treatment Plant Redundancy and Reliability Requirements

WWTF Component	Flow Criteria	Load Requirement	Redundancy
Influent Screens	Pass all flows	-	1 Unit Out of Service
Primary Clarifiers	PHF + Recirculation	Peak Hour Design Load (1)	All Units in Service
Primary Sludge Pumps	Peak Instantaneous Design Flow	Maximum Daily Design Load	1 Unit Out of Service
Degritting Cyclone	PHF	-	Minimum 2 Units
Grit Classifier	PHF	-	1 Unit Out of Service
Aeration Basins	Maximum Week Design Flow Maximum Daily Design Flow	Maximum Daily Design Load Maximum Daily Design Load	All Units in Service All Units in Service
Internal Recycle Pumps	PHF	-	1 Unit Out of Service
Aeration Systems	-	Peak Hour Design Load (2)	1 Unit Out of Service
Secondary Clarifiers	PHF + Recirculation	Peak Hour Design Load (1)	All Units in Service
RAS Pumps	MMF	-	1 Unit Out of Service
WAS Pumps	Peak Instantaneous Design Flow	Maximum Daily Design Load	1 Unit Out of service
Effluent Filters	All flows requiring tertiary treatment	-	-
UV Channel	PHF	-	1 Unit Out of Service
Effluent Pump Station	Peak Instantaneous Design Flow	-	1 Unit Out of Service
Gravity Thickener	-	Maximum Daily Design Load (2)	1 Unit Out of Service
Rotary Drum Thickener	-	Maximum Daily Design Load (2)	1 Unit Out of Service
Primary Anaerobic Digesters	-	Maximum Daily Design Load (2)	1 Unit Out of Service
Digested Sludge Pumps	-	-	1 Unit Out of Service
Dewatering Centrifuge	-	Maximum Daily Design Load (2)	1 Unit Out of Service
Biosolids Dryer	-	Maximum Daily Design Load (2)	1 Unit Out of Service

Notes:
(1) Total suspended solids (TSS) loading only.
(2) 5-day biochemical oxygen demand (BOD_5) loading only.
Abbreviations: PHF - peak hour flow; MMF - maximum monthly flow

2.2.3 Financial Policies

The City's financial polies support the operation of the wastewater utility. A summary of financial polices applicable to the Plan are outlined in Table 2.6.

Table 2.6 Financial Policies

Subject	Policy	Source
Credits	Those properties that have been disconnected from the city sewer system since January 1, 1972, shall receive a credit for the prior connection. The credit for the prior connection shall be in an amount equal to the sewer system development charge for the use classification of the prior connection. The sewer system development charge imposed under this chapter shall be the difference between the amount due under the present use classification less the amount that would have been assessed under the use classification for the prior connection, provided however, that the city shall not be required to reimburse the property owner in the event the credit exceeds the sewer system development charge for the new connection.	CMC 13.72.040(A)
Credits	Those properties that are not presently connected to the city's sewer system but which have been assessed and paid a monthly penalty pursuant to Section 13.60.050(B) shall receive a credit against the sewer system development charge in an amount equal to the total monthly penalties paid prior to connection, provided however, that the city shall not be required to reimburse the property owner in the event the credit exceeds the sewer system development charge for the new connection.	CMC 13.72.040(B)
Violation	Any person, firm or corporation who violates or refuses or fails to comply with any of the provisions of Sections 13.60.020 through 13.60.110 shall be guilty of a misdemeanor and shall be punished by a fine of not less than twenty-five dollars nor more than one hundred dollars or imprisoned in the city jail for a period of thirty days or by both such fine and prison term.	CMC 13.60.090
Inflow Connection	There is imposed upon those property owners who are within the area served by the sanitary system and who refuse to connect to such sanitary sewer system a penalty in an amount equal to the charge that would have been made for sewer service if such property had been connected to the sanitary sewer system. Such penalties as provided herein shall accrue monthly until such property is connected to the sanitary sewer system. All penalties collected pursuant to this provision shall be considered revenue of the sanitary sewer system.	CMC 13.60.050(B)
Sewer Service Development	Pursuant to the authority conferred upon cities and towns by RCW 35.92.020 and 35.92.025, the city council of the city finds that property owners who seek to connect property to the sewer system of the city should be assessed a charge in order that such property shall bear its equitable share of the cost of the sewer system. The council further finds that the charge should be based upon the property owner's anticipated use of the sewer system as related to the historical cost of the sewer system and the projected cost of additions to the sewer system to meet new demand. That portion of the charge based upon the historical costs of the sewer system shall be measured by the undepreciated value of the sewer system and plant in service at the time the charge is imposed. That portion of the charge based upon the projected cost of future improvements shall be based upon appropriate studies by engineers and/or financial consultants. The charge imposed by this chapter shall be denominated as a "sewer system development charge" and shall be in addition to any sewer connection or permit fees imposed by other ordinances of the city.	CMC 13.72.010
Damage to STEP	The cost of repairing any damage to a STEP system which has resulted from the negligence, gross negligence, or intentional acts of the owner shall be the responsibility of the owner. This responsibility includes any clogging which may result due to improper use of the STEP system by the owner.	CMC 13.62.070
Connection Charges for STEP	Except as hereinafter provided, the connection charge for connecting a STEP/STE sewer system to the Camas municipal sewer system shall be the cost of materials, the costs of labor for city personnel at then prevailing rate for such personnel, and the amount of any fees or charges required to be paid to any third parties in order to make such connection.	CMC 13.64.050(A)
Connection Charges for STEP	The connection charge for connecting a STEP/STE sewer system to the Camas municipal sanitary sewer system with a one-inch service line or less shall be as per the fee schedule established by the city council per resolution, or the actual cost to the city calculated in accordance with subsection A of this section, whichever is greater.	CMC 13.64.050(B)
Connection Charges for STEP	No connection charge will be assessed if a service line has already been installed connecting the subject property to the city sanitary sewer system.	CMC 13.64.050(C)

Notes:
Abbreviations: RWC - Revised Code of Washington.

2.2.4 Regulatory Requirements

The City's criteria is developed based on federal and state statues, regulations, and permits. These laws help to determine the design criteria for the City's collection, treatment, and disposal facilities. These regulatory requirements are outlined in Table 2.7.

Table 2.7 Regulatory Requirements

Subject	Policy
Federal Clean Water Act Condition S1	Condition S.1 of the City's permit requires the treatment plant effluent to meet limits for BOD_5, TSS, fecal coliform bacteria, pH, and total ammonia.
Federal Clean Water Act Condition S2	Condition S.2.lists monitoring requirements including influent and effluent flow, BOD_5, TSS, pH, temperature, total ammonia, fecal coliform, priority pollutant metals, oil and grease and cyanide. A program to address oil and grease is also required. The City must monitor twice per 5 years for effluent whole effluent toxicity and conduct quarterly and yearly priority pollutant monitoring of its influent and effluent in support of its industrial pretreatment program. Additionally, per the terms of the City's coverage under the Statewide Biosolids permit, the City must annually test its biosolids for pollutants and compliance with pathogen reduction and vector attraction reduction criteria.
Federal Clean Water Act Condition S4	Condition S.4.A specifies the WWTF design capacity for maximum month BOD_5 loading is 5,616 lbs/day and 6,405 lbs/day for TSS. The peak hour flow, dry weather monthly average, and maximum month average flow capacities for the WWTF are 11.09, 2.86 and 6.10 mgd, respectively. Condition S.4.B requires the City to prepare a plan to maintain adequate capacity when flows and loadings to the WWTF exceed 85% of design capacity for 3-consecutive months.
National Environmental Policy Act	The NEPA was established in 1969 and requires federal agencies to determine environmental impacts on all projects requiring federal permits or funding. Federally delegated activities such as NPDES permits or Section 401 Certification are considered state actions and do not require NEPA compliance. If a project involves federal action (through, for example, an Army Corps of Engineers Section 404 permit), and is determined to be environmentally insignificant, a (FONSI) is issued, otherwise an Environmental Assessment (EA) or Environmental Impact Statement (EIS) would be required. NEPA is not applicable to projects that do not include a federal component.
Federal Clean Air Act	The Federal Clean Air Act requires all wastewater facilities to plan to meet the air quality limitations of the region. The City falls in the jurisdiction of the Southwest Clean Air Agency (SWCAA). The SWCAA is responsible for enforcing federal, state and local outdoor air quality standards and regulations in Clark, Cowlitz, Lewis, Skamania and Wahkiakum counties of southwest Washington state. The Camas generator is permitted by SWCAA.
State Water Pollution Control Act	The intent of the state Water Pollution Control Act is to "maintain the highest possible control standards to ensure the purity of all waters of the state consistent with public health and the enjoyment…the propagation and protection of wildlife, birds, game, fish and other aquatic life, and the industrial development of the state." Under the RCW 90.48 and the (WAC) 173-240, Ecology issues permits for wastewater treatment facilities and land application of wastewater under WAC 246-271.
Criteria for Sewage Works Design, Ecology	Ecology has published design criteria for collection systems and wastewater treatment plants. While these criteria are not legally binding, their use is strongly encouraged by Ecology since the criteria are used by the agency to review engineering reports for upgrading wastewater treatment systems. Commonly referred to as the "Orange Book," these design criteria primarily emphasize unit processes through secondary treatment, and also includes criteria for planning and design of wastewater collection systems. Any expansion or modification of the City collection system and/or WWTF plant will require continued conformance with Ecology criteria.
Certification of Operators of Wastewater Treatment Plants, WAC 173-230	Wastewater treatment plant operators are certified by the state Water and Wastewater Operators Certification Board. The operator assigned overall responsibility for operation of a wastewater treatment plant is defined by WAC 173-230 as the "operator in responsible charge." This individual must have state certification at or above the classification rating of the plant. The City WWTF is currently assigned a Class 4 rating and the operating staff assigned to the plant have the required certification. (One of the operators has a Class 4 certification; two have Class 3 certification, and one has Class 2 certification).
Surface-Water Quality Standards (WAC 173-201A)	In the State of Washington, WAC 173-201A establishes water quality standards for surface waters based on maintaining public health, recreational use and protection of fish, shellfish, and wildlife. Surface water quality standards include five groups: AA (extraordinary), A (excellent), B (good), C (fair), and Lake Class. Each class has its own characteristic use and measurable criteria. Measurable parameters used to distinguish the different surface water classifications include fecal coliform levels, dissolved oxygen concentration, temperature, pH, and turbidity. The surface water criteria include 29 toxic substances, including ammonia, residual chlorine, several heavy metals, polychlorinated biphenyls (PCBs), and pesticides.
State Environmental Policy Act	WAC 173-240-050 requires a statement in all wastewater comprehensive plans regarding proposed projects in compliance with the SEPA, if applicable. The capital improvements proposed in this plan will fall under SEPA regulations. A SEPA checklist is included in Appendix A of this report for use in the environmental review for the project. In most cases a DNS is issued; however, if a project will have a probable significant adverse environmental impact an EIS will be required.
Accreditation of Environmental Laboratories (WAC 173-050)	The State of Washington established a requirement that all laboratories reporting data to comply with NPDES permits must be generated by an accredited laboratory. This accreditation program establishes specific tasks for QA/QC that are intended to ensure the integrity of laboratory procedures. Accreditation requirements must be met for any on-site laboratory or outside laboratory used to analyze samples. Only accredited laboratories may be used for analyses reported for compliance with NPDES permits. In planning for an on-site laboratory, staffing must be sufficient to allow for QA/QC procedures to be performed. The Camas WWTF lab is currently accredited for determination of the following parameters TSS, BOD_5, ammonia, dissolved oxygen, pH and fecal coliform.
Minimal Standards for Solid Waste Handling (WAC 173-304)	Grit and screenings are not subject to the sludge regulations in WAC 173-308, but their disposal is regulated under the state solid waste regulations, WAC 173-304. Waste placed in a municipal solid waste landfill must not contain free liquids, nor exhibit any of the criteria of a hazardous waste as defined by WAC 173-303. To be placed in a municipal solid waste landfill, grit, screenings, and incinerator ash must pass the paint filter test. This test determines the amount of free liquids associated within the solids, and includes the TCLP test, which determines if the waste has hazardous characteristics.
Shoreline Management Act	The Shoreline Management Act of 1971 (RCW 90.58) establishes a broad policy giving preference to shoreline uses that protect water quality and the natural environment, depend on proximity to the water, and preserve or enhance public access to the water. The Shoreline Management Act jurisdiction extends to lakes or reservoirs of 20 acres or greater, streams with a mean annual flow of 20 cfs or greater, marine waters, and an area inland 200 ft from the ordinary high-water mark. Projects are reviewed by local governments according to state guidelines and a local Shoreline Master Program. The Camas wastewater treatment plant and portions of the collection system are located within shoreline areas.

Notes:
Abbreviations: cfs - cubic feet per second; DNS - determination of non-significance; FONSI - finding of no significant impact; lbs/day - pounds per day; mgd - million gallons per day; NEPA - National Environmental Policy Act; TCLP - toxic characteristic leachate procedure; QA/QC - quality assurance and quality control; WAC - Washington Administrative Code

2.2.4.1 NPDES Permit

Table 2.8 presents a brief overview of relevant design criteria and effluent limitations contained in the City's WWTF NPDES Permit No. WA0020249. The City's current permit was issued September 15, 2015 and effective October 1, 2015. This NPDES permit places limits on various water quality parameters, flow rates, and waste loading pertaining to the discharge of treated effluent from the WWTF.

Table 2.8 NPDES Influent Design Criteria and Effluent Limits

NPDES Influent Design Criteria and Effluent Limits		
NPDES Influent Design Criteria		
Parameter		Value
MMF		6.1 mgd
Monthly Average Dry Weather Flow		2.86 mgd
BOD_5 Max Month Loading		5,616 lbs/day
TSS Max Month Loading		8,011 lbs/day
NH_3-N Max Month Loading		1,956 lbs/day
NPDES Effluent Limits		
Parameter	Average Monthly Limit	Average Weekly Limit
BOD_5	• 20 mg/L • 74% removal of influent • 1,017 lbs/day	• 30 mg/L • 1,525 lbs/day
TSS	• 20 mg/L • 76% removal of influent • 1,017 lbs/day	• 30 mg/L • 1,525 lbs/day
Fecal Coliform Bacteria(1)	• 200 organisms/100 mL	• 400 organisms/100 mL
NH_3-N Summer(2)	• 20 mg/L	• N/A
NH_3-N Winter	• 7 mg/L	• N/A

Notes:
(1) Geometric mean.
(2) Summer ammonia limits apply to the months of June through September.
Abbreviations: mg/L - milligrams per liter; mL - milliliter; NH_3-N - ammonia.

Chapter 3

BASIS OF PLANNING

3.1 Introduction

This chapter presents an evaluation of historical wastewater flows and loads through the City of Camas's (City's) collection system and entering the wastewater treatment facility (WWTF). This chapter establishes the WWTF's flow and load projections based upon future population growth through 2035.

The remainder of this Chapter is divided into four sections:

- Section 3.2 provides definitions for the wastewater flow terminology used in this chapter, as it is not commonly used outside of planning and design evaluations.
- Section 3.3 presents the collection system flow monitoring results, which are used to set a baseline for flow projections and development of the hydraulic model.
- Section 3.4 presents projected flows and loads for the City's collection system, which are used in hydraulic modelling evaluations.
- Section 3.5 presents projected flows and loads for the WWTF, which are used in unit process capacity evaluations.

The collection system and WWTF projections are based on demographic growth projections from the *2035 Comprehensive Plan*. However, slightly different methodologies are used to project wastewater flows in the collection system and WWTF due to the requirements of the analyses and availability of data. Two major factors drive these differences. First, the collection system uses flow monitoring data from four-month period in the winter of 2018 and 2019, while the WWTF analysis uses historical influent data from 2015 through 2018. Second, the WWTF flows ware only projected for 2035, while collection system flows are projected for 2035 and buildout period. Collection system piping is typically sized using the buildout period projections since these pipes have a 75-year service life.

3.2 Definitions

Wastewater flows are analyzed by separating dry weather flow from wet weather flow to establish base flows. These base flows identified during dry weather are then used as the basis to project both wet and dry weather flows. Due to the separate collection system and WWTF projections established, the following terminology was utilized to differentiate the various flow parameters:

- **Influent Dry Weather Flow (IDWF)** is the average daily flow during the two driest months of the year (July and August). The IDWF includes the base flow generated by the City's residential and commercial connections plus the dry weather groundwater infiltration (GWI) component. For the City, the IDWF was estimated throughout the service area based on the historical influent flow data from the WWTF.

- **Average Dry Weather Flow (ADWF)** establishes a similar flow parameter as IDWF; ADWF was differentiated as it was based upon collection system flow monitoring data period of record that differs from the IDWF.
- **Average Annual Flow/Load (AAF/AAL)** is the average flow or load that occurs over a calendar year. AAF and AAL were estimated based on the historical influent flow and load data from the City's WWTF.
- **Maximum Month Flow/Load (MMF/MML)** is the maximum 30-day running average influent flow observed at the WWTF during a calendar year. MMF and MML were estimated based on the historical influent flow and load data from the City's WWTF.
- **Peak Day Flow/Load (PDF/PDL)** is the maximum 24-hour average flow and load observed at the WWTF during a calendar year. PDF and PDL were estimated based on the historical influent flow and load data from the City's WWTF.
- **Peak Hour Flow (PHF)** is the highest observed hourly flow that occurs during the design storm. Wet weather inflow and infiltration (I/I) causes flows in the collection system to increase. PHF is typically used for designing sewers and lift stations. Therefore, the PHF and the collection system "Design Flow" are synonymous and will be used interchangeably throughout this Plan.

3.3 Collection System Flow Monitoring Results

The City contracted with ADS to conduct a temporary flow monitoring program within the City's sanitary sewer collection system. The purposes of the Flow Monitoring Program were to collect data for correlating real collection system flows with the hydraulic model's predicted flows, evaluate the system's capacity, and estimate basin I/I. The temporary flow monitoring data was collected from November 16, 2018, to March 18, 2019. The "Camas Flow Monitoring Report 2019" prepared by ADS summarizes the flow monitoring program and was submitted to the City as a stand-alone report. The report can be found as Appendix D - Temporary Flow Monitoring and RDII Analysis (ADS, 2019).

3.3.1 Average Dry Weather Flow Data

Average dry weather flow projections are derived from land use category data and corresponding wastewater flow factors. This method assumes that areas with similar land uses, such as low-density residential parcels, produce equivalent quantities of wastewater flow on a per area basis. System-wide flows can be compared to recorded flows obtained from temporary collection system flow monitors, or from the treatment plant influent flow meter to verify accuracy. This method of estimating base flows is an industry standard providing sufficiently accurate data for planning purposes.

3.3.1.1 ADWF Development

Existing ADWFs for each basin were estimated using data from the Camas flow monitoring report for each of the flow monitoring basins. ADWF was then developed using the driest days from the flow monitoring period based on the following set of minimum criteria:

- Less than 0.1 inch of rain in the previous day.
- Less than 0.4 inches of rain in the previous 3 days.
- Less than 1.0 inch of rain in the previous 5 days.
- In addition, those dry days that exhibited unusual flow patterns were not used to generate net dry day flow values for a basin.

Characteristic dry weather 24-hour diurnal flow patterns were developed for each basin from hourly data. The hourly flow data were also used to calibrate the hydraulic model for the observed dry weather flows during the flow monitoring period. Hourly patterns for weekday and weekend flows vary and were separated to better define dry weather flow. An example of the dry weather flow diurnal patterns from Flow Meter 5-1-1, are shown in Figure 3.1.

Carollo Engineers, Inc. (Carollo) estimated the average weekday and weekend dry weather levels and velocities at each site from the data provided by ADS for use in the model calibration process.

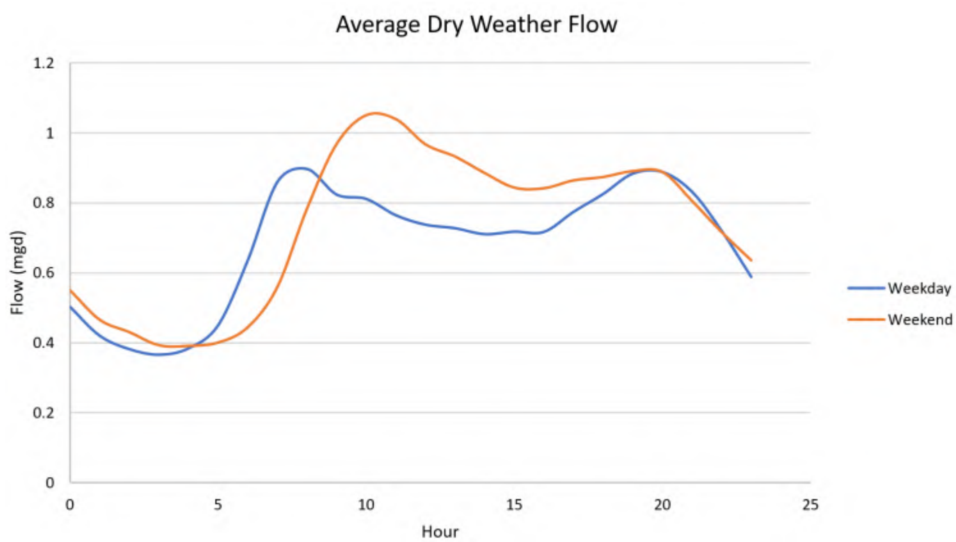

Figure 3.1 Typical Weekday vs Weekend Dry Weather Flow Variation (Meter 5-1-1)

Further detail on dry weather flow (DWF) development can be found in Appendix E - Hydraulic Model Development (Carollo, 2020).

3.3.2 Rainfall Data

An important part of the flow monitoring program is the collection and analysis of rainfall data. Three significant rainfall events occurred during the flow monitoring period, as well as other minor events. The storms recorded during this period caused an I/I response in the collection system, therefore were appropriate for I/I analysis and model calibration purposes. Further detail on the three storms used to calibrate the model can be found in Appendix E - Hydraulic Model Development (Carollo, 2020).

3.3.3 Wet Weather Flow Data

The flow monitoring data were also evaluated to determine how the collection system responds to wet weather events. As mentioned above, the flow monitoring program captured three main rainfall events. The rainfall event that occurred on December 23, 2018, was associated with the largest rainfall dependent infiltration and inflow (RDI/I) response during the flow monitoring period and is the most appropriate to be used for RDI/I analysis.

Figure 3.2 shows an example of the wet weather response at Meter 5-1-1 during the December 23, 2018, rainfall event. This figure also illustrates the volume of RDI/I that entered the system from the collection system upstream of Meter 5-1-1. The light grey line represents the

ADWF, while the green line represents the measured flow during the storm event. As can be seen in the figure, the flow increased by 4 to 8 times ADWF due to RDI/I entering the system during the wet weather events.

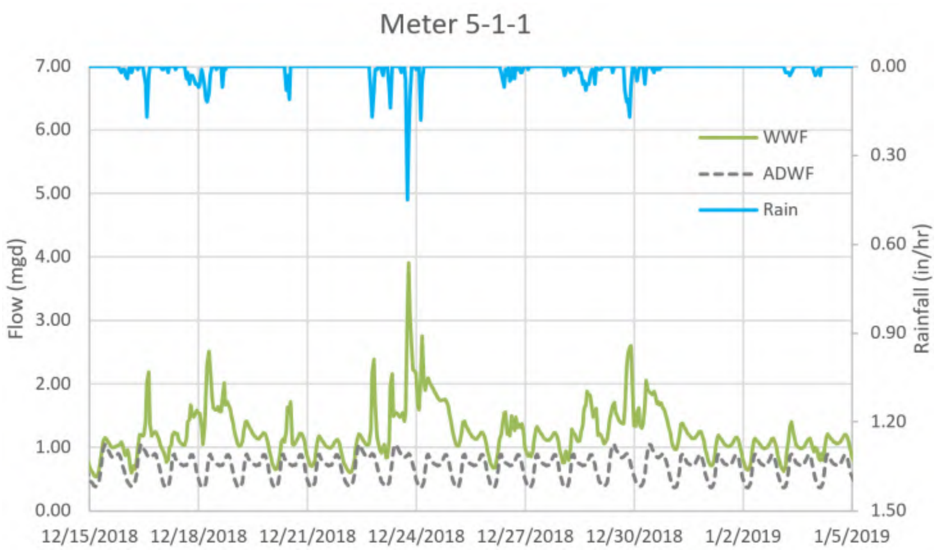

Figure 3.2 Example Wet Weather Response (Meter 5-1-1)

3.4 Collection System Flow Projections

Wastewater collection systems has several distinct flow sources based on the contributors in the service area:

1. Residential flow and base infiltration.
2. Commercial and industrial flow.
3. Wet weather I/I.

The flow from these sources have been grouped into these categories based on typical analytical procedures and the availability of information for each source. Residential flows include contributions from single family homes and multifamily units. The Washington State Department of Ecology (Ecology) issues discharge permits for the City's large industrial customers since the City does not have a pretreatment program in place. Wet weather I/I is caused by rainfall events and includes contributions from connected impervious areas such as roof drains and catch basins (inflow), and groundwater (infiltration) leaking into the collection system. The sum of these components is the complete flow through the collection system into the WWTF.

The flows throughout the collection system were estimated using the calibrated hydraulic model to predict dry and wet weather flows, as presented in Appendix E - Hydraulic Model Development (Carollo, 2021).

3.4.1 Sewered Population

Population projections are determined from the *2035 Comprehensive Plan*, the *Water SystemPlan* (Carollo Engineers, 2016), and the North Urban Growth Area Buildout Memo (BergerABAM, 2014), which are summarized by year in Table 3.1. Additional details on the methods for population projection are available in Appendix E - Hydraulic Model Development (Carollo, 2021).

Table 3.1 Population Summary

Year	Population Projections	Source
2020	26,065	(1) (2)
2035	36,000	(3)

Notes:
(1) Population data from the Comprehensive Plan was provided for 2015.
(2) The 2020 population was taken from April 2020 census data. https://www.census.gov/quickfacts/fact/table/camascitywashington/PST045219.
(3) Population data from the Water System Plan and the North Shore Population Estimate Memo was provided for 2035. Half of the North Shore area was assumed to be developed.

3.4.2 Land Use

Land use designations and regulations provide important information for evaluating sewer system capacity. Existing and future land use information is an integral component in projecting wastewater generation within the service area. The type of land use in an area will affect the volume of the wastewater generated. Adequately estimating the generation of wastewater from various land use types is important in sizing collection system facilities.

The City has six major land use categories for parcels within the UGB, as shown in Figure 3.3, which are sub-divided into the nine categories used in the *2035 Comprehensive Plan*. Acreage totals for each land use category are summarized by acreage in Table 3.2.

Table 3.2 Comprehensive Plan Land Use Summary

Comprehensive Plan Designation	Total Acreage(1)
Single Family High	425
Single Family Medium	3,617
Single Family Low	871
Multi Family High	246
Multi Family Low	279
Commercial	992
Industrial	2427
Parks(2)	851
Open Space/Green Space	492
Gross Total	10,200
Rights-of-Way and Stormwater Facilities	-27.7%(3)
Net Total	7,375

Notes:
(1) Total area within each comprehensive plan designation within the urban growth boundary.
(2) Applies only to land held in public trust.
(3) Based on typical County infrastructure deduction used in Clark County Buildable Lands Report.

Maps of the City's existing and future land use within the Service Area were developed with data provided by the City's Planning Department. Existing development information was taken from zoning data. Additional details on developing flows by land use type can be found in Appendix E - Hydraulic Model Development (Carollo, 2020).

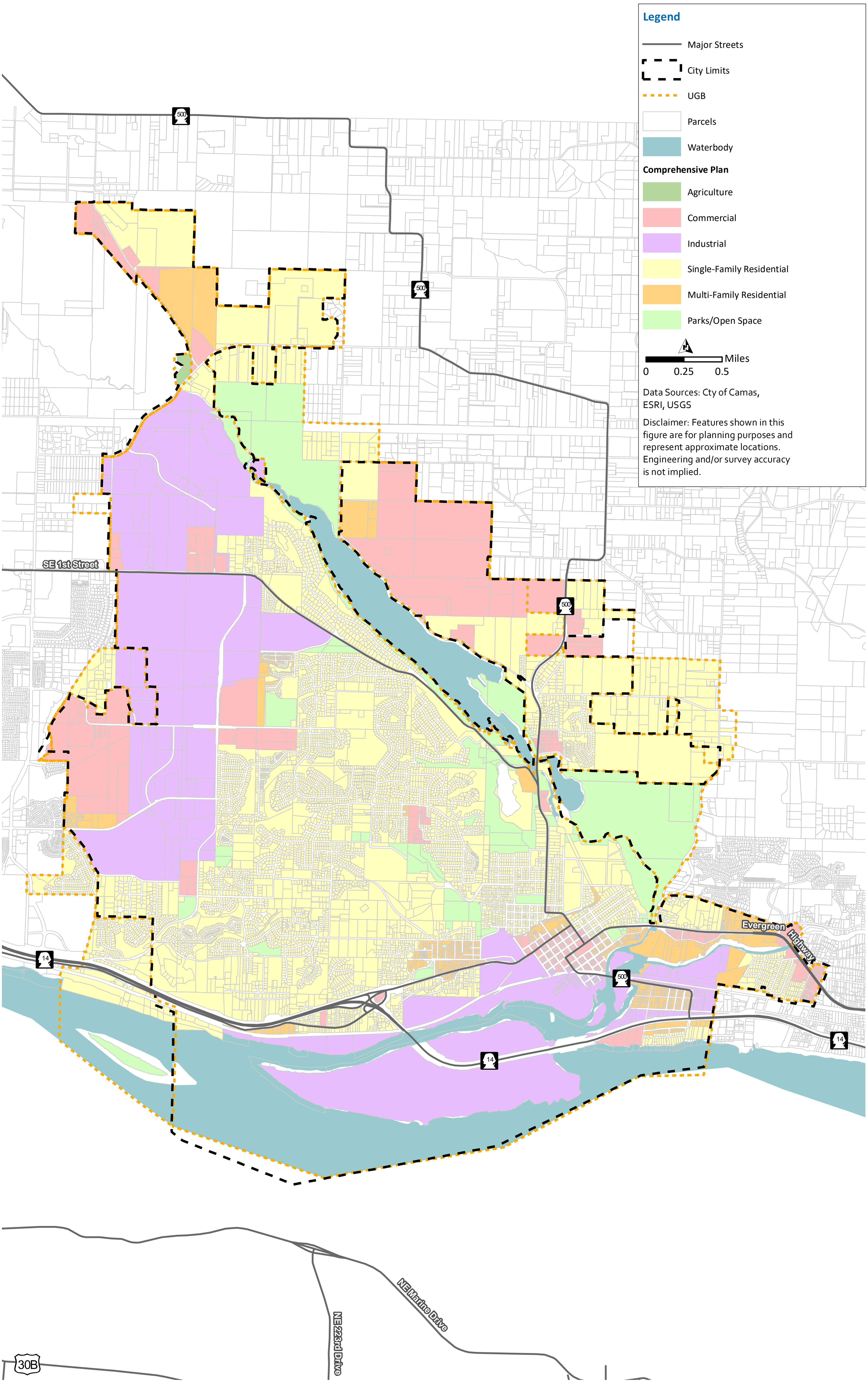

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Figure 3.3 Land Use

3.4.3 Wastewater Flow Factors

Relationships between land use and wastewater generation were developed to project wastewater flows and allocate future flows to the collection system. These relationships, called wastewater flow factors, are established based on the average wastewater flow generated for each existing land use type. The land use flow factors were established to project the estimated ADWF through future development of the City's wastewater collection system and project future flows within the Study Area boundary.

Average wastewater flow coefficients are volume rates, usually expressed in gallons per acre per day (gpad), applied to either gross or net acres to calculate average day flow generated from a particular land use. A flow coefficient was developed for each of the land use classifications that were discussed in Section 3.4.2. The flow coefficient provides a means to transform a land use category from acreage into wastewater flow. The resulting flow is then applied to the appropriate sewer area in the sewer system model. Wastewater flow coefficients for residential areas typically range between 500 to 3,000 gpad, and commercial or industrial areas might range from 1,000 to 4,000 gpad, with typical values averaging approximately 1,500 gpad. Land uses designated as open space and parks are assumed to generate negligible amounts of sewage flow, and as a result have a flow coefficient of zero. Additional detail on the development of these flow factors is provided in Appendix E - Hydraulic Model Development (Carollo, 2021). Table 3.3 summarizes the flow factors used to project dry weather flows.

Table 3.3 Wastewater Flow Factor Development Summary

Land Use Type	Developed Area (acres)	Wastewater Flow Factor (gpad)	Existing ADWF (mgd)
Single Family Low	95	450	0.04
Single-Family Medium	693	670	0.46
Single Family High	22	800	0.02
Multi-Family Low	11	1,250	0.01
Multi-Family High	123	1,520	0.19
Commercial	110	1,270	0.14
Industrial	98	1,000	0.10
Agriculture	0	0	0.00
Park/Open Space	117	0	0.00
		Total Estimated Existing ADWF	**0.96**
		Measured Existing ADWF	**0.97**
		Percent Difference	**-0.2%**

3.4.4 Industrial Customer Flows

The City currently has three major industrial customers which must submit industrial discharge monitoring reports to Ecology for various flows, constituents, and characteristics as a condition of their discharge permits. The collective AAF from these contributors is 0.92 million gallons per day (mgd) with a PDF of 1.1 mgd as shown in Table 3.4. These flows can represent a large portion of influent flows for the WWTF. Flow data was taken from available DMR data from 2017 to 2022, as reported to and recorded on the Department of Ecology's Water Quality Permitting and Reporting Information System (PARIS).

Table 3.4 Industrial Customer Flows

Industry	MDF (gpd)	PDF (gpd)	AAF (gpd)
Wafertech Industries	525,000	737,000	629,408
Analog Devices	222,100	381,697	288,812
nLIGHT	156	9,971	3,014
All Flows	747,256	1,128,668	921,234

Notes:
Abbreviations: gpd – gallons per day; MDF - minimum daily flow.

3.4.5 Hydraulic Model Dry Weather Flow Projections

Developing an accurate estimate of the future quantity of wastewater generated at buildout of the collection system is an important step in sizing sewer system facilities for future scenarios. To estimate ADWF for specific areas, such as individual wastewater basins, dry weather flows are typically estimated based on the area contributing to flows and flow factors developed for each land use type. This method is developed based on the assumption that areas with similar land uses, such as low-density residential parcels, produce equivalent quantities of wastewater flow. System-wide flows can be compared to known flows at flow monitors, or at the treatment plant to verify accuracy of planning flow factors based on current development and measured flows. This method of estimating base flows is an industry standard for planning and provides sufficiently accurate data for planning purposes. Table 3.5 outlines the projected ADWFs for each flow monitoring basin for current, 2035, and buildout conditions.

Table 3.5 ADWF Projections for Hydraulic Modelling

Flow Meter Basin	Existing ADWF (mgd)	2035 ADWF (mgd)	Buildout ADWF (mgd)
Basin 5-1-1	0.53	1.25	2.12
Basin 5-1-2	0.15	0.25	0.38
Basin 10-10-12	0.17	0.19	0.22
Basin 8-1-1	0.12	0.13	0.13

3.4.6 Design Storm

Design storms are rainfall events used to analyze the performance of a collection system during peak flows and volumes and have a specific recurrence interval and rainfall duration. The design storm is used for sizing projects. The National Oceanic and Atmospheric Administration (NOAA) publishes isopluvial (rainfall contour) maps[1] that approximate the total rainfall depth for a range of storm size recurrence intervals for standardized storm durations.

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

[1] Miller, J., R. Frederick, and R, Tracey. Precipitation-Frequency Atlas of the Western United States, Volume IX-Washington. Washington DC, NOAA 1973.

Discrete storm events are established based on the period of time that there is no rainfall between rain events. A 20-year recurrence interval is recommended to match the pump station life cycle sizing in Ecology's Criteria for Sewage Works Design book (Orange Book); therefore the collection system must also be able to convey a 20-year storm.

The NOAA information is based on older data and does not provide a hydrograph corresponding to the accumulated rainfall. To find a suitable storm hydrograph, a statistical analysis on historical rainfall records recorded by the City and other nearby gauges was conducted. 20-year rainfall records from the City's HYDRA Rainfall Network and a 60-year record from the Portland International Airport were used to select a 20-year occurrence rainfall event on December 6, 2015. This storm had 3.37 inches of rainfall in 24 hours, which was consistent with 20-year recurrence intervals from other regional rain gauges. However, we will refer to this event as a 10-year design storm as it aligns with a 10-year recurrence defined by NOAA.

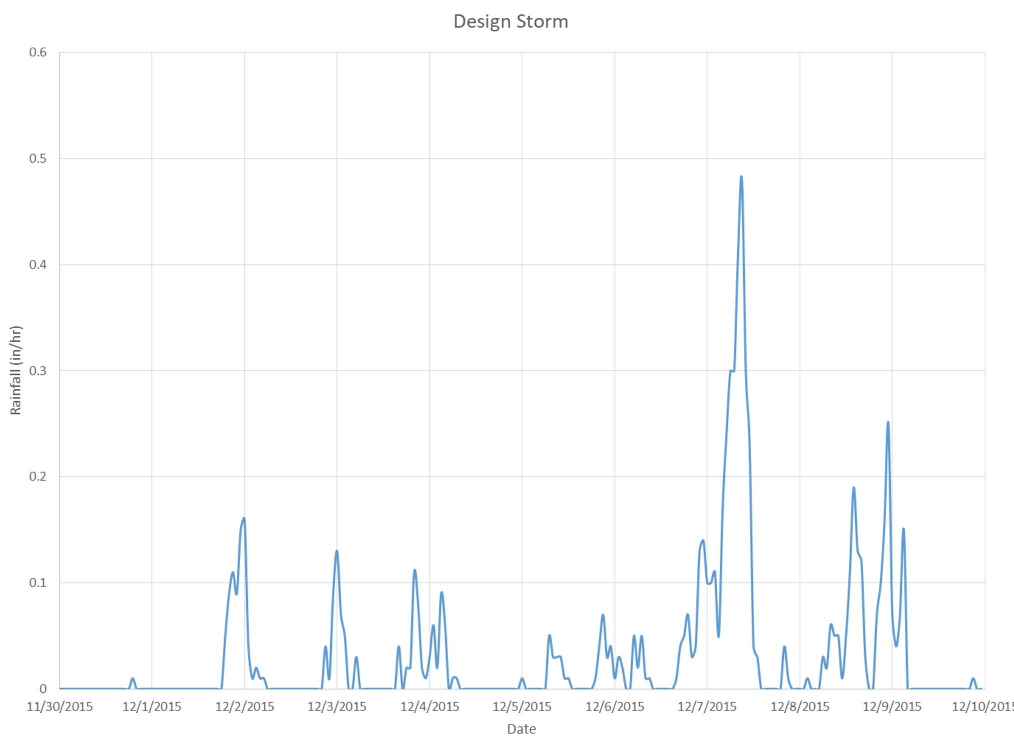

Figure 3.4 Design Storm Hyetograph

3.4.7 Hydraulic Model Wet Weather Flow Projections

To predict future Peak Wet Weather Flow (PWWF), I/I in the future service area must be defined. It is assumed that maintenance will keep up with system degradation, so no net change in I/I was used for future modeling scenarios within the existing service area. Additional area was added to the model for future scenarios in the North Shore that will add additional I/I flows into the system. The North Shore scenarios used the calibrated I/I parameters from Basin 8-1-1, as Basin 8-1-1 has a low I/I response indicative of recent construction. This corresponded to an I/I flow rate of 2000 gpad. Table 3.6 outlines the projected PWWF's for each flow monitoring basin for current, 2035, and buildout conditions. To properly convey the flows throughout the system to find the true peaks, significant upsizing was done on the piping and pump station capacity to eliminate hydraulic restrictions.

Table 3.6 PWWF Flow Projections for Hydraulic Modelling

Flow Meter Basin	Existing PWWF (mgd)	2035 PWWF (mgd)	Buildout PWWF (mgd)
Basin 5-1-1	4.63	11.38	12.76
Basin 5-1-2	0.39	1.51	1.66
Basin 10-10-12	0.54	0.56	0.59
Basin 8-1-1	0.43	0.44	0.44

3.4.8 Hydraulic Model Flow Projections Summary

Table 3.7 presents the total projected ADWF and PWWF for the three planning periods for the modeled portion of the system (gravity and Septic Tank Effluent Pump [STEP] that is upstream of gravity). The table also includes the ratio between PWWF to ADWF, called the Peaking Factor, which ranges from 5.7 to 8.2.

Table 3.7 Flow Projections Summary

Planning Horizon	ADWF (mgd)	PWWF (mgd)	Peaking Factor (PWWF:ADWF)
2018	0.80	5.45	6.8
2035	1.63	13.33	8.2
Buildout	2.63	14.86	5.7

3.5 WWTF Flow and Load Projections

The City's WWTF receives flows from the gravity collection system, septic tank effluent, and the septage receiving station. The sum of these flows is greater than the collection system flow projections because that analysis only focused on the portion of the system included in the hydraulic model and did not include septic tank flows, which make up to 50 percent of the total influent flow. Thus, load and peak hour flow projections were developed independently for the WWTF based on measured influent flows and wastewater characteristics, typical septage and STEP system characteristics, and population growth projections. The City expects that half of additional plant flow from population growth within the service area will come from the gravity sewer system, while the other half of the additional flow will come from the STEP system.

The influent flow projections developed for the WWTF are summarized in Table 3.8. Note that the 2035 PHF projection was developed by multiplying the projected PDF of 10.8 mgd by a diurnal peaking factor of 1.25 recorded during a peak flow event in February 2017. Additionally, it is assumed that no additional flow enters the collection system due to inflow and infiltration (I/I) as the City mitigates existing sources of I/I and installs new sewer and STEP system connections which do not contribute to overall I/I.

Table 3.8 WWTF Influent Flow Projection

Flow Parameter	2021 Flow (mgd)	2035 Flow (mgd)
ADWF	2.2	3.4
AAF	2.8	4.0
MMF	4.8	6.2
PDF	8.4	10.8
PHF	10.0	13.5

Wastewater loading data are important for sizing several critical treatment processes. The wastewater loading components of principal interest are the 5-day biological oxygen demand (BOD_5), the total suspended solids (TSS), and ammonia (NH4). Influent loading was projected using the same method described for influent flow projections. Historical values for BOD_5, TSS, and NH_3 and projections to 2035 are detailed in Table 3.9 and Figure 3.5 below.

Table 3.9 Current and Projected WWTF Loads

Load Parameter	2021 Load (ppd)	2035 Load (ppd)
Sewered Population(1)	18,900(1)	36,000
BOD_5 (ppd)		
Average Annual	2,400	6,000
Max Month	3,300	8,200
Max Week	4,300	10,600
Peak Day	5,300	13,000
TSS (ppd)		
Average Annual	2,400	6,300
Max Month	3,300	10,500
Max Week	4,300	17,000
Peak Day	5,300	19,300
Ammonia (ppd)		
Average Annual	900	1,400
Max Month	1,100	2,000
Peak Day	1,800	4,300

Notes:
(1) Current sewered population is based on 2035 Comprehensive Plan.

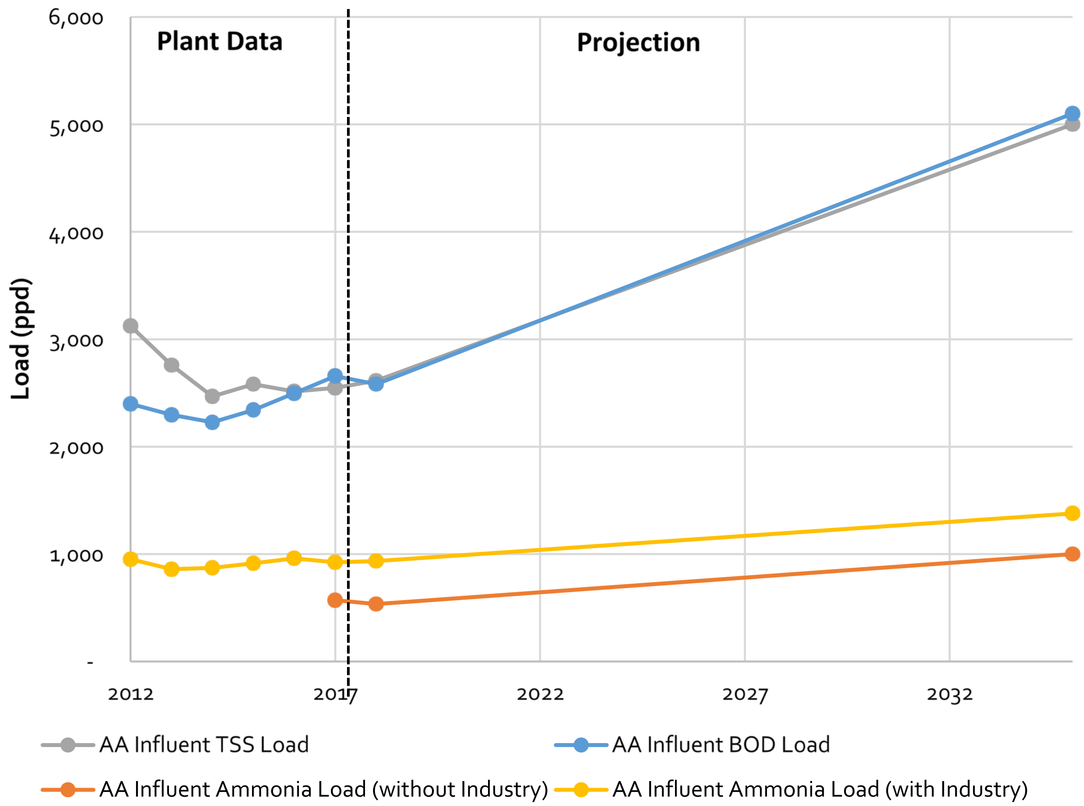

Figure 3.5 Current and Projected WWTF Loads

Chapter 4

EXISTING SYSTEM

4.1 Introduction

The purpose of a sewage collection system is to adequately convey sewage to locations where it can be treated and safely discharged. This chapter describes the City of Camas's (City's) existing sewer collection system, adjacent sewer service areas, and wastewater treatment facility (WWTF). The City's collection system utilizes both conventional gravity sewer with lift stations (LS) as well as Septic Tank Effluent (STE) Pumping Stations (STEP), Septic Tank Effluent Filter Systems (STEF), and Septic Tank Effluent Gravity Systems (STEG) to convey wastewater to the WWTF. These systems are influenced by the natural environment, critical areas, and the service area which are summarized in this Chapter.

This chapter will serve as the framework on which to base the General Sewer Plan (Plan), which was last updated in 2010. These considerations establish the basis of planning for the demographic and system analysis which will be the framework for identifying potential for development within the established service area. Consideration for the adequacy of the system to serve the anticipated development within the service area study boundaries is also reliant upon existing system characteristics.

4.2 Sewer Service Area

The City's service area is shown in Figure 4.1. The service area contains approximately 7,400 acres. The current service area includes the City limits and the future service area extends to the Urban Growth Area (UGA). Adjacent sewer systems include City of Vancouver, the Discovery Clean Water Alliance (CWA), and City of Washougal. These systems are described in greater detail in Section 4.5.

4.3 Collection System

The City's sewer system is comprised of four major facility types:

1. Conventional Gravity Sewer.
2. STE Systems.
3. STEP Transmission Mains.
4. Lift Stations (LS) with Force Mains.

The conventional gravity sewer system is the most common sewer conveyance method in the region and relies on a downward slope throughout the profile to convey flow to a WWTF or intermediate LS. In addition to the conventional gravity sewer system and LS, three STE systems are utilized in the City's collection system: STEF, STEG, and STEP, which are explained in further detail in Section 4.3.2. Twenty-nine LS are located within the service area which convey sewage and STE for treatment where gravity sewers are not effective. Properties within the sewer service area outside of the gravity sewer portion of the City's collection system use on-site septic tank systems which provide some wastewater treatment, solids settling, and digestion. Similar to LS, STEP systems allow service where gravity systems may not be effective, or which were originally located outside the public boundaries of a public sewer system service area.

Figure 4.2 and Table 4.1 below details the pipe infrastructure in the City's system by sewer type. As previously mentioned, the infrastructure is predominantly gravity sewer and nearly half of the City's pipelines serve STE systems.

Table 4.1 Summary of Pipe Infrastructure by Type

Sewer Type	Pipe Length (feet)	Pipe Length (miles)
Gravity Main	236,200	44.7
Force Main	38,260	7.2
STEP Main	255,070	48.3
STEP Bypass Main	8,040	1.5
Total	**537,570**	**101.8**

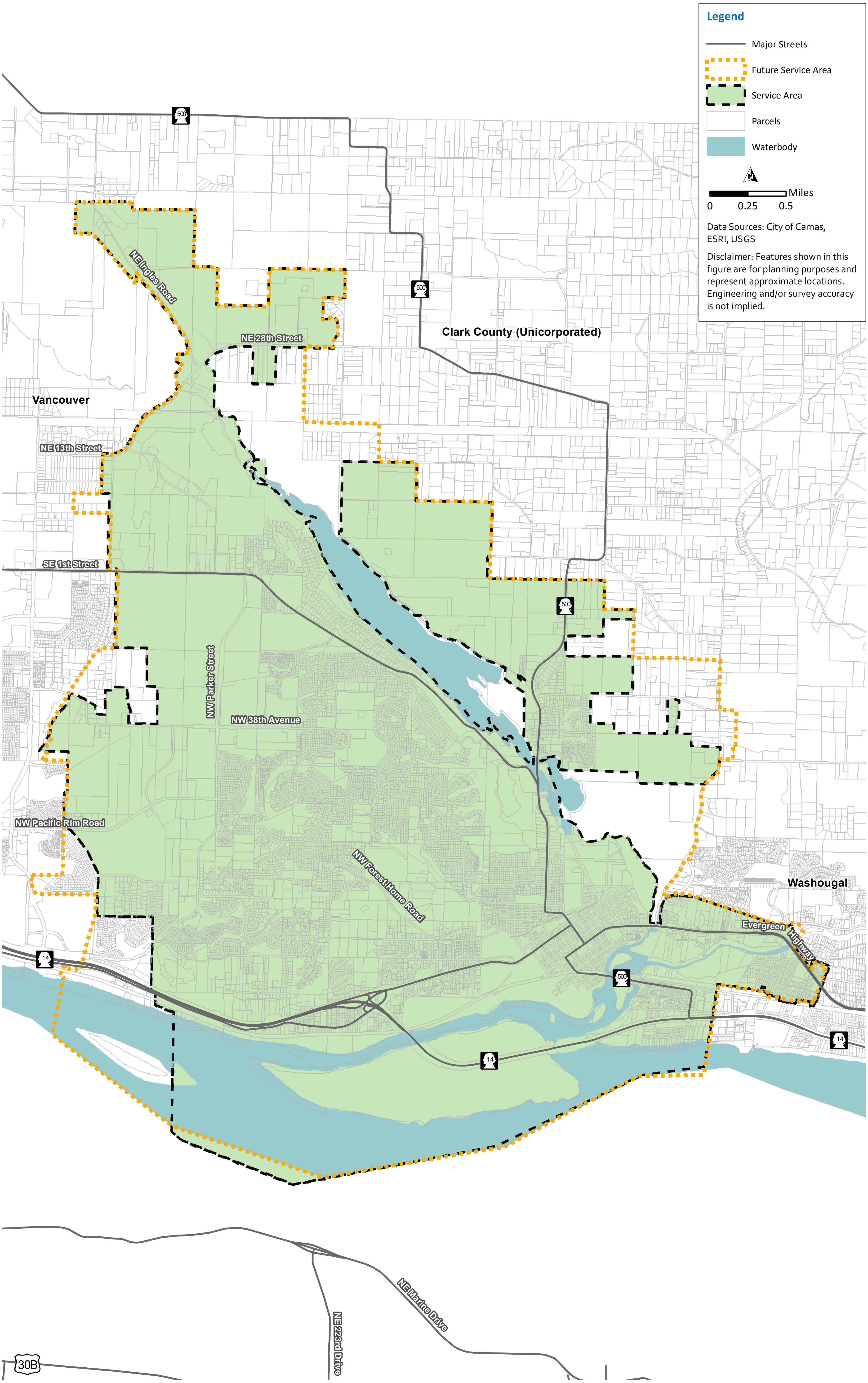

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Figure 4.1 Sewer Service Area

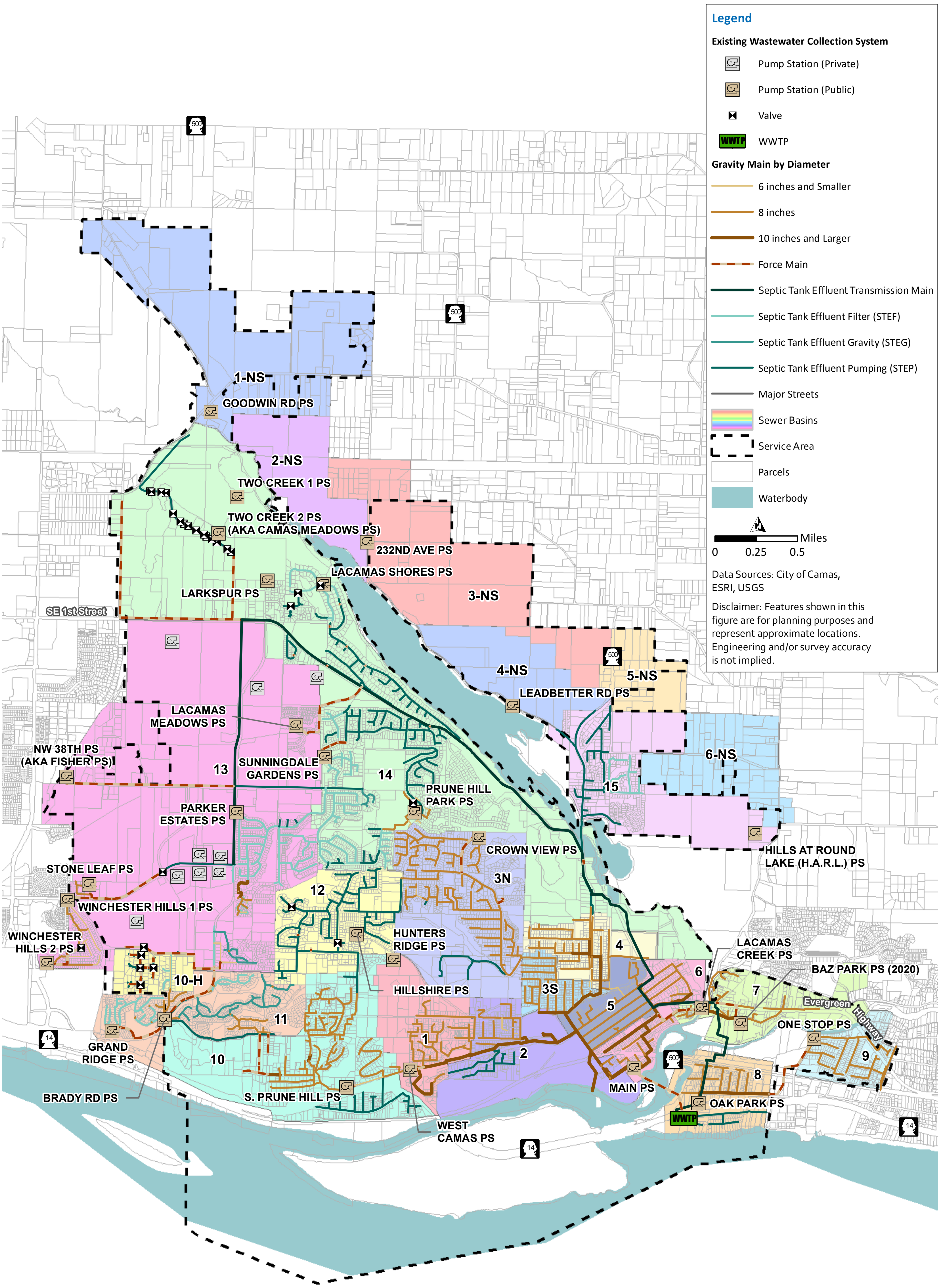

Figure 4.2 Existing Wastewater Collection System

4.3.1 Gravity System

Portions of the system served by conventional gravity sewers date from its beginning in the 1920's and includes the following basins identified in Figure 4.2: Downtown, Oak Park, Parkers Landing, basins along the Columbia River and State Route (SR) 14, and portions of Prune Hill. The North Shore area is and will continue to be served from conventional gravity sewers. Properties served by STE systems are located on the northern and western sides of the City.

The earliest portions of the gravity sewer system was constructed with vitrified clay pipe (VCP). Much of this VCP was later replaced with cast iron, concrete, and eventually polyvinyl chloride (PVC). Therefore, the relative age of sanitary sewer can be identified by the material type. The system utilizes a pipe diameter ranging from four inch to 24-inch segments where the majority of the system is eight inches or less in diameter. A summary of pipe infrastructure by diameter is shown in Table 4.2.

Table 4.2 Summary of Gravity Sewer Infrastructure by Size

Pipe Diameter (inches)	Pipe Length (feet)	Pipe Length (miles)
4	40	0.01
6	13,760	2.6
8	191,920	36.3
10	9,380	1.8
12	9,640	1.8
15	2,610	0.5
18	3,570	0.7
21	3,140	0.6
24	1,150	0.2
27	980	0.2

4.3.2 STE Systems

Starting in the 1985, the City required new customers in the western portion of the service area to be served using the STE system. Due to the City's topography and shallow bedrock, the STE systems allowed the City to serve areas without the costly installation of gravity sewers. The three STE systems address site specific challenges within the City's collection system. STEP systems consist of a septic tank equipped with a pump at the outlet to convey effluent flows to the STEP transmission main, rather than an on-site drain field. STEG systems consist of a septic tank with an outlet that conveys effluent flows by gravity to the STE transmission main. STEF systems utilize a siphon to convey effluent flows to the STE transmission main. Figure 4.2 shows the STEF, STEG, and STEP systems and STE transmission mains within the City's conventional gravity collection system.

The City owns and maintains residential STE systems. The City pumps out the septage from the STE systems on a five-to-seven-year cycle. Commercial and Industrial systems are owned and maintained by the property owner. The City receives and treats septage from both systems at the WWTF.

Table 4.3 Summary of STE Infrastructure by Size

Pipe Diameter (inches)	Pipe Length (feet)	Pipe Length (miles)
Unknown	40	0.01
1	1,880	0.4
2	50,235	9.5
3	9,740	1.9
4	23,680	4.5
6	57,440	10.9
8	40,980	7.8
10	25,950	4.9
12	320	0.06
18	2,450	0.5
21	230	0.04

4.3.3 STEP Transmission Main

The STEP transmission main is a transmission main that conveys STE system flows and major industrial dischargers to the WWTF. The pressurized transmission main is shown in Figure 4.2, The STEP main is approximately 36,970 linear feet in length and is 21-inches to 24-inches in diameter. The transmission main conveys flows directly to the WWTF without receiving flows from the other sewer systems.

4.3.4 Lift Stations

The City currently operates twenty-nine LS, whose characteristics are summarized in Table 4.4. Of these twenty-nine LS, thirteen serve the gravity system and fifteen serve the STE systems. One LS is dedicated to odor control. The LS are identified in Figure 4.2. There are approximately 51,460 ft, or 9.7 miles, of force main associated with the LS ranging from 4-inches to 18-inches in diameter. The majority of LS serve relatively small service areas and have capacities less than 500 gallons per minute (gpm). The Main LS, with a capacity of 7,700 gpm station, conveys the majority of the gravity system to the WWTF through an 18-inch diameter force main under Lacamas Creek.

Table 4.4 Summary of Lift Stations

	Lift Station	Location	Basin Number	STE or RAW	Quantity of Pumps	Pump Motor Size (HP)	Pump Capacity (gpm, ea.)	Total Station Capacity (gpm, 1 standby)	TDH (feet)
1	232nd Avenue	Near 618 NE 232rd Avenue	2-NS	RAW	2*	15.2	365	365	87
2	Baz Park	1906 NE 3rd Loop	7	RAW	2	7.5	488	488	38
3	Brady Road	919 NW Brady Road	11	STE	2	35	511	511	60
4	Camas Meadows	6902 NW Morgan Way	14	STE	2	35	221	221	222
5	Crown View	3222 NW Ivy Lane	3	RAW	2	20	222	222	124
6	Fisher	5870 NW 38th	13	STE	2	23	126	126	206
7	Goodwin Rd	2305 NE Goodwin Road	1-NS	RAW	2*	15.2	300	300	94
8	Grand Ridge	843 NW Grande Ridge Road	11	STE	2	11	133	133	160
9	Hills at Round Lake (HARL)	1960 NE Tanoak Drive	15	STE	2	11	256.9	256.9	93.2
10	Hillshire	2303 NW Artz Court.	12	RAW	2	10	175	175	70.1
11	Hunters Ridge	2021 NW 17th Avenue	1	RAW	2	23	152	152	174
12	Lacamas Creek	1641 NE 3rd Avenue	7	RAW	2*	25	950	950	67
13	Lacamas Meadows	3263 NE 45th Avenue	13	STE	2	23	173	173	203
14	Lacamas Shores	6230 NW El Rey Drive	14	STE	2	23	195	195	168
15	Larkspur	6162 NW Larkspur	14	STE	2	23	264	264	154
16	Leadbetter Rd	1050 SE Leadbetter Road	4-NS	RAW	2*	26.6	605	605	111
17	Lower (aka South) Prune Hill	2381 NW 6th Place	10	RAW	2	10	600	600	39
18	Main Station	480 SE 3rd Avenue	5	RAW	3	125	3850	7700	85
19	Oak Park	907 SE Polk Street	8	RAW	2	10	350	350	57
20	One Stop	200 SE Yale	9	RAW	2	5	231	231	36.2
21	Parker Estates	3436 NW Parker	13	STE	2	20	339	339	103
22	Prune Hill Park	3403 NW Sierra Drive	14	STE	2	7.5	350	350	53
23	Stone Leaf	5713 NW 26th Avenue	13	STE	2	23	423	423	81.2
24	Sunningdale Gardens	4043 NW Dahlia Loop	14	STE	2	10	260	260	63
25	Two Creeks	7402 NW Morgan Way	14	STE	2	10	166	166	70.7
26	West Camas	1625 NW 6th Place	1	RAW	2	30	1000	1000	74
27	Winchester Hills 1	19617 SE 34th Street	13	STE	2	6.5	97.9	97.9	66.7
28	Winchester Hills 2	19320 SE 42nd Circle	13	STE	2	5	125	125	65
29	Remote Odor Control Station	325 NE 23rd Avenue	14	N/A	N/A	N/A	N/A	N/A	N/A

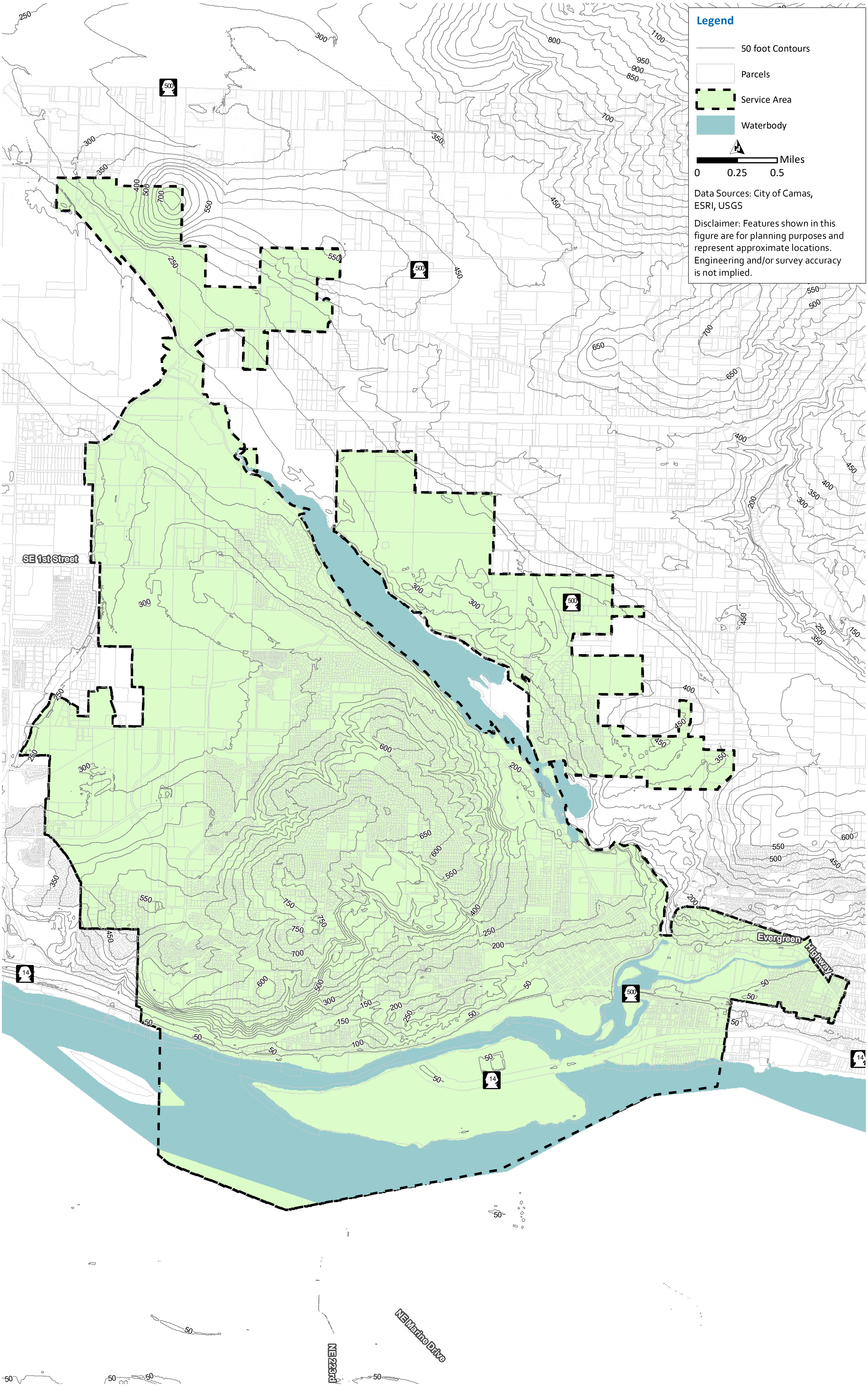

Figure 4.3 Topography

4.4 Wastewater Treatment Facility

The City's WWTF is located along the Columbia River in the southeastern portion of its sewer service area. The WWTF was originally constructed in 1972 and has had several modifications since that time. The first major upgrade and expansion of liquid stream processes was completed in February of 2000. A subsequent Phase 2A upgrade, primarily addressing solids treatment, including anaerobic digesters and sludge drying facilities, was completed in 2012. Phase 2B, completed in 2014 improved blower controls, added a third secondary clarifier, new effluent filters, and digester gas treatment facilities.

The facility process flow diagram is shown in Figure 4.4. An aerial view of the WWTF with each unit process and building identified is shown in Figure 4.5. The liquid stream treatment begins with climbing bar screens at the plant headworks to remove larger material which is washed, compacted, and disposed of at a landfill. Primary solids-liquid separation occurs in two circular primary clarifiers with the primary effluent discharging to a splitter box where it is combined with return activated sludge (RAS) from the secondary clarifiers (SC) and split between three aeration basins (ABs), where biomass is aerated to promote biological oxidation and improve water quality. Secondary treatment in the ABs consists of influent channel selector zones followed by two aerated and three anoxic zones to remove carbonaceous material and reduce ammonia concentrations. Magnesium hydroxide ($Mg(OH)_2$) is added at the SC splitter box to provide supplemental alkalinity.

Mixed liquor from the three ABs is combined and split between three secondary clarifiers. The three clarifiers provide separation of the biomass from the secondary treatment processes (termed activated sludge) and discharge of liquid effluent to two mechanical disc filters. Ultraviolet (UV) disinfection is provided in an open channel system with four banks of UV lamps prior to discharge to the outfall in the Columbia River.

The effluent either flows by gravity or is pumped to the outfall via the three effluent pumps, which are operated with two duty and one standby configuration. Transitions between gravity and pumped effluent flow are performed automatically when the pumps are placed in "auto" mode. When the Columbia River level rises, gravity effluent discharge is stopped by closing the flap gate in the effluent manhole. The existing outfall is a 36-inch corrugated metal pipe (CMP) and extends approximately 850 feet south into the Columbia River channel. The diffuser portion of the outfall is located along the outer 150 feet of the pipe and is equipped with 16 vertical risers, with each oriented vertically with rubber Tideflex check valve-type nozzles. The vertical risers discharge effluent perpendicular to the flow of the Columbia River.

Solids from the primary clarifiers are first conveyed to two hydro-cyclones and a classifier for degritting then thickened in the gravity thickener. Thickened primary sludge (TPS) is then pumped to anaerobic digesters. Solids from the secondary clarifiers are moved by a sludge-scraper mechanism to a wet well and then withdrawn by pumps. The settled solids (RAS) are pumped back to the aeration basin splitter box. Excess activated sludge wasted (WAS) from SC Number 3 is sent to a storage tank and thickened in a rotary drum thickener. Thickened primary and secondary solids are then combined in anaerobic digesters for stabilization, removal of volatile solids, and production of biogas. Dewatering of the digested sludge is accomplished through a centrifuge and then conveyed to a belt dryer, which evaporates most of the remaining water content in the biosolids. The dewatered and dried biosolids are dried to achieve Class A and are hauled off-site for land application. Odors are controlled at the plant through unit-specific odor control ductwork. The odorous air is then blown through a bark media biofilter.

The unit capacity for each major unit at the WWTF is summarized in Table 4.5.

Table 4.5 Unit Process Capacity

Unit	Number of Units	Design Criteria(1)
Bar Screens		
Climbing Bar Screens	2	• Perforation Size: 1/4 in (6 mm)
Manual Coarse Bar Screen (Bypass)	1	• Bar Spacing: 3/4 in (19 mm)
Primary Clarifiers	2	• Diameter: 60 ft (each) • Depth: 10 feet • Volume: 211,500 gallons
Aeration Basins	3	• Volume: 100,800 ft^3 (each)
Aerobic	3	• Total Volume: 176,400 ft^3
Anoxic	2	• Total Volume: 108,360 ft^3
Selector (SAx)	3	• SAx-1 Volume: 2,700 ft^3 • SAx-2 Volume: 1,600 ft^3 • SAx-3 Volume: 4,500 ft^3 • SAx-4 Volume: 9,000 ft^3
Secondary Clarifiers		
SC Number 1	1	• Diameter: 75 feet • Depth: 13 feet • Volume: 424,000 gallons
SC Number 2	1	• Diameter: 75 feet • Depth: 17 feet • Volume: 461,800 gallons
SC Number 3	1	• Diameter: 75 feet • Depth: 14 feet • Volume: 462,700 gallons
Effluent Disc Filters	2	• Capacity: 3.0 mgd (each)
UV Disinfection(1)	4	• Peak Day Process Flow: 10.04 mgd
Hydrocyclones	2	• Capacity: 220 gpm
Gravity Thickener	1	• Diameter: 30 feet • Depth: 10 feet
Anaerobic Digesters	2	• Volume: 24,500 ft^3 (each)
Centrifuge	1	• Capacity: 130 gpm
Rotary Screen Thickener	1	• Capacity: 100-300 gpm

Notes:
Abbreviations: ft^3 - cubic feet; mm - millimeter.

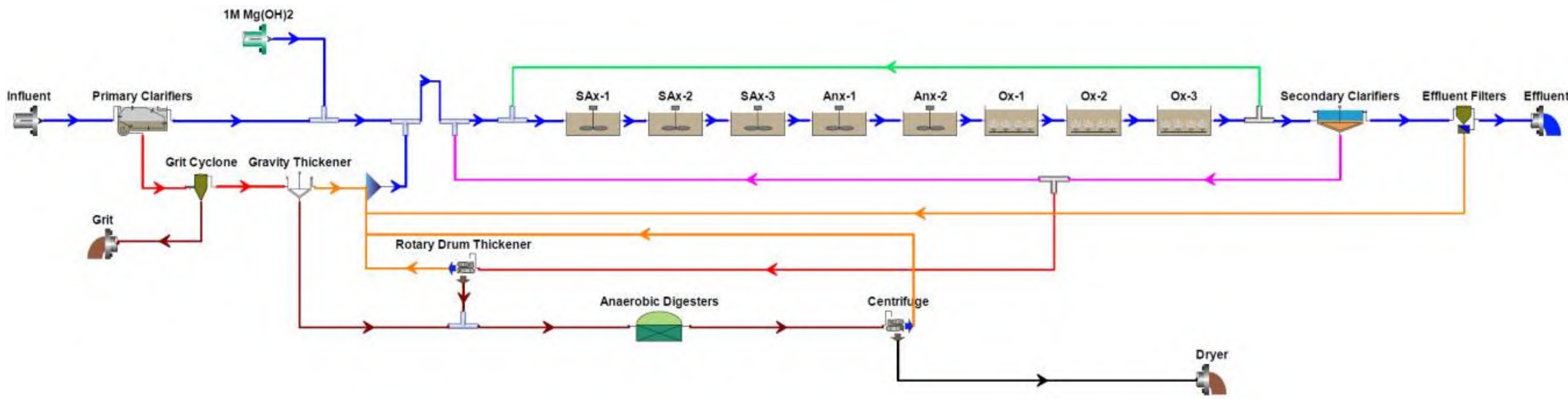

Figure 4.4 BioWin Process Flow Diagram

Figure 4.5 WWTF Aerial Image with Site Plan

4.4.1 Recent Plant Upgrades

As noted, several upgrades have taken place at the WWTF since the previous General Sewer Plan (Gray and Osborne, 2010), which have increased capacity and efficiency:

- **WWTF Improvements Phase 2A (2012):** Several improvements took place with this design to improve the following:
  - The addition of solids handling equipment which includes a rotary screen thickener, two anaerobic digesters, a waste gas burner, and sludge holding tank.
  - Modifications to headworks which includes the addition of Bar Screen No. 2 and Washer/Compactor No. 2.
  - Installation of the Plant Drain Pump Station No. 2, Biofilter No. 2, and the Septage/Centrate/ WAS Storage Tank.
  - Reduction to the height of the aeration basins (AB) and the addition of baffle walls within the selector zone.
- **WWTF Improvements Phase 2B (2014):** This project focused on modifications to the sludge storage area, the addition of Secondary Clarifier No. 3, modification of Secondary Clarifier No. 2, and addition of two effluent disk filters.
- **Installation of a Thermal Dryer (2012):** This allowed the facility to produce Class A Biosolids for land application.

Additionally, two studies have been completed focusing on assessing the condition of equipment. The WWTF and Pump Station Condition Assessment Report (HDR, 2018) recommended several improvements in the immediate term which include an odor control evaluation, polymer usage evaluation, replacement/upgrading grit hydrocyclones and classifiers, modeling of the AB's, blower filter replacement, a cross connection evaluation, supervisory control and data acquisition (SCADA) upgrade, replacement of variable frequency drive (VFDs) in the equipment building and plant effluent building, and replacement of pH and dissolved oxygen (DO) analyzers. An additional condition assessment was completed on the gravity thickener which identified six major components which were severely deteriorated as well as the conduit and wiring within.

4.4.2 Plant Flows

The WWTF receives influent flows from the Main and Oak Park pump stations and a septage truck unloading station. STEP flows in the collection system are conveyed to the plant through the Main and Oak Park pump stations. The combined flow from the pump stations and septage truck unloading station are measured by a Parshall flume. The combined flow measured by the Parshall flume is recorded as the WWTF influent flow.

The WWTF has a five-year average annual flow (AAF) of 2.8 mgd from the collection system with approximately 33 percent of the AAF from industrial users. This relatively high percentage of industrial users increases the influent ammonia concentrations but decreases the total suspended solids (TSS) and biochemical oxygen demand (BOD) concentrations resulting in a high nitrogen and low carbon influent compared to a typical municipal facility. The previously described STEP and STEF system which contributes nearly 60 percent of the average day dry weather influent flows also contributes to unique influent characteristics when brought into the facility due to an estimated 35 percent reduction of BOD in the 5-day test (BOD_5) and a 60 percent reduction of TSS in the septic tank. Although septic tank solids are also returned to the facility through septic delivery, these solids also have reduced BOD_5 and TSS loadings due to the nearly five-year detention time. National Pollution Discharge Elimination System (NPDES) effluent discharge limitations, prohibitions, and requirements are similar to other municipal facilities with standard 30/30 monthly TSS and BOD concentration limits with a mandatory 85 percent reduction in each. However, the WWTF has ammonia limits of 20 mg/L (NH_3 as N) in the summer and seven mg/L (NH_3 as N) in the winter.

4.4.3 NPDES Violations

The current NPDES permit was effective October 1, 2015, and expired September 30, 2020, but as of February 2022 the City is working with Ecology on an extension request. The plant has had few permit violations since issuance of the latest permit, with the last violation occurring in October 2019. These violations include minimum pH value, average monthly ammonia concentration, average weekly TSS concentration and load, and average weekly BOD_5 concentration and load. A list of permit violations is shown in Table 4.6. The violations in 2017 occurred due to a toxic slug introduced in the influent which reduced the viable mixed liquor population resulting in floating sludge and higher than expected discharge concentrations from the secondary clarifiers which overwhelmed the filters pushing a higher percentage of flow through the filter by-pass.

Table 4.6 Five-Year NPDES Permit Violation Summary

Violation Date	Type / Parameter	Measurement Value(2)	Effluent Limit(2)
October 2019	pH Daily Minimum	5.9	6 (min)
February 2018	Ammonia Winter(1) Monthly Average	13.2 mg/L	7 mg/L
February 2017	TSS Weekly Average	51.5 mg/L 3,532 ppd(2)	30 mg/L 1,525 ppd
February 2017	BOD_5 Weekly Average	41.2 mg/L 2,623 ppd	30 mg/L 1,525 ppd

Notes:
(1) Winter Ammonia limits apply to the months of October through May.
Abbreviations: mg/L - milligrams per liter; ppd - pounds per day.

4.5 Adjacent Sewer Service Areas

Four sewer service areas with their own WWTFs are within a 20-mile radius of the Camas WWTF. All of the facilities listed in Table 4.7 have Columbia River outfalls. Distances vary from the closest, Washougal WWTF, approximately 3.5 miles away, to the farthest, Salmon Creek WWTF, approximately 20 miles away.

Table 4.7 Adjacent Service Areas WWTFs

Facility/Service Area	MMF (mgd)(1)	Biological Treatment Process	Disinfection	Biosolids
Salmon Creek (Clark County)	10.3	Aeration Basins	UV	Land Applied
Marine Park (Vancouver)	16.1	Aeration Basins	UV	Incinerated
Westside (Vancouver)	28.3	Aeration Basins	UV	Incinerated
Washougal	2.2	Oxidation Ditch	UV	Lagoon

Notes:
Abbreviations: MMF - maximum monthly flow.

All of these nearby treatment facilities utilize activated sludge treatment processes and UV disinfection; however, the greatest variation in treatment can be seen in the processing of biosolids. Salmon Creek WWTF operates similarly to Camas through the land application of biosolids. Marine Park and Westside incinerate of solids produced at those City of Vancouver facilities.

4.5.1 City of Vancouver

The City of Vancouver currently uses 716 miles of sanitary sewer and forty-one pump stations to convey sewage to Vancouver's Marine Park and Westside WWTFs. Vancouver's collection system is divided into three basins currently: the Westside Basin, Eastside Basin, and Diversion Basin. Wastewater generated in the Eastside Basin is conveyed to and treated exclusively at the Marine Park facility. Diversion Basin wastewater is conveyed to and treated at either the Marine Park or Westside WWTF. Westside Basin sewage is conveyed to and treated exclusively at the Westside Treatment Facility.

The largest nearby treatment facility is Westside in Vancouver at 28.3 mgd average annual flow. Altogether, Marine Park and Westside WWTFs serve 195,000 residents per2022 census data. Currently, Marine Park does not treat its solids on-site and instead conveys them to Westside through a force main and gravity sewer. Once at Westside, a fluidized bed furnace incinerates scum and solids from the primary and secondary clarifiers at both plants.

4.5.2 City of Washougal

The City of Washougal currently operates fourteen LS throughout the City and conveys sewage through more than 1.5 miles of force mains to the Washougal Treatment Plant. The treatment plant consists of an oxidation ditch followed by a secondary clarifier and UV disinfection. Similar to other pants in the region, effluent is discharged to the Columbia River.

4.5.3 Clark County

Clark County formed the Discovery Clean Water Alliance (CWA) in January 2013 to provide framework for regional wastewater collection. The CWA serves unincorporated Clark County, the City of Battle Ground, the City of Ridgefield, and Clark Regional Wastewater District.

Nearby Salmon Creek WWTF is part of the CWA and serves approximately 100,000 residents. Although the average annual flow is typically between 8-10 mgd, the plant has the capacity to treat up to 15 mgd. Future expansion is underway to improve the Columbia River outfall as well as increase capacity to 17.5 mgd. Odor control will be built as well due to odorous air present particularly during the summer and early fall.

4.6 Natural Environment and Critical Areas

Topics considered to describe the existing system's natural environment include topography, soils and geology, and climate including rainfall. Critical areas within the natural environment highlight the connection between the sewer system and these characteristics. Critical areas include wetlands, critical aquifer recharge areas (CARA), geologically hazardous areas, frequently flooded areas, and fish and wildlife habitat conservation areas.

4.6.1 Natural Environment

Relatively steep topography with slow to moderate infiltration rates comprise a majority of the City's geography. The City enjoys moderate temperatures between the average high of 62 degrees Fahrenheit (°F) and average low of 37°F. Heavy rainfall, characteristic of the Pacific Northwest region, provides an average annual precipitation of 84 inches while snowfall is not typically heavy, annually averaging 9 inches.

4.6.1.1 Topographical Characteristics

As shown in Figure 4.3, elevation ranges from slightly above sea level (20 feet) to greater than 750 feet in the City. Steep slopes comprise a large portion of the landscape which range from 5 to 15 percent. A relatively flat plateau is present at the most central portion of the City near Prune Hill while the older, denser zones lie along the Columbia River. Similarly, the UGA was developed on a steep slope with the plateau at 470 feet elevation residing just outside of the City Limits.

4.6.1.2 Soils and Geology

According to the National Resources Conservation Service (NRCS), Clark County is approximately 5 percent cinebar stony silt loam with 30 to 70 percent slopes. However, the City is a much higher percentage of Lauren gravelly loam from 0 to 8 percent slopes and Hesson Clay loam from 0 to 8 percent slopes. These soil types are categorized as hydrological soil groups B and C, respectively, which indicate slow to moderate infiltration rates when wet with a slow to moderate rate of water transmission. This indicates moderate runoff coefficients for the region. Additional details on the soil groups are available in Figure 4.2.

4.6.1.3 Climate

The City's climate is characterized by a combination of rainfall, wind, and temperature patterns for the nearby region. The average high temperature is 62°F and the average low is 37°F. The temperature is known to vary from 36°F to 84°F throughout the year with a warm season from June to September. Altogether, summers last approximately three months with warm weather and winters are cold with the heaviest rainfall occurring late November or early December.

Historical precipitation data was gathered from Airport Way #2 Rain Gage (Station 111) of the City of Portland HYDRA Rainfall Network. The average five-year rainfall patterns indicate the November through February period averaging five inches per month or more with a peak in January at approximately 6.4 inches. The maximum annual rainfall occurred in 2017 at 53.24 inches total which is 32 percent greater than the average. The driest month of the year is typically July with no rainfall recorded for 2017 and 2018. The average annual rainfall patterns are detailed in Table 4.4. Average annual snowfall is nine inches and average annual precipitation is approximately 84 inches.

Table 4.8 City of Portland Station Precipitation 2017-2022

Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	**Annual**
2017	4.25	11.63	9.02	5.33	2.64	1.49	0	0.12	2.54	5.33	7.06	3.83	**53.24**
2018	6.08	2.85	3.16	5.54	0.27	1.99	0	0.08	1.11	3.61	3.29	6.09	**34.07**
2019	3.31	5.2	1.7	4.46	1.77	2.13	0.28	1.25	3.85	1.8	1.73	4.73	**32.21**
2020	9.6	2.59	3.37	1.29	3.42	3.11	0.04	0.59	2.53	1.92	6.14	6.03	**40.63**
2021	7.64	4.36	2.41	0.5	1.6	0	0.02	0.09	4.09	4.87	7.8	8.89	**42.27**
2022	7.25	3.14	-	-	-	-	-	-	-	-	-	-	**-**
Average	**6.36**	**4.96**	**3.93**	**3.42**	**1.94**	**1.74**	**0.07**	**0.43**	**2.82**	**3.51**	**5.20**	**5.91**	**40.30**
Minimum	**3.31**	**2.59**	**1.70**	**0.50**	**0.27**	**0.00**	**0.00**	**0.08**	**1.11**	**1.80**	**1.73**	**3.83**	**16.92**
Maximum	**9.60**	**11.63**	**9.02**	**5.54**	**3.42**	**3.11**	**0.28**	**1.25**	**4.09**	**5.33**	**7.80**	**8.89**	**69.96**

4.6.2 Critical Areas

Critical areas define crucial components for planning in an area including protected lands, e.g., wetlands, CARAs, and conservation areas, as well as areas with greater risk to its inhabitants, e.g., frequently flooded areas and geologically hazardous areas. Identifying these areas allows for the mitigation of unnecessary risk or harm to protected lands; additionally, policies in the *Camas 2035 Comprehensive Plan* (Camas, 2016) outline goals to protect and restore these sites.

4.6.2.1 Wetlands

Ecology currently rates wetlands based upon several key factors including their 'ability to be replaced, sensitivity to disturbances, rarity, functional performance, and importance in biodiversity' (Ecology, 2006). These levels include categories I-IV with a Category I wetland requiring the greatest protection. As defined by the wetland rating system, Category I wetlands have valuable biodiversity and hydrogeomorphic functionality in pollutant removal, stormwater storage, and even buffering natural disasters.

Within the City, there are >1,200 acres of recognized wetland which are protected by several local, state, and federal ordinances and laws including the Growth Management Act, Critical Areas Ordinance, Clean Water Acts, and City municipal code (CMC) 18.31.050. These regulations entail the study of a wetland's functionality and that adverse impacts be avoided or reduced. Figure 4.6 illustrates the City's wetlands delineated using reports filed with the city and published data.

4.6.2.2 Critical Aquifer Recharge Areas

The majority of raw water supply for the City is provided by groundwater resources. This critical resource is protected by the CARA ordinance and the CMC. CMC 16.70.050 focuses on Aquifer Recharge Areas and required reports for proposed activities.

CARAs are located in multiple regions of the City and surrounding areas. Currently, two wellhead protected areas are within the City limits with the southernmost protected area extending beyond the UGA. Figure 4.4 shows these regions in relation to wells which serve more than 20 people.

4.6.2.3 Frequently Flooded Areas

Frequently flooded areas are defined as regions with >1 percent chance of flooding per year. These regions are near surface water bodies which include Lacamas Lake, Columbia River, Washougal River, Jones Creek, Boulder Creek, Round Leaf Lake, and Fallen Leaf Lake. Due to low elevations, portions of the southeastern region of the City are located within the 100-and 500-year Federal Emergency Management Agency (FEMA) floodplain. Construction regulations focus on decreasing flood hazards of the structure which area detailed in a critical area report.

4.6.2.4 Geologically Hazardous Areas

Geologically hazardous areas are typically defined by the possibility of natural disasters including earthquakes and volcanic activity. These hazard potentials are then increased by the presence of steep slopes prone to landslide, particular soil groups prone to liquefaction, and other circumstances which have the potential to compound emergency scenarios. The United State currently operates on a Category 1-4 system to determine building code stringency as it pertains to natural disasters where category 4 is the most stringent. The City is rated as a Category 4 which indicates a high potential for landslides and other events.

In Chapter 40.430, Clark County defines three types of geologic hazard areas which include seismic, landslide, and steep slope. The county's Geologic Hazard regulation requires developers to have a Geologic Hazard Area Study completed on any property which is identified in a hazard area.

4.6.2.5 Fish and Wildlife Habitat Conservation Areas

As defined in the City's 2035 Comprehensive Plan, one of the primary plans for the City is to protect "habitat and safe passage for wildlife from Green Mountain to the Columbia River" (Camas, 2035). Multiple threatened species have been found to inhabit or pass through the region, and regulations are currently in place to prevent harm to any habitat including Washington Administrative Code (WAC) 365-190-130. These regions are defined as Fish and Wildlife Habitat Conservation Areas which are protected.

Regulations include completing a habitat assessment before construction. These regulations impact any proposed sanitary sewer pipelines or pump stations in order to protect the fish and wildlife habitat.

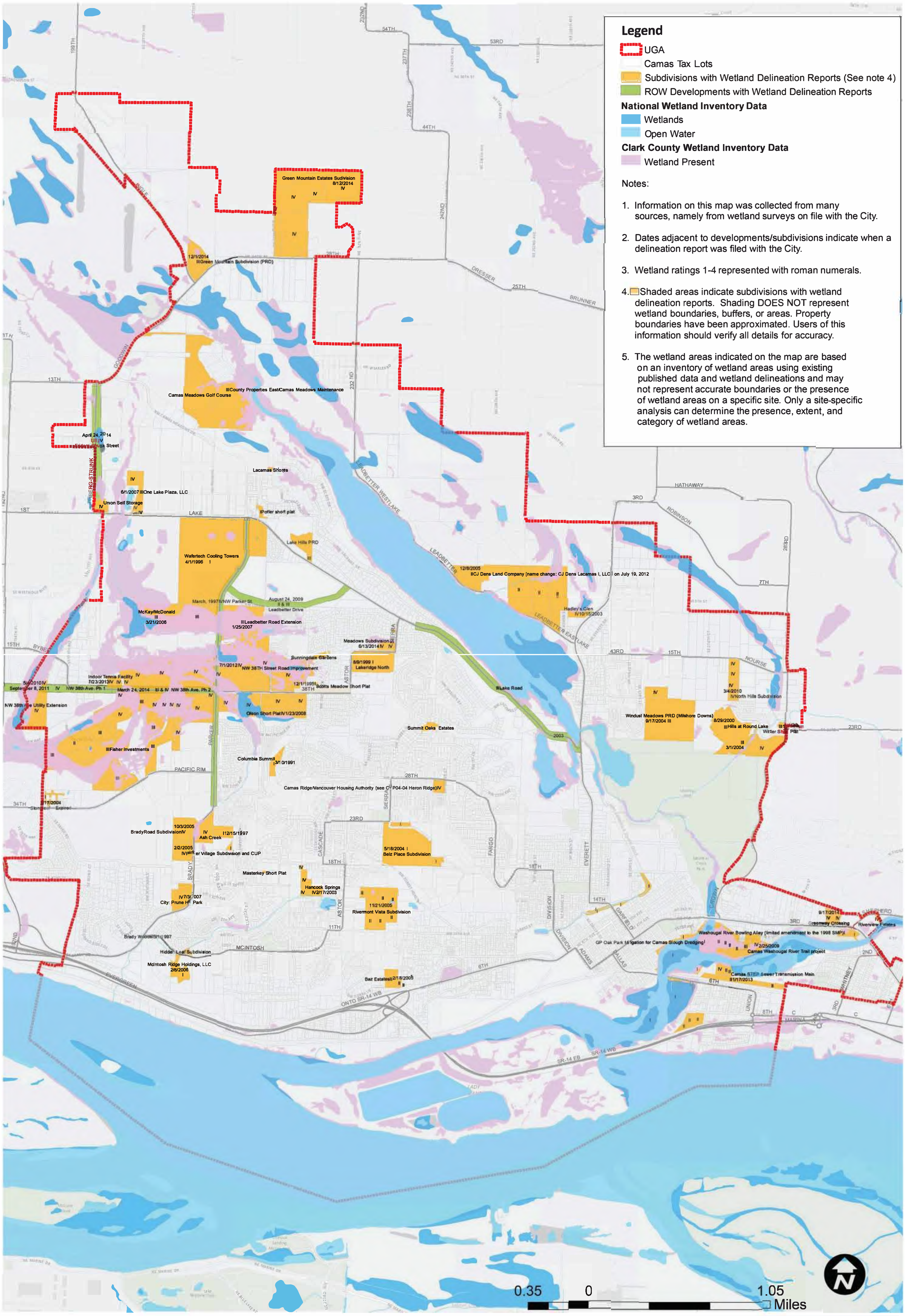

Figure 4-6 Camas Wetlands Map

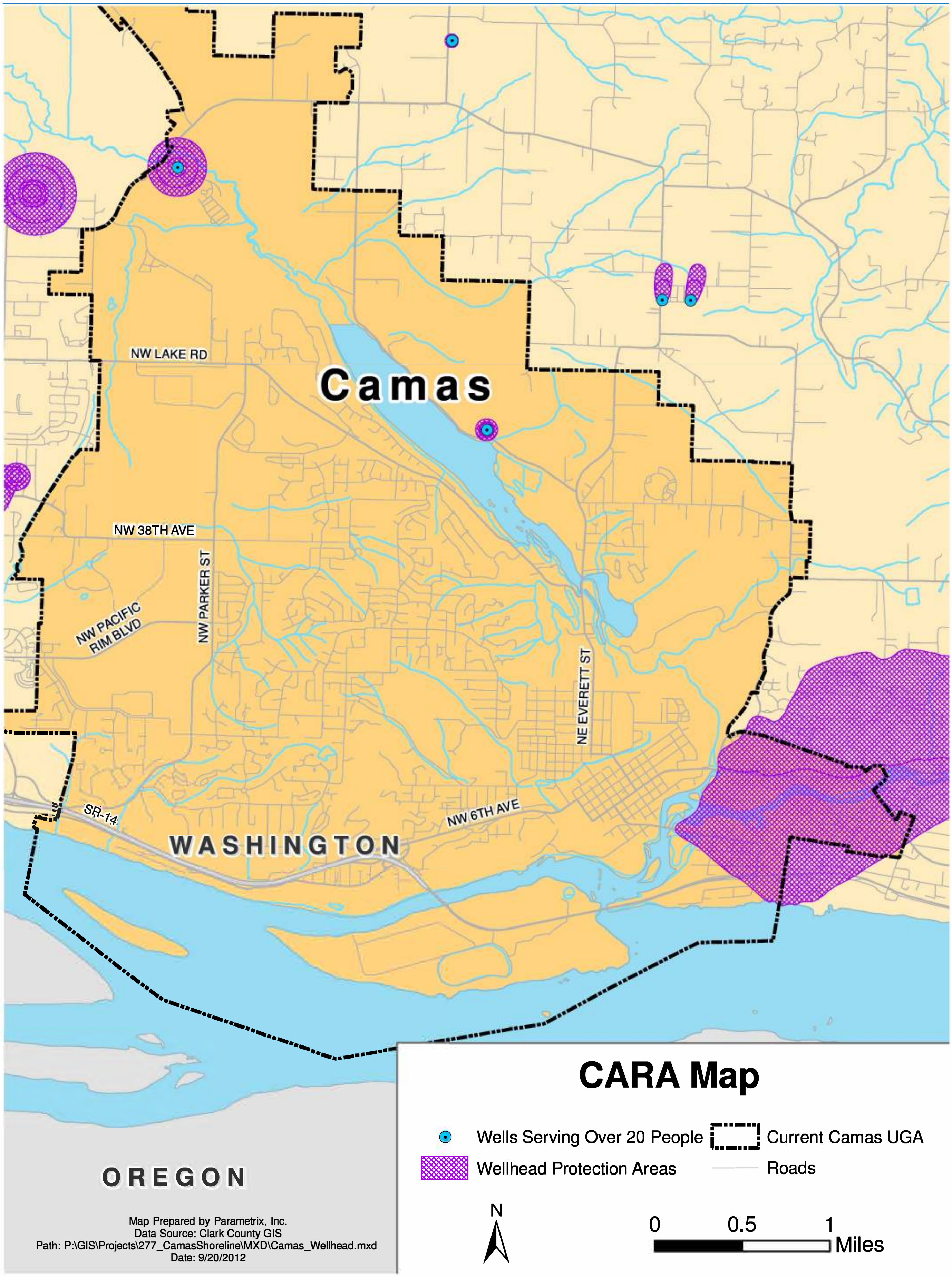

Figure 4.7 CARA Map

4.7 Water System

The City owns and operates a multi-source municipal water system, shown in Figure 4.8, which uses ground water and surface water to supply, treat, store, and distribute potable water to residential and commercial customers. The City currently obtains its water from ten groundwater wells and two surface water resources. The wellhead protection areas are regulated to prevent leakage from the sanitary sewer system from infiltrating a well; these areas are shown in Figure 4.9. The surface water resources include the Jones Creek Intake constructed in 1913 and the Boulder Creek Intake constructed in 1931. These intakes are permitted to flow at 1,570 gpm and have lower operating expense than groundwater sources. The ten groundwater wells are located in the 343 Zone excluding Well 9 which is located in the 544 Zone.

The City currently maintains the capacity to store 8.45 million gallons (MG) at multiple facilities including Butler Reservoir (1.2 MG), Gregg Reservoir (0.1 MG), Lacamas Reservoir (2.0 MG), Lower Prune Hill Reservoirs (2.0 MG), and the Upper Prune Hill Reservoirs (3.15 MG). This capacity is available for normal and emergency conditions, such as fire suppression. Service is provided to customers across five major pressure zones and 18 subzones. Eight booster pump stations are used to move water between pressure zones. Table 4.9 below lists the booster pump stations and their capacities.

Table 4.9 Camas Booster Pump Stations

Booster Pump Station	Capacity (gpm)
Butler	1,400
New Gregg	1,000
Forest Home	3,500
Lower Prune Hill	2,500
Lacamas	2,500
Angelo	4,000
Upper Prune Hill	2,900
Crown Road	1,600

The City owns over 143 miles of pipelines in its water transmission and distribution system compared to only 87.5 miles of collection system. Approximately 47 percent of the pipeline is Ductile Iron followed by Cast Iron at 15 percent. Additionally, the distribution system includes numerous meters, isolation valves, and hydrants. An emergency intertie is available with the City of Washougal as well while an agreement with the City of Vancouver includes the use of two fire hydrants located at SE 1st and Friberg.

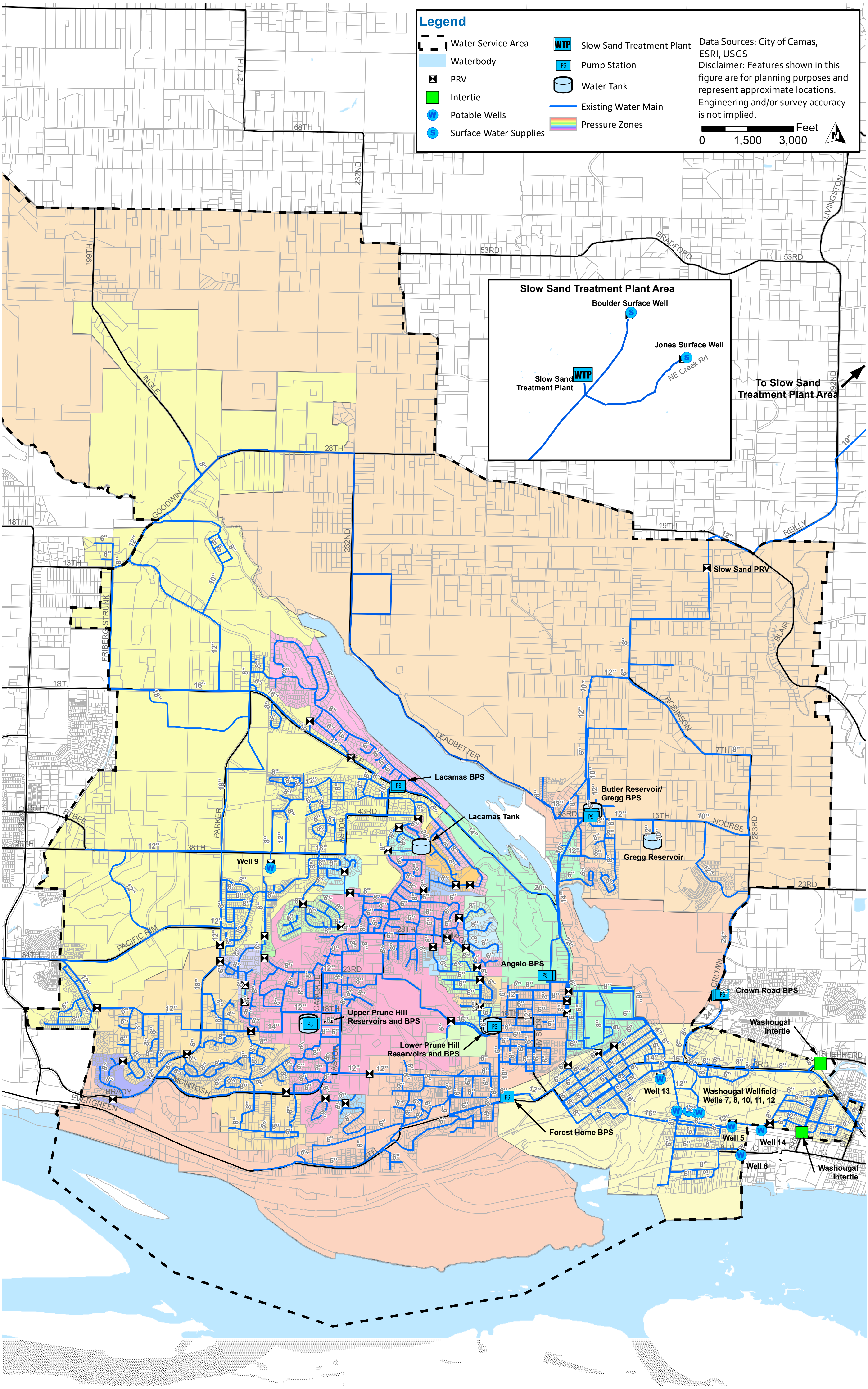

Figure 4.8 Water System Map

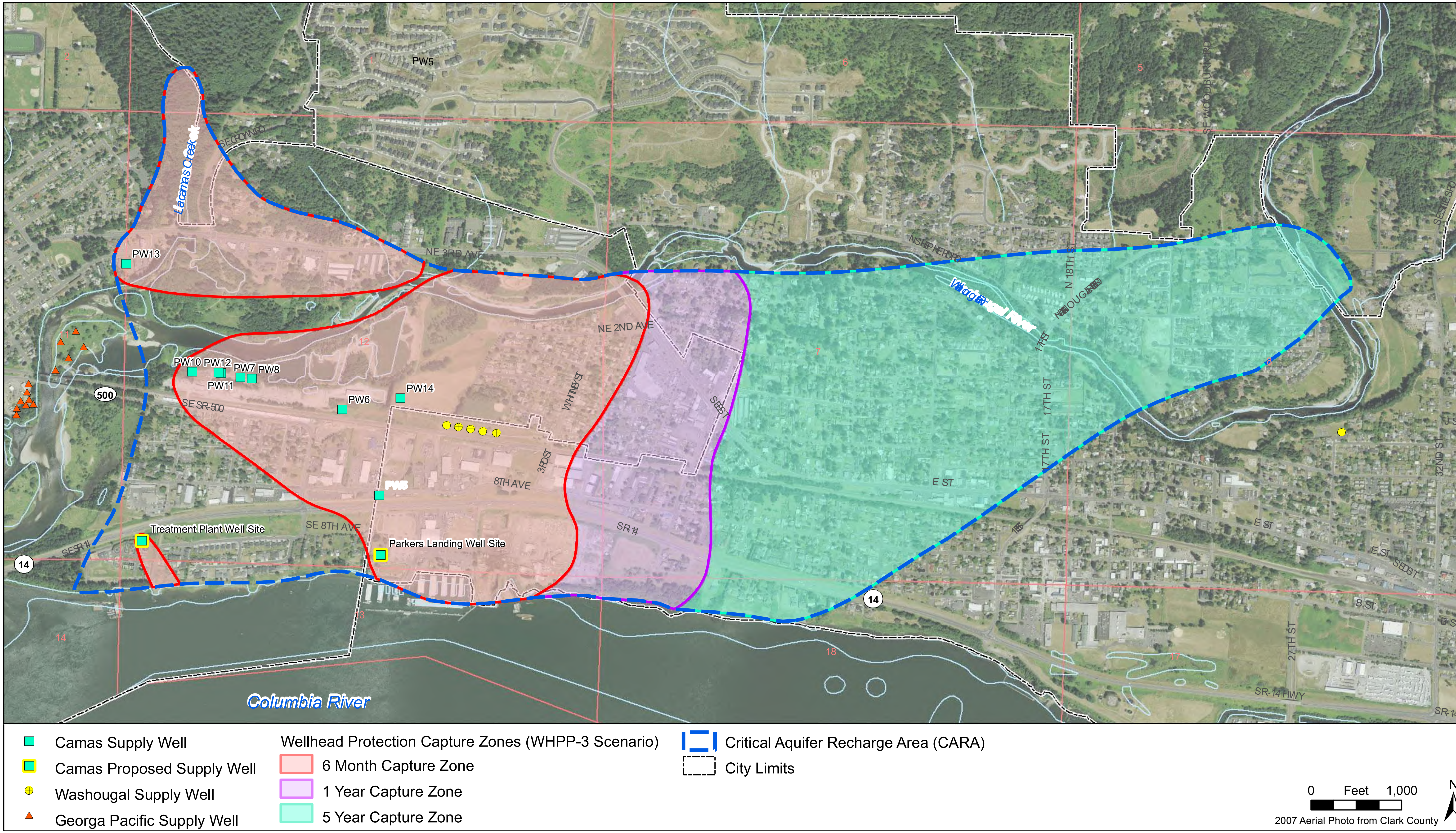

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Figure 4.9 Wellhead Protection Capture Zones

Chapter 5

INFLOW / INFILTRATION PROGRAM

5.1 Introduction

Special condition S.4.E of the City's 2015 National Pollutant Discharge Elimination System (NPDES) Permit required the City to submit an annual Inflow and Infiltration (I/I) Analysis Report. The City received lower than typical treatment plant process removal efficiencies in their 2015 NPDES permit to account for the dilute Septic Tank Effluent Pump (STEP); Septic Tank Effluent Filter (STEF); and Septic Tank Effluent Gravity (STEG), which contribute approximately half of the plant influent, as well as low strength industrial wastewater. This accounts for the lower biological solids loading expected from septic tank effluent, which makes removal efficiency more difficult to achieve at the WWTF. This lower treatment standard could also potentially mask excessive I/I. Therefore, the City was required to conduct an Annual I/I Analysis report to prove the City is controlling I/I. The City completed the following reports: Infiltration and Inflow Study (Gray & Osborne, 2016); the May 2016-April 2017 Annual Inflow and Infiltration Report; the May 2017-April 2018 Annual Inflow and Infiltration Report; and the May 2018- April 2019 Annual Inflow and Infiltration Report. In 2020 an Infiltration and Inflow Follow-Up Study (Gray & Osborne, 2020) was completed to document improvements within the City's collection system. This section references findings from these reports as well as generally describing the City's I/I program.

Infiltration and inflow consist of two components which may combine or act independently to increase flow volume and peak flows in the sewer system. If too much I/I enters the sewer system such that the sewer system is operating at or above its capacity, sanitary sewer overflows (SSO) could occur. More dilute waste can also be difficult to treat if using percent removal criteria as the basis, as noted above. Proper attention to the lower than typical biological solids loading under these conditions is warranted in design and operation of the WWTF. The definitions of infiltration and inflows are described below:

- **Infiltration:** Infiltration is defined as stormwater or groundwater flows that enter the sewer system by percolating through the soil and then through defects in pipelines, manholes (MH), and joints. Examples of infiltration entry points are cracks in pipelines, misaligned joints, and root penetration. Due to this process, infiltration may be seen hours after a storm has occurred.
- **Inflow:** Inflow may be seen immediately after or during the storm. Inflow occurs when stormwater enters the sewer system via storm drain cross connections, leaky MH covers, or cleanouts. Examples of inflow entry points are roof drains and downspout connections, leaky MH covers, and illegal storm drain connections. Gross pipeline or system structural defects can be severe enough to allow storm or groundwater to enter the system rapidly and exhibit response time characteristics that could be categorized as inflow.

Key adverse effects of I/I on wastewater collection and treatment facilities include:

- Surcharging of sewer MHs.
- Sewage backups in facilities.
- Hydraulic overloading of unit processes at the wastewater treatment facility (WWTF).
- Reduced treatment efficiency at the WWTF due to dilute concentrations.
- Prematurely reaching capacity for collection systems and/or WWTF components.

This Chapter focuses on summarizing the City's efforts on I/I reduction from 2016 through 2020 and the quantifiable, positive improvement that has been accomplished in reducing I/I. It summarizes the amount of I/I for these years and specific projects completed to address I/I.

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5.2 Historical I/I Control Efforts

The City has conducted I/I studies since 1977. The City has spent more than $4.55 million in collection system I/I work and $750,000 in wastewater treatment facility improvements to address I/I flows.

The 1977 I/I Report attributed approximately 2.6 million gallons per day (mgd) to infiltration and 2.1 mgd to inflow. Major infiltration sources identified included roof and foundation drains, catch basins and multi-hole MH covers. By 1987, a sealing project was underway for individual sewer services.

In 1994, CH2M Hill wrote a memorandum stating that estimated I/I entering the system was 3.54 mgd and the major source was likely faulty service connections. It was concluded that a more cost-effective alternative to reducing I/I would be to increase treatment capacity.

In 1997, a Facility Plan determined the City had excessive I/I based on U.S. Environmental Protection Agency (EPA) criteria, and an 8-year sewer system rehabilitation program began based upon basins with the highest risk. During this study, a peak I/I flow of 3.4 mgd was determined.

In 2007, excessive inflow was determined at 62 gpcd for infiltration and 383 gpcd for inflow. This is based on the EPA criteria for excessive I/I to be 120 gallons per capita day (gpcd) for infiltration and 275 gpcd for inflow. At total of 26 collection system projects were identified to address capacity and condition issues, 18 of which would reduce I/I.

In 2016, the City commissioned an evaluation of the collection system to document existing infiltration and inflow as a condition of their new stormwater permit. This evaluation utilized pump station run time, WWTF flow, and precipitation records to identify basins that were yielding high I/I values. This provided data to confirm the basins with high I/I, which were 3s, 3n, 4, and 10. Then smoke testing, manhole inspection, and CCTV inspection were used to identify specific locations within basins where improvements could be made to lower I/I. The results of 2016 I/I Study were used to plan and prioritize projects in order to reduce I/I:

1. In 2020, the City commissioned a follow-up study to document the reduction in I/I achieved by implementing the recommendations of the 2016 evaluation. The specific objectives of the 2020 study included: Comparing the I/I with that measured in previous

flow monitoring efforts completed for the 2016 I/I Study to assess the efficacy of rehabilitation efforts
2. Identifying areas of the City where the I/I related peaking factor exceeds 3.4:1
3. Identifying additional areas of high I/I in order to new areas for rehabilitation

The 2020 Study demonstrated that since 2016, the City has observed a reduction in peak WWTF flows and high flow events, even though the population of the City and the extent of the sewer system have both increased over this time. Additionally, the City's WWTF no longer experiences excessive infiltration or inflow as defined by the EPA, which is examined below in Section 5.7.3.

The most recent I/I projects completed are summarized in this report. Future planned projects can be viewed in Appendix F.

5.3 Required I/I Reporting

Special condition S.4.E of the 2015 Camas WWTP NPDES permit required the City to conduct a study of inflow sources and annual analysis of I/I using the Washington State Department of Ecology's (Ecology) Information Manual for Treatment Plant Operators. Special condition S.4.E indicates the Annual I/I Report should include:

1. Average monthly flow and total precipitation for each month for the past year.
2. Maximum monthly and peak hourly hydraulic design capacity for the plant.
3. Design population equivalent for the treatment plant and population served by the facility for the past year.
4. The amount of I/I for each year since the base year and the percent of maximum monthly design capacity each year's I/I represents.
5. Percent increase or reduction in I/I for each year after the base year I/I.
6. Additional lengths of sewer lines added to collection system for the past year.

The Annual I/I reports for 2016, 2017, and 2018 and the City's I/I Program are provided in Appendix F and summarized throughout this chapter. Values in this Chapter are based on numbers that were reported in the Annual Reports. Please note that the City is updating their treatment plant capacity and values may change after completion.

5.4 Calculated I/I

Special condition S4.E.3 of the 2015 NPDES permit states that the annual period for the required I/I reporting is May 1st through April 30th. The 2016 Annual Report selected May 2011-April 2012 to be the base year to compare future I/I against, which is highlighted in Table 5.1. This base year was selected because it represents the 20-year median rainfall very closely. The average 12-month rainfall in Camas from the twenty-year period of 1997 to 2017 was 46.43 in, and from May 2011-April 2012 the rainfall was 47.60 in, which was the 50th percentile of all twenty 12-month totals and only 1.17 inches more than the twenty-year average. Additionally, using 2011-2012 as the selected base year incorporates the City's recent growth. Per permit requirements, the I/I was compared with maximum monthly hydraulic design capacity for the Camas Wastewater Treatment Plant. Additionally, I/I was compared with the previous year. The fluctuations seen in I/I in Table 5.1 are largely due to variations in rainfall. Reductions in I/I from specific projects are presented in further sections.

Table 5.1 Annual Report Calculated I/I

Year	Calculated I/I (mgd)	I/I as Percent of Design Capacity	I/I Percent Increase/Decrease
2011	1.511	25%	N/A
2012	2.340	38%	+55%
2013	0.591	10%	-75%
2014	0.985	16%	+67%
2015	2.277	37%	+131%
2016	1.920	31%	-16%
2017	1.021	17%	-47%
2018	1.052	17%	+3%

5.5 Field Investigation

Several evaluations were conducted to determine areas of excessive I/I. Field investigation methods include flow monitoring and analysis, smoke testing, MH inspection, and video inspection.

5.5.1 Flow Monitoring and Analysis

According to the NPDES permit, the City is required to:

- Quantify the level of inflow from each collection system basin or sub-basin in order to identify areas exceeding a peak day to monthly average peaking factor of 3.4:1 during the design rainfall event.
- Prioritize the list of projects to most cost effectively reduce the level of inflow to a peaking factor of 3.4:1 or less.

The analysis for flow monitoring includes evaluation of WWTF flow data, pump station run-time data, and collection system flow monitoring data. The highest-ranking storm event identified occurred on January 1, 2009 with 3.1 inches rainfall and 7.711 mgd WWTF influent followed by January 19, 2012 at 2.0 inches rainfall and 7.534 mgd WWTF influent. The design storm was estimated with the January 1, 2009, rainfall event. For pump station run-time, Crown View, Lacamas Creek, South Prune Hill, and West Camas were identified to exceed the peaking factor criterion of 3.4:1. Thus, the basins these pump stations are located in were targeted for further flow assessment.

Major storm events and corresponding WWTF influent flow are typically indicative of I/I activity in a collection system. During the 2016 I/I Study, basins of concern were Crown View (Basin 3N), Lacamas Creek (Basin 7), South Prune Hill (Basin 10), and West Camas (Basin 10) with ratio normalized to peak day of 5.904, 5.433, 3.554, and 3.299, respectively.

The highest priority flow monitoring locations are Basins 3 and 4 with the greatest I/I which exceeds the NPDES Peaking Factor criterion. Basins 3 and 4 are shown in Figure 4.2 in Chapter 4.

For the 2020 I/I Follow-up Study, temporary flow meters were installed in October 2019 in the collection system to determine the state of I/I in the City and assess the impact of previous I/I reduction projects. From this evaluation, the City was able to see areas still with peaking factors exceeding the NPDES Peaking Factor Criterion for peak day to average flow of 3.4:1.

5.5.2 Smoke Testing

Smoke testing is a typical means of conducting a physical assessment of a wastewater collection system. Smoke testing locates potential sources of I/I by blowing artificial smoke into a collection system, typically at a MH, and visually observing where the smoke escapes, indicating breaks in the collection system as well as cross connections between the sewer system and storm drain systems and roof drains.

Smoke testing was conducted from August 14 to August 26, 2015 as a part of the 2016 I/I Study. The test identified 92 locations where inflow could potentially occur where a majority was cleanouts that were either broken or without covers or where smoke was observed coming out of the ground. The highest observed sources of smoke occurred in Basin 3N, 3S, 4, and 5, as summarized in Table 5.2. A small number of roof drains and catch basins connected to the sewer system were identified. Defects were also identified near two MHs in Basin 3N through smoke testing.

Table 5.2 2015 Smoke Test Results

Basin	Cleanouts	Catch Basins	MHs	Roof Drains	"Ground Smoke" (Likely Side Sewers)	Total
1	1	0	0	0	1	2
2	3	0	0	0	1	4
3N	12	0	2	1	3	18
3S	2	0	0	1	13	16
4	4	1	0	1	6	12
5	2	1	0	1	10	14
6	0	2	0	2	3	7
7	1	0	0	0	0	1
8	4	0	0	0	1	5
9	3	0	0	0	0	3
10	6	1	0	0	3	10
Total	**38**	**5**	**2**	**6**	**41**	**92**

5.5.3 Manhole Inspection

Wastewater collection system MHs represent a relatively easy means of viewing what is occurring in a collection system because they:

- Allow for a visual inspection of flow.
- Are potential sources of I/I themselves due to deterioration or how they were constructed.
- Are insertion points for flow meters to measure flows within a collection system.

During the investigations in 1997 and 2015, all basins were tested. In the 1997 study, leaking MHs were found in Basins 1, 2, 3N, 4, 5, 6, 7, and 10. In the 2016 study, of the 95 MHs inspected in Basin 3S, 3N, 4, 5, and 7, only 14 were found to have reportable issues. Defects identified in these MHs are summarized in Table 5.3.

Table 5.3 2015 Manhole Inspection Results

Basin	Number of MHs leaking (2015)
3S	3
3N	4
4	2
5	4
7	1
Total	**14**

5.5.4 Video Inspection

The City contracts with specialist firms to perform regular closed-circuit television (CCTV) inspections of its gravity sewer system. The inspections identify structural and operational defects, such as broken pipes, cracks, grease, roots, sag, separated and offset joints, and other problems. Several structural defects identified in CCTV inspections were repaired when identified. Other defects may be addressed through increased preventative maintenance, repair, or monitoring. In 2016 as a result of the flow monitoring work completed for the 2016 I/I Study, the City selected an area of the sewer system that frequently exceeded the 3.4:1 peak to average flow ratio. This area was the section of sewer system that drains to the Crown View Lift Station, and CCTV inspections were evaluated to identify potential I/I sources. The results were used to develop a list of projects which the City incorporated into their ongoing repair and replacement program.

5.6 Identified I/I Projects

From the field investigation, projects were developed and given a level of priority based on their potential to remove I/I. Priority basins for I/I reduction were 3N, 3S, and 4. Future I/I projects are slated for the City's other basins.

High priority projects developed to guide the likely schedule of I/I mitigation projects were described as follows:

- Action explicitly required by NPDES permit.
- Disconnect catch basins from sanitary sewer and connect to storm sewer.
- Repair cleanouts with > 500 gallons per day (gpd) estimated inflow.
- Disconnect downspouts.
- Replace significantly deteriorated MHs.
- Raise MH lids to minimize inflow.
- Repair significantly deteriorated or sagging pipe, with highest priority on problems observed in Basins 3N, 3S and 4, followed by Basins 5 and 6.

With the completion of high priority work only, the sewer system is anticipated to achieve the NPDES permits required ratio of peak day to monthly average flows in all basins. If it is not reduced, then the medium high priority projects will be completed, then the medium and lastly the low. Table 5.4 includes basins targeted and total capital required to complete the projects. The suggested timeline was for high priority projects to be completed in 2016-18, medium high priority in 2019, medium priority in 2020-2025, and low priority from 2026-2029.

Table 5.4 Summary of I/I Projects and Costs Listed in 2016 I/I Study

Year	Basins	Targeted Cost(1)
2016	3N, 3S, 4	$328,000
2017	1, 2, 3N, 3S, 4, 5, 6, 10	$380,000
2018	2, 3N, 3S, 4, 5, 6, 7	$500,000
2019	5, 7, 8, 9, 10	$130,000
2020	3N	$150,000
2021	3N, 3S	$135,000
2022	3S,	$150,000
2023	3S, 4	$150,000
2024	4, 5, 8, 9	$150,000
2025	9, 10	$50,000
2026-2028	1, 2, 5, 6, 7, 8, 9	$325,000

Notes:
(1) All cost values were determined by Gray & Osborne. All values are believed to be in 2016 dollars.

The 2015 I/I report included a project schedule with all planned projects for the next 10 years. The 2016, 2017, and 2018 Annual Reports denote on the project schedule which projects have been completed.

5.7 Completed I/I Projects

As mentioned previously, five high priority projects have been completed, as shown in Table 5.5. These projects have cost the City in excess of $1.5 million dollars. The City conducted pre- and post- construction monitoring for the two largest projects, which are summarized in Section 5.7.1 and 5.7.2.

Table 5.5 Completed I/I Projects

Year	Basin	Project Title	Description	Project Cost(1)
2019	10	View Ridge Court Sewer Replacement	Replacement of sewers	$370,000(3)
2017	4	NE Dallas Street Sewer Replacements	Replacement of several sewer pipes	$129,000(3)
2017	4	NE Adams Street Sewer Replacements	Replacement of several sewer pipes	$100,000(3)
2017	4	Everett and Franklin Sewer Replacement	Replacement of sewer line from 19th and Franklin to Everett and Everett to 21st	$352,000(3)
2016	4	Franklin Street Sewer Improvement	Replace sewer line between MH 4-1-1 and MH 4-1-4	$952,883(2)
2018	3S	Mill Ditch Repair	Replaced section of sewer line between Dallas Street and Birch Street	$417,105(2)
2018	3S	Mill Ditch Repair	Rehabilitate or replace 15-inch CONC from MH 3-2-6 to 3-1-1 (1,370 feet)	

Notes:
(1) Cost values reflect actual construction costs at the time of completion.
(2) Value from the 2017 Annual Report.
(3) Value from the I/I Follow-Up Study.

5.7.1 Franklin Street Sewer Improvement Project

The Franklin Street Sewer Replacement Project was completed in October 2016. The project involved replacing and upsizing approximately 1,600 feet of sewer line that had been video inspected along Franklin Street between NE 19th Avenue and NE 14th Avenue and were found to contain cracks and sag. Table 5.6 summarizes the inflow before the project and changes in flow observed after project completion. The project effectively reduced inflow by approximately half during typical flow conditions. No reduction was seen during the largest storm monitored, which is likely due to upstream inflow sources outside of the scope of the project.

Table 5.6 Franklin Street Sewer Project I/I and Flow

Manhole	Basin Measured	Flow Meter Installed	Flow Meter Removed	Parameter (mgd)	Daily Flows (mgd)			Rainfall/ days[1]
					Min	Ave	Max	(in/day)
MH 3-2-6 Pre-Construction	4	1/5/2016	1/20/2016	Flow Inflow	0.411 0.303	0.749 0.641	1.019 0.911	0.3593
MH 3-2-6 Post-Construction	4	3/4/2017	3/30/2017	Flow Inflow	0.127 0.017	0.447 0.337	1.054 0.944	0.3362

Notes:
(1) This is the total cumulative rainfall over the duration the flow metered.

5.7.2 Mill Ditch Repair Project

The Mill Ditch Sewer Line Replacement was completed in April 2018. The project included replacing approximately 900 feet of deteriorated 15-inch concrete main with 21-inch high-density polyethylene (HDPE) pipe and manholes. Table 5.7 summarizes the inflow before the project and changes in flow observed after project completion. The project effectively reduced inflow by approximately half during typical flow conditions. Due to the timing of the project and dry spring weather, post construction flow monitoring was not completed until 2019. The increase in inflow during the largest storm monitored is likely due to differences in rainfall intensity between the pre- and post-construction periods and upstream inflow sources outside of the scope of the project.

Table 5.7 Mill Ditch Project I/I and Flow

Manhole	Basin Measured	Flow Meter Installed	Flow Meter Removed	Parameter (mgd)	Daily Flows (mgd)			Rainfall[1]
					Min	Ave	Max	(in/day)
MH 5-8-1 Pre-Construction	3N, 3S, 4	2/5/2016	2/23/2016	Flow Inflow	0.352 0.68	0.909 1.114	1.969 1.617	0.1756
MH 5-8-1 Post-Construction	3N, 3S, 4	3/19/2019	6/4/2019	Flow Inflow	0.46 0.245	0.795 0.58	2.496 2.28	0.0906

Notes:
(1) This is the total cumulative rainfall over the duration the flow metered.

5.7.3 I/I Reduction Summary

In 2020, the City commissioned a follow-up study to document the reduction in I/I achieved by implementing the recommendations of the 2016 evaluation. The purpose of this work was to compare estimated per capita I/I from the 2016 study and 2020 against EPA criteria. The EPA's threshold for excessive infiltration is 120 gallons per capita per day (gpcd) is and the threshold for excessive inflow is 275 gpcd. The per capita infiltration flow accounts for domestic wastewater flow, infiltration, and nominal industrial and commercial flows. Inflow values are based on the maximum daily influent flow at the WWTF between 2019 and 2020.

The initial Infiltration and Inflow Study (Gray & Osborne, 2016) determined that per capita infiltration in the collection system was 80 gpcd, which was below the EPA threshold for excessive infiltration. This study determined that inflow was a much more significant source of I/I in the collection system with an estimated flow 348 gpcd, which is excessive per EPA criteria. As a result of I/I projects completed between 2016 and 2020 the City's per capita infiltration was reduced to 46 gpcd. During this same period the City's per capita inflow was reduced to 176 gpcd and is no longer considered excessive.

Table 5.8 summarizes the improvements in per capita I/I for the City's collection system.

Since 2016, the City has completed I/I reduction projects each year, totaling well over $1 million. According to the 2020 Follow-up I/I Study, along with the reduction of I/I since 2016, the performance of the WWTF has improved as well. The WWTF has not experienced an I/I related effluent violation for over three years (since February 2017). While the I/I reduction is presumably not the only reason the WWTF's efficacy has improved, reductions in I/I due to the City's reduction efforts has certainly played a crucial role.

Table 5.8 Per Capita I/I Compared to EPA Criteria

Parameter	EPA Criteria for Excessive I/I (gpcd)	I/I Value for Camas in 2014 (gpcd)	Current I/I Value for Camas (gpcd)
EPA Excessive Infiltration Criteria	120	80	46
EPA Excessive Inflow Criteria	275	348	176

5.8 Planned I/I Projects

The City has two major pump station improvements projects planned to be constructed within the next five years. These are the Crown View Pump Station Improvements project and the Lacamas Creek Pump Station Replacement project. The design for each of these projects was completed in 2020 but bidding documents have not been issued for construction. In addition, the City will continue to address I/I throughout the collection system through their ongoing repair and replacement program. The 2020 Follow-up I/I Study expects that the Crown View Pump Station Improvement will significantly reduce I/I in Basin 3n, and the Lacamas Creek project will significantly reduce I/I in Basin 7.

Table 5.9 Planned I/I Projects

Year	Basin	Project Title	Description	Project Cost
Ongoing	N/A	Gravity Main Repair and Replacement	Ongoing repair and replacement of gravity mains at end of useful life.	$150,000/year
2020	3N	Crown View Pump Station Improvements	Includes stormwater improvements to reduce I/I entering the pump station	-
2020	7	Lacamas Creek Pump Station	Includes replacing the pump station and sewer pipe	$4.03M

Chapter 6

COLLECTION SYSTEM

6.1 Introduction

The City of Camas's (City) customer base continues to increase through system expansion. With this growth, some of the City's sewer infrastructure may reach conveyance capacity. This chapter presents an evaluation of the available capacity of the existing system to convey current and future sewer flows. The City's collection system is broken up between gravity mains and septic tank effluent pumping (STEP) systems that flow to the Treatment Plant separately.

Using the City's updated sewer model, major pipes and pump stations in the modeled collection system were evaluated for meeting established capacity criteria. The modeled collection system is primarily large gravity sewers which represent a skeletonized version of the system. The City has a limited GIS inventory of the collection system so no updates to the extent of the system that is modeled could be made. The STEP system was not included in the hydraulic model. Thus, capacity evaluation was only performed for the modeled gravity portion of the collection system. An overview of the modeled collection system is shown in Figure 6.1. The current modeled service area, in pink, represents the portion of the model evaluated in the existing scenario based on flow monitoring. The system was calibrated with four flow meters, which delineated the model system into four flow monitoring basins with similar diurnal patterns and wet weather flow parameters, also shown in Figure 6.1. The 2035 year and build-out scenarios expanded the modeled service area to the NUGA in the North of the system, shown in green. Additional details on the model used to evaluate the collection system can be found in Appendix E - TM Hydraulic Model Development. This chapter identifies recommended projects that correct capacity deficiencies and will be required to serve future users.

6.2 Evaluation Criteria

Defining performance criteria is a critical step in the master planning process because it sets metrics by which the collection system infrastructure will be evaluated to meet service goals set by the City. Sewer pipe capacities are dependent on many factors, including roughness of the pipe, the maximum allowable depth of flow, or slope of pipe. The City's application of these factors and established requirements are discussed below.

It is important to differentiate performance and design criteria when judging the performance of collection system infrastructure. Design criteria establish the standards for designing and constructing new sewers. Performance criteria establish the standards that are used to analyze adequacy of existing facilities and to trigger future infrastructure needs. Performance criteria are commonly less stringent than design criteria because existing sewer systems typically have aged significantly and would require extensive reconstruction to meet standards for new design. It is generally inappropriate to use standard design criteria as performance criteria, especially when significant wet weather flows impact an existing collection system (as is the case with an aged sewer system). For instance, new sewers are designed to convey flow under non-surcharged conditions (assuming limited inflow and infiltration [I/I]), while surcharging may be permissible during the analysis of existing sewers, especially during peak wet weather flows (PWWFs). The following sections describe the City's established design criteria and performance criteria used herein.

6.2.1 Design Criteria

The design criteria are used to size new infrastructure recommended to alleviate system deficiencies for this system evaluation.

6.2.1.1 Conveyance System

It is common practice to use diameter-based flow depth criteria for pipes when designing new gravity sewers. The depth/diameter (d/D) ratio is defined as the depth of flow in a pipe during peak flow conditions divided by the pipe's diameter. The City's Sewer Standards define the acceptable d/D values for design of new sewers under design storm conditions:

- All sewers shall be designed to flow at a d/D no greater than 1.2 at peak flow rates under build-out conditions, and d/D of 1.0 for existing condition.
- No surcharging (d/D>1) is allowed at shallow manholes. Shallow manhole are defined as manholes where the distance between crown of pipe and manhole rim is less than three feet.
- During the PWWF for design storm, water levels were not allowed to rise up to three feet below manhole rim.

6.2.1.2 Pump Stations and Force Mains

Any new pump stations recommended will need to follow the City's Sewer Standards for pump stations and force main construction to meet Department of Ecology (DOE) requirements. These are detailed in Section 2.2.2 of Chapter 2 - Policies.

6.2.2 Performance Criteria

6.2.2.1 Design Storm

The sewer system hydraulic capacity analysis was performed using a historical 10-year, 24-hour rainfall event (Station Portland Airport (PDX), HYDRA Rain Gauge Network) on December 6, 2015. This design storm is discussed in Section 3.4.6 of Chapter 3 - Basis of Planning.

For this general sewer plan (Plan), the HYDRA historical event referenced above was selected as the design storm for modeling system response and system performance evaluation to realistically represent peak wet weather conditions. The historical HYDRA event was chosen for three reasons:

- The National Oceanic and Atmospheric Administration (NOAA) Precipitation Atlas defines a 10 year, 24-hour event as 3.5 inches per 24 hours based on isopluvial lines through Camas.
- The rain gauge measured 3.37 inches per 24 hours and includes storm hydrograph data. This event had a 20-year recurrence interval based on evaluation of the historical dataset.
- The City 's historical 20-year, 24-hour volume is approximately the same as the NOAA, 10-year.

6.2.2.2 Conveyance System

When evaluating existing sewers, using a conservative d/D ratio may lead to unnecessary replacement of existing pipelines. The PWWF was defined using the standards summarized in Section 6.2.1.1.

Sewer pipes were allowed to surcharge under these PWWF conditions. If the flow depth was greater than the maximum allowable Hydraulic Grade Line (HGL), then the sewer was deemed deficient and mitigation might be proposed to provide greater flow capacity. Shallow manholes locations are shown on Figure 6.1.

6.2.2.3 Pump Stations and Force Mains

The City's performance criteria for existing pump stations include firm capacity, which is capacity with largest pump out of service and force main velocities. According to City Sewer Standards:

- Firm pump capacity shall be provided to handle the PWWF from the pump station's tributary area.
- Firm pump capacity is defined as the largest pump out of service.

The evaluation of existing force mains is based on a maximum pipe velocity of eight feet per second (ft/sec) for the design storm. No such evaluation was performed in this Plan as the hydraulic model was set up with simplified pump station assumptions and did not model force mains directly.

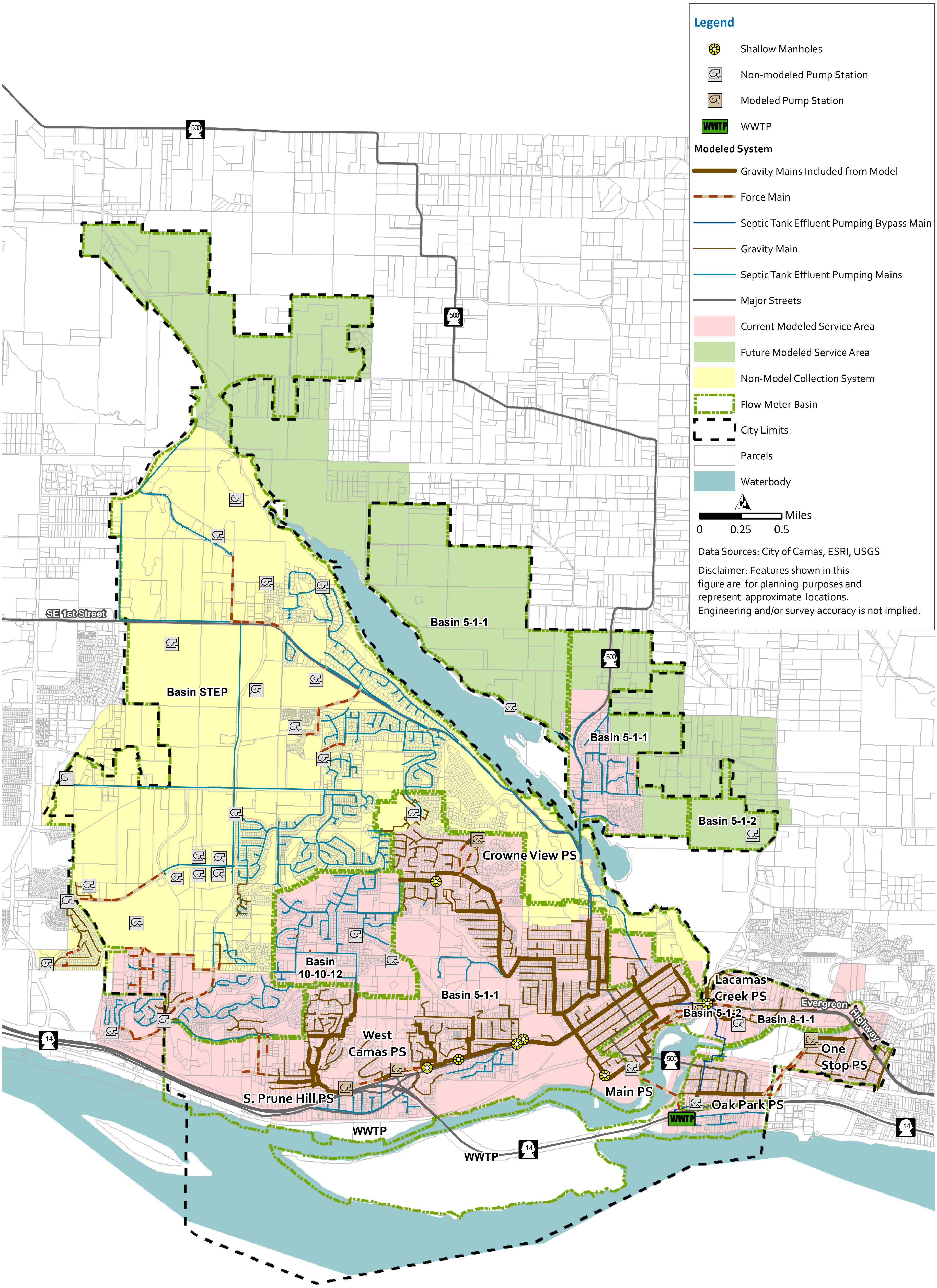


Figure 6.1 Shallow Manholes

6.3 Gravity Collection System Evaluation

A capacity analysis of the modeled collection system was performed using the City's calibrated hydraulic model and using the evaluation criteria identified above in Section 6.2. The capacity analysis entailed identifying areas in the sewer system where the performance criteria for surcharging was exceeded, or where the capacity of pump stations was exceeded. The collection system was evaluated for three development scenarios:

- Existing: Matching existing conditions.
- 2035: Incorporating growth through 2035 as identified in the previous comprehensive plan.
- Build-Out: Development of the full-service area including urban growth boundary (UGB).

For the remainder of the chapter, the system evaluation will focus on the existing and build-out system. The difference between the 2035 year and build-out system were negligible in terms of collection system capacity criteria.

6.3.1 Key Causes of Deficiencies

The calibrated hydraulic model was exercised under design storm conditions and predicted results analyzed using the performance criteria to identify segments of the system not meeting that criteria. The key causes triggering deficiencies in the City's collection system include:

- Adverse slopes and misaligned inverts.
- Shallow manholes.
- Pipe restrictions caused by a single or few smaller diameter pipes between larger diameter pipes.
- Pipe diameter not sufficient to convey the PWWF.
- Pump station firm capacity not sufficient to pump the PWWF.
- Backwater condition.

6.3.2 Existing System Problem Areas

For the existing sewer collection system, the PWWF was routed through the hydraulic model to assess performance. In accordance with the established criteria for existing sewers, where the model predicted potential deficiencies, these were identified. In general, the smaller sewer mains further upstream in the system have sufficient capacity to convey existing flows during the design storm. Existing deficiencies are primarily located in Flow Monitoring Basin 5-1-1, with primary capacity issues in the downstream larger trunk lines receiving flow from smaller tributary areas and delivering sewage to NE Adams. Specific manhole locations of these deficiencies are discussed in Section 6.5. Each portion of the system with localized capacity issues is broken into seven different existing system problem areas, further discussed in Section 6.5. Basin 5-1-1 experiences elevated I/I that appears to be the main cause of observed deficiencies along 6th Avenue, Division Street, and NW Fargo Street. The locations of these predicted deficiency problem areas under existing PWWF conditions are shown on Figure 6.2 in red.

6.3.3 Build-Out System Problem Areas

The Service Area scenario (build-out) system analysis was performed in a similar manner to the existing system analysis. The build-out condition evaluated whether or not the sewers would be adequately sized to convey the future PWWFs, including urban reserve areas. This analysis incorporates the preliminary assumptions made for how/where to connect the growth areas to the existing system.

Two additional deficiency problem areas occur during build-out conditions. The additional projected flows from the North Shore area add significant amounts of flow and are predicted to exceed the criteria and cause additional surcharging in the system. Additional growth upstream of 6th Avenue NW causes existing deficiencies to worsen under build-out conditions. The build-out deficiency problem areas are shown in red on Figure 6.3.

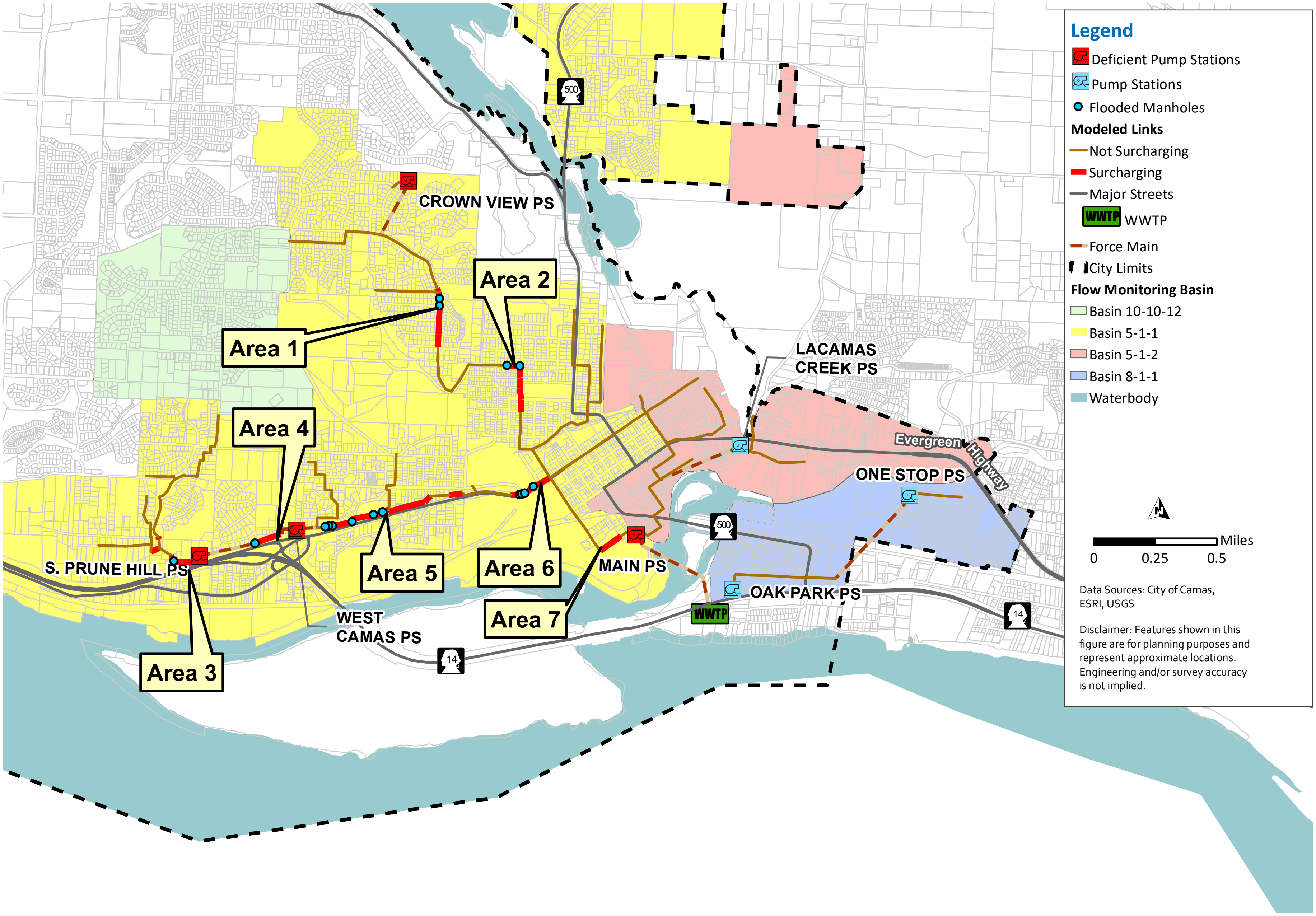
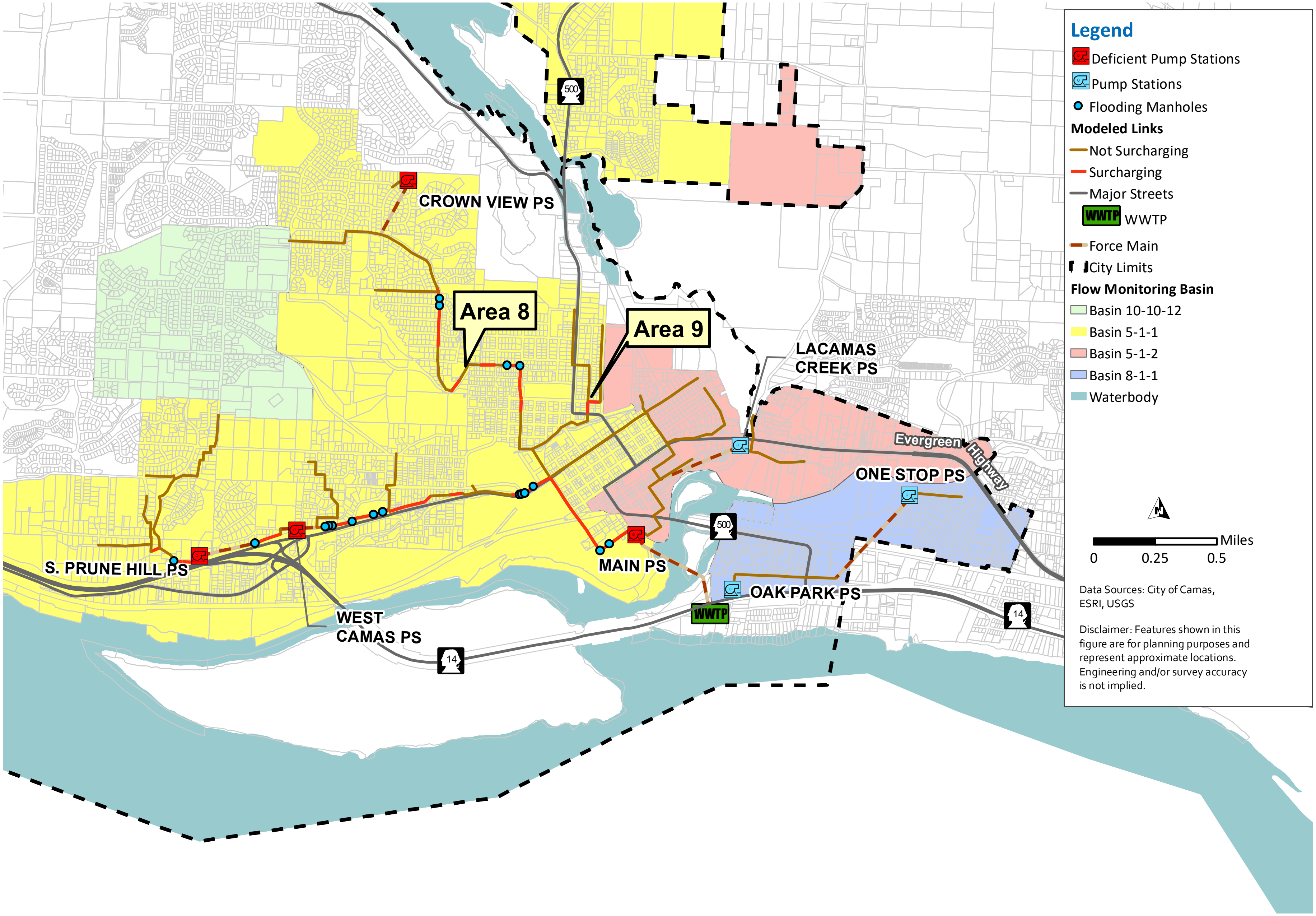


Figure 6.2 Existing Potential Problem Areas and Deficiencies



Legend
Deficient Pump Stations
Pump Stations
Flooding Manholes
Modeled Links
Not Surcharging
Surcharging
Major Streets
WWTP
Force Main
City Limits
Flow Monitoring Basin
Basin 10-10-12
Basin 5-1-1
Basin 5-1-2
Basin 8-1-1
Waterbody
0 0.25 0.5 Miles
Data Sources: City of Camas, ESRI, USGS
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.
CROWN VIEW PS
Area 8
Area 9
LACAMAS CREEK PS
Evergreen Highway
ONE STOP PS
S. PRUNE HILL PS
MAIN PS
OAK PARK PS
WEST CAMAS PS
WWTP
500
14

6.4 Pump Station Evaluation

Ensuring that pump stations have adequate capacity to convey peak flows is important to prevent sewage overflows at or near pump stations. In accordance with the established performance criteria, the City's existing pump stations were evaluated using the calibrated system model to determine if each one has available capacity to convey existing and future PWWFs. If a pump station has inadequate capacity to pump the PWWFs, the water level in the wet well may rise to the overflow point, spilling sewage. Pump stations predicted to experience an influent PWWF greater than the existing firm capacity of the station were flagged as deficient. The firm capacity of a pump station is defined as the capacity with the largest pump out of service.

The City's hydraulic model includes five of the seven pump stations located in the City's Gravity Collection System. In addition to the five collection system pump stations included in the model, there are two additional pump stations located just upstream of the WWTF (Oak Park and Main). These two stations were also evaluated utilized existing and projected influent flows, despite not being included in the model. All seven stations are shown in Figure 6.1 in blue. The estimated current and future peak flows were compared the to the pump station firm capacities. Table 6.1 summarizes the results of the pump station evaluation. Figures 6.2 and 6.3 show deficient pump stations in red and pump stations meeting the firm capacity in blue. Firm capacities were based on draw down testing performed by the City. Table 6.1 includes the total capacity at each station, as an additional point of reference for the modeled PWWF's. The total capacity was conservatively assumed to be twice the field measured firm capacity as all stations have two pumps.

Table 6.1 Pump Station Evaluation

Pump Station Name	Firm Capacity (gpm)	Existing Modeled PWWF (gpm)	Build-Out Modeled PWWF (gpm)	Firm Excess Deficiency	Build-Out Excess Deficiency
One Stop	229	67	72	No	No
South Prune Hill	449	1,104	1,113	Yes	Yes
West Camas	579	1,302	1,302	Yes	Yes
Crown View Plaza	148	512	530	Yes	Yes
Lacamas Creek(1)	Current = 346, Build-out = 570	215	525	No	No
Oak Park	426	148	153	No	No
Main	3,851	3,909	5,682	Yes	Yes

Notes:

(1) Lacamas Creek has been design, but not yet constructed. The designed capacity is shown as the 1.27 cfs value for firm capacity. This is used to evaluate the pumps under build-out conditions.

Abbreviations: gpm - gallons per minute; cfs - cubic feet per second.

Based on the analysis and the results presented in Table 6.1, four of the City's pump stations are considered deficient per the City's firm capacity performance criteria. Deficiencies are identified for these four pump stations under existing conditions. These deficiencies are exacerbated under service area build-out conditions.

The collection system model had a simplified set up of the pump stations. Force mains were not included in the model, pumps were setup to discharge into the gravity system at the location of the force main, and associated losses were factored into the pump curves. This setup was consistent with how the model had previously been set up. Future analysis should add force mains to the model, so that force main velocity evaluation can occur. For this plan, no recommendations were made for pump station force mains.

6.4.1 Pump Station Run Times

The gravity collection system model includes only five pump stations and has PWWF information upstream of seven pump stations. The City's STEP system includes 20 pump stations. These stations are not included in the model, therefore no evaluation of performance was available for PWWFs. Historical pump station run times were analyzed for all pump stations to gauge the average capacity of the stations. The station run time data was typically weekly by hour. The number of hours between data points was divided by the number of hours the pump ran to estimate a daily average. This daily average was converted to an annual average for every station. The resulting capacity is displayed in Table 6.2. No conclusions could be made on how pump stations performed during peak wet weather events utilizing the average daily run times. It is difficult to make any determinations from this data, and all stations should undergo additional evaluation to confirm capacity is appropriate to expected wastewater flow conditions.

Table 6.2 STEP Pump Station Percent of Time Running During the Day Based on Pump Hours

Pump Station Name	2014	2015	2016	2017	2018	2019	Potential Capacity Deficiency
Harl	3%	7%	7%	9%	10%	12%	No
Leadbetter	-	-	-	-	1%	1%	No
232nd	-	-	-	-	1%	1%	No
Goodwin	-	-	-	-	1%	2%	No
Two Creeks	3%	3%	3%	4%	3%	5%	No
Camas Meadows	3%	3%	2%	2%	3%	3%	No
Larkspur	2%	3%	3%	4%	5%	2%	No
Lacamas Shores	18%	24%	43%	50%	60%	48%	Yes
Lacamas Meadows	35%	19%	14%	15%	15%	15%	No
Sunningdale Gardens	37%	41%	51%	66%	50%	69%	Yes
Prune Hill Park	6%	6%	6%	6%	6%	6%	No
Hillshire	15%	15%	11%	13%	8%	8%	No
Hunter Ridge	3%	3%	4%	4%	4%	5%	No
Brady Rd	14%	15%	17%	16%	16%	16%	No
Grand Ridge	13%	18%	20%	19%	27%	21%	No
Winchester Hills 2	50%	32%	24%	22%	25%	36%	Yes
Winchester Hills 1	15%	17%	20%	19%	19%	22%	No
Stone Leaf	2%	2%	3%	3%	3%	3%	No
Parker Estates	16%	18%	21%	20%	18%	17%	No
Fisher	1%	1%	1%	1%	1%	2%	No

The relation between average pump station capacities to PWWF depends on the peaking factor of the tributary area, and therefore varies for every station. Considering the limitations in the pump station operational data (daily run times), for the stations identified in Table 6.2, where percent capacity is estimated at 40 percent or higher, the City should assume there is a substantial risk of failing to meet capacity during existing PWWF events. Applying the methodology described herein, Lacamas Shores, Sunningdale Gardens, and Winchester Hills 2 all have exhibited average capacity above 40 percent at some point in the last five years. These stations should be prioritized and undergo future evaluation, possibly including focused flow and pressure monitoring to gain a better understanding of what happens during peak flows and their capacity to inform future capital improvement planning. No future projections were performed for these stations. Future projects should prioritize projecting flows and understanding how the upstream tributary areas of these stations will develop.

6.5 Capacity Evaluation Summary

The City's model predicted several locations where the sewer system may have inadequate capacity for existing PWWF conditions. The deficiencies increase with projected additional growth and City expansion.

Four of the City's seven gravity system pump stations included in the model are considered deficient due to lack of pump redundancy. Additionally, three STEP system pump stations evaluated based on run times may be deficient in the future.

Figures 6.2 and 6.3 highlight the location of system piping and pumping capacity deficiencies identified in this analysis based on the established performance criteria.

Following the completion of the existing, 20 year, and build-out system analysis, improvement projects and alternatives were identified to mitigate capacity deficiencies predicted in the existing and build-out pipeline system. The City has nine localized areas of capacity system deficiencies and four pump stations that will need to be upgraded to meet firm capacity criteria. The following sections describe each of the nine problem areas and the suggested pipeline improvements in addition to proposed pump station upgrades. Figure 6.4 identifies the proposed pipeline improvements for each problem area, discussed in the following sections.

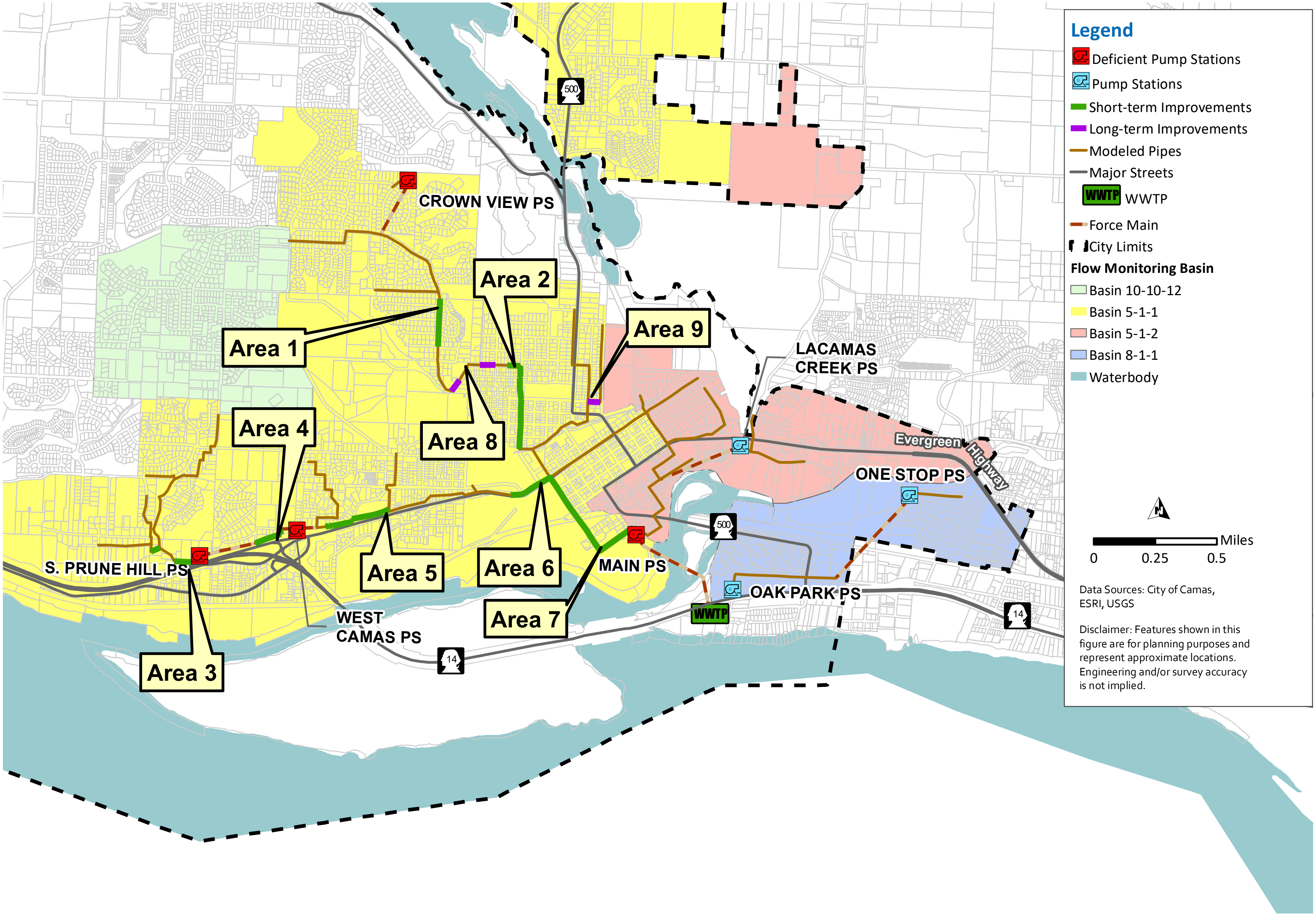


Figure 6.4 Proposed Pipeline Improvements

6.5.1 Area 1

Area 1 experiences surcharging along NW Fargo Street, as illustrated in Figure 6.2, under existing conditions. The model showed potential manhole flooding during the design storm at modeled manholes 3-1-26 and 3-1-25. This deficiency is caused by capacity limitations due to pipe diameter and slope constraints in the reach, as shown in Figure 6.5 of the pipe profile plot with HGL in blue. The proposed improvements to mitigate these deficiencies consist of upsizing pipes between manholes 3-1-26 to 3-1-22 from 8-inch to 12-inch, shown in red on Figure 6.4. This piping upsize effectively alleviates the surcharging and meets the City's design criteria, as illustrated in Figure 6.6.

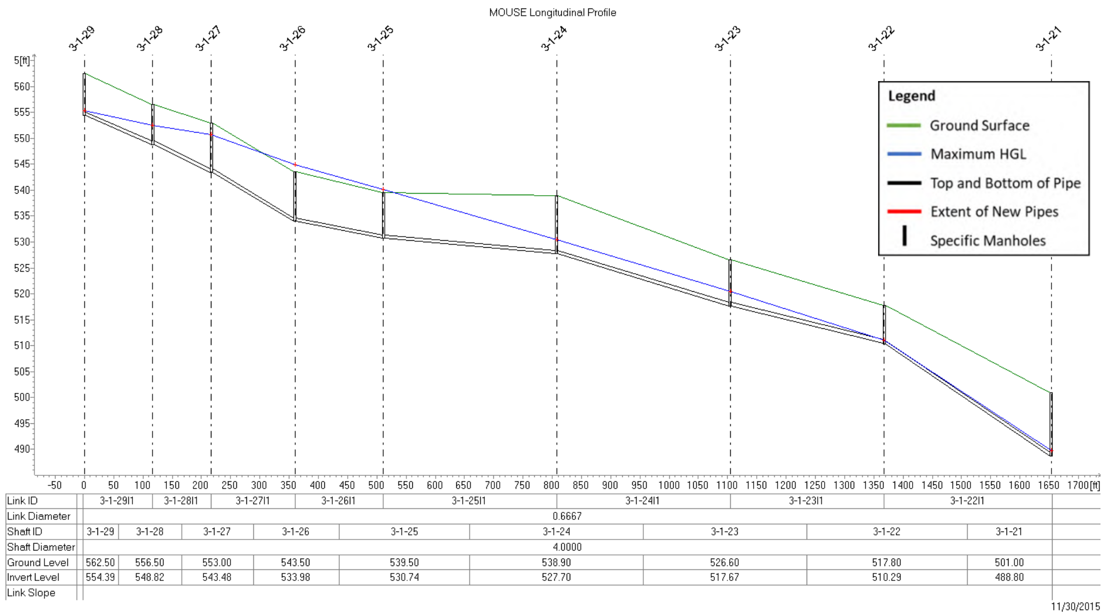


Figure 6.5 Area 1: HGL and Profile Plot

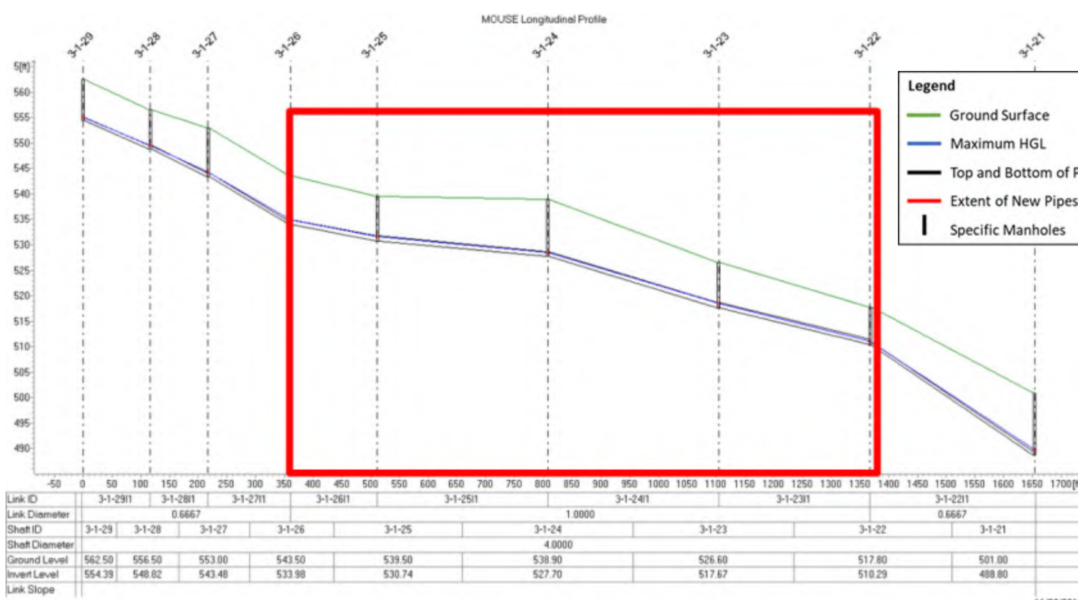


Figure 6.6 Area 1: HGL and Profile Plot after Improvements

6.5.2 Area 2

Area 2 experiences surcharging along Division St, during existing conditions. The model showed potential manhole flooding during the design storm at model manholes 3-1-11, 3-1-10, and 3-1-6. This deficiency is caused by capacity limitations at the lower sloped pipelines in the reach, as shown through the pipe profile plot and HGL on Figure 6.7. The proposed improvements consist of upsizing pipes between manholes 3-1-11 to 3-1-2 from 8-inch to 12-inch, shown boxed in on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown in Figure 6.8.

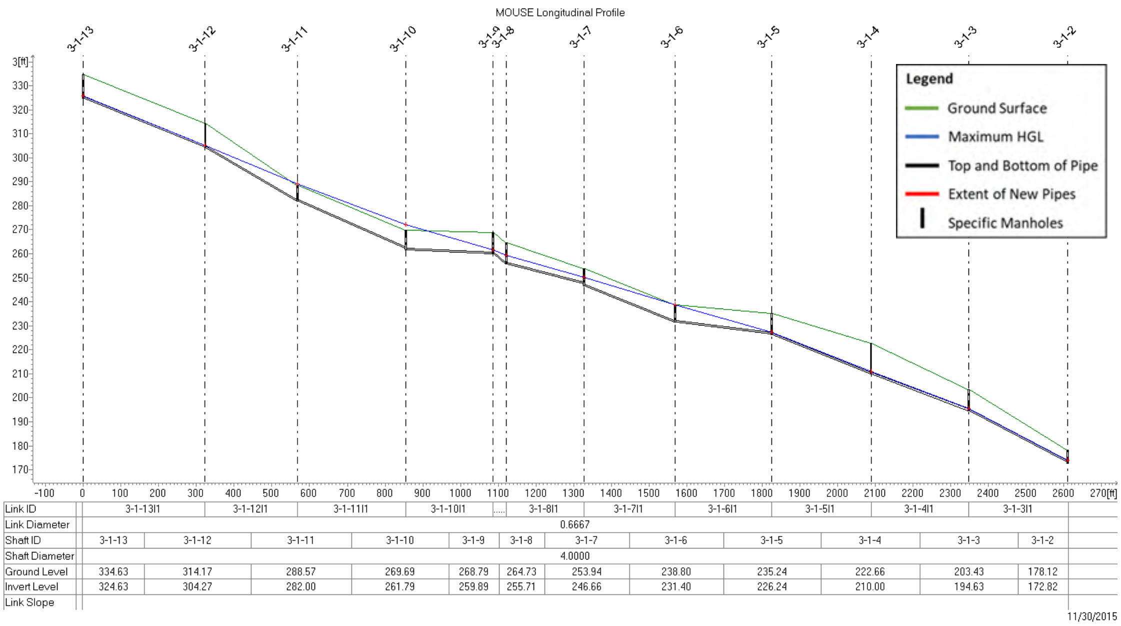


Figure 6.7 Area 2: HGL and Profile Plot

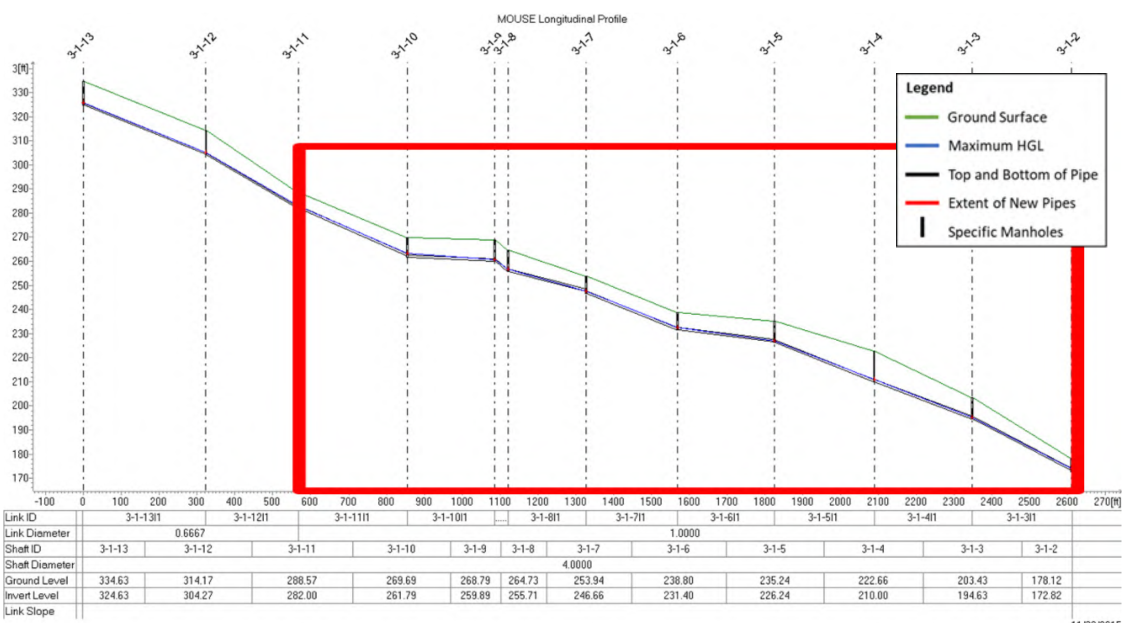


Figure 6.8 Area 2: HGL and Profile Plot after Improvements

6.5.3 Area 3

Area 3 experiences surcharging along NW 6th Place just upstream of the South Prune Hills Pump Station (PS), during existing conditions. The model showed potential manhole flooding during the design storm at manhole 10-1-8. This deficiency is caused by the significant change in grade from the steep upstream slopes to the shallow downstream slope near the pump station. An additional capacity restriction occurs further upstream between manholes 10-1-11 and 10-1-10, due to a shallow slope. This deficiency is shown through the profile plot and HGL in blue on Figure 6.9. The proposed improvements consist of upsizing pipes between manholes 10-1-11 to 10-1-10 from 8-inch to 12-inch and 10-1-8 to 10-1-5 from 10-inch to 12-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown in Figure 6.10.

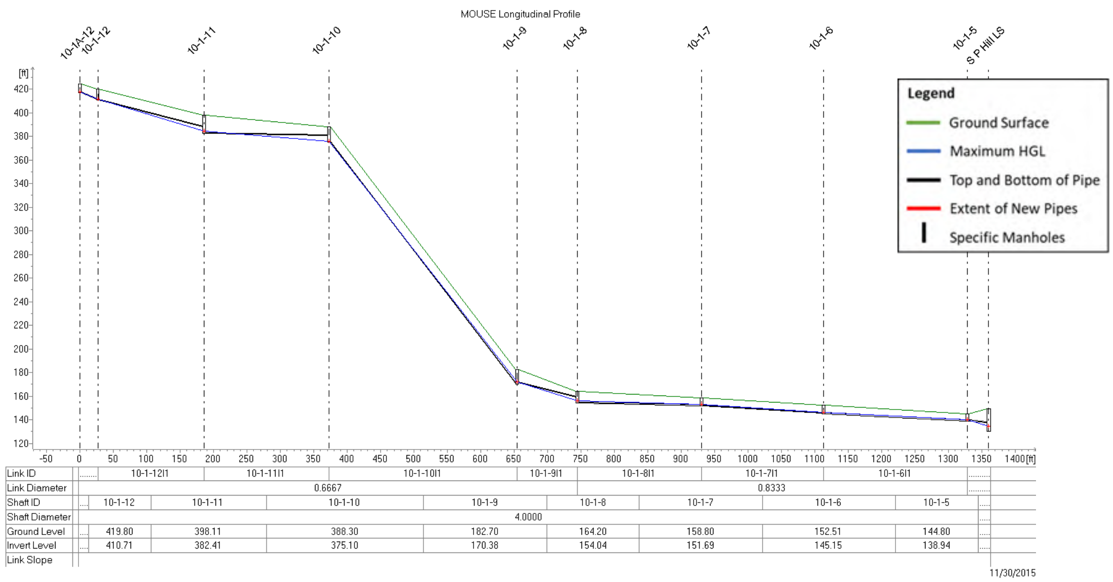


Figure 6.9 Area 3: HGL and Profile Plot

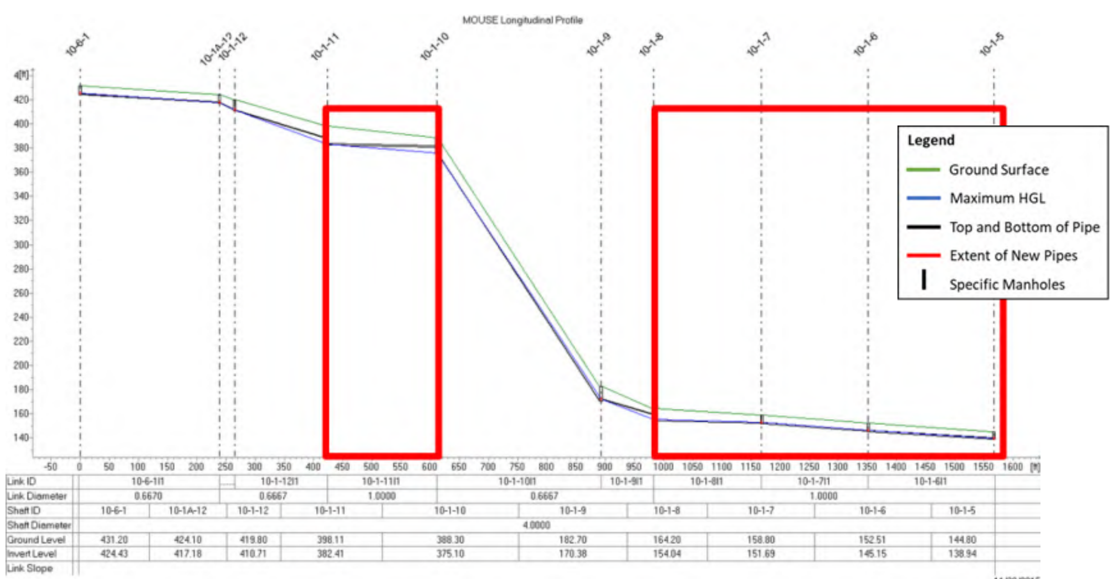


Figure 6.10 Area 3: HGL and Profile Plot after Improvements

6.5.4 Area 4

Area 4 experiences surcharging and flooding along NW 6th Place, shown in Figure 6.2, during existing conditions. The model showed potential manhole flooding during the design storm at manhole 10-1-3, just downstream of the South Prune Hills PS. This deficiency is caused by capacity limitations between the pump stations coupled with backwatering from the West Camas PS. This is shown through the profile plot and HGL in blue on Figure 6.11. The proposed improvements consist of upsizing pipes between manholes 10-1-3 and the West Camas PS wet well from 10-inch to 18-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown in Figure 6.12. Note this deficiency depends upon the timing and extent of the proposed West Camas PS improvements as well, identified in Section 6.4. The results shown above assume that the lift station is upsized to convey its firm capacity.

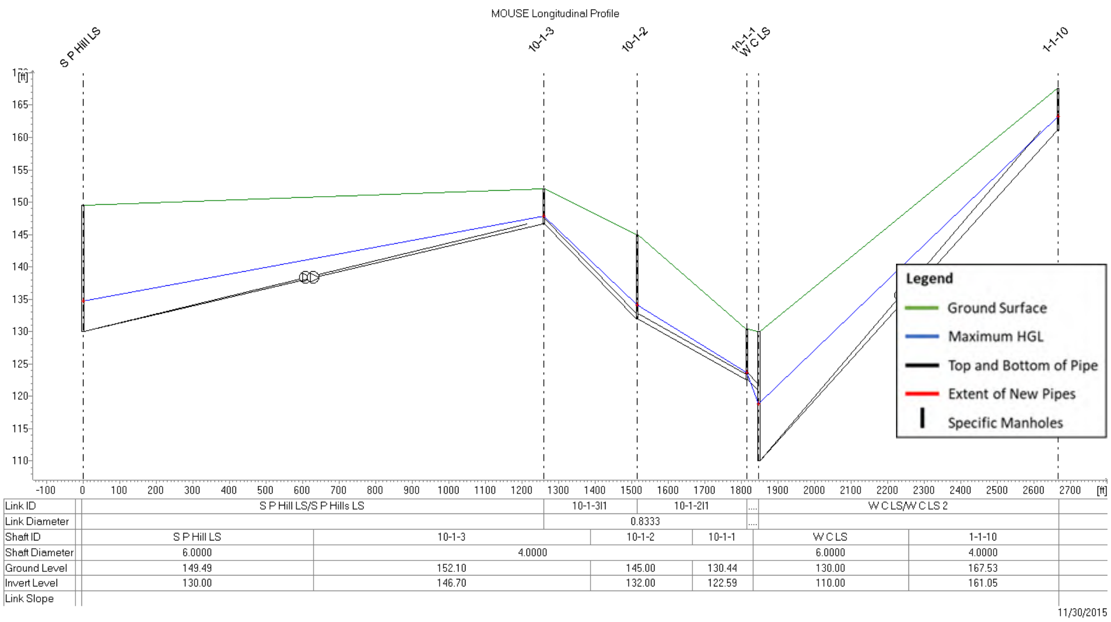


Figure 6.11 Area 4: HGL and Profile Plot

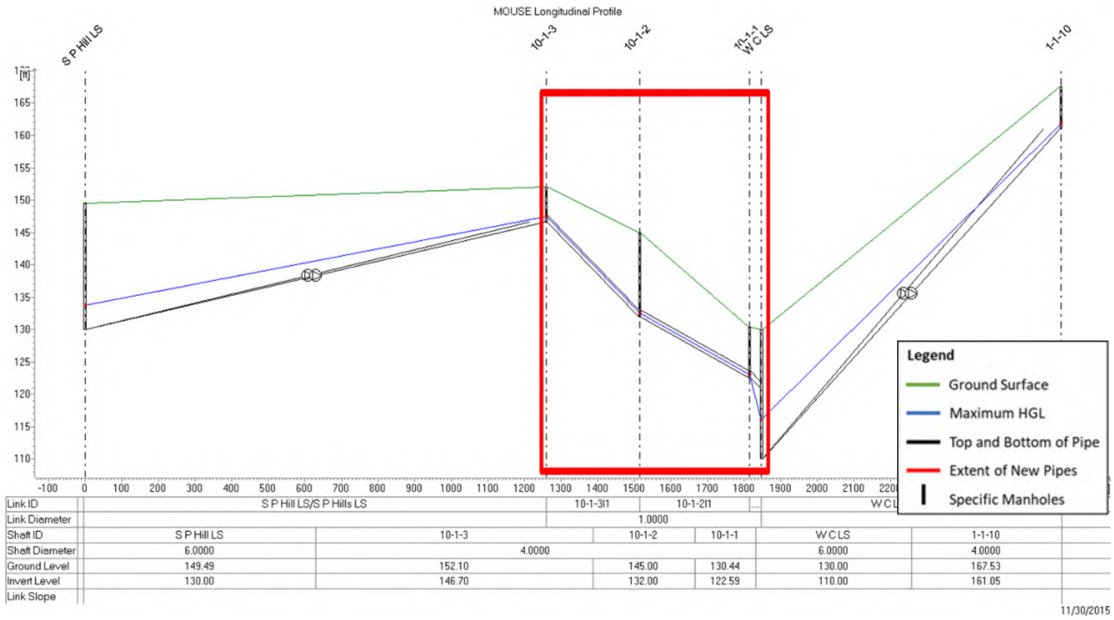


Figure 6.12 Area 4: HGL and Profile Plot after Improvements

6.5.5 Area 5

Area 5 experiences surcharging and flooding downstream of the West Camas PS along NW 6th Place and through Forest Home Park, during existing conditions. The model showed potential manhole flooding during the design storm at manholes 1-1-9, 1-1-8, and 1-1-7. This deficiency is caused by capacity limitations due to both pipe size and slope, as shown in the profile plot and HGL in Figure 6.13. The proposed improvements consist of upsizing pipes between manholes 1-1-9 to 1-1-7 from 12-inch to 15-inch and upsizing pipes between manhole 1-1-7 to 1-1-2 from 12-inch to 18-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown by the HGL in Figure 6.14.

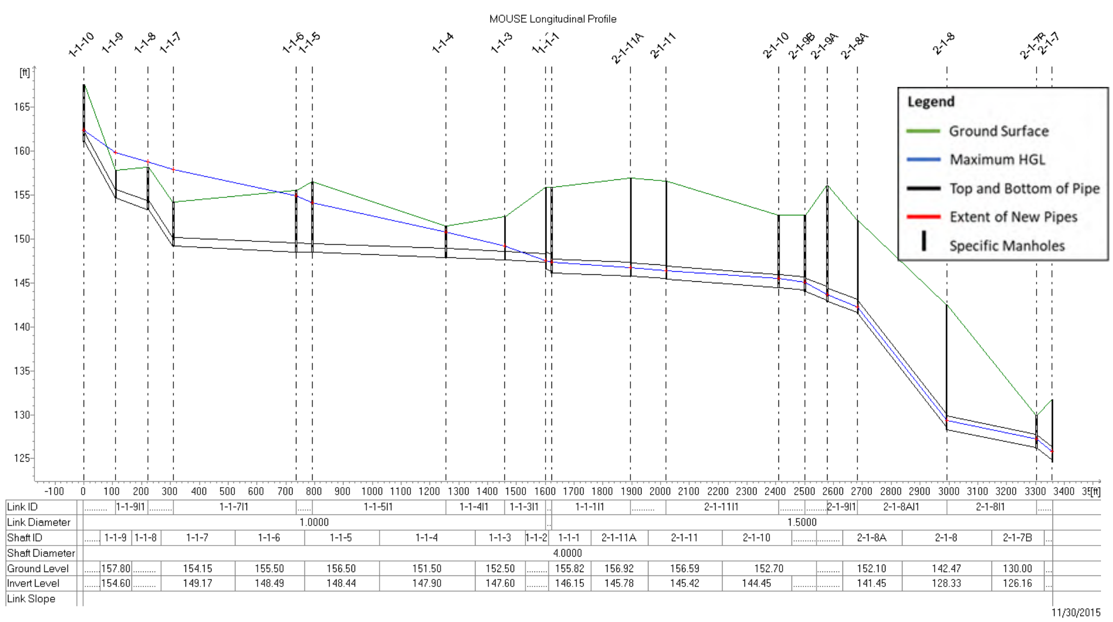


Figure 6.13 Area 5: HGL and Profile Plot

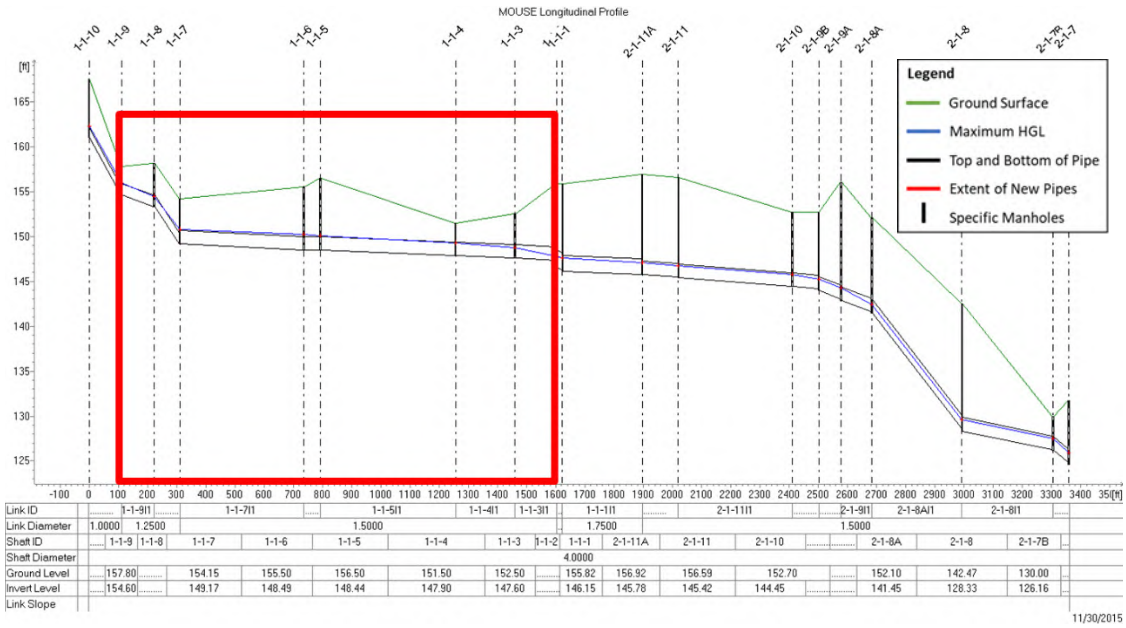


Figure 6.14 Area 5: HGL and Profile Plot after Improvements

6.5.6 Area 6

Area 6 experiences surcharging and flooding along NW Fargo Street, during existing conditions. The model showed no potential manhole flooding during the design storm, however flooding is very close at Manholes 2-1-2. This deficiency is caused by capacity limitations at the lowered sloped pipelines and a drop manhole at 2-1-1. The HGL and pipe profile through the reach is shown in Figure 6.15. The proposed improvements consist of upsizing pipes between manholes 2-1-3 to 2-1-1 from 12-inch to 18-inch, manholes 2-1-1 to 5-1-12 from 12-inch to 21-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown by the HGL in Figure 6.16.

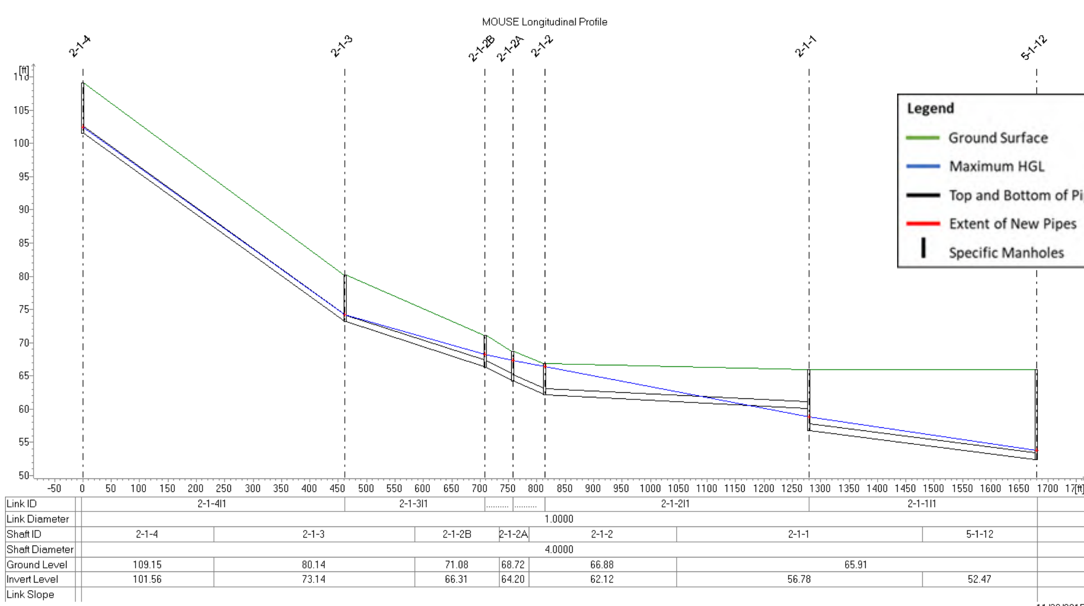


Figure 6.15 Area 6: HGL and Profile Plot

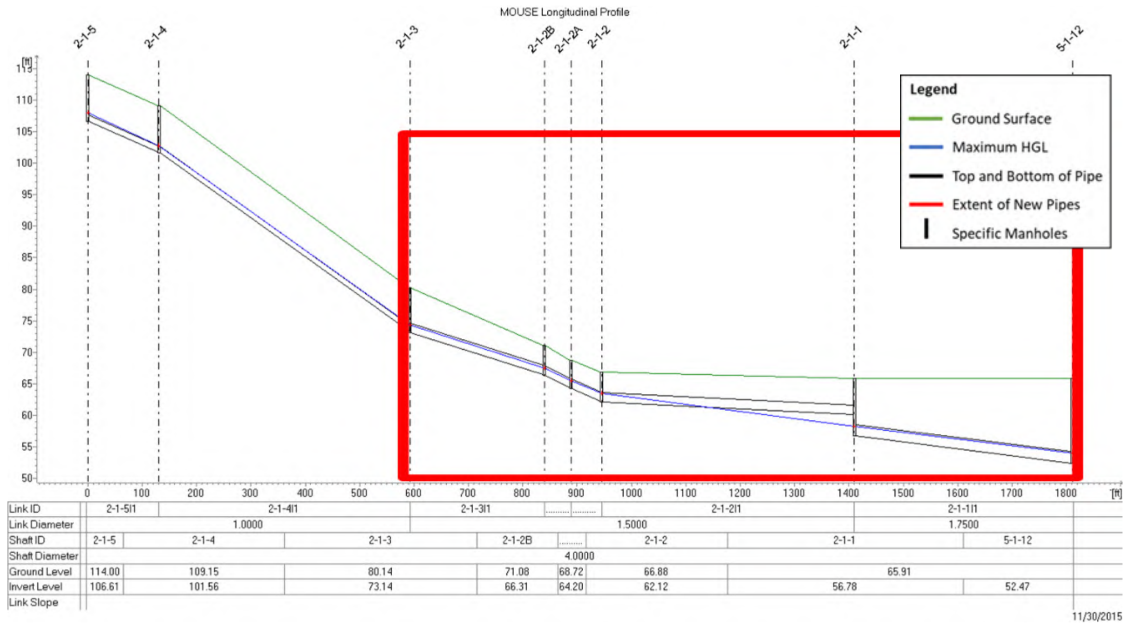


Figure 6.16 Area 6: HGL and Profile Plot after Improvements

6.5.7 Area 7

Area 7 experiences surcharging along SE 3rd Avenue, during existing conditions. Under build-out conditions, additional flows from the North Shore expansion and from 6th Avenue as a result of improvement projects for Areas 3, 4, 5 and 6, the surcharging at Area 7 greatly increases, shown in Figure 6.3. The model showed potential manhole flooding during the design storm for build-out conditions with upstream capacity improvements at manholes 5-1-5 and 5-1-6. This deficiency is caused by capacity limitations due to pipe slope constraints. This is shown through the profile plot and HGL in blue on Figure 6.18. Figure 6.17 shows the profile under existing conditions where the surcharging is less severe. The proposed improvements consist of upsizing pipes between manholes 5-1-10 to 5-1-12 from 21-inch to 24-inch, manholes 5-1-10 to 5-1-8 from 24-inch to 27-inch, manholes 5-1-8 to 5-1-6 from 21-inch to 24-inch, manholes 5-1-6 to 5-1-2 from 24-inch to 27-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown by the HGL in Figure 6.19.

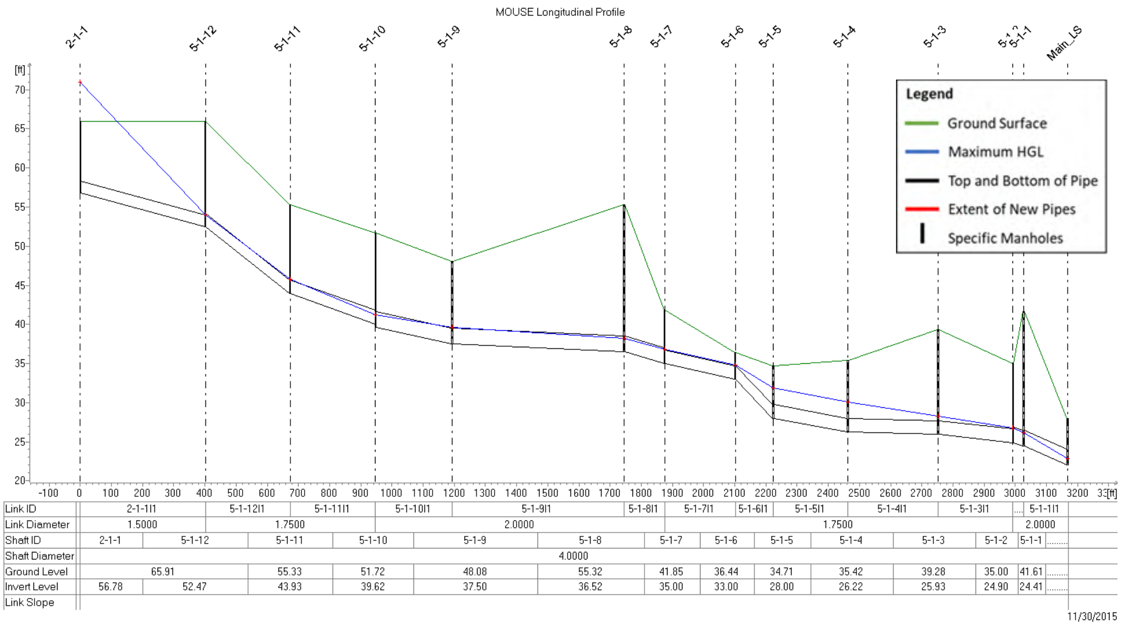


Figure 6.17 Area 7: HGL and Profile Plot Under Existing Conditions

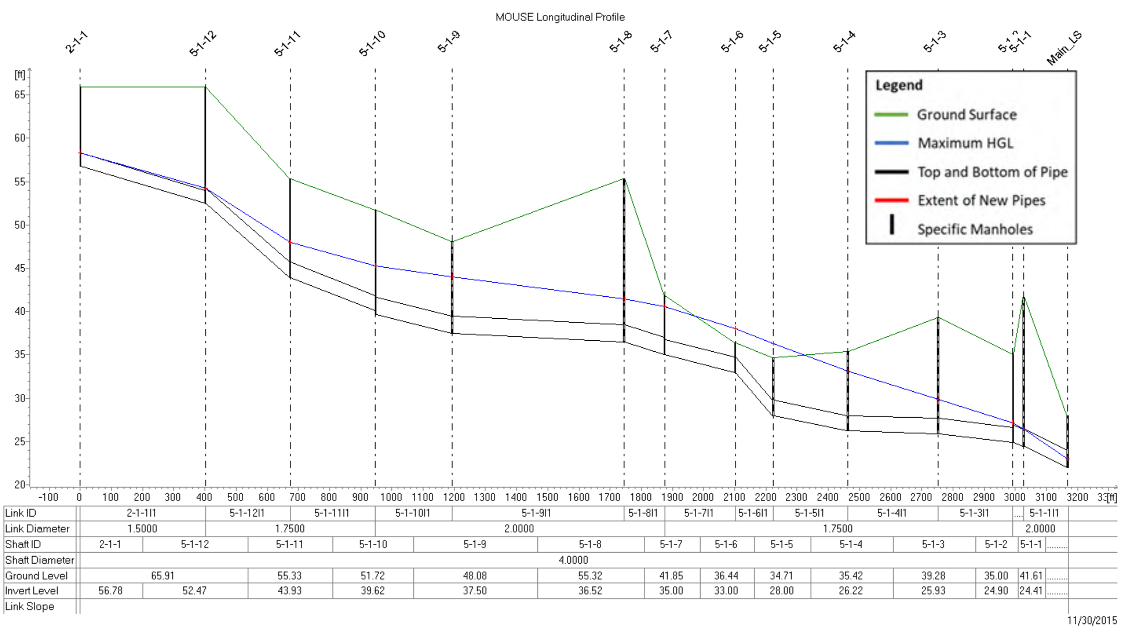


Figure 6.18 Area 7: HGL and Profile Plot under Build-Out Conditions with Upstream Improvement Projects Completed

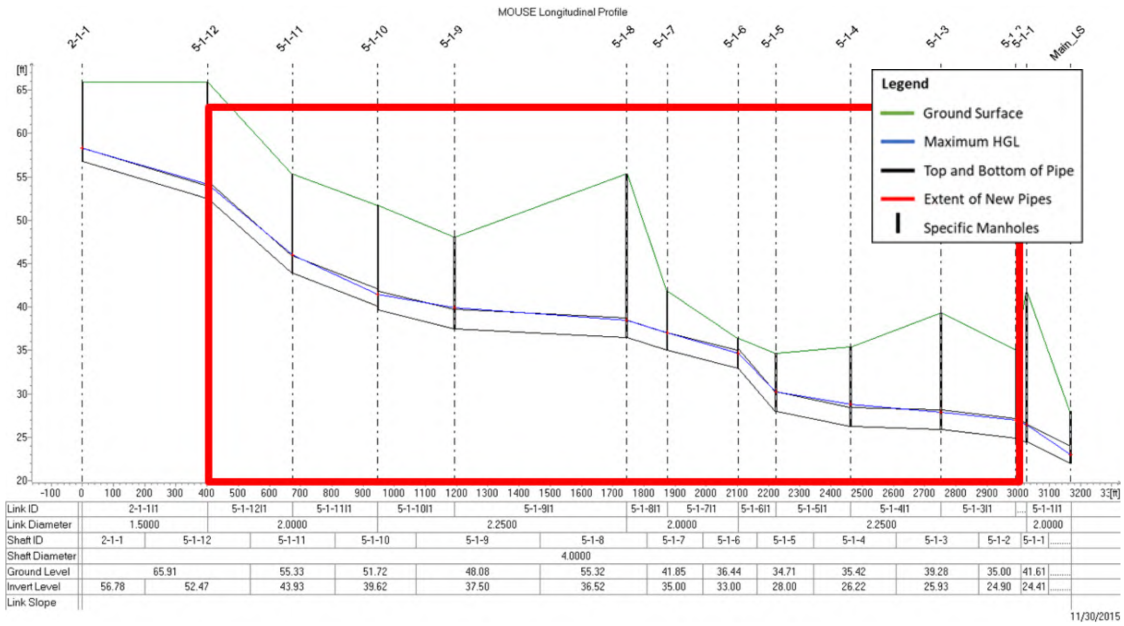


Figure 6.19 Area 7: HGL and Profile Plot under Build-Out Conditions with All Improvement Projects Completed

6.5.8 Area 8

Area 8 experiences surcharging along NW 18th Loop, during build-out conditions. There is no risk of flooding. This deficiency is caused by increased flows under future conditions which cause capacity issues. This is shown through the profile plot and HGL in blue on Figure 6.20. The proposed improvements consist of upsizing pipes between manholes 3-1-1 to 3-1-16 and manhole 3-1-13 to 3-1-12, from 8-inch to 12-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown by the HGL in Figure 6.21.

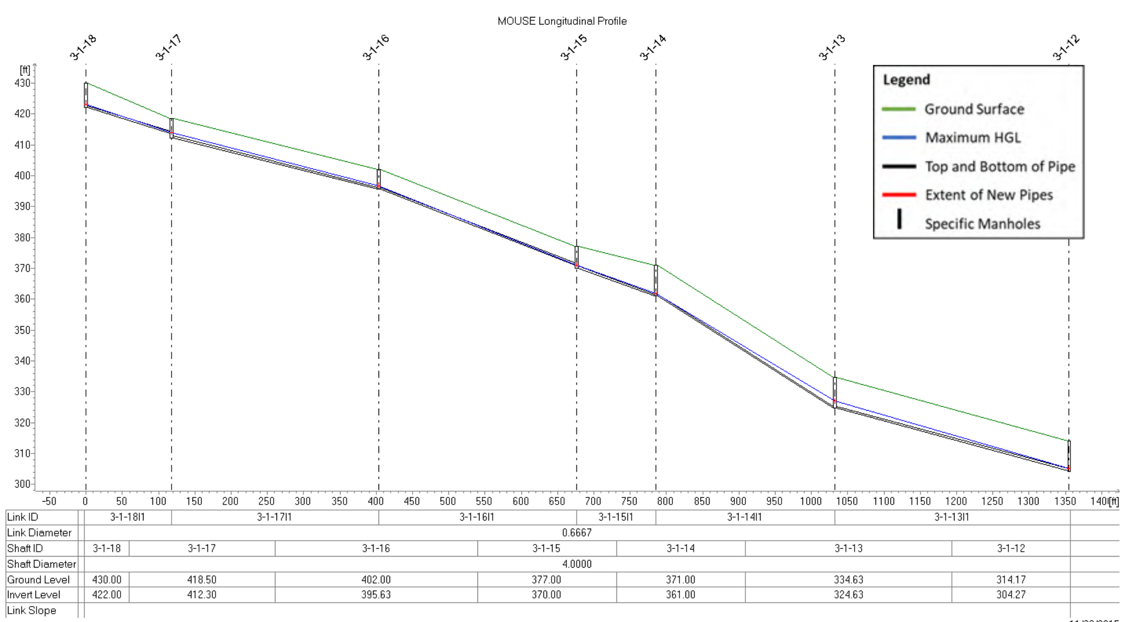


Figure 6.20 Area 8: HGL and Profile Plot under Build-Out Conditions

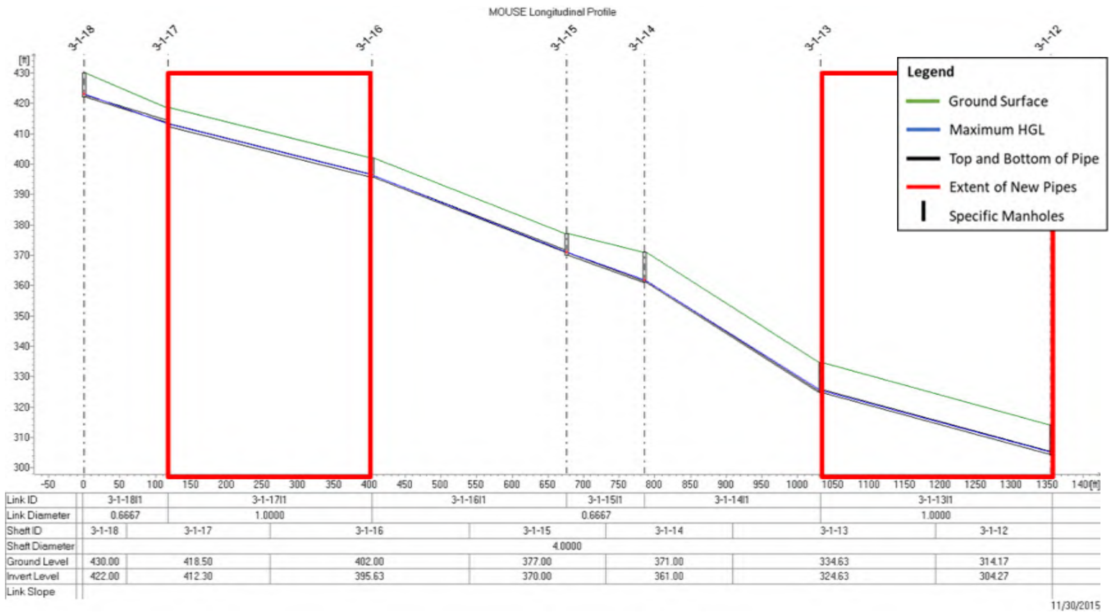


Figure 6.21 Area 8: HGL and Profile Plot under Build-Out Conditions, with Improvement Project

6.5.9 Area 9

Area 9 experiences surcharging along NE 15th Avenue between NE Garfield Street and NE Franklin Street, during build-out conditions. There is no risk of flooding. This deficiency is caused by increased flows under future conditions which cause capacity issues. This is shown through the profile plot and HGL in blue on Figure 6.22. The proposed improvements consist of upsizing pipes between manholes 4-1-2 to 4-2-1, from 8-inch to 18-inch, shown on Figure 6.4. This effectively alleviates the surcharging and meets the City's design criteria, as shown by the HGL in Figure 6.23. There is no threat of surcharging, so fixing this deficiency is a low priority and long-term project.

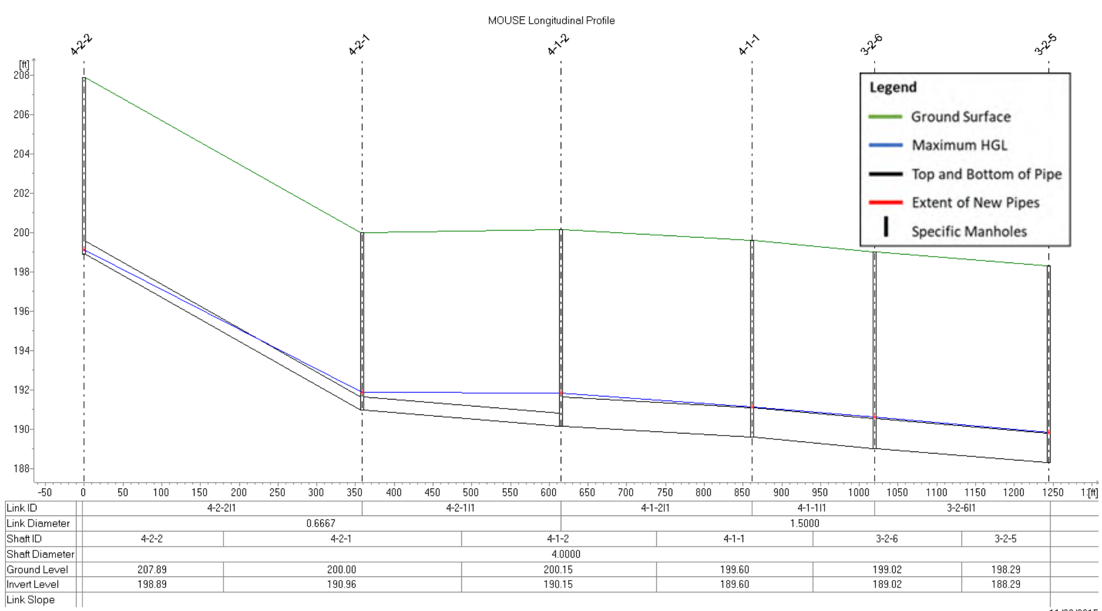


Figure 6.22 Area 9: HGL and Profile Plot under Build-out Conditions

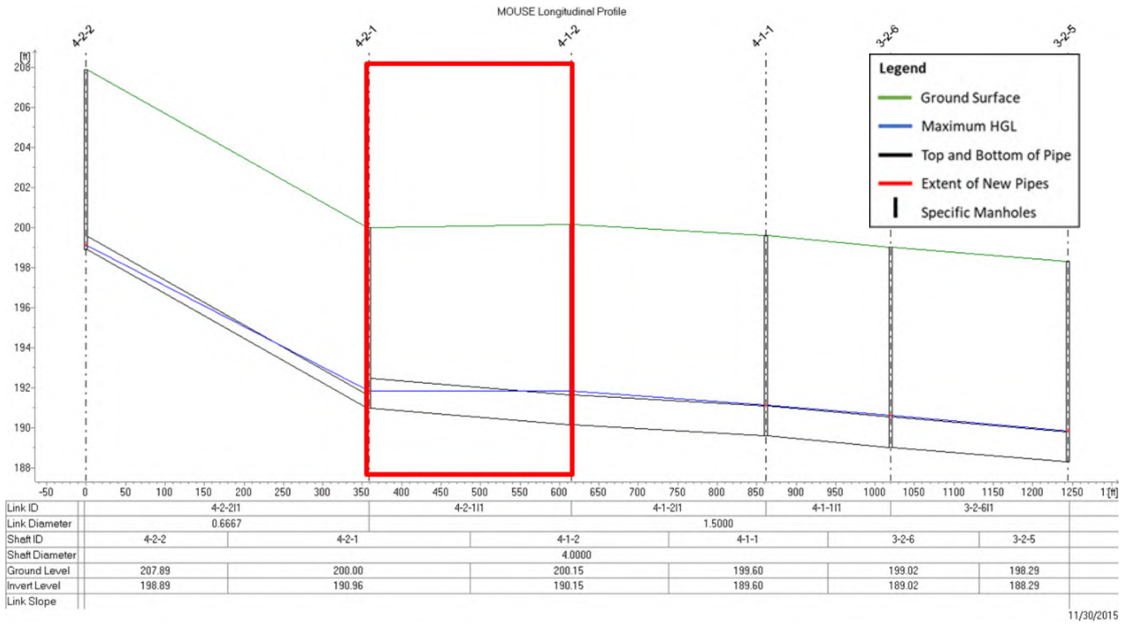


Figure 6.23 Area 9: HGL and Profile Plot under Build-out Conditions, with Improvement Project

6.6 Recommended Collection System Improvements

A number of recommended gravity collection system improvement projects for both pipes and pump stations have been identified to mitigate potential existing, 2035 Year Planning Horizon, and build-out deficiencies and to serve future users. The pipeline improvement projects were described in Section 6.5 and are summarized in Section 6.6.1. Pump Station Improvements are summarized in Section 6.6.2.

Figure 6.4, Table 6.3, and Table 6.4 identify the location and relevant components of the recommended system improvement projects. Table 6.3 and 6.4 referenced details of the improvement (length, diameter, street location, etc.). The improvements summarized in Table 6.3 and 6.4 utilize a numbering system cross-referenced with Figure 6.4. The deficiencies addressed by each project are explained in Section 6.5. The columns used in Table 6.3 and 6.4 refer to the following:

- Project ID: Assigned unique identifier associated with each improvement project. This is an alphanumeric number that starts with one letter indicating the type of improvement P= Pipe, PS = Pump Station, and continues with a number and a letter.
- Improvement Type: Gravity pipelines or pump stations.
- Location: Street in which the improvement is proposed.
- Existing Size: This represents the diameter of the existing pipelines (inches), or the total capacity of existing pump stations (million gallons per day [mgd]).
- Proposed Size: This represents the diameter of the proposed pipelines, or the total capacity of pump stations after proposed improvement, or upon construction if a new facility to serve future growth.

- Length: Estimated length of the proposed improvement in feet. It should be noted that the length estimates do not account for re-routing the alignment to avoid unknown conditions, if more detailed planning and design identifies such constraints.
- Phase: Phase in which the improvement is recommended. Improvements are recommended either for Short-term (Existing) or Long-term (2035 Year Planning Horizon or Build-out).

All proposed improvement projects are allocated to Short-Term (Existing Deficiency) and Long-Term (Build-out deficiency or no risk of flooding) phases based on when the model scenarios predict they are required. Detailed project prioritization based on condition of pipes and funding availability is presented separately in Chapter 9 - CIP and Chapter 10 - Financial Analysis. The two planning phases can be further described as follows:

- Short-term (2022-2031): Proposed facilities that alleviate deficiencies under existing flow conditions.
- Long-term (2032 - 2041): Proposed facilities that alleviate deficiencies for estimated 2035 or UGB flows and proposed facilities to serve service area expansion required under build-out conditions.

The projects were phased based on the best available information for how the City plans to develop moving forward. The actual implementation of the improvements serving future users ultimately depends on growth. The phasing presented below are estimates and will change with the City's planning assumptions or growth projections. Table 6.3 and 6.4 show all collection system projects allocated to the two planning periods.

6.6.1 Recommended Pipeline Improvements

Certain proposed improvements will serve future users, even when an improvement calls for the upgrade of an existing facility. In these cases, an existing sewer or pump station may have sufficient capacity to convey current PWWFs, but as growth continues and more users are added to the system, the increased flow results in capacity deficiencies. These projects, as well as new trunk sewers to extend sewer collection system service to future growth areas, are future improvements.

In most cases, a project is needed to correct an existing capacity deficiency but is sized to accommodate additional flows from future development.

Table 6.3 Recommended Pipe Capacity Projects

Project ID	Improvement Type	Location	Existing Size (inch)	Proposed Size (inch)	Length (feet)	Phase
P-1	Gravity	NW Fargo Street between NW 23rd and NW 19th Avenue	8	12	1,007	Short-term
P-2	Gravity	Division Street between NW 18th and NW 11th Avenue	8	12	2,043	Short-term
P-3	Gravity	NW 6th Place, just upstream of South Prune Hills PS	8 10	12 12	188 616	Short-term
P-4	Gravity	NW 6th Place between South Prune Hills PS and West Camas PS	10	12	588	Short-term
P-5	Gravity	NW 6th Avenue downstream of West Camas PS and through Forest Home Park	12 12	15 18	311 1,340	Short-term
P-6	Gravity	NW 6th Avenue between NW 7th Avenue and SE Adams Street	12 8	18 21	817 401	Short-term
P-7	Gravity	NE and SE Adams Street between SE 3rd Avenue and NW 6th Avenue	21 24	24 27	773 925	Short-term
P-8	Gravity	NW 18th Loop	8	12	609	Long-term
P-9	Gravity	NE 15th Avenue between NE Garfield Street and NE Franklin Street	8	18	256	Long-term

6.6.2 Recommended Pump Station Improvements

It is recommended that the Main, South Prune Hill, West Camas, and Crown View Plaza PSs all be upgraded to provide pump redundancy under existing conditions. These stations do not meet the required firm capacity, based on the City's performance criteria. It is recommended that the City improve these pump stations through addition of redundant pumps. Table 6.4 shows the recommended pump station improvements.

Table 6.4 Recommended Pump Station Improvement Projects

Project ID	Improvement Type	Location	Description	Phase
PS-1	Gravity	South Prune Hills	Add pump capable of pumping 664 gpm	Existing
PS-2	Gravity	West Camas	Add pump capable of pumping 723 gpm	Existing
PS-3	Gravity	Crown View Hill	Add pump capable of pumping 382 gpm.	Existing
PS-4	Gravity	Main	Add pump capable of pumping 1,831 gpm.	Existing
PS-5	Gravity	Lacamas Shores, Sunningdale Gardens, Winchester Hills 2	Add flow monitors and pressure sensors to get a better understanding of what happens during peak flows and their capacity to aid in future capital improvement planning	Existing

6.7 Recommended Collection System Future Projects

Our collection system evaluation was limited to the collection system that was modeled. The collection system includes gravity and STEP elements, but only portions of the gravity system and none of the STEP system were set up for capacity evaluation with the hydraulic model. There was insufficient data to evaluate the STEP system; therefore, specific improvement projects were not developed. Other factors such as limited pump telemetry and a lack of extensive city-wide geographic information system (GIS) limited the scope of the collection system evaluation. The following bullet points explain future projects the City should undergo to allow more effective evaluation of the gravity and STEP system, respectively:

- **Gravity Collection System Model:** The gravity collection system model is skeletonized, only 24 percent of the gravity system pipes and none of the force mains are included. While most of the critical trunks are included, a full pipe or less skeletonized model is needed for a more robust evaluation of the system. In order to expand the model, accurate and updated GIS for the collection system should be developed.
- **Gravity Pump Station Instrumentation:** The lack of pump station instrumentation limited the extent stations could be evaluated. The City conducted draw down testing that resulted in lower capacities than previous modeling concluded. It is recommended that the City improve instrumentation of these stations to better understand the reasons for these revisions.

- **STEP Main Flows:** As discussed in Chapter 7, with the City's combined treatment plant influent monitoring restricted the ability to separate out STEP flows from Gravity System Flows with a high degree of confidence. Recently, this issue was resolved and future monitoring will allow a greater understanding of the STEP Main flows. If Oak and Main PSs are flow metered, the STEP system flow can be determined. A future study is recommended once sufficient historical data is available.
- **STEP Main Modeling:** The STEP system should be added to the collection system model in order to evaluate that portion of the system. Additional metering at pump stations further upstream would allow proper calibration of the STEP portion of the model. While these pump stations would not need to be included in the model. Accurate data on Pump Station inflows to the STEP system would need to be determined. The addition of a manhole with a flow meter near NW Lake Rd and NW Lacamas Drive or NW Parker Street and NW Knapp Lane to aid in calibration should also be considered. Figure 6.24 shows the potential overview of a STEP main model, in dark grey, and proposed monitoring locations to add to the STEP system. Inflows are shown in orange and black triangles. These inflows are based on the Gray and Osborne 2009 General Sewer Plan Appendix F, Figure F-1. These inflows give an overview of where additional monitoring could be implemented in order to further refine the system during STEP model calibration.
- **STEP Main Condition Assessment:** The addition of manholes to the STEP system would help facilitate investigation of the STEP mains condition and allow any partially obstructed portion of the STEP Main to be identified. A future investigation of debris, solids, and other obstruction is recommended in the sags in the system.
- **STEP System Lift Stations:** The STEP System Lift stations could not be evaluated under PWWF events using the system model, due to a lack of data. Supervisory control and data acquisition (SCADA) with historian capabilities would assist with the evaluation of all stations and determining pump run times at these stations. Based on the City's pump station run time tests, a representative peak flow could be determined. This program should start with the most at risk stations defined in Section 6.4, and expand to all city owned pump stations.

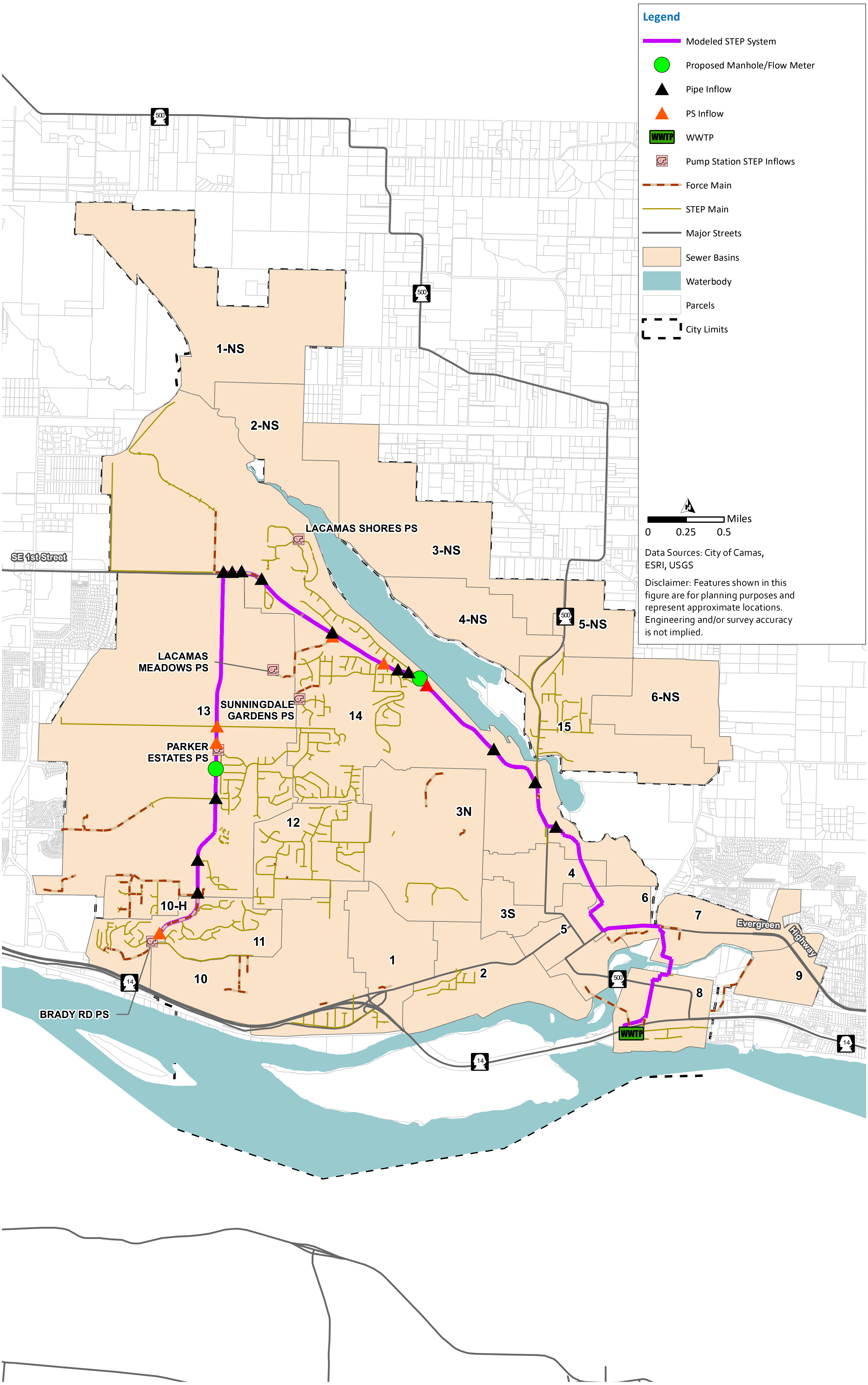


Figure 6.24 Overview of Potential STEP Main Model

Chapter 7

WASTEWATER TREATMENT FACILITY

7.1 Introduction

The City of Camas (City) serves the water quality needs of approximately 8,500 residential, industrial, and commercial accounts by maintaining and operating their wastewater treatment facility (WWTF) which has a maximum month design flow of 6.1 million gallons per day (mgd).

To support development of the City's General Sewer Plan (the Plan), a unit process analysis was completed to identify shortfalls in plant capacity that will prevent the City from reliably treating and disposing of projected flow and loads at the end of the planning period (i.e., year 2035). To address the identified deficiencies, an alternatives analysis of the most viable improvement options was conducted, which resulted in the development of 14 projects to be incorporated into the general sewer plan's capital improvement program (CIP).

This chapter summarizes the methods and results of these tasks, thus defining the condition and capacities of the WWTF's unit processes and presenting sequenced recommendations that will allow the City to reliably and cost-effectively serve their customers now and into the future.

7.1.1 Current National Pollution Discharge Elimination System Permit

The City's WWTF effluent must comply with limits on biological oxygen demand, total suspended solids, ammonia, pH, and fecal coliform bacteria as conditions of their National Pollutant Discharge Elimination System (NPDES) permit. The current permit, Permit Number (No.) WA0020249, was issued in 2015 effective through September 2020. The City began coordinating with the Washington Department of Ecology (Ecology) to request a permit extension in March 2020, but a formal extension or new permit has not been issued as of January 2022. The City will continue to work with Ecology to extend or renew their NPDES permit and will continue to comply with their current discharge limits, which are summarized in Table 7.1.

Table 7.1 NPDES Permit Effluent Limits for Permit No. WA0020249

NPDES Permit Effluent Limits		
Parameter	**Average Monthly**	**Average Weekly**
Biological oxygen demand (BOD_5)	• 20 mg/L • 1,017 ppd • 74% removal	• 30 mg/L • 1,525 ppd
Total suspended solids (TSS)	• 20 mg/L • 1,017 ppd • 76% removal	• 30 mg/L • 1,525 ppd
Ammonia (NH3 as N) during summer(1)	• 20 mg/L	-
Ammonia (NH3 as N) during winter(2)	• 7 mg/L	-
Parameter	**Minimum**	**Maximum**
pH	• 6 SU	• 9 SU
Parameter	**Monthly Geometric Mean**	**7-Day Geometric Mean**
Fecal coliform bacteria	• 200/100 mL	• 400/100 mL

Notes:
(1) Summer months include June through July.
(2) Winter months include October through May (inclusively).
Abbreviations: BOD_5 - five-day biochemical oxygen demand; mg/L - milligrams per liter; mL - milliliter; ppd - pounds per day; SU - standard units.

7.1.2 Past Evaluation of Reuse

In the 2010 iteration of the general sewer plan, the City explored their potential to practice wastewater reclamation, or the production and beneficial use of reclaimed water. As such, an evaluation was completed to understand the feasibility of reusing effluent from the WWTF or constructing a new water reclamation facility (WRF) to treat wastewater for reuse.

The evaluation determined that, though environmental and social benefits are difficult to quantify and assess, the City and their surrounding communities can benefit indirectly from the use of reclaimed water in the following ways:

- Development of additional outdoor recreational sites for the community.
- Irrigation of parks and playfields, which can potentially increase property values.
- Conservation of the quality and quantity of the City's water resources.
- A flexible and reliable alternative water source for industrial water customers.

However, the evaluation also confirmed that the production of reclaimed water is only economically feasible if the cost of producing reclaimed water is less than or equal to the cost of purchasing water or developing additional water rights.

Capital, operation, and maintenance costs for the two alternatives were taken from the 2010 general sewer plan and converted from 2006 dollars to 2021 dollars. A new 20-year present worth analysis was conducted with the updated values. Both the 2010 general sewer plan and the current 20-year present worth analysis found that neither the costs to modify the existing WWTF nor construct a satellite WRF were less than or equal to the cost of developing additional water rights, which are available at notably lower costs. The cost to develop and acquire additional water rights was expected to not exceed 5 million dollars in 2006 which would be 7.9 million dollars in 2021.

Comparisons of the two alternatives are shown in Table 7.2. Alternative 1 has a 20-year present worth of $15.8 million dollars and alternative 2 has a 20-year present worth of $42.6 million dollars. Both alternatives are considerably larger than the 7.9 million dollars to develop and acquire additional water rights. Therefore, water reclamation and reuse were determined to be economically infeasible at this time and not pursued at the City's WWTF.

Chapter 10 of the *2010 General Sewer/Wastewater Facility Plan* (Gray & Osbourne, Inc. 2010) documents the feasibility evaluation of reuse in further detail.

Table 7.2 Reuse Alternative Cost Comparison

	Alternative 1 Modify Existing WWTF	Alternative 2 Construct Satellite WRF
Capital Cost(1)	$12,837,000	$35,878,000
Annual O&M Cost(2)	$157,700	$350,500
20-year Present Worth(3)	$15,841,000	$42,554,000

Notes:
(1) 2010 general sewer plan used 2006 costs. The ENR CCI 20-City Average for June 2006 and June 2021 were used.
(2) 2010 general sewer plan reported 2004 costs. Costs were updated using the ENR CCI 20-City Average for March 2004.
(3) Discount rate assumed 5% bond repayment rate and 4% inflation for a total rate of 1%.
Abbreviations: O&M - operations and maintenance.

7.2 Unit Process Analysis

A unit process analysis comparing the design or rated capacity of each WWTF unit process against its requisite treatment demands under current and projected flows and loads. This comparison identified deficiencies or limitations in the plant's current installed capacity to meet its various regulatory and operational requirements by 2035.

To this end, the unit process analysis was completed in the following six sequential tasks:

- Compile and analyze five years (i.e., January 2014 to December 2018) of WWTF data.
- Develop a hydraulic model of the collection system (collection system model) to estimate future peak hour flow (PHF) at the WWTF under the design storm.
- Estimate future flows and loads from 2019 through 2035 to approximate each unit process's necessary treatment performance.
- Develop and calibrate hydraulic and BioWin models to assess how future flows and loads will affect existing plant facilities and their performances.
- Conduct plant tours to complete condition assessments of the existing facilities and identify operational limitations.
- Determine future treatment capacities for existing unit processes and estimate the ideal timing of future plant improvements.

The following sections highlight key points and findings from these six tasks.

7.2.1 Flows and Loads

Tables 7.3 and 7.4 present the current and projected flows and loads, which must be treated and discharged to the Columbia River. These projections were developed according to measured influent flows and wastewater characteristics, typical septage and septic tank effluent pump (STEP) system characteristics, and population growth projections. Chapter 3 details the method by which these flows and loads were analyzed.

Table 7.3 Current and Projected Flows

Flow Parameter	Current Flow (mgd)	2035 Flow (mgd)
ADWF	2.2	3.4
AAF	2.8	4.0
MMF	4.8	6.2
PDF	8.4	10.8
PHF	10.0	13.5

Notes:
Abbreviations: AAF - average annual flow; ADWF - average dry-weather flow; MMF - maximum monthly flow.

Table 7.4 Current and Projected Loads

Load Parameter	Current Load (ppd)	2035 Load (ppd) 50% STEF/STEP
BOD_5		
Average Annual	2,400	6,000
Max Month	3,300	8,200
Max Week	4,300	10,600
Peak Day	5,300	13,000
TSS		
Average Annual	2,500	6,300
Max Month	4,200	10,500
Max Week	7,000	17,000
Peak Day	7,900	19,300
Ammonia		
Average Annual	900	1,400
Max Month	1,100	2,000
Peak Day	1,800	4,300

Notes:
Abbreviations: STEF - Septic tank effluent filter; Hydraulic Modeling.

Carollo Engineers' Hydraulix® modeling software was used to establish the hydraulic capacities of individual unit processes and water surface elevations (WSE) under current and future flows. More specifically, this software modeled the flow through the WWTF by calculating both energy grade lines and hydraulic grade lines according to headloss and velocity at each hydraulic element under various influent flow conditions identified in Table 7.3.

Each individual unit process was considered "at risk" when the model indicated less than 18 inches of freeboard in a structure or less than six inches of fall from flow over a weir to the downstream water surface. A unit process was considered "overloaded," or as having a true hydraulic limitation, when the model indicated less than 12 inches of freeboard or a weir was submerged. Less than 12 inches of freeboard in an open channel puts the WWTF at risk of flow overtopping a structure and must be avoided at all costs.

7.2.2 BioWin Modeling

BioWin version 6.1 was employed to develop an overall process model of the WWTF. This model was calibrated using existing treatment facility operational data and then confirmed by running the calibrated model as a steady-state simulation using average plant influent and effluent values (BOD, TSS, ammonia) from 2018.

Once the calibration effort was deemed acceptable, parameters were established for future conditions under which the WWTF must operate. Specifically, this effort adopted the flows and load projections presented in Tables 7.3 and 7.4 while assuming that effluent limits on ammonia would be as low as seven mg/L for all scenarios.

Finally, the BioWin model was used to model performance of the secondary treatment unit processes under anticipated future conditions, under the following future scenarios:

- A TSS removal rate of 65 percent under current AAF, current MMF, and 2035 AAF conditions and 52 percent under 2035 MMF conditions.
- A minimum aerobic solids retention times (aSRT) of eight days under average conditions and 6.6 days under maximum month conditions.
- The sludge volume index (SVI), which is aquantification of mixed liquor suspended solids (MLSS) settleability, cannot exceed 150 milliliters per gram (mL/g) if capacity limitations are to be prevented.

In regard to the final point, the highest allowable maximum month MLSS concentration, 3,500 milligrams per liter (mg/L), is limited by the capacity for suspended solids to settle in the SCs under peak day flow (PDF). A state point analysis (SPA) was conducted to determine the maximum allowable MLSS concentration, which was 2,330 mg/L with one SC out of service and all three ABs in service. The loading conditions that will result in this maximum month MLSS concentration at a 6.6-day aSRT is a PDF of 9.0 mgd. Section 7.4.2.1 discusses this topic further.

7.2.3 Condition Assessment

A condition assessment was conducted to identify major facility deficiencies and provide a general priority rating for mechanical equipment, treatment units, structures, and electrical, instrumentation, and control (E&IC) systems. The information compiled was used during the planning process to determine which portions of the facility can be retained, which require major upgrades, and which should be abandoned or replaced.

To begin, the assessment team reviewed each unit process's drawings and design criteria, including the Washington State Department of Ecology's (Ecology) recommended WWTF redundancy criteria for flows and loads as published in *Criteria for Sewage Works Design* (2008).

Table 7.5 summarizes the criteria that each facility component must meet.

Table 7.5 Design Criteria for Each WWTF Component

WWTF Component	Flow Criteria	Load Requirement	Redundancy
Influent Screens	• PHF.	-	• 1 unit out of service.
Primary Clarifiers	• PHF + Recirculation.	• Peak hour design load	• All units in service.
Aeration Basins	• Maximum month design flow. • AAF.	• Maximum month design load. • Average annual load.	• All units in service • 1 unit out of service.
Internal Recycle Pumps	• PDF.	-	• 1 unit out of service.
Aeration Systems	-	• Maximum week design load.	• 1 unit out of service.
Secondary Clarifiers	• PDF + Recirculation.	• Maximum month design load.	• all units in service.
RAS Pumps	• 100% of MMF. • 50% of PHF.	-	• 1 unit out of service.
Effluent Filters	• All flows requiring tertiary treatment.	-	-
UV Channel	• PHF.	-	• 1 unit out of service.
Primary Sludge Pumps	• Peak instantaneous design flow.	• Maximum daily design load.	• 1 unit out of service.
Degritting Cyclone	• PHF.	-	• N/A
Grit Classifier	• PHF.	-	• N/A
Gravity Thickener	-	• Maximum daily design load.	• N/A
WAS Pumps	• Peak instantaneous design flow.	• Maximum daily design load.	• 1 unit out of service.
Rotary Drum Thickener	-	• Maximum daily design load.	• 1 unit out of service.

Notes:
Abbreviations: N/A - not applicable; RAS - return activated sludge; UV - ultraviolet; WAS - waste activated sludge.

Next, the team discussed maintenance history, plant shortcomings, and general operational issues with City staff, who also accompanied the team on walk-through inspections of the WWTF's following processes and associated major equipment:

- Preliminary treatment.
- Primary treatment.
- Secondary treatment.
- Aeration blowers.
- Tertiary filtration.
- UV disinfection.
- Effluent pump station and pumps.
- Primary sludge and degritting.

- WAS system.
- Anaerobic digestion and waste gas flare.
- Dewatering centrifuge.
- Biosolids belt dryer.
- Plant drain and non-potable pump station.
- Biofilters and septage-receiving station.
- Facility control systems, including the programmable logic controller (PLC) and central supervisory control and data acquisition (SCADA).

Note that, although they were a part of the assessment, anaerobic digestion and the waste gas flare, dewatered sludge conveyance, and the biosolids belt dryer were not evaluated in detail since they were recently upgraded. Additionally, the biofilters and septage-receiving station were not analyzed in detail and should be more closely reviewed in a subsequent project.

Table 7.6 summarizes each key WWTF component's condition and capacity findings.

Table 7.6 Conditions and Capacity Findings from the WWTF Conditions Assessment

<table>
<tr><th>WWTF Component</th><th>Condition</th><th>Capacity</th></tr>
<tr><td>Influent Screens</td><td>• No significant conditions issues identified.</td><td>• 14.0 mgd</td></tr>
<tr><td>Primary Clarifiers</td><td>• No condition issues identified.</td><td>• 2,380 gpd/sq ft PHF</td></tr>
<tr><td>Aeration Basins (AB)</td><td>• Weir walls between zones are uneven.</td><td rowspan="2">• 8.37 mgd (2 ABs, 2 SCs per SPA) (max month)
• 9.12 mgd (3 ABs, 2 SCs per SPA)
• 9.71 mgd (3 ABs, 3SCs per SPA)</td></tr>
<tr><td>Secondary Clarifiers (SC)</td><td>• SC No. 1 in poor condition.</td></tr>
<tr><td>Internal Recycle Pumps</td><td>• No condition issues identified.</td><td></td></tr>
<tr><td>Aeration Systems</td><td>• Unable to control blowers when operating multiple in parallel.</td><td></td></tr>
<tr><td>RAS Pumps</td><td>• No condition issues identified.</td><td></td></tr>
<tr><td>Effluent Filters</td><td>• No condition issues identified.</td><td>• 6.0 mgd</td></tr>
<tr><td>UV Channel</td><td>• No condition issues identified.</td><td>• 13.7 mgd at 70% UV Transmittance</td></tr>
<tr><td>Primary Sludge Pumps</td><td>• No condition issues identified.</td><td>• 220 gpm (each)</td></tr>
<tr><td>Degritting Cyclone</td><td>• End of useful life.</td><td>• 220 gpm (each)</td></tr>
<tr><td>Grit Classifier</td><td>• End of useful life.</td><td>• 15 gpm</td></tr>
<tr><td>Gravity Thickener</td><td>• End of useful life.</td><td>• 400 gpm</td></tr>
<tr><td>WAS Pumps</td><td>• No condition issues identified.</td><td>• 200 gpm</td></tr>
</table>

WWTF Component	Condition	Capacity
Rotary Drum Thickener	• Significant Observed Deterioration.	• 200 gpm.
Centrifuge	• Near end of useful life.	
Plant Drain Pump Stations	• Show signs of concrete corrosion and pumps at the end of useful life.	• Plant Drain Pump Station No. 1: 250 gpm at 35 feet TDH • Plant Drain Pump Station No. 2: 500 gpm at 40 feet TDH
Non-Potable Pumps	• No condition issues identified.	• 200 gpm at 185 feet TDH
Effluent Pump Station	• No condition issues identified.	• 12.4 mgd at 18 feet TDH

Notes:
Abbreviations: gpd/sq ft -gallons per day per square foot; gpm - gallons per minute; TDH - total dynamic head.

7.3 Summary of Key Improvements and Preferred Alternatives

Comprehensive analysis of the WWTF's unit processes identified several current and anticipated condition or capacity issues in the WWTF's hydraulic, liquid treatment, solids treatment, and plant support systems. The following sections highlight key issues with unit processes at the WWTF and also recommend improvements to mitigate them; collectively, this information served as the basis for the subsequent alternatives analysis and project development for inclusion in the general sewer plan's recommended CIP.

Each unit process's complete description; condition findings, hydraulic capacity, and process capacity analyses; and recommendations for improvements and alternatives are available in Appendix I: Wastewater Treatment Facility Engineering Reports.

7.3.1 Basis of Project Costs

Cost estimates for treatment projects include 30 percent for construction contingency, 1.3 percent for builder's risk and insurance, 15 percent for general contractor overhead, risk, and profit, and 1 percent for performance and payment bond for a total overall construction adjustment factor of 53 percent. Planning adjustment mark-ups include 25 percent for engineering, legal, and design and 5 percent for owner's reserve for change orders for a total overall planning adjustment factor of 30 percent.

All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021). Cost estimates were developed using a Class 4 budget estimate, as established by the American Associate of Cost Estimators (AACE). This level of estimate is used for feasibility studies and assumes a one percent to 15 percent level of project definition. The expected accuracy range is of the Class 4 cost estimates are -30 percent to +50 percent.

7.3.1.1 Total Treatment Project Capital Improvement Cost

The costs presented in this Plan are high-level planning costs to help the City in making financial decisions.

As shown in the following sample calculation of the capital improvement cost, the total cost of all project contingencies (construction and planning) and allied costs (engineering services, construction management, and project administration) is 82 percent of the baseline project cost.

Example:

Baseline Project Cost	**$1,000,000**
Overall Construction Adjustment Factor (53%)	$530,000
Construction Cost	**$1,530,000**
Engineering, Legal, Design (25%)	$382,500
Owner's Reserve (5%)	$76,500
Total Capital Improvement Cost	**$1,989,000**

7.3.2 Hydraulics

To ensure that the plant's unit processes have adequate capacity to handle future flows, hydraulic improvements are recommended in the following areas.

7.3.2.1 Inlet to the Headworks Channel

The headworks's hydraulic capacity is currently limited by the inlet pipe's configuration. Flow from the existing inlet pipe enters a shallow influent channel vertically from below, directing flow *upward* instead of *toward* the flume. As a result, flow upstream of the Parshall flume occasionally sprays out over the top of the headworks structure, especially at high influent flow rates.

To prevent flow measurements from being skewed and raw sewage from splashing over the top of the structure, the inlet pipe to the headworks channel is recommended to be modified by installing a rigid plate or slab over the top of the influent channel to the flume. The new tread plate will replace the existing metal cover with a resilient, watertight alternative.

The estimated total project cost of these modifications is $6,000. They may be implemented at any time either by City staff or a general contractor as part of a larger project. Before implementing the project, the tread plate's load rating must be considered, and the anchorage design must be reviewed to resist the thrust caused by peak flows.

7.3.2.2 Tertiary Filter Bypass System

The plant's two tertiary disc filters are hydraulically bottlenecked by a set of serpentine bypass weirs whose current configuration provides minimal freeboard in the filter influent channel. At sufficiently reduced freeboard, flow may flood the SCs' effluent weirs, splash out of the channel, and potentially damage sensitive equipment and electronics, particularly those of the UV system. If left unmodified, the filters' removal efficiency will decrease as future flows increase and require more bypass, which will also decrease the removal rate of TSS.

To prevent the weirs from limiting the plant's overall hydraulic capacity, the tertiary filter bypass system is recommended to be reconfigured in the following manner:

- Remove the original weir wall between the filter influent channel and the existing serpentine weirs.
- Remove the concrete fill in the corners of the bypass channel to increase the depth and decrease the flow velocity.
- Reverse the serpentine weirs so that flow enters up between and through the launders, allowing for a uniform velocity as flow approaches the bypass weir, which, in turn, leads to more uniform weir loading.

As shown in Table 7.7, the total estimated project cost of the recommended modifications is approximately $49,000. These modifications can be implemented as a standalone project or along with other project efforts to reduce overhead costs. Although the timing of this improvement is not constrained, implementation during the dry weather season is recommended since the work will require temporary bulkheads upstream and downstream of each bypass channel.

Table 7.7 Filter Bypass Modification Costs

Description	Cost(1)
Demolition of Existing Structures	$7,000
New Concrete	$5,000
Structural Steel	$10,000
Bypass Weir Removal and Reinstallation	$3,000
Total Direct Cost	**$25,000**
Total Estimated Construction Cost	**$38,000**
Total Estimated Project Cost	**$49,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.3 Liquids Treatment

To address process and condition issues identified in the plant's secondary treatment system, modifications in the following areas are recommended.

7.3.3.1 Secondary Clarifier No. 1

The WWTF's three SCs all have differing effective sidewater depths and configurations, with SC Nos. 2 and 3 performing well. SC No. 1, however, performs poorly and unreliably not only because of the condition of its mechanical equipment but also because it has a center-well sludge-collection mechanism without a sloped floor to its center.

This clarifier is a major existing limitation and, as such, restoring it to its full design capacity is key to also restoring the process and hydraulic capacities associated with the secondary treatment process. As it stands, with all three ABs operating under MMF conditions and using only the two SCs that are currently operable, the secondary system will have insufficient capacity by approximately year 2024.

As such, SC No. 1 is recommended to be replaced with a new 75-foot-diameter, sloped-bottom clarifier similar in design to SC No. 3 since past retro-fit projects have not improved the clarifier's performance. Operating three fully functional SCs will increase the allowable maximum month MLSS concentration from 2,330 mg/L to 2,950 mg/L and slightly increase the allowable PDF from nine mgd to 9.4 mgd.

As shown in Table 7.8, the total estimated project cost to replace SC No. 1 is approximately $5.15 million. To replace SC No. 1, the plant must be operated using only two SCs through at least one wet weather season when peak flow events are likely, placing it at a higher risk of permit violations during construction.

Table 7.8 Replacement Costs for Secondary Clarifier No. 1

Description	Cost(1)
Demolition of Existing Equipment and Structure	$333,000
New Concrete Basin (Similar to SC No. 3)	$1,357,000
75-foot-diameter Spiral Scraper Mechanism	$420,000
Two 30-hp Vertical Centrifugal RAS Pumps	$147,000
Piping Modifications	$158,000
Electrical, Instrumentation, and Controls Upgrades	$175,000
Total Direct Cost	**$2,590,000**
Total Estimated Construction Cost	**$3,958,000**
Total Estimated Project Cost	**$5,146,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).
Abbreviations: hp - horsepower.

7.3.3.2 Secondary Treatment System

The plant's existing secondary treatment system has the following notable issues:

- Aerated volume in existing ABs is insufficient to maintain the eight-day aSRT necessary for stable nitrification.
- The baffle walls that divide the ABs' zones were poorly cut to their current top elevation and/or in deficient condition.
- RAS pumps for SC No. 2 are undersized and cannot prevent a sludge blanket failure under peak flow and load conditions.

The following sections detail each of these issues and their recommended improvements.

Aeration Basins

Flow and load projections predict that approaching 2030, the ABs' current capacity will become insufficient in maintaining an MLSS concentration below 3,500 mg/L under average loading conditions with one basin out of service at the 8-day aSRT required for stable nitrification.

To resolve this issue, the City is recommended to convert the existing ABs' anoxic zone volume into usable aerobic zone volume. If aeration diffusers are added to the final anoxic zone, the overall aerated volume can be increased by approximately 31 percent, leading to an approximate 24 percent decrease in the MLSS concentration allowing the system to maintain an eight-day aSRT. At this rate, the year when the firm AB capacity is exceeded might be prolonged from 2030 to 2038, and the overall SC capacity increases.

Supports for the diffusers in the new aerated zone must be designed to withstand forces exerted by the existing mixer so this zone can operate flexibly as a swing zone that provides either anoxic or aerobic conditions. To this end, the conversion of the current final anoxic zone to an aerated swing zone will require the following modifications:

- **Install a new diffuser grid:** The new diffusers are recommended to be the same type as those currently installed in each of the ABs' oxic zones, which are nine-inch Sanitaire membrane diffusers.
- **Connect the diffuser grid to the existing air pipe header:** Each new zone's aeration piping will include a modulated airflow control valve and a thermal mass flow meter accessible from the walkways between the ABs.

As shown in Table 7.9, the total estimated project cost for these modifications is approximately $340,000.

Table 7.9 Aeration Basin Diffuser Modification Costs

Description	Cost(1)
Three New Sanitaire Diffuser Grids	$69,000
Air Piping Modifications	$60,000
Electrical, Instrumentation, and controls Upgrades	$42,000
Total Direct Cost	**$171,000**
Total Estimated Construction Cost	**$261,000**
Total Estimated Project Cost	**$340,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

Aeration Basins' Baffle Walls

The marine plywood baffle walls in the ABs' selector zones are in poor condition. In addition, the concrete baffle walls between the ABs' anoxic/oxic zones are uneven and have exposed rebar. These issues not only compromise the structural integrity of the baffle walls but also may cause short-circuiting and backflow between the zones.

To resolve these issues, the marine plywood baffle walls in the selector zones are recommended to be removed, but not replaced. Meanwhile, the concrete baffle walls between the anoxic/oxic zones are recommended to be repaired to cover the exposed rebar and provide an even top of wall elevation. The total estimated project cost for these improvements is approximately $40,000.

Secondary Clarifier No. 2's RAS Pumps

According to the state point analysis introduced in Section 7.2.3, under max month MLSS concentrations and PDF, the current RAS rate is insufficient in preventing the sludge blanket in the SCs from rising. The current rated capacity of the RAS pumps in SC No. 1 is only 1,000 gallons per minute (gpm) and 1,050 gpm in SC No. 2, well below SC No. 3's RAS firm pumping capacity of 1,400 gpm.

Even if SC No. 1 is rehabilitated and additional aerated zones are added to the ABs, PDF will still be limited to 10.6 mgd at a maximum month MLSS concentration of approximately 2,725 mg/L. However, additionally increasing both SC nos. 1 and 2's RAS pumping capacities to 1,400 gpm will increase the allowable maximum month MLSS concentration to 3,000 mg/L at a PDF of 10.9 mgd. This capacity expansion extends the predicted point in time at which the secondary treatment process runs out of capacity to handle PDFs and maximum month MLSS concentrations from 2033 to 2036.

Since SC No. 1 is recommended to be wholly replaced, only SC No. 2's two RAS pumps are recommended to be replaced. The pumps were assumed to be replaced with larger units, although the existing pumps may be sufficient with replacement of impellers.

As detailed in Table 7.10, the total project cost to replace SC No. 2's RAS pumps is approximately $391,000.

Table 7.10 SC No. 2's RAS Pumps Replacement Costs

Description	Cost(1)
Removal of Existing Pump	$3,000
Two 30-hp Vertical Centrifugal RAS Pumps	$147,000
Electrical, Instrumentation, and Controls Upgrades	$47,000
Total Direct Cost	**$197,000**
Total Estimated Construction Cost	**$300,000**
Total Estimated Project Cost	**$391,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

Timing of the Recommended Improvements for the Secondary Treatment System

The recommended improvements to SC No. 1, the ABs, and the RAS pumps will provide the WWTF with sufficient secondary treatment capacity through 2036, beyond the planning horizon. However, these projects must be implemented with considerations made for permit requirements and process implications.

To replace SC No. 1, the plant must operate with only two units online during a wet weather season when peak flow events will likely increase the risk of violating permit demands when the new SC is being constructed. However, if the aeration improvements are implemented before the new SC is constructed, the secondary treatment process can be operated at a significantly lower MLSS concentration, reducing the risk of settling failure in SC Nos. 2 and 3. Ideally, aeration improvements and SC reconstruction could occur during the same dry weather period when the plant has sufficient capacity to operate with tanks out of service, allowing the aeration improvements to be completed before wet weather flows occur.

The replacement of SC No. 1 is also a sensible time to replace the existing RAS pumps for both SC Nos. 1 and 2. Since SC No. 2 is required while SC No. 1 is under construction, increasing SC No. 2's RAS rate to match that of SC No. 3 will provide an additional buffer against sludge blanket failure while SC No. 1 is out of service.

Section 7.4.2 discusses potential implementation years for these projects. Note that, even with these efforts complete, the City must still begin preparing even more secondary treatment capacity, either by process expansion or intensification, no later than 2031.

7.3.3.3 Aeration Blowers

The WWTF's four multistage centrifugal aeration blowers have the following notable issues:

- The blowers' firm capacity is insufficient to meet projected 2035 air demands.
- The blowers' current operational configuration risks overloading the blower motors and, thus, the four units cannot be run simultaneously.
- Each blower's variable frequency drives (VFD) cannot effectively modulate airflow by changing blower speeds.
- The control valves are oversized and ineffective in controlling dissolved oxygen (DO).
- Adding a fourth aerated zone to each AB will place additional demand on an already undersized system.

To provide capacity, redundancy, and control over a range of current and projected air demands, as well as to meet NPDES permit limits, two of the existing aeration blowers are recommended to be replaced with high-speed turbo blowers, which are more compact, efficient, with VFD speed control, better suited to the task than the existing multistage centrifugal blowers.

Preliminary analyses indicate that two new 300-hp turbo blower units in a duty/standby configuration alongside the two existing 150-hp multistage centrifugal blowers have enough capacity to fulfill 2035 peak air demands. Under these peak conditions, one of the new turbo blowers can be run in parallel with the existing blowers to supply the airflow rate required for aeration, with the second new turbo blower ready on standby. For conditions with low air demand, the plant may continue to use the two existing multistage centrifugal blowers.

As shown in Table 7.11, the total estimated project cost to replace the WWTF's aeration blowers, along with necessary mechanical and electrical improvements, is $1.86 million.

Table 7.11 Aeration Blower Replacement Costs

Description	Cost(1)
Two 300-hp turbo blowers	$691,000
Equipment pads	$3,000
Air piping modifications	$15,000
Electrical, instrumentation, and controls upgrades	$228,000
Total Direct Cost	**$937,000**
Total Estimated Construction Cost	**$1,432,000**
Total Estimated Project Cost	**$1,861,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.3.4 UV Disinfection System

The WWTF's existing UV disinfection system is nearing the end of its useful life and, given this age, many of its replacement components are no longer manufactured. As the current system continues to age, repair and replacement parts will become increasingly difficult to procure even as the frequency of component failure likely increases.

To eliminate the risk of losing the plant's UV capacity permanently upon a non-replaceable component failing, the UV system is recommended to be replaced with more modern equipment designed specifically for wastewater and water reuse applications.

The following modifications to the existing UV channel and ancillary equipment are recommended to install a newer model system:

- Complete computational fluid dynamics (CFD) modeling to ensure appropriate and even velocity distribution for flow entering the first new UV bank.
- Replace the existing level control gate with a new unit to provide the deeper water level required by newer UV equipment.
- Demolish and replace the existing ramp up to the level control gate to suit the design requirements of the replacement equipment.
- Replace the four existing banks of UV lamps with three new banks.
- Replace the existing power distribution centers (PDC) with three new PDCs.
- Remove the four step-down transformers currently installed for the existing UV system.
- Cut a small trench in the channel floor for routing hydraulic hoses if required by the new UV system manufacturer.

As shown in Table 7.12, the estimated project cost to replace the existing UV system, including the temporary disinfection process, is approximately $1.15 million. To minimize the volume of bypass pumping and disinfection required, this work is recommended to be performed during an extended low flow period (e.g., dry weather season). A temporary disinfection process, such as a skid-mounted UV disinfection system, will be required while the UV channel is being modified.

Table 7.12 UV Disinfection System Replacement Costs

Description	Cost(1)
New UV Equipment	$340,000
Existing UV Channel Modifications	$65,000
Electrical, Instrumentation, and Controls Upgrades	$65,000
Temporary Disinfection	$110,000
Total Direct Cost	**$580,000**
Total Estimated Construction Cost	**$887,000**
Total Estimated Project Cost	**$1,153,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.3.5 Effluent Pump Station

The effluent pump station is a low-head pump station that is only required under elevated river conditions, which occur infrequently. Although the pump station is in good condition, its current firm capacity is insufficient by at least 1 mgd to handle the projected 2035 PHF. The process implications of exceeding the effluent pumps' capacity are catastrophic since flow cannot be removed from the effluent wet well quickly enough to avoid submerging the upstream processes.

To ensure that treated effluent is effectively conveyed out of the plant under 2035 PHF conditions with one pump out of service, the effluent pump station's capacity is recommended to be expanded by replacing the pumps with units capable of providing sufficient flow capacity for condition projected through 2035.

As shown in Table 7.13, the total project cost to replace the existing effluent pumps is estimated to be $1,275,000. The effluent pump station is recommended to be modified during a low river stage when the pumps are unlikely to be needed.

Table 7.13 Effluent Pump Replacement Costs

Description	Cost(1)
Three Centrifugal Pumps, 4,700 gpm at 21 feet TDH	$485,000
Structural and Mechanical Modifications	$11,000
Electrical, Instrumentation, and Controls Upgrades	$146,000
Total Direct Cost	**$642,000**
Total Estimated Construction Cost	**$981,000**
Total Estimated Project Cost	**$1,275,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.4 Solids Treatment

To resolve redundancy and condition-related deficiencies identified in the solids processes, modifications to the following areas are recommended.

7.3.4.1 Grit-Separation System

The WWTF's degritting room is filled with odorous air that likely contains significant levels of hydrogen sulfide, which corrodes the degritting equipment in the space; as evidence of this, the cyclones, classifier, gravity thickener, and turbo pumping systems (TPS) pumps all exhibit conditions that indicate a corrosive atmosphere and signify the end of their useful life, requiring extensive rehabilitation or replacement.

In addition to increasing the number of air changes in the degritting room and implementing air treatment using biofilters, the entire grit separation system is recommended to be replaced. As shown in Table 7.14 the total project cost to replace the existing grit separation system is estimated to be $954,000. This project is recommended to be implemented within the next five to 10 years, though replacement may be required sooner if the existing equipment's condition continues to deteriorate.

Table 7.14 Grit-Separation Improvement Costs

Description	Cost[1]
Demolition	$20,000
New Degritting Equipment	$294,000
Piping Modifications	$9,000
Electrical, Instrumentation, and Controls Upgrades	$157,000
Total Direct Cost	**$480,000**
Total Estimated Construction Cost	**$734,000**
Total Estimated Project Cost	**$954,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.4.2 Thickened Primary Sludge Pumps

As with the rest of the equipment in the degritting room, the two existing, 130-gpm, progressive cavity TPS pumps have also been corroded by high levels of hydrogen sulfide and are nearing the end of their useful life. Furthermore, these pumps are oversized for the City's sludge flow and concentrations which unnecessarily increases maintenance costs. As such, the existing units are recommended for replacement with new, appropriately sized, 70-gpm progressive cavity units.

As shown in Table 7.15, the projected cost to replace the two existing TPS pumps is $154,000. The priority and timing for this replacement depend on the availability of replacement parts as well as the integrity of the pumps' non-replaceable parts.

Table 7.15 Thickened Primary Sludge Pump Replacement Cost

Description	Cost[1]
Demolition of Existing Pumps	$10,000
Two New 70-gpm Progressing Cavity Pumps	$43,000
Piping Modifications	$6,000
Electrical, Instrumentation, and Controls Upgrades	$19,000
Total Direct Cost	$78,000
Total Estimated Construction Cost	**$119,000**
Total Estimated Project Cost	**$154,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.4.3 Sludge Recirculation Pumps

The plant's rotary-lobe-style sludge recirculation pumps have historically had significant issues with microplastics infiltrating the pump shaft seal and damaging the overall unit. Despite replacements and corrections by the manufacturer, the frequency and severity of the maintenance issues have not improved.

Given that the solids content in the WWTF's digester ranges from 1.9 to 5.6 percent, a heavy-duty piston-style pump is recommended to replace the existing pumps. This new unit's shaft seal is located on top of the disk instead of underneath, which eliminates the leaking issue that piston-style pumps often have. And, because the seal has no gaps like a traditional mechanical seal might, infiltration of round microplastics is not anticipated to be an issue. While the seal must be replaced when it wears, the wear parts on this type of pump are anticipated to last three to four times longer than they might on progressive cavity or rotary-lobe pumps.

As shown in Table 7.16, the projected cost to replace the three existing rotary-lobe pumps with three double-disc piston-style pumps is $509,000. This project may be implemented at any time when the budget becomes available, and, to minimize risk, may be piloted to determine its application suitability.

Table 7.16 Sludge Recirculation Pump Replacement Cost

Description	Cost(1)
Demolition	$20,000
Three Double-Disc Piston Pumps: 200 gpm, 54 feet TDH	$144,000
Piping Modifications	$24,000
Electrical, Instrumentation, and Controls Upgrades	$68,000
Total Direct Cost	**$256,000**
Total Estimated Construction Cost	**$391,000**
Total Estimated Project Cost	**$509,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.4.4 Rotary Drum Thickener

After 10 years of operation, the plant's rotary drum thickener is showing significant signs of wear. Although the City recently added a new manufacturer-designed stabilization wheel that may allow this existing unit to continue operating, it remains a single point of failure without an operational plan in place to accommodate such a failure.

For full redundancy, a new thickening building capable of housing two RDTs and associated support equipment is required; however, the City's budgetary and site constraints do not currently allow for this construction to take place. Therefore, the City is recommended to continue monitoring and carefully implementing their current protocol for when the RDT is unavailable and proceed with other improvements to the WWTF's unit processes.

The City's current RDT protocol relies on use of the WAS storage tank when the RDT must be taken offline for maintenance. Process modeling of the WWTF indicates that the WAS-wasting rate, which has historically averaged approximately 37,000 gallons per day (gpd), may exceed 100,000 gpd under 2035 MM conditions. This means that, with the RDT offline, the current tank's capacity will be exceeded within one and a half days. Given these projections, planned maintenance activities must be scheduled during demand seasons when the WAS-wasting rate is low, and the RDT operation schedule must be extended during high demand periods to keep the WAS storage tank's levels as low as feasible.

Once the storage tank has reached its maximum capacity, excess WAS is directed to the gravity thickener to be co-thickened with primary sludge. However, this temporary operation affects performance in the following ways:

- Percent capture and thickened sludge concentrations are considerably reduced compared to what would be observed under normal operations.
- Hydraulic loading to the digesters is increased, resulting in a reduction of hydraulic residence time below the recommended 15 days when co-thickening.

While co-thickening's effects may be less severe at lower flows and loads, the temporary operation will not provide reliable thickening relief beyond one to two days at peak flows such as those projected under the 2035 MMF scenario.

With this being said, implementing the recommended improvements to the ABs will allow the secondary treatment process to be operated at a significantly lower MLSS, reducing the risk of settling failure in SC Nos. 2 and 3 and allowing SC No. 1 to be used for additional WAS storage during an emergency. In its current configuration, SC No. 1 can provide nearly 430,000 gallons of storage, which is equivalent to four days of continuous wasting under the 2035 MMF scenario. Note that using this SC for emergency storage will require connections and temporary piping routed from the control building No. 1 for SC Nos. 2's and 3's WAS pump.

7.3.4.5 Dewatering Centrifuge

The plant's existing DS-403 Sharple dewatering centrifuge is over 20 years old and, thus, exhibiting signs of being at the end of its useful life. In 2021 the City purchased a second, refurbished DS-403 Sharple centrifuge to provide dewatering redundancy. In the near term the centrifuge will act as a spare unit should an emergency replacement be required. The City is currently developing plans to modify the dewatering room and install the stand-by centrifuge, which will include the following modifications:

- Install a redundant centrifuge.
- Upsize the centrate piping to reduce any hydraulic restrictions.
- Increase the number of air changes per hour in the room.
- Clean out the existing odor-control piping connected to the centrate chute to confirm that nothing is blocking the ventilation of the centrifuge.

Table 7.17 shows costs for the modifications needed to install the redundant centrifuge in the existing building.

Table 7.17 Dewatering Centrifuge Improvement Costs

Description	Cost(1)
Existing Centrifuge Overhaul	$106,000
Piping and Mechanical Modifications	$39,000
Electrical, Instrumentation, and Controls Upgrades	$168,000
Total Direct Cost	**$313,000**
Total Estimated Construction Cost	**$479,000**
Total Estimated Project Cost	**$622,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.4.6 Biosolids Belt Dryer

As mentioned earlier, the biosolids belt dryer was not analyzed or assessed in detail, per the City's direction. However, the condition and capacity of the biosolids dryer are recommended for evaluation within the next five years.

7.3.5 Plant Support Systems

To accommodate future flows and provide reliable operation, modifications are recommended in the following plant support systems.

7.3.5.1 PLC, RIO, and SCADA

The City WWTF's control system includes a mixture of owner PLC systems and vendor PLC systems, which communicate to a central SCADA system that monitors and controls the entire plant. The existing PLC hardware utilizes the Modicon Quantum PLC platform, which includes remote input/output (RIO) racks. Meanwhile, data transfer utilizes older Data Highway Plus (DH+) serial communications.

The existing Modicon Quantum PLCs are outdated and no longer commercially available through the manufacturer. Since the failure of an existing module without a spare in stock could suspend automated control of a portion of the facility, the continued use of this PLC platform poses a significant operational risk.

In addition, the plant's existing Wonderware SCADA application is installed on a single computer server without redundancy, meaning this computer represents a single point of failure. If the computer fails for any reason or Wonderware is corrupted, the WWTF can no longer be governed via the control room. In a worst-case scenario, operators will be required to run all equipment manually from the field until the SCADA system is brought back online.

To minimize risks and employ up-to-date technologies, the WWTF's existing PLC network and SCADA system are recommended to be upgraded.

The following PLCs require replacement:

- Control building 1, PLC E, 1 rack.
- Control building 2, PLC E, 1 rack.
- UV building, PLC D1, 1 rack.
- UV building, UV panel, 1 rack.
- Equipment building, PLC C1, 1 rack.
- Digester building, PLC F, 3 rack.
- Main influent pump station, 1 rack.

Additionally, the following remote input/output cabinets require replacement:

- UV building, PLC D1, 2 RIO.
- Equipment building, PLC C1, 4 RIO.

These units are recommended to be replaced by modern equivalents on a standardized communication protocol, which will allow for a sequenced conversion process. Note that any changes made to the PLC programs by other facility equipment upgrades or changes in operational sequences will increase replacement costs since more PLC programming time will be required.

Meanwhile, the SCADA system must be upgraded and expanded to incorporate a level of redundancy. To develop a modern system with desired features, including advanced data analysis, report generation, and secure remote accessibility, the following upgrades are recommended:

- Replace the existing SCADA server with matching redundant SCADA servers.
- Upgrade the SCADA human-machine interface (HMI) application to a redundant configuration.
- Upgrade or add a SCADA historian application.
- Add a SCADA reporting application.
- Harden the system for improved remote access security by upgrading the network switch with a demilitarized zone (DMZ).
- Rebuild HMI graphics to take advantage of increased system functionality, correct existing errors with data collection and display, and provide robust communications with the upgraded PLC hardware.
- Integrate the existing Hach WIMS data with the SCADA historian and reporting applications.

In addition, the City is recommended to develop a comprehensive and living SCADA master plan that identifies and prioritizes system improvements at the WWTF as well as the City's 27 remote sites, including lift stations, pump stations, and tanks. At this time, controls at these sites are a mix of older hard-wired controls and some PLC control, with hard-wired being the norm; as such, all of the City's remote sites are recommended to be converted to PLC-based controls that utilize a standard format control panel design with radio telemetry communications to the WWTF.

Upgrades to improve the telemetry system are recommended for Lacamas Shores, Sunningdale Gardens, and Winchester Hills 2 in the near term, given that these sites' run-time data all showed risks of capacity deficiencies; the addition of flow meters and pressure sensors is recommended to better understand these stations' capacities or lack thereof. Updates to the other 22 sites are recommended in the long term as the City's budget allows.

Table 7. 18 represents a budgetary cost estimate to implement the proposed upgrades to the City's SCADA, PLC, and RIO systems.

Table 7.18 Camas WWTF Control System Upgrade Cost

Description	Total Estimated Project Cost(1)
SCADA Master Plan	$210,000
SCADA System Upgrade	$644,000
PLC Hardware Upgrade (Nine Cabinets)	$1,295,000
RIO Hardware Upgrade (Six Cabinets)	$650,000

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.5.2 Plant Drain Pump Station No. 1

Plant drain pump station No. 1 shows signs of concrete corrosion, and its pumps are nearing the end of their useful life. In addition to these condition-related issues, this station is already required to operate at its total installed hydraulic capacity for extended periods under current conditions and is unlikely to reliably accommodate future recycle flows and loads.

As such, plant drain pump station No. 1 is recommended to be rehabilitated through the following improvements:

- Replace the existing pumps with a new set of submersible pumps, each capable of pumping 500 gpm. The existing motor starter may be reused and connected to the new pumps.
- Install a liner in the existing wet well to extend the life of the existing structure.
- Replace the control panel, pump guide rails, and discharge piping within the wet well.

As shown in Table 7.19, the projected cost to replace plant drain pump station No. 1's pumps and accessories is $517,000.

Table 7.19 Plant Drain Pump Station No. 1 Replacement Cost

Description	Cost(1)
Demolition and Temporary Pumping	$42,000
Wet Well Liner	$95,000
Plant Drain Pumps and Piping	$60,000
Electrical, Instrumentation, and Controls Upgrades	$63,000
Total Direct Cost	**$260,000**
Total Estimated Construction Cost	**$398,000**
Total Estimated Project Cost	**$517,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.3.5.3 Non-Potable Pump No. 3

The non-potable water pump station's three pumps are in reasonably good condition. However, non-potable water pump No. 3 is not currently usable since its intake is located below the UV channel's discharge weir due to air entrainment caused by cascading water and prevents the unit from properly priming, which also causes it to fail.

To mitigate this issue, this pump is recommended to be relocated within the wet well but out of the direct flow path of the weir. While modifications to the pump column are not necessary, a new hole must be cut in the elevated slab over the non-potable pump station's wet well. The total estimated project cost to relocate non-potable water pump No. 3 is approximately $43,000.

Because air entrainment is a persistent issue, any future improvements to the UV system must be made with consideration for the location of these pumps. If a second parallel UV channel must be installed at some point, the entire non-potable water pump station must be modified or most likely relocated to sit within the effluent pump station, and the pumps must be relocated close to the existing UV equipment, which may potentially complicate access to the effluent pump station's electrical room and back-up generator.

7.3.5.4 Odor Control and Treatment

Located in the WWTF's equipment building, the centrifuge room and primary sludge degritting room share a combined odor-control system. Because these rooms lack sufficient airflow, both experience persisting odor issues and corrosion of the assets contained within.

The current centrifuge room exhausts air at a rate of 700 cubic feet per minute (cfm), accounting for approximately 3.5 air changes per hour (ACH). The room also has point-source odor control, which pulls 500 cfm of air from various equipment, accounting for approximately 2.5 ACH. Combined, the room exhausts six ACH.

To improve odor control, the ducting is recommended to be balanced to exhaust 1200 cfm from the overall centrifuge room, 400 cfm from the cake conveyor, and 100 cfm from each centrifuge. This solution will provide the room with 6 ACH, in addition to a more robust point-source connection to prevent odorous air from escaping the centrifuge, for a total of 8.5 ACH. To supply the space with the proper amount of intake air, this alternative requires the installation of a second intake louver on the west wall.

Meanwhile, the primary-sludge-degritting room exhausts 700 cfm of air, accounting for approximately 6.3 ACH. Increasing the exhaust airflow to 1350 cfm is recommended. Furthermore, the three duct drops on the west wall must be balanced to pull 250 cfm each, and the drops above the storage containers must be balanced to pull 300 cfm each. Together, these modifications will provide the space with a total of 12.2 ACH. Similar to that of the centrifuge room, this solution requires a second intake louver to be installed on the east or south wall to supply the proper amount of intake air into the space.

The improvements recommended for both rooms require the shared odor-control fan to exhaust 4850 cfm in total. The current fan only exhausts 3600 cfm. If the fan does not have sufficient capacity to provide the required increase in airflow, a new odor-control fan must be installed in the same location as the existing unit.

Table 7.20 shows the estimated costs associated with the odor-control improvements, including a new fan. Note that this improvement plan's increased airflow will reduce contact time with the biofilter, thus reducing some of the filter's effectiveness and the quality of the air passing through and leaving it. Therefore, the frequency at which media should be replaced will be modestly increased.

Table 7.20 Odor Control Improvement Costs

Description	Cost(1)
Additional Ducting and Louvers	$6,000
New Exhaust Fan Capable Of Exhausting 4,850 cfm	$21,000
Testing and Balancing	$1,000
Total Direct Cost	**$28,000**
Total Estimated Construction Cost	**$42,000**
Total Estimated Project Cost	**$55,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.4 Recommended WWTF Improvement Projects

The improvements recommended to address WWTF capacity limitations over the next 20 years and address current condition issues that prohibit reliability or performance are summarized in this section. The recommended alternatives presented in Section 7.3 were re-organized and, in some cases, grouped together to suggest construction sequencing and project timing the City should consider when implementing these improvements.

The following 14 distinct projects were developed for incorporation into the City's general sewer system plan CIP:

- **TP-1 Aeration Basin Improvements:** This project improves the ABs' performance by making the following modifications:
  - Install new aeration diffusers and associated zone controls in each AB's final anoxic zone to create a new aerated swing zone.
  - Demolish the marine plywood baffle walls at the upstream end of the ABs.
  - Repair and relevel the concrete baffle walls dividing each zone in each AB.
- **TP-2 Secondary Clarifier Improvements:** This project enhances the SCs' performance and capacity by making the following modifications:
  - Demolish SC No. 1 and replace it with a new clarifier that matches SC No. 3's design including RAS pumping capacity.
  - Replace SC No. 2's RAS pumps to provide a firm capacity that matches those of SC No. 3.
- **TP-3 Aeration Blower Replacement:** This project replaces two of the existing aeration blowers with larger high-speed turbo blowers to meet projected aeration demands.
- **TP-4 Disinfection Building and Hydraulic Improvements:** This project enhances plant hydraulics and modifies the disinfection building with the following improvements:
  - Replace the existing UV disinfection equipment and provide a temporary UV skid to bypass the existing channel.
  - Modify the filter bypass so it does not limit the plant's hydraulic capacity.
  - Reconfigure the non-potable water pump station to prevent air entrainment in the pump suction.
  - Redirect the headworks channel inlet pipe to improve flow measurements and prevent splashing of raw sewage out of the top of the structure.
- **TP-5 Effluent Pump Station Improvements:** This project increases the effluent pump station's capacity, as required, to pump 100 percent of 2035's projected PHFs to the outfall in the Columbia River by replacing the existing effluent pumps with larger units.
- **TP-6 Grit-Separation and Odor-Control Improvements:** This project replaces the existing grit-separation equipment, including hydrocyclones and grit classifiers, and increases the capacity of the odor control systems servicing the grit-handling area and dewatering building, which will extend the life and reduce maintenance of new installed equipment.
- **TP-7 Thickened Primary Sludge Pump Replacement:** This replaces the existing TPS pumps with new progressive cavity pumps.
- **TP-8 Sludge Recirculation Pump Replacement:** This project replaces the existing digested sludge pumps with new double-disc piston-style pumps.

- **TP-9 Mechanical Dewatering Improvements:** This project rehabilitates the existing dewatering centrifuge and modifies the space to accommodate a standby unit for redundancy.
- **TP-10 Plant Drain Pump Station Improvements:** This project repairs the existing plant drain pump station No. 1's structure and replaces its pumps.
- **TP-11 SCADA Master Plan:** This project prepares a SCADA master plan that will provide the City with a roadmap to prioritize and implement planned system upgrades designed to address system deficiencies and enhance facility operation. This project includes an in-depth investigation of the existing SCADA control system for the City's WWTF and associated remote sites.
- **TP-12 SCADA Improvements:** This project upgrades the existing SCADA system to provide redundancy and take advantage of modern features, including advanced data analysis, report generation, and secure remote accessibility.
- **TP-13 PLC and RIO Cabinet Improvements:** This project includes replaces existing Modicon Quantum hardware with new, standardized PLCs and RIO cabinets for all process areas at the WWTF.
- **TP-14 Secondary Treatment Expansion Planning Project:** This project plans for a future secondary treatment expansion to accommodate flows and loads outside the planning windows.

7.4.1 Cost Summary of the Improvement Projects

Table 7.21 summarizes the total project cost for each improvement project. Costs are rendered in 2021 dollars and include all construction, engineering, legal, and administrative markups.

Table 7.21 Recommended WWTF Project Costs

Project ID	Improvement Type	Total Project Cost(1)
TP-1 Aeration Basin Improvements	Capacity	$376,000
TP-2 Secondary Clarifier Improvements	Capacity/Condition	$5,539,000
TP-3 Aeration Blower Replacement	Capacity	$1,862,000
TP-4 Disinfection Building and Hydraulic Improvements	Condition/Capacity	$1,252,000
TP-5 Effluent Pump Station Improvements	Capacity	$1,276,000
TP-6 Grit Separation and Odor Control Improvements	Condition	$1,010,000
TP-7 TPS Pump Replacement	Condition	$154,000
TP-8 Sludge Recirculation Pump Replacement	Condition	$509,000
TP-9 Mechanical Dewatering Improvements	Condition	$622,000
TP-10 Plant Drain PS Improvements	Capacity/Condition	$517,000
TP-11 SCADA Master Plan	Planning	$209,000
TP-12 SCADA Improvements	Network	$645,000
TP-13 PLC and RIO Cabinet Improvements	Network	$1,946,000
TP-14 Secondary Treatment Expansion Planning	Planning	$75,000
WWTF Recommended Improvements Total	**–**	**$15,992,000**

Notes:
(1) All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021).

7.4.2 Implementation Timing for the Improvement Projects

Implementation timing for the 14 projects was considered in the context of the following factors:

- **Each project's high or low criticality to the WWTF's operation:** Criticality to the process was higher for processes that are essential for liquid treatment and less so for solid treatment processes.
- **The risk of failure associated with the equipment being addressed by a project:** Risk of failure was high or low depending on the age of the equipment, availability of replacement parts from manufacturers, and installed redundancy.

Table 7.22 lists the projects, possible sequencing, start years for design and planning, possible years of implementation for capacity reasons (if applicable), and brief explanations of project prioritization rationale. It is suggested that the City closely track key factors, including growth within service area, useful life, and condition of plant components, to allow for optimal timing and phasing of improvements. Proper timing and phasing of projects will prevent the City from incurring unnecessary construction, operation, and maintenance costs to increase capacity before it is needed to serve users.

Table 7.22 Recommended WWTF Project Implementation Schedule

Project ID	Recommended Start Year	Year Required Online	Reason for Prioritization
TP-1 Aeration Basin Improvements	2026	2030	Improve capacity before TP-2.
TP-2 Secondary Clarifier Improvements	2027	2030	Meet capacity only.
TP-3 Aeration Blower Replacement	2028	2032	Meet capacity only.
TP-4 Disinfection Building and Hydraulic Improvements	2021	2026	Address aging equipment whose parts are unavailable from manufacturers.
TP-5 Effluent Pump Station Improvements	2026	2029	Meet capacity only.
TP-6 Grit Separation and Odor Control Improvements	2023	2027-2032	Eliminate ongoing corrosion in the building and improve workspaces.
TP-7 TPS Pump Replacement	2032	N/A	Anticipated end of useful life.
TP-8 Sludge Recirculation Pump Replacement	2032	N/A	Anticipated end of useful life.
TP-9 Mechanical Dewatering Improvements	2024	N/A	Create redundancy.
TP-10 Plant Drain Pump Station Improvements	2021	2021	Address immediate capacity needs and corrosion issues.
TP-11 SCADA Master Plan	2022	N/A	Update out-of-date software.
TP-12 SCADA Improvements	2023	N/A	Update out-of-date software.
TP-13 PLC and RIO Cabinet Improvements	2023	N/A	Update out-of-date software.
TP-14 Secondary Treatment Expansion Planning	2031	N/A	Secondary treatment inadequate by 2036.

Chapter 8

OPERATION AND MAINTENANCE

8.1 Introduction

This chapter provides an overview of the City of Camas (City) Wastewater Utility organization, staffing, and operation and maintenance (O&M) program. This chapter documents existing practices and identifies changes that may improve system operation and maintenance.

8.2 Organization Structure

The City Public Works Department is organized as shown in Figure 8.1 and is managed by Steve Wall. The Utility group is managed by Rob Charles. There are various groups relevant to this General Sewer Plan (Plan) including the wastewater treatment facility (WWTF), and a combined group with responsibilities pertaining to sewer and water disciplines. The WWTF is supervised by Bob Busch.

Note, Stormwater and Sewer/Water groups assist each other during abnormal conditions, such as cleanup after a major storm or repairs requiring specialized staff and equipment.

The Capital Engineering group managed by James Carothers leads major wastewater capital projects, such as new lift stations. The Utility group leads lift station retrofits, "repair & replacement" projects, and operations and maintenance projects.

8.3 Staffing

8.3.1 Maintenance and Operations Staff

The City combines staff for water and sewer disciplines. Therefore, staff under this branch will work on both water and sewer mains including the septic tank effluent (STE) systems. They are also in charge of making sewer system repairs. Operational staff work full shifts on weekdays and there is always at least one person on duty during the day on weekends. There is always at least one person on call in the evenings to address emergencies.

No additional positions are sought although as of March 2022, there are three vacant water/sewer staff positions the City is seeking to fill.

8.3.2 Wastewater Utility Engineering Staff

WWTF staff work primarily on the treatment plant and are also in charge of the sewer lift stations in the conveyance system. The City's WWTF National Pollutant Discharge Elimination System (NPDES) permit requires a Washington Wastewater Treatment Facility Operator (WWTFO) Class IV certified operator to be responsible for the plant at all times. Table 8.1 lists WWTF staff certifications. The City has two Class IV operators in the case that one is unavailable. The NPDES permit does not require anyone other than the responsible operator(s) to hold a certification, but the City requires all operators to have a Class I certification or have the ability to acquire one within six months of employment.

Table 8.1 Wastewater Utility Operator Certifications

Name	Position	Certification
Bob Busch	WWTF Supervisor	WWTFO Class IV
William Blake	WWTF Operator Lead	WWTFO Class IV
Ole Helland	WWTF Operator	WWTFO Class II
Ken Murray	WWTF Operator	WWTFO Class I
Steve Carroll	WWTF Operator	WWTFO Class I
Joe Calderone	WWTF Operator	WWTFO Class I
Matt Golphenee	WWTF Operator	WWTFO Class II
Jacob Taylor	WWTF Operator	WWTFO Class II

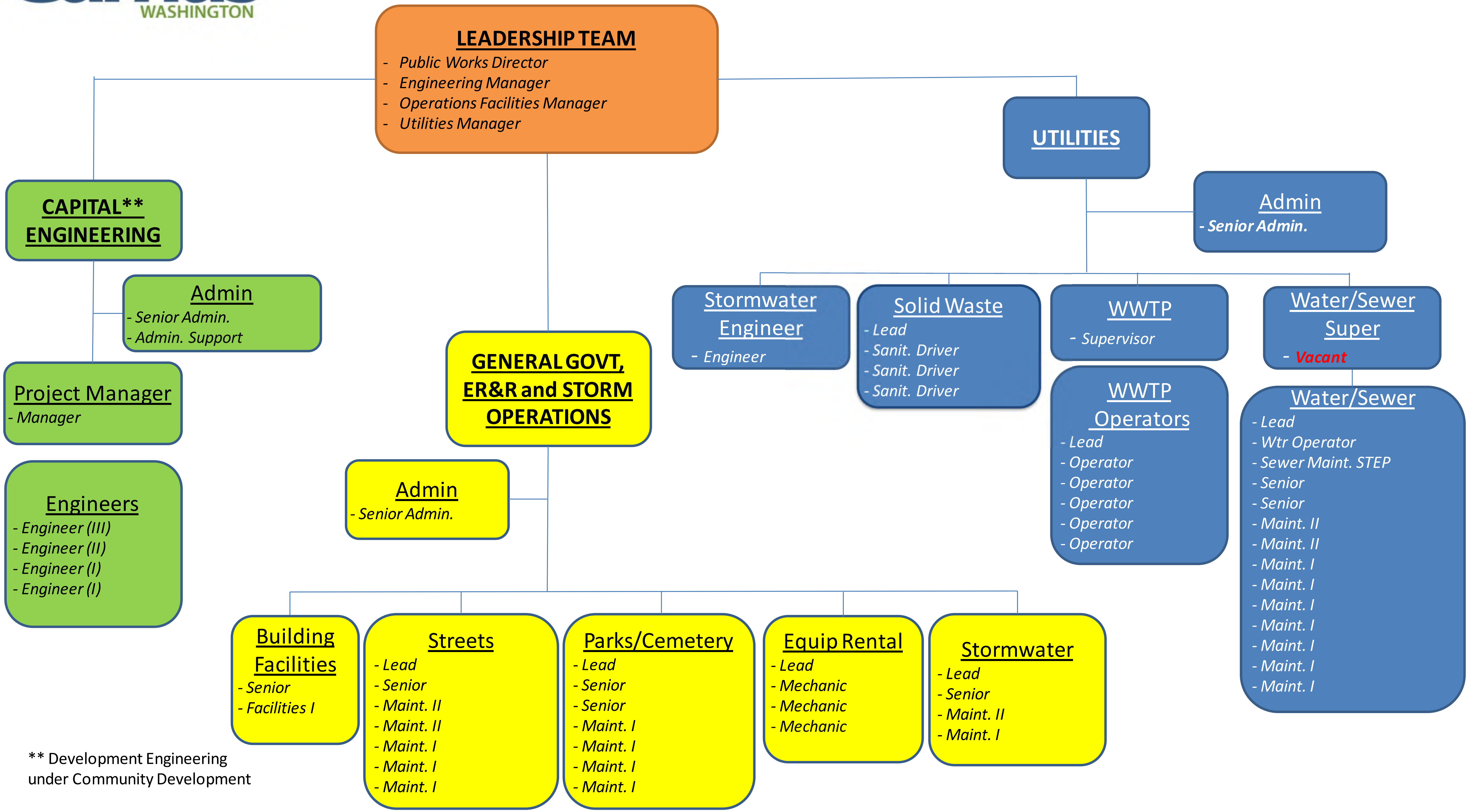
8.4 Records

For O&M record keeping, the WWTF uses a Computerized Maintenance Management System (CMMS), data-tracking Excel spreadsheets, handwritten logbooks, and an electronic repository of equipment documentation. The WWTF staff have a "WWTF" shared drive at the plant, which is a reference library of construction documents, O&M documentation for individual equipment, training materials, etc.

Septic tank effluent pump (STEP) systems are tracked in a separate management system involving record keeping, both on paper and on a tablet. The City currently uses IAUDIT on iPads to document work and plans to move to the same software as the WWTF in the future to better track current activities. The implementation plan is to add new activities to the software as it comes up.

City staff and third-party customer service representatives receive utility-related calls made by system users, and information is dispatched to the appropriate utility staff.

PUBLIC WORKS DEPARTMENT - ORGANIZATIONAL CHART



8.5 Current Operation and Maintenance Program

8.5.1 Maintenance

8.5.1.1 Lift Station Inspection and Maintenance

Lift station inspection and maintenance is completed by City WWTF Operators listed in Table 8.1.

For all lift stations, pump run hours are closely tracked to identify potential issues. Additionally, periodic maintenance is completed. Table 8.2 presents each activity and frequency staff completes for the sewer lift stations.

Table 8.2 Summary of WWTF Sewer Lift Station Maintenance

Frequency	Component	Activity
Daily	SCADA	• Review lift station alarm history. Check pump/level/pressure/flow trend charts.
	Record Keeping	• Update pump runtime tracking spreadsheets. Review updated sheets for anomalies. Submit requests for any necessary maintenance via CMMS.
Weekly	Controller	• Check for active alarms. Verify pumps, level indicator, and other controller-monitored equipment is operating normally in "AUTO". Document pump run hours. Verify no tripped breakers.
	Pumps	• Run pumps in hand to verify proper operation. Inspect for unusual sounds, vibration, or leaks.
	Genset	• Check ATS status and verify there are no faults and system is ready for emergency operation. Check generator fuel. Check generator for leaks or signs of mechanical failure. Check generator control paned for faults. Generator auto-exercises on Thursdays.
	Dry Well	• Verify dry well is dry. Verify sump pump or floor drain is functioning properly. When running pumps, verify check valves open/close. Verify force main pressure (static and pumping). Check for piping leaks.
	Wet Well	• Inspect influent flow, verifying it is not abnormally high or low, color, odor, etc. Inspect for excess debris or grease accumulation. If able, break up FOG and pump out. Verify level sensors are free of debris or obstructions, clean, as necessary.
	Odor Control System	• Verify proper operation and odor level. Inspect for unusual sounds, vibration, odor, and leaks.
	Surge Tank	• Verify proper operation, checking controller for any faults.
	Grounds	• Monitor physical appearance of station. Remove any accumulated trash or debris. Monitor and control vegetation. Monitor for odors emanating from station.
Quarterly	Pumps	• Perform draw down testing for each pump.
	Record Keeping	• Update pump tracking spreadsheet with draw down test results.
	Odor Control System	• Change out carbon media at Lacamas Meadows Lift Station. In depth check of biofilter systems.
Bi-Annually	Gas Sensors	• Calibrate lower explosive limit meters.
	Grounds	• Herbicide application, where necessary.
	Odor Control System	• Change out odor control media on carbon absorber units.
	Isolation Valves	• Exercise isolation valves at all lift stations to maintain operability.
Annually	Generator	• Third-party preventative maintenance.
	Pumps	• Pull pumps for visual inspection.
	Main Pump Station Pumps	• Third-party preventative maintenance.
	Piping	• Winterize any water piping.
	Odor Control System	• Winterize biofilters prior to freezing weather. Turn off odor control units that are not operated during winter months. Turn on odor control units that are operated during summer months.
	Wet Well	• Cleaning of any wet wells that have accumulated excessive FOG/floatables/debris.
Every 3 Years	Pumps	• Third-party pump inspections and testing.

Notes:
Abbreviations: ATS - automatic transfer switch; FOG - fats, oils, and grease; SCADA - Supervisory Control and Data Acquisition.

8.5.1.2 Pipeline Video Inspection

A closed-circuit television (CCTV) inspection of the gravity main by push camera was completed in 2013. For future inspections, the City will contract with CCTV inspection contractors on an as needed basis for their CCTV and manhole inspection programs. Inspections will be performed in accordance with all industry standards and best practices.

8.5.1.3 Manhole Inspection and Maintenance

The City inspects manholes on an as-needed basis and the manhole inspection program will be contracted out to a third party as well. The City may choose to implement their own standards for manhole inspections, rather than rely on the NASSCO standards.

8.5.1.4 Root Cutting

Root maintenance is completed as needed. It is anticipated that additional root cutting tasks may be identified through contracted video inspection on an as needed basis.

8.5.1.5 Grease Removal

The City educates customers on FOG as part of their general education program. It is anticipated that through video inspection, the City may identify pipes with heavy FOG. Initially, it is recommended the preventative maintenance activities involving FOG include outreach to local business or industries and or more frequent cleaning, especially if an area is persistently found to be impacted by FOG. If FOG is more widespread than currently thought, then the City may consider a FOG program.

8.5.1.6 Hydraulic Line Cleaning

Flushing is done every month for flat areas in the system. Where normal flushing is insufficient to address known problem areas, pipe jetting is completed either as preventative maintenance or on an as needed basis. The City would like to implement a comprehensive jetting program that may be completed by the City or will be contracted out to a third party.

8.5.1.7 Repair Sewers

Point repairs are conducted to address pipe deficiencies identified through CCTV inspection and are undertaken as required and as resources allow. Work may be completed by City staff or through a small works type contract.

8.5.1.8 STEP Maintenance

The City owns and maintains the STEP system. Currently, the City conducts solids pumping from about 600 STEP tanks annually through contractors. Additional it maintains the step tanks, pumps, and telemetry concurrently. The City has an active STEP tank education program with customers.

It is recommended to conduct a STEP tank condition assessment to identify repair and replacement needs including inspection of the STEP tank and connections to the STEP tank as well as an inspection of the proper function of the STEP tank. From this condition assessment, a STEP repair and replacement program should be developed and included in the City's Capital Improvement Program (CIP). Current STEP tank replacement costs are about $11,000 per STEP tank to be installed by a contractor.

8.5.2 Operations

The City operations group are generally divided into treatment, pump stations, and pipes.

The City operators at the WWTF conduct various activities, including: monitoring and adjusting treatment parameters, conducting water quality measurements and other related lab tests, and managing the City's Class A, Exceptional Quality Biosolids program.

The WWTF operators are also responsible to monitor the pump stations throughout the collection system. The treatment facility operators monitor the sanitary pump stations while the water/sewer staff monitor the septic tank effluent systems throughout the City.

City staff are responsible for pipe activities associated with operating the collection system, including repairing pipelines.

City staff also lead operations during emergencies or natural disasters. Emergency operations include preparing and planning for emergencies and conducting drills.

Individual staff duties and operations include administration tasks, training, and tool maintenance. Staff have their own administrative duties to complete weekly as well as meetings to attend in addition to their normal operator duties. They are also in charge of maintaining and cleaning their tools and equipment. The City values the importance of training staff; thus, staff will also allocate time annually to training and conferences as a means to further develop their skills.

8.6 Future Operation and Maintenance Needs

The WWTF plans to expand their internal maintenance capabilities while reducing dependency on third-party maintenance contracting. The WWTF is working to develop deeper pump, clarifier and instrumentation inspection and maintenance skills. The WWTF plans to constantly expand and improve their usage of the CMMS and its work ordering and tracking capabilities. Furthermore, the WWTF has an ongoing effort to develop an extensive set of Standard Operating Procedures for common operations, maintenance, safety, and administrative tasks.

As stated above, the City will contract with CCTV inspection contractors to complete video inspection in the collection system. It is recommended to develop a hydraulic line cleaning program while completing the video inspection. The hydraulic line cleaning program can be completed by the City or third-party contractors. With this inspection and cleaning program, it is expected that other repair needs will be identified for roots, FOG, and point repairs.

Currently the City's staffing focus is to fill the current vacant water/sewer supervisor and staff positions. In the future, to aid in the development of non-capital utility projects the City wants to add a staff civil engineer and an electrician to the utility team.

Chapter 9

CAPITAL IMPROVEMENT PLAN

9.1 Introduction

This chapter summarizes the Capital Improvement Plan (CIP) for the City of Camas (City) General Sewer Plan (Plan). The CIP includes projects needed to accommodate growth, repair and replace aged infrastructure, and attain level of service goals. The CIP is arranged in terms of short-term (2022-2031) and long term (2032-2041) periods. Projects are grouped into pipeline, pump station, septic tank effluent pump (STEP), inflow and infiltration (I/I), maintenance, treatment plant, and general types of infrastructure work. The CIP consists of the cost estimates and schedules for the recommended improvements.

The following sections present cost estimating assumptions, recommended projects, estimated costs for each project, and a summary of the CIP.

9.2 Cost Estimating Assumptions

Cost estimates were developed for each of the recommended projects in the CIP for budgeting purposes. The CIP costs are planning level estimates only and should be refined during pre-design of the projects as final costs of a project with depend on actual labor and materials costs, competitive market conditions, final project scope, implementation schedule, and other variable factors. The CIP cost estimate should be periodically reevaluated to account for changes in inflation.

All costs are in 2021 dollars and are benchmarked to an Engineering News Report (ENR) Construction Cost Index 20-city average of 12112 (June 2021). Cost estimates were developed using a Class 4 budget estimate, as established by the American Associate of Cost Estimators (AACE). This level of estimate is used for feasibility studies and assumes a one percent to 15 percent level of project definition. The expected accuracy range is of the Class 4 cost estimates are -30 percent to +50 percent.

9.2.1 Conveyance Cost Assumption

This section provides the CIP for pipelines, lift stations, and STEPs. Cost estimates for conveyance infrastructure represent total project cost including materials, construction, engineering, legal, and administrative costs. Costs were represented as unit costs, as described in subsequent sections. Costs are based on costs provided by the City or similar projects completed by Carollo Engineers. The following are the total marks-ups to direct costs: 30 percent for construction management contingency, 30 percent for engineering, legal, and design costs, and 10 percent for administration contingency.

9.2.1.1 Total Conveyance Project Capital Improvement Cost

The costs presented in this Plan are high-level planning costs to help the City in making financial decisions.

As shown in the following sample calculation of the conveyance projects capital improvement cost, the total cost of all project contingencies (construction and planning) and allied costs (engineering services, construction management, and project administration) is 82 percent of the baseline project cost.

Example:

Baseline Project Cost	**$1,000,000**
Construction Management Contingency (30%)	$300,000
Construction Cost	**$1,300,000**
Engineering, Legal, Design (30%)	$390,000
Administration (10%)	$130,000
Total Capital Improvement Cost	**$1,820,000**

9.2.1.2 Pipeline Unit Costs

For pipes, baseline project costs are calculated by multiplying the estimated new pipe length by a proposed unit cost. All of the known pipelines involved in this CIP are between eight-inches and 27-inches. Pipeline unit costs are available in Table 9.1; broken down by pipeline diameter and depth of installation. These unit costs were used to estimate the total cost of replacement. The unit costs assume open-trench construction in improved areas. Costs include pavement cutting, excavation, hauling, shoring, pipe materials and installation, backfill material and installation, and pavement replacement.

Table 9.1 Pipeline Construction Unit Costs

Pipeline Diameter (inches)	Cost per LF (10+ feet deep)	Cost per LF (5 feet deep)
8	$330	$223
10	$341	$233
12	$351	$243
15	$372	$266
18	$383	$277
21	$388	$282
24	$397	$287
27	$404	$298

Notes:
Abbreviations: LF - linear feet.

9.2.1.3 Pump Station Unit Costs

Pump station unit costs were based on costs to similar projects Carollo Engineers has completed in the past. There are unit costs for pump station upgrades and telemetry. Pump station upgrades include repair and replacement to the station itself and force main cleaning. Pump station telemetry includes upgrading or updating the SCADA system at the pump stations.

9.2.1.4 STEP Unit Costs

Since there was no data for the STEP systems, STEP CIP projects are targeted to assess the conditions of the STEP system to determine future maintenance and repair and replacement projects. STEP main conditioning assessment and cleaning, and STEP system lift stations SCADA were based on similar projects Carollo Engineers have completed for other cities in the past.

9.2.2 Treatment Cost Assumptions

Cost estimates for treatment projects include 30 percent for construction contingency, 1.3 percent for builder's risk and insurance, 15 percent for general contractor overhead, risk, and profit, and one percent for performance and payment bond for a total overall construction adjustment factor of 53 percent. Planning adjustment mark-ups include 25 percent for engineering, legal, and design and 5 percent for owner's reserve for change orders for a total overall planning adjustment factor of 30 percent.

9.2.2.1 Total Treatment Project Capital Improvement Cost

The costs presented in this Plan are high-level planning costs to help the City in making financial decisions.

As shown in the following sample calculation of the capital improvement cost, the total cost of all project contingencies (construction and planning) and allied costs (engineering services, construction management, and project administration) is 82 percent of the baseline project cost.

Example:

Baseline Project Cost	**$1,000,000**
Overall Construction Adjustment Factor (53%)	$530,000
Construction Cost	**$1,530,000**
Engineering, Legal, Design (25%)	$382,500
Owner's Reserve (5%)	$76,500
Total Capital Improvement Cost	**$1,989,000**

9.3 Capital improvement Plan

As discussed, the CIPs are prioritized based on their urgency and risk to mitigate deficient systems. The timing for implementing these improvement projects is based on the affordability and urgency of the project. It is recommended that the City monitor growth and adjust project implementation accordingly.

9.3.1 Planning Periods

The following terms are used to define timing and prioritization into three planning periods:

- **Short-term (2022 - 2031).** Proposed facilities determined to be a high priority.
- **Long-term (2032 - 2041).** Proposed facilities determined to be a low priority or proposed facilities to service major growth areas to be developed in the long-term.

9.3.2 Project Types

Projects are categorized by type. These types include the following:

- "G" = Growth.
- "R&R" = Repair and Replacement.
- "LOS" = Level of Service.

Growth projects are focused on updating infrastructure to address the needs of expanding. Repair and replacement projects are focused on renewing or replacing infrastructure in poor condition. Level of Service projects are focused on upgrading infrastructure to address level of service concerns. The types aid the City in determining the appropriate funding sources.

9.3.3 Project and Program Naming

An individual Project Sheet was generated for each CIP project and includes project identifiers, description, costs, project type, and comments to aid in future implementation. Project are separated into the following categories:

- "P" = Pipeline.
- "PS" = Pump Station.
- "G" = General.
- "S" = STEP.
- "I&I" = Inflow and infiltration.
- "M" = Maintenance.
- "TP" = Treatment plant.

A summary of all CIP projects by facility type and project type is shown in Table 9.2. A summary of costs by project category and type is presented at the end of the chapter.

Table 9.2 Capital Improvement Plan Summary

City of Camas
General Sewer Plan
Capital Improvement Plan

Capital Improvement Plan Summary

Project		CIP Project Subtotal[1]	Total CIP Cost Estimate	CIP Phasing												Project Type		
				2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Short-term (2022-2031)	Long-term (2032-2041)	Growth	Repair & Replacement	Level of Service
Gravity Pipeline																		
P-01	NW Fargo St Upsize	$ 354,000	$ 644,000	$ -	$ 644,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 644,000	$ -	0%	0%	100%
P-02	Division St Upsize	$ 717,000	$ 1,306,000	$ -	$ 1,306,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,306,000	$ -	0%	0%	100%
P-03	NW 6th Pl West Upsize	$ 282,000	$ 514,000	$ -	$ 514,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 514,000	$ -	0%	0%	100%
P-04	NW 6th Pl East Upsize	$ 207,000	$ 376,000	$ -	$ 376,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 376,000	$ -	0%	0%	100%
P-05	NW 6th Ave West Upsize	$ 454,000	$ 825,000	$ -	$ 825,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 825,000	$ -	0%	0%	100%
P-06	NW 6th Ave East Upsize	$ 339,000	$ 617,000	$ -	$ 617,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 617,000	$ -	0%	0%	100%
P-07	Adams St Upsize	$ 678,000	$ 1,235,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 554,000	$ 681,000	$ -	$ 1,235,000	$ -	50%	0%	50%
P-08	NW 18th Loop Upsize	$ 214,000	$ 389,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 389,000	50%	0%	50%
P-09	NE 15th Ave Upsize	$ 98,000	$ 179,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 179,000	50%	0%	50%
	Gravity Subtotal		**$ 6,085,000**	**$ -**	**$ 4,282,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 554,000**	**$ 681,000**	**$ -**	**$ 5,517,000**	**$ 568,000**			
Pump Station																		
PS-01	South Prune Hills Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	0%	0%	100%
PS-02	West Camas Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ -	$ -	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	50%	0%	50%
PS-03	Crown View Hill Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ -	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	0%	0%	100%
PS-04	Main Pump Station Improvements	$ 280,000	$ 510,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 510,000	$ -	$ 510,000	$ -	50%	0%	50%
PS-05	Upgrade Pump Station Telemetry	$ 320,000	$ 14,560,000	$ -	$ -	$ -	$ 1,747,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,747,000	$ 12,813,000	50%	0%	50%
	Pump Station Subtotal		**$ 16,600,000**	**$ -**	**$ 510,000**	**$ 510,000**	**$ 1,747,000**	**$ 510,000**	**$ -**	**$ -**	**$ -**	**$ 510,000**	**$ -**	**$ 3,787,000**	**$ 12,813,000**			
General																		
G-01	Gravity Collection System Model	$ 270,000	$ 491,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 491,000	75%	0%	25%
	General Subtotal		**$ 491,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 491,000**			
STEP																		
S-01	STEP Main Flows	$ 126,000	$ 229,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 229,000	75%	0%	25%
S-02	STEP Main Modeling	$ 53,000	$ 96,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 96,000	75%	0%	25%
S-03	STEP Main Condition Assessment/ Cleaning	$ 451,000	$ 821,000	$ -	$ -	$ 821,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 821,000	$ -	0%	0%	100%
	STEP System Subtotal		**$ 1,146,000**	**$ -**	**$ -**	**$ 821,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 821,000**	**$ 325,000**			
Inflow and Infiltration																		
I&I-01	Ongoing I&I Program	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	50%	0%	50%
	Inflow and Infiltration Subtotal		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**			
Maintenance																		
M-01	WWTP R&R	$ 2,000,000	$ 2,000,000	$ 2,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,000,000	$ -	0%	100%	0%
M-02	Pump Station R&R	$ 12,000,000	$ 12,000,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 600,000	$ 6,000,000	$ 6,000,000	0%	100%	0%
M-03	Sewer Main R&R	$ 3,000,000	$ 3,000,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 1,500,000	$ 1,500,000	0%	100%	0%
M-04	STEP Tank R&R	$ 2,800,000	$ 5,095,000	$ -	$ 1,019,000	$ 1,019,000	$ 1,019,000	$ 1,019,000	$ 1,019,000	$ -	$ -	$ -	$ -	$ 5,095,000	$ -	0%	100%	0%
	Maintenance Subtotal		**$ 22,095,000**	**$ 2,750,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 1,769,000**	**$ 750,000**	**$ 750,000**	**$ 750,000**	**$ 750,000**	**$ 14,595,000**	**$ 7,500,000**			
Treatment Plant																		
TP-01	Aeration Basin Improvements	$ 189,223	$ 376,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 376,000	$ -	$ -	$ -	$ 376,000	$ -	80%	20%	0%
TP-02	Secondary Clarifier Improvements	$ 2,785,535	$ 5,539,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,539,000	$ -	$ -	$ 5,539,000	$ -	50%	50%	0%
TP-03	Aeration Blower Replacement	$ 936,557	$ 1,862,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,862,000	$ -	$ 1,862,000	$ -	100%	0%	0%
TP-04	Disinfection Building / Hydraulic Improvements	$ 629,472	$ 1,252,000	$ -	$ 1,252,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,252,000	$ -	20%	80%	0%
TP-05	Effluent Pump Station Improvements	$ 641,550	$ 1,276,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,276,000	$ -	$ -	$ -	$ 1,276,000	$ -	100%	0%	0%
TP-06	Grit Separation / Odor Control Improvements	$ 507,998	$ 1,010,000	$ -	$ -	$ -	$ 1,010,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,010,000	$ -	0%	100%	0%
TP-07	TPS Pump Replacement	$ 77,520	$ 154,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 154,000	0%	100%	0%
TP-08	Sludge Recirculation Pump Replacement	$ 256,077	$ 509,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 509,000	0%	100%	0%
TP-09	Mechanical Dewatering Improvements	$ 828,992	$ 1,648,000	$ -	$ -	$ -	$ -	$ 1,648,000	$ -	$ -	$ -	$ -	$ -	$ 1,648,000	$ -	0%	100%	0%
TP-10	Plant Drain Pump Station No. 1 Improvements	$ 260,057	$ 517,000	$ -	$ 517,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 517,000	$ -	50%	50%	0%
TP-11	SCADA Master Plan	$ 208,964	$ 209,000	$ -	$ -	$ 209,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 209,000	$ -	50%	50%	0%
TP-12	SCADA Improvements	$ 324,439	$ 645,000	$ -	$ -	$ -	$ 645,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 645,000	$ -	50%	50%	0%
TP-13	PLC & RIO Improvements	$ 978,424	$ 1,946,000	$ -	$ -	$ -	$ 1,946,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,946,000	$ -	50%	50%	0%
TP-14	Secondary Treatment Expansion Planning	$ 75,000	$ 75,000			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 75,000	100%	0%	0%
	Treatment Plant Subtotal		**$ 17,018,000**	**$ -**	**$ 1,769,000**	**$ 209,000**	**$ 3,601,000**	**$ 1,648,000**	**$ -**	**$ 1,652,000**	**$ 5,539,000**	**$ 1,862,000**	**$ -**	**$ 16,280,000**	**$ 738,000**			
CIP Total			**$ 63,435,000**	**$ 2,750,000**	**$ 8,330,000**	**$ 3,309,000**	**$ 7,117,000**	**$ 3,927,000**	**$ 1,769,000**	**$ 2,402,000**	**$ 6,843,000**	**$ 3,803,000**	**$ 750,000**	**$ 41,000,000**	**$ 22,435,000**	**$ 17,495,700**	**$ 30,920,800**	**$ 15,018,500**
Annual Cost			$ 3,172,000	$ 2,750,000	$ 8,330,000	$ 3,309,000	$ 7,117,000	$ 3,927,000	$ 1,769,000	$ 2,402,000	$ 6,843,000	$ 3,803,000	$ 750,000	$ 4,100,000	$ 2,244,000	$ 875,000	$ 1,546,000	$ 751,000

Notes:
1. CIP Project Subtotal is project cost before contingency costs are added. CIP Project Cost = Estimated Construction Cost. Total CIP Project Cost = Estimated Construction Cost plus merkups for contingency, construction overhead (as applicable), engineering, and administration.
2. Part of existing City CIP Project.

9.4 Pump Station Projects

Pump stations in the CIP are all recommended to be upgraded to provide pump redundancy under existing conditions. These stations do not meet the required firm capacity. It is recommended that the City improve these pump stations redundancy and add a third redundant pump with the same capacity as the current pumps.

9.4.1 PS-01: South Prune Hills Pump Station

The South Prune Hills Pump Station captures flows from the Southwest portion of the system. Based on the modeled flows to the pump station wet well, and City draw down testing, the pump station receives more peak wet weather flow (PWWF) than its firm capacity during existing and buildout conditions. The stations firm capacity needs to convey more than double its current firm capacity from 449 gallons per minute (gpm) to 1,113 gpm. Extensive upgrades to the station are recommended in the short-term. The estimated cost is $510,000 in 2023.

9.4.2 PS-02: West Camas Pump Station Improvements

The West Camas Pump Station captures flows from the Southwest portion of the system and is just downstream of the south Prune Hills PS. Based on the modeled flows to the pump station wet well, and City draw down testing, the pump station receives more PWWF than its firm capacity during existing and buildout conditions. The stations firm capacity needs to convey more than double its current firm capacity from 579 gpm to 1,302 gpm. Extensive upgrades to the station are recommended in the short-term, but later than project PS-01, which currently restricts flow to the West Camas Pump Station. The estimated cost is $510,000 and is planned for 2026.

9.4.3 PS-03: Crown View Hill Pump Station

The Crown View Hill Pump Station captures flows from the Northern portion of the system. Based on the modeled flows to the pump station wet well, and City draw down testing, the pump station receives more PWWF than its firm capacity during existing and buildout conditions. The stations firm capacity needs to convey more than triple its current firm capacity from 148 gpm to 530 gpm. Extensive upgrades to the station are recommended in the short-term. The estimated cost is $510,000 and is planned for 2024.

9.4.4 PS-04: Main Pump Station Improvements

The Main Pump Station captures flows from the majority of the system, except Flow Monitoring Basin 8-1-1. This station is just upstream on the WWTP. Based on the modeled flows to the pump station wet well, and City draw down testing, the pump station receives more PWWF than its firm capacity during existing and buildout conditions. The stations firm capacity needs to convey more than its current firm capacity from 3,851 gpm to 5,682 gpm. Extensive upgrades to the station are recommended in the long-term, after upstream stations have been upgraded. The estimated cost is $510,000 and is planned for 2030.

9.4.5 PS-05: Upgrade Pump Station Telemetry

The telemetry and control system is how flow rates are measures and maintenance needs are updated. Supervisory control and data acquisition (SCADA) systems collect data from City lift stations, which can then be accessed by Civil Engineers and control sub consultant to help the City maintain the system. Upgrades to improve the telemetry system are recommended for

Lacamas Shores, Suningdale Gardens, and Winchester Hills 2 in the near term. These sites run time data all showed a risk of capacity deficiencies. The addition of flow meters and pressure sensors is recommended to better understand these stations capacity or lack thereof. Updates to the other 22 stations are recommended in the long-term. The near-term section of the project is planned for 2025 and the estimated cost is $1,747,000. The remainder of the project has an estimated cost of $12,813,000 and is planned for the long term.

9.5 STEP Projects

Since data was not available to evaluate the STEP system, improvement projects were not developed. However, CIP STEP projects include monitoring, modeling, and condition assessments to evaluate the STEP system in the future.

9.5.1 S-01: STEP Main Flows

Issues with treatment plant inflow monitoring restricted the ability to separate out STEP flows from Gravity System Flows. Recently, this issue was resolved, and future monitoring will allow a greater understanding of the STEP Main flows. If Oak and Main PSs are flow metered, the STEP system flow can be determined. A future study is recommended once sufficient historical data is available. The estimated cost is $229,000 and is planned for the long term.

9.5.2 S-02: STEP Main Modeling

The STEP system should be added to the collection system model in order to evaluate that portion of the system. Additional metering at pump stations further upstream would allow calibration of the STEP portion of the model. The addition of a manhole with a flow meter near Northwest (NW) Lake Rd and NW Lacamas Drive or NW Parker Street and NW Knapp Lane to aid in calibration should also be considered. Figure 6.24 shows the potential overview of a STEP main model and proposed monitoring locations to add to the STEP system, shown as green circles. Inflows are shown in red and black triangles. These are based on the Gray and Osborne 2010 General Sewer Plan Appendix F. These inflows give an overview of where additional monitoring could be available in order to divide up the system during STEP model calibration. The estimated cost is $96,000 and is planned for the long term.

9.5.3 S-03: STEP Main Condition Assessment and Cleaning

The addition of manholes to the STEP system would help investigation of the STEP mains condition and allow any partially obstructed portion of the STEP Main to be identified. A future investigation of debris, solids, and other obstruction is recommended in the sags in the system. The estimated cost is $821,000 and is planned for 2024.

9.6 Pipeline Projects

CIP pipeline projects were determined from the results of a skeletonized model evaluation. Most pipeline projects address level of service concerns and some are combined growth and level of service projects.

9.6.1 P-01: NW Fargo Street Upsize

Model surcharging and manhole flooding at manholes 3-1-26 and 3-1-25 revealed the need for upsizing. To alleviate surcharging 1,007 LF of pipe between manholes 3-1-26 to 3-1-22 should be upsized from 8- to 12-inch pipe, along NW Fargo Street between NW 23rd and NW 19th Avenue. This project is at a depth of approximately 10 feet. This estimated cost is $644,000 and is planned for 2023.

9.6.2 P-02: Division Street Upsize

Model surcharging and manhole flooding at manholes 3-1-11, 3-1-10, and 3-1-6 revealed the need for upsizing. To alleviate surcharging 2,043 LF of pipe between manholes 3-1-11 to 3-1-2 should be upsized from 8 to 12-inch pipe. This project is a gravity pipeline along Division Street between NW 18th and 11th Avenue, at an approximate depth of 10 feet. The estimated cost is $1,306,000 and is planned for 2023.

9.6.3 P-03: NW 6th Place West Upsize

Model surcharging and manhole flooding at manholes 10-1-8 revealed the need for upsizing. To alleviate surcharging 188 LF of pipe between manholes 10-1-11 to 10-1-10 should be upsized from 8 to 12-inch pipe and 616 LF of pipe between manholes 10-1-8 to 10-1-5 from 10 to 12-inch pipe. This project is a gravity pipeline along NW 6th Place, just upstream of the South Prune Hills Pump Station, at an approximate depth of 10-15 feet. The estimated cost is $514,000 and is planned for 2023.

9.6.4 P-04: NW 6th Place East Upsize

Model surcharging and manhole flooding at manholes 10-1-3 revealed the need for upsizing. To alleviate surcharging 188 LF of pipe between manhole 10-1-3 to the West Camas Pump Station wet well should be upsized from 10 to 12-inch pipe. This project is a gravity pipeline along NW 6th Place between South Prune Hills PS and West Camas PS, at an approximate depth of 5-10 feet. The estimated cost is $376,000 and is planned for 2023.

9.6.5 P-05: NW 6th Avenue West Upsize

Model surcharging and manhole flooding at manholes 1-1-9, 1-1-8, and 1-1-7 revealed the need for upsizing. To alleviate surcharging 311 LF of pipe between manholes 1-1-9 to 1-1-7 should be upsized from 12- to 15-inch pipe, and 1,340 LF of pipe between manholes 1-1-7 to 1-1-2 should be upsized from 12-inch to 18-inch. This project is a gravity pipeline along NW 6th Avenue, downstream of the West Camas PS and through Forest Home Park, at an approximate depth of five feet. The estimated cost is $825,000 and is planned for 2023.

9.6.6 P-06: NW 6th Avenue East Upsize

Model surcharging occurs between manholes 2-1-3 to 5-1-12, along NW 6th Avenue. To alleviate surcharging 817 LF of pipe between manholes 2-1-3 to 2-1-1 should be upsized from 12 to 18-inch pipe, and 401 LF of pipe between manholes 2-1-1 to 5-1-12 should be upsized from 12-inch to 21-inch. This project is a gravity pipeline along NW 6th Avenue, between NW 7th Avenue and Southeast (SE) Adams Street, at an approximate depth of five feet. The estimated cost is $617,000 and is planned for 2023.

9.6.7 P-07: Adams Street Upsize

Model surcharging occurs along SE 3rd Avenue, and flooding emerges at manholes 5-1-5 and 5-1-6 during buildout conditions. To alleviate surcharging 773 LF of pipe between manholes 5-1-10 to 5-1-12 and manholes 5-1-6 to 5-1-8 should be upsized from 21 to 24-inch pipe, and 925 LF of pipe between manholes 5-1-10 to 5-1-8 and manholes 5-1-6 to 5-1-2 should be upsized from 24-inch to 27-inch. This project is a gravity pipeline along Northeast (NE) and SE Adams Street between SE 3rd Avenue and NW 6th Avenue, at an approximate depth of 5-10 feet. The total estimated cost is $1,235,000 and is planned for $554,00 in 2027 and $681,000 in 2030.

9.6.8 P-08: NW 18th Loop Upsize

Model surcharging occurs along NW 18th Loop, during buildout conditions. To alleviate surcharging 609 LF of pipe between manholes 3-1-1 to 3-1-16 and manholes 3-1-13 to 3-1-13 should be upsized from 8 to 12-inch pipe. This project is a gravity pipeline along NW 18th Loop, at an approximate depth of 5-10 feet. The estimated cost is $389,000 and is planned for the long-term.

9.6.9 P-09: NE 15th Avenue Upsize

Model surcharging occurs along NE 15th Avenue, during buildout conditions. To alleviate surcharging 256 LF of pipe between manholes 4-1-2 to 4-2-1 should be upsized from 8 to 18-inch pipe. This project is a gravity pipeline along NE 15th Avenue between NE Garfield Street and NE Franklin Street, at an approximate depth of 10 feet. The estimated cost is $179,000 and is planned for the long-term.

9.7 Inflow and Infiltration Projects

9.7.1 I&I-01: Ongoing I&I Program

The City has an on-going I&I program which should continue and focus on high I&I areas from the modeling efforts. Further discussion is provided in Chapter 5.

9.8 Maintenance Projects

9.8.1 M-01: WWTP Repair and Replacement

Ongoing R&R is an item in the City's 2020 Sewer Capital Budget. No construction, E/L/D, or admin are applied, as the $2,000,000 cost is from the City's budget.

9.8.2 M-02: Pump Station Repair and Replacement

Ongoing R&R is an item in the City's 2020 Sewer Capital Budget. No construction, E/L/D, or admin are applied, as the $600,000 cost is from the City's budget. The cost is multiplied by a quantity of 20 for an estimated total cost of $12,000,000.

9.8.3 M-03: Sewer Main Repair and Replacement

Ongoing R&R is an item in the City's 2020 Sewer Capital Budget. No construction, E/L/D, or admin are applied, as the $150,000 cost is from the City's budget. The cost is multiplied by a quantity of 20 for an estimated total cost of $3,000,000.

9.8.4 M-04: STEP Tank Repair and Replacement

A STEP Tank R&R program is recommended to maintain the STEP collection system and prevent aging infrastructure and increases to infiltration in the system. This program will be a three-step process of assessment, repairs, and replacement. This should be performed for all tanks in the STEP system over the next 5 years. The estimated cost is $5,100,000 and is planned from 2023 to 2028.

9.9 Treatment Plant Projects

Treatment plant projects in the CIP occur at the Wastewater Treatment Plant (WWTP). The projects aim to mitigate capacity limitations over the next 20 years and address current condition issues that prohibit reliability or performance. Projects were grouped together to consider construction sequencing and project timing.

9.9.1 TP-01: Aeration Basin Improvements

This project includes general modifications to the aeration basin to improve performance, including the following:

- Demolition of the existing marine plywood baffle walls at the upstream end of the aeration basin.
- Installation of new aeration diffusers and associated zone controls in the final anoxic zone to create a new aerated swing zone.
- Repair and releveling of the concrete walls dividing each zone in each aeration basin.

The estimated cost is $376,000 and is planned for 2028.

9.9.2 TP-02: Secondary Clarifier Improvements

This project involves the replacement of two of the existing aeration blowers with larger high-speed turbo blowers to meet projected future aeration demands. The estimated cost is $5,539,000 and is planned for 2029.

9.9.3 TP-03: Aeration Blower Replacement

This project includes the demolition of the existing Secondary Clarifier No. 1 and replacement with a new clarifier matching the design of the existing Secondary Clarifier No. 3, as well as replacement of the existing Secondary Clarifier No. 2 RAS pumps to provide firm capacity matching that of Secondary Clarifier No. 3. The estimated cost is $1,862,000 and is planned for 2030.

9.9.4 TP-04: Disinfection Building / Hydraulic Improvements

This project includes modifications to the Disinfection Building and general hydraulic improvements, including the following:

- Replacing the existing UV disinfection equipment and providing temporary UV skid to bypass existing channel.
- Modifying the filter bypass so it does not limit the plant hydraulic capacity.
- Reconfiguring the NPW Pump Station to prevent air entrainment in pump suction.
- Redirecting the headworks channel inlet pipe to improve flow measurement and prevent splashing of raw sewage out of the top of the structure.

The estimated cost is $1,252,000 and is planned for 2023.

9.9.5 TP-05: Effluent Pump Station Improvements

This project involves increasing the capacity of the existing effluent pump station as required to pump 100 percent of projected 2035 peak hour flows to the outfall in the Columbia River. It assumes that this is accomplished by replacement of the existing effluent pumps with larger pumps. The estimated cost is $1,276,000 and is planned for 2028.

9.9.6 TP-06: Grit Separation / Odor Control Improvements

This project involves replacement of existing grit separation equipment, including hydrocyclones and grit classifiers, as well as increasing the capacity of the odor control systems servicing the grit handling area and the dewatering building. The estimated cost is $1,010,000 and is planned for 2025.

9.9.7 TP-07: TPS Pump Replacement

This project involves replacement of the existing thickened primary sludge pumps with new progressive cavity pumps. The estimated cost is $154,000 and is planned for the long-term.

9.9.8 TP-08: Sludge Recirculation Pump Replacement

This project involves replacement of the existing digested sludge pumps with new double disc piston-style pumps. The estimated cost is $509,000 and is planned for the long-term.

9.9.9 TP-09: Mechanical Dewatering Improvements

This project involves rehabilitation of the existing dewatering centrifuge and the addition of a second dewatering centrifuge for redundancy. The estimated cost is $1,648,000 and is planned for 2026.

9.9.10 TP-10: Plant Drain Pump Station No. 1 Improvements

This project involves repair of the existing Plant Drain Pump Station No. 1 structure and replacement of the existing pumps. The estimated cost is $517,000 and is planned for 2023.

9.9.11 TP-11: SCADA Master Plan

The SCADA master plan will provide the City with a road map to planned system upgrades designed to address system deficiencies and enhance facility operation. Development of the master plan will include an in-depth investigation of the existing SCADA control system for the City's wastewater treatment facility (WWTF) and the associated remote sites. The estimated cost is $209,000 and is planned for 2024.

9.9.12 TP-12: SCADA Improvements

Upgrades to the existing SCADA system to provide redundancy and take advantage of modern features including advanced data analysis, report generation, and secure remote accessibility. The estimated cost is $654,000 and is planned for 2025.

9.9.13 TP-13: PLC and RIO Improvements

This project includes replacement of the existing Modicon Quantum hardware with the Modicon M580 PLC and X80 I/O. The estimated cost is $1,946,000 and is planned for 2025.

9.9.14 TP-14: Secondary Treatment Expansion Planning

This project plans for a future secondary treatment expansion to accommodate flows and loads outside the planning windows. The estimated cost is $75,000 and is planned for the long-term.

9.10 General Projects

9.10.1 G-01: Gravity Collection System Model

The gravity collection system model is heavily skeletonized, only 24 percent of the gravity system pipes are included. A full pipe or less skeletonized model is needed for a more robust evaluation of the system. In order to expand the model, accurate and updated GIS for the collection system should be developed. The estimated cost is $491,000 and is planned for the long-term.

9.11 Summary of CIP

Recommended improvements include five pump station projects, three STEP projects, nine pipeline projects, one inflow and infiltration project, four maintenance projects, 14 treatment plant projects, and one general project. Most projects are allocated as repair and replacement projects at $30.9 M. Level of service projects are at $17.5 M and growth projects are at $15.0 M. The total CIP is $63.4 M.

The CIP recommends budgeting $41.0 M in the short term. The average annual short-term cost for all recommended projects is approximately $4.1 M per year from 2022 through 2031. The CIP recommends $22.4 M in the long-term with an average annual long-term cost of approximately $2.2 M per year from 2032 through 2041.

Detailed sheets for each CIP project presented in this chapter can be found in Appendix K of the Plan. Table 9.3 summarizes the total cost and annual cost for each planning period.

Table 9.3 CIP Planning Period Summary

Planning Period	Total Cost	Annual Cost
Short-term (2022-2031)	$41.0 M	$4.1 M
Long-term (2032-2041)	$22.4 M	$2.2 M

Maintenance projects accounts for 35 percent of the CIP projects at $22.1 M, followed by treatment plant projects at $17.0 M (27 percent) and pump station projects at $16.6 M (26 percent). Table 9.4 summarizes the total estimated capital costs by facility type. Figure 9.1 shows the various project types of CIP allocation.

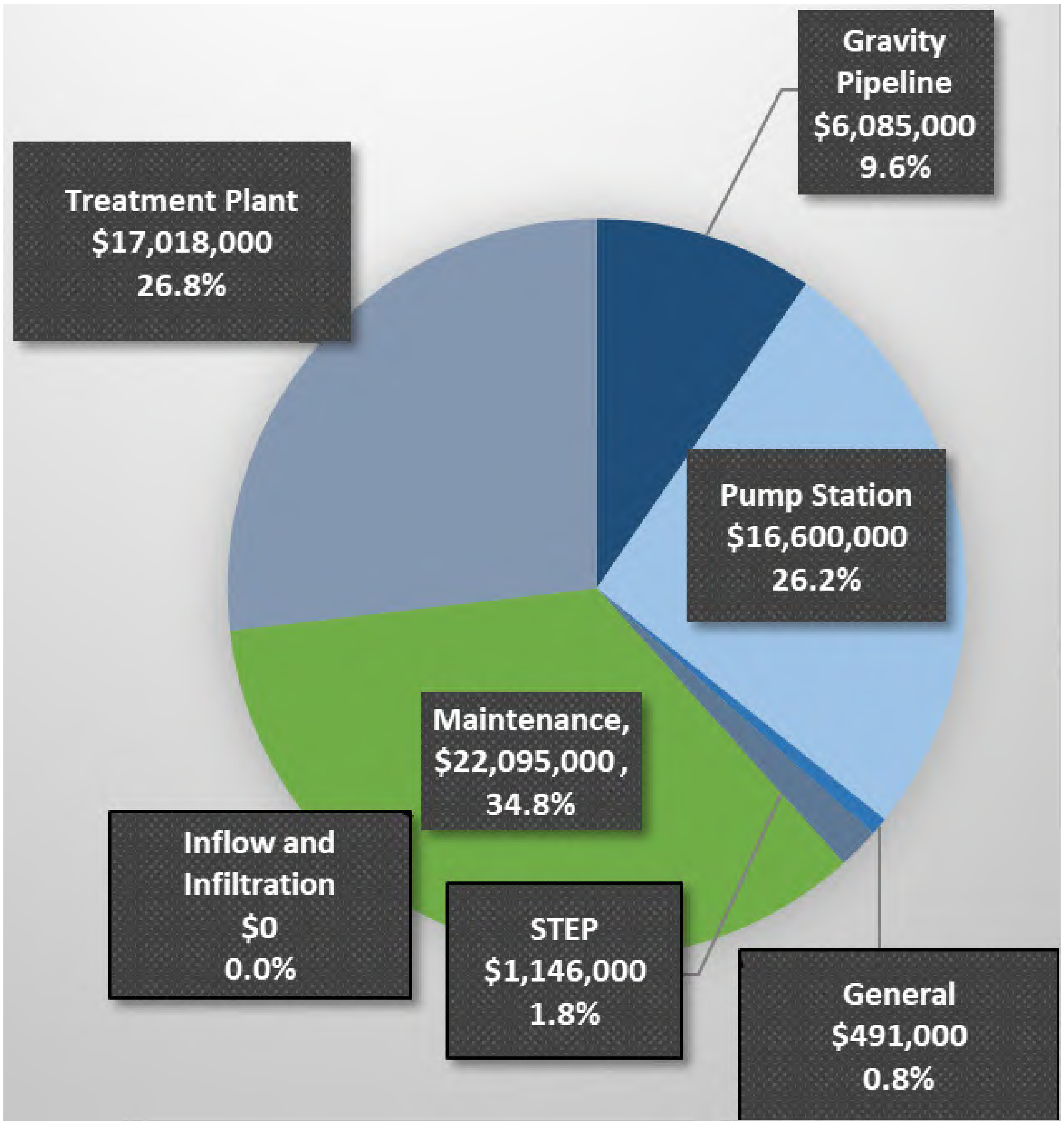


Figure 9.1 Cost by Project Type

Table 9.4 CIP Summary by Project Type

Project ID	Title	Total Capital Cost	Planning Period	
			Short-term (2022-2031)	Long-term (2032-2041)
Pump Station				
PS-01	South Prune Hills Pump Station Improvements	$510,000	$510,000	
PS-02	West Camas Pump Station Improvements	$520,000	$510,000	
PS-03	Crown View Hill Pump Station Improvements	$520,000	$510,000	
PS-04	Main Pump Station Improvements	$520,000	$510,000	
PS-05	Upgrade Pump Station Telemetry	$14,560,000	$1,747,000	$12,813,000
STEP				
S-01	STEP Main Flows	$229,000		$229,000
S-02	STEP Main Modeling	$96,000		$96,000
S-03	STEP Main Condition Assessment/ Cleaning	$821,000	$821,000	
Pipeline				
P-01	NW Fargo Street Upsize	$664,000	$664,000	
P-02	Division Street Upsize	$1,306,000	$1,306,000	
P-03	NW 6th Place West Upsize	$514,000	$514,000	
P-04	NW 6th Place East Upsize	$376,000	$376,000	
P-05	NW 6th Avenue West Upsize	$825,000	$825,000	
P-06	NW 6th Avenue East Upsize	$617,000	$617,000	
P-07	Adams Street Upsize	$1,235,000	$1,235,000	
P-08	NW 18th Loop Upsize	$389,000		$389,000
P-09	NE 15th Avenue Upsize	$179,000		$179,000
Inflow and Infiltration				
I&I-01	Ongoing I&I Program	--		

Project ID	Title	Total Capital Cost	Planning Period	
			Short-term (2022-2031)	Long-term (2032-2041)
Maintenance				
M-01	WWTP Repair and Replacement	$2,000,000	$2,000,000	
M-02	Pump Station Repair and Replacement	$12,000,000	$6,000,000	$6,000,000
M-03	Sewer Main Repair and Replacement	$3,000,000	$1,500,000	$1,500,000
M-04	STEP Tank Repair and Replacement	$5,095,000	$5,095,000	
Treatment Plant				
TP-01	Aeration Basin Improvements	$376,000	$376,000	
TP-02	Secondary Clarifier Improvements	$5,539,000	$5,539,000	
TP-03	Aeration Blower Replacement	$1,862,000	$1,862,000	
TP-04	Disinfection Building / Hydraulic Improvements	$1,252,000	$1,252,000	
TP-05	Effluent Pump Station Improvements	$1,276,000	$1,276,000	
TP-06	Grit Separation / Odor Control Improvements	$1,010,000	$1,010,000	
TP-07	TPS Pump Replacement	$154,000		$154,000
TP-08	Sludge Recirculation Pump Replacement	$509,000		$509,000
TP-09	Mechanical Dewatering Improvements	$1,648,000	$1,648,000	
TP-10	Plant Drain Pump Station No. 1 Improvements	$517,000	$517,000	
TP-11	SCADA Master Plan	$209,000	$209,000	
TP-12	SCADA Improvements	$645,000	$645,000	
TP-13	PLC and RIO Improvements	$1,946,000	$1,946,000	
TP-14	Secondary Treatment Expansion Planning	$75,000		$75,000
General				
G-01	Gravity Collection System Model	$491,000		$491,000

Chapter 10

FINANCIAL PLAN

10.1 Introduction

This chapter was prepared by FCS GROUP to provide a financial program that allows the City of Camas (City) sewer utility to remain financially viable during the planning period. This financial viability analysis considers the historical financial condition, current and identified future financial and policy obligations, operation and maintenance (O&M) needs, and the financial impacts of the capital projects identified in this General Sewer Plan (Plan). Furthermore, this chapter provides a review of the sewer utility's current rate structure with respect to rate adequacy and customer affordability.

10.2 Past Financial Performance

This section includes a historical summary of financial performance as reported by the City, including fund resources and uses arising from cash transactions, as well as a historical summary of comparative statements of net position, which are useful indicators of the City's financial position.

10.2.1 Comparative Financial Statements

The City legally owns and operates both a water and sewer utility. Operations and financial reporting occur on a combined utility fund basis. Table 10.1 shows a summary of the utility fund resources and uses arising from cash transactions for the previous 6 years (2015 through 2020) for the water and sewer utilities combined. Table 10.2 shows a summary of assets and liabilities, with the difference between the two reported as "net position." Increases or decreases in net position are useful indicators of the financial position of the City's utility fund. Noteworthy findings and trends are discussed following each table to demonstrate the historical performance and condition of the City's combined utility fund.

Table 10.1 Summary of Historical Fund Resources and Uses Arising from Cash Transactions

	2015	2016	2017	2018	2019	2020
Operating Revenues						
Charges for Service	$11,202,674	$11,411,593	$12,034,637	$12,436,638	$12,625,383	$13,595,484
Total Operating Revenues	$11,202,674	$11,411,593	$12,034,637	$12,436,638	$12,625,383	$13,595,484
Operating Expenses						
Water Operations and Maintenance	$1,885,556	$2,453,392	$2,102,232	$1,820,073	$3,175,678	$2,918,824
Sewer Operations and Maintenance	2,300,528	2,730,173	2,160,594	2,328,923	2,366,102	2,362,571
Customer Accounts	39,123	77,005	81,347	103,290	82,415	113,647
Administration	1,277,740	1,181,535	1,744,099	1,692,329	1,667,443	1,643,828
Taxes	389,507	435,240	470,531	517,704	589,618	535,323
Depreciation and Amortization	3,071,893	3,183,705	3,521,386	3,758,016	4,474,904	4,661,734
Total Operating Expenses	$8,964,347	$10,061,050	$10,080,189	$10,220,335	$12,356,160	$12,235,927
Operating Income (Loss)	$2,238,327	$1,350,543	$1,954,448	$2,216,303	$269,223	$1,359,557
Nonoperating Revenues (Expenses)						
Interest Earnings	$26,983	$204,446	$249,358	$403,216	$1,000,866	$547,253
State and Federal Grants	-	-	-	-	-	67,417
Interest and Fiscal Charges	(842,275)	(1,136,153)	(1,132,064)	(1,081,102)	(1,723,672)	(1,578,632)
Gain (Loss) on Disposal of Assets	(30,508)	3,821	(126,326)	298	-	(109,215)
Miscellaneous Revenue (Expense)	161,635	641,503	204,474	511,028	292,041	13,650
Debt Issuance Cost	-	-	-	-	(147,928)	-
Total Non-Operating Revenues (Expenses)	$(684,165)	$(286,383)	$(804,558)	$(166,560)	$(578,693)	$(1,059,527)
Income (Loss) before Contributions and Transfers	$1,554,162	$1,064,160	$1,149,890	$2,049,743	$(309,470)	$300,030
Capital Contributions	2,601,733	5,881,163	7,175,669	12,838,554	17,022,644	12,594,638
Transfers In	-	-	191,461	117,744	86,217	132,782
Transfers Out	-	-	(139,172)	-	-	-
Increase (Decrease) in Net Position	$4,155,895	$6,945,323	$8,377,848	$15,006,041	$16,799,391	$13,027,450
Total Net Position Beginning of Year	$68,680,879	$71,814,867	$78,614,731	$86,899,537	$101,905,578	$119,750,648
Change in Accounting Principles	(1,021,907)	-	(154,994)	-	-	-
Prior Period Adjustment	-	(145,459)	61,952	-	1,045,679	(223,860)
Total Net Position, End of Year	$71,814,867	$78,614,731	$86,899,537	$101,905,578	$119,750,648	$132,554,238
O&M Coverage Ratio	125.0%	113.4%	119.4%	121.7%	102.2%	111.1%
Net Operating Income as a % of Operating Revenue	20.0%	11.8%	16.2%	17.8%	2.1%	10.0%
Debt Service Coverage Ratio	5.93	10.45	3.58	3.89	3.09	3.94

Table 10.2 Summary of Historical Comparative Statements of Net Position

	2015	2016	2017	2018	2019	2020
Current Assets						
Cash, Cash Equivalents, Pooled Investments	$4,619,622	$6,652,747	$7,300,446	$16,034,437	$19,009,248	$12,109,932
Receivables						
Accounts	1,603,637	1,705,130	2,467,888	1,683,994	1,700,675	1,987,362
Developer Agreement	-	-	-	-	166,096	332,192
Restricted Assets						
Cash and Cash Equivalents	6,743,812	6,433,517	10,348,092	5,218,201	5,120,589	19,444,546
Investments	15,024,018	15,119,563	6,475,060	1,496,284	11,143,904	2,092,214
Interest Receivable	8,858	600	-	-	821	-
Total Current Assets	$27,999,947	$29,911,557	$26,591,486	$24,432,916	$37,141,333	$35,966,246
Long Term Assets						
Developer Agreement	$-	$-	$-	$-	$1,670,408	$1,504,312
Non-Depreciable Assets						
Land and Improvements to Land	1,108,023	1,015,178	942,835	942,835	1,073,895	1,930,433
Land Rights	-	92,845	477,394	537,394	1,619,493	3,024,486
Construction In Progress	10,074,376	4,155,957	12,576,133	2,893,525	2,600,268	4,949,841
Deferred Charges	-	-	-	-	-	-
Property, Plant and Equipment (Net)						
Building	20,913,401	21,438,584	20,914,486	24,929,225	23,949,529	23,022,438
Intangible Assets	388,526	385,721	-	55,674	310,067	255,323
Improvements Other than Buildings	5,177,60	9,918,134	9,546,801	10,483,732	10,605,403	18,545,390
Machinery and Equipment	18,567,85	18,986,219	17,816,343	16,851,938	16,236,367	16,785,492
Infrastructure	39,776,49	45,498,995	49,354,925	68,820,466	79,901,446	81,112,850
Total Noncurrent Assets	$96,006,27	$101,491,633	$111,628,917	$125,514,789	$137,966,876	$151,130,565
Total Assets	$124,006,225	$131,403,190	$138,220,403	$149,947,705	$175,108,209	$187,096,811
Total Deferred Outflows of Resources						
Deferred Amount on Refunding	246,166	223,615	201,065	127,163	171,584	$31,247
Amounts Related to Pensions	150,855	280,188	181,133		35,152	233,890
Total Deferred Outflows of Resources	397,021	503,803	382,198	127,163	206,736	$265,137
Liabilities						
Current Liabilities						
Accounts Payable	$1,161,415	$633,737	$1,412,772	$1,115,924	$445,392	$241,793
Customer Deposits	-	-	-	-	-	2,714
Accrued Interest Payable	227,132	293,713	275,429	146,455	360,199	344,933
Accrued Employee Benefits	12,916	15,476	11,162	12,417	14,053	17,002
Line of Credit	-	2,647,259	40,664	-	-	1,050,000
Unearned Revenues	35,000	-	-	-	-	2,892
Total OPEB liability - Short Term	-	-	-	-	-	13,182
Bonds, Notes and Loans Payable	2,752,641	3,012,332	3,260,036	3,367,485	3,121,308	2,642,168
Payable from Restricted Assets	78,375	407	890,039	495,674	35,330	101,849
Total Current Liabilities	$4,267,479	$6,602,924	$5,890,102	$5,137,955	$3,976,282	$4,416,533
Annual Revenue Bond Debt Service	*$896,195*	*$433,960*	*$1,531,475*	*$1,534,175*	*$1,534,775*	*$1,530,075*
Non-Current Liabilities						
Bonds, Notes and Loans Payable	$45,838,121	$44,347,386	$43,590,207	$41,307,897	$49,591,611	$48,401,818
Unearned Revenue - Developer Credit	1,083,944	604,647	453,149	310,525	694,296	689,310
Net Pension Liability	1,031,588	1,500,278	1,195,273	712,058	552,735	647,872
Accrued Employee Benefits	208,142	200,800	352,597	111,755	126,478	153,020
Total OPEB Liability	-	-	-	273,813	243,715	231,418
Total Non-Current Liabilities	$48,161,795	$46,653,111	$45,591,226	$42,716,048	$51,208,835	$50,123,438
Total Liabilities	$52,429,274	$53,256,035	$51,481,328	$47,854,003	$55,185,117	$54,539,971
Deferred Inflows of Resources						
Amounts Related to Pensions	$159,105	$36,227	$221,736	$315,287	$351,113	$212,790
Inflows - Amounts Related to OPEB	$-	$-	$-	$-	$28,067	$24,949
Total Deferred Inflows of Resources	$159,105	$36,227	$221,736	$315,287	$379,180	$237,739
Net Position						
Net Investment in Capital Assets	$64,569,715	$67,960,072	$73,863,415	$85,894,304	$98,157,464	$106,694,344
Restricted for Debt Service	1,548,179	1,567,095	1,603,591	1,622,623	1,698,047	1,716,329
Restricted for Capital Purposes	2,208,041	5,776,990	5,100,355	6,650,823	12,208,294	11,582,557
Unrestricted	3,488,932	3,310,574	6,332,176	7,737,828	7,686,843	12,561,008
Total Net Position	71,814,867	78,614,731	86,899,537	101,905,578	119,750,648	132,554,238
Current Ratio	1.5	1.3	1.7	3.4	5.3	3.3
Debt to Net Position Ratio	0.7	0.6	0.5	0.4	0.4	0.4
Debt to Noncurrent Capital Assets Ratio	0.5	0.5	0.4	0.4	0.4	0.3

Notes:
Abbreviations: OPEB - other post-employment benefits.

10.2.2 Findings and Trends

- The City's combined water and sewer charges for services increased from $11.2 million (M) in 2015 to $13.6M in 2020. The average annual compounding increase is 4.0 percent per year, with a total increase of 21.4 percent from 2015 to 2020. Expenses range from $9.0M in 2015 to $12.2M in 2020, showing increases every year. With an average annual compounding increase of 6.4 percent, expenses have grown faster than revenues over the past 6 years and have increased 36.5 percent overall. While combined water and sewer maintenance and operations expenses have increased 26.2 percent, the largest contributor to increases in expenses is depreciation and amortization, growing by 51.8 percent since 2015.
- The O&M coverage ratio (total operating revenues divided by total operating expenses) started at 125.0 percent in 2015 and has trended downward reaching a low of 102.2 percent in 2019 before recovering to 111.1 percent in 2020. A ratio of 100.0 percent or greater shows that revenue will successfully cover expenses, and the City has remained above this ratio for the past six-year period.
- Net operating income as a percent of operating revenue was 20.0 percent in 2015. This metric has varied over the past 6 years with a high of the 2015 figure of 20.0 percent reaching a low of 2.1 percent in 2019 before increasing to 10.0 percent in 2020. Similar to the O&M coverage ratio, these trends help to show how successfully operating revenue actually covered operating expenses, with higher positive numbers being the best and negative numbers showing need for improvement. In addition, these trends demonstrate the ability of the utility to invest in capital, whether through direct cash transfers or the issuance and servicing of debt.
- The debt service coverage ratio measures the amount of cash flow available to meet interest and principal payments. Typically, bond debt service coverage requires a minimum factor of 1.25 during the life of the loans. This ratio is calculated by dividing cash operating income (revenues less expenses before depreciation) by annual revenue bond expenses. The debt service coverage ratio for revenue bond debt ends 2015 at 5.93 and fluctuates year to year to a low of 3.09 in 2019 and a high of 10.45 in 2016. The ability of this ratio to remain at levels significantly higher than the bond covenant minimum of 1.25 indicates a stable capacity for new debt and will likely result in more favorable terms when entering the bond market.
- The current ratio is a measure of short-term liquidity or the City's ability to pay its current bills - it is calculated by dividing unrestricted current assets (excluding inventories and prepaid items) by current liabilities. A ratio of 1.0 indicates that the utility has exactly enough to pay its bills; higher values are desirable as they suggest an ability to pay large or unanticipated bills. The ratio begins at 1.5 in 2015 decreasing to 1.3 in 2016 before rebuilding to a high of 5.3 in 2019 and ending 2020 at 3.3 suggesting that the City has capacity to meets its short-term financial obligations.

10.3 Financial Plan

The sewer utility is responsible for generating sufficient revenue to meet all of its costs. The primary source of funding is derived from ongoing monthly service charges, with additional revenue coming from inspection fees, investment earnings, space and facilities leases, rents and charges and other miscellaneous revenues. The City controls the level of user service charges and, with City Council approval, can adjust user service charges as needed to meet financial objectives.

The financial plan can only confirm financial feasibility if it considers the total system costs of providing sewer services, both operating and capital. To meet these objectives, the following elements have been completed:

1. Capital Funding Plan. Identifies the total capital improvement plan (CIP) obligations of the planning period. The plan defines a strategy for funding the CIP, including an analysis of available resources from rate revenues, existing reserves, connection charges, debt financing, and any special resources that may be readily available (e.g., grants, developer contributions, etc.). The capital funding plan impacts the financial plan through the use of debt financing (resulting in annual debt service) and the assumed rate revenue made available for capital funding.
2. Financial Forecast. Identifies future annual non-capital costs associated with the operation, maintenance, and administration of the sewer system. Included in the financial plan is a reserve analysis that forecasts cash flow and fund balance activity, along with testing for satisfaction of actual or recommended minimum fund balance policies. The financial plan ultimately evaluates the sufficiency of utility revenues in meeting all obligations, including cash uses such as operating expenses, debt service, capital outlays, and reserve contributions, as well as any coverage requirements associated with long-term debt. The plan also identifies the future adjustments required to fully fund all utility obligations in the planning period.

10.3.1 Capital Funding Plan

To properly evaluate future capital funding needs, capital costs were escalated by 3.50 percent annually to the year of planned spending. The CIP used for this PLAN identifies $47.5M in project costs over the 10-year planning horizon from 2022-2031. The 20-year period through 2041 includes $86.0M in total project costs.

A summary of the 10-year and 20-year CIPs are shown in Table 10.3. As shown, each year has varied capital cost obligations depending on construction schedules and infrastructure planning needs. Table 10.4 provides more detail for the 10-year CIP.

Table 10.3 10-Year and 20-Year CIPs

Year	Escalated $
2022	$2,846,250
2023	8,923,304
2024	3,668,747
2025	8,166,921
2026	3,445,478
2027	2,174,553
2028	3,056,015
2029	9,010,924
2030	5,183,099
2031	1,057,949
10-Year Total	**$47,533,240**
2032 - 2041	38,425,499
20-Year Total	**$85,958,739**

Table 10.4 10-Year CIP (Escalated $)

Project	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Gravity Pipeline										
Northwest Fargo Street Upsize		$689,869								
Division Street Upsize		1,399,020								
Northwest 6th Place West Upsize		550,610								
Northwest 6th Place East Upsize		402,781								
Northwest 6th Avenue West Upsize		883,761								
Northwest 6th Avenue East Upsize		660,946								
Adams Street Upsize								729,512	928,133	
Pump Station										
South Prune Hills Pump Station Improvements		546,325								
West Camas Pump Station Improvements					605,720					
Crown View Hill Pump Station Improvements			565,446							
Main Pump Station Improvements									695,078	
Upgrade Pump Station Telemetry				2,004,723						
STEP										
STEP Main Condition Assessment/ Cleaning			910,257							
Maintenance										
WWTP R&R	2,070,000									
Pump Station R&R	621,000	642,735	665,231	688,514	712,612	737,553	763,368	790,085	817,738	846,359
Sewer Main R&R	155,250	160,684	166,308	172,128	178,153	184,388	190,842	197,521	204,435	211,590
STEP Tank R&R		1,091,578	1,129,784	1,169,326	1,210,252	1,252,611				
Treatment Plant										
Aeration Basin Improvements							478,377			
Secondary Clarifier Improvements								7,293,805		
Aeration Blower Replacement									2,537,715	
Disinfection Building / Hydraulic Improvements		1,341,174								
Effluent Pump Station Improvements							1,623,428			
Grit Separation / Odor Control Improvements				1,158,998						
Mechanical Dewatering Improvements					738,741					
Plant Drain Pump Station No. 1 Improvements		553,823								
SCADA Master Plan			231,722							
SCADA Improvements				740,152						
PLC & RIO Improvements				2,233,080						
Total	$2,846,250	$8,923,304	$3,668,747	$8,166,921	$3,445,478	$2,174,553	$3,056,015	$9,010,924	$5,183,099	$1,057,949

Notes:
Abbreviations: PLC - programable logic controller; R&R - programable logic controller; RIO - remote input/output; SCADA - supervisory control and data acquisition; WWTP - wastewater treatment plant.

10.4 Available Funding Assistance and Financing Resources

Feasible long-term capital funding strategies must be defined to ensure that adequate resources are available to fund the CIP identified in this PLAN. In addition to the City's resources, such as accumulated cash reserves, capital revenues, and rate revenues designated for capital purposes, capital needs can be met from outside sources, such as grants, low-interest loans, and bond financing. The following is a summary of the City's internal and external resources.

10.4.1 City Resources

Resources appropriate for funding capital needs include accumulated cash in the capital fund, rate revenues designated for capital spending purposes, developer contributions, and capital-related charges such as connection fee revenue. The first two resources will be discussed in the Fiscal Policies section of the Financial Forecast. Capital-related charges are discussed below.

10.4.1.1 System Development Charges

A connection charge such as the City's system development charge (SDC) refers to a one-time charge imposed on new customers as a condition of connecting to the sewer system. The purpose of the SDC is two-fold: 1) to promote equity between new and existing customers; and 2) to provide a source of revenue to fund capital projects. Revenue can only be used to fund utility capital projects or to pay debt service incurred to finance those projects. In 2021, the City charged all new customers an SDC dependent upon the location of the property. A charge of $2,493 per meter capacity equivalent (MCE) was charged for connections in the South Area while a charge of $4,420 per MCE was charged for connection in the North Shore Area.

10.4.1.2 Local Facilities Charges

While a connection charge is the manner in which new customers pay their share of system investment costs, local facilities charge funding is used to pay the costs of local facilities that connect each property to the system's infrastructure. Local facilities funding is often overlooked in rate forecasting because it is funded upfront by either connecting customers and developers, or through an assessment to properties, but never from rates.

A number of mechanisms can be considered toward funding local facilities. One of the following scenarios typically occurs: (a) the utility charges a connection fee based on the cost of the local facilities (under the same authority as the facilities assessment fee); (b) a developer funds an extension of the system to its development and turns those facilities over to the utility (contributed capital); or (c) a local assessment is set up called a Utility Local Improvement District (ULID/LID) or a Local Utility District (LUD), which collects tax revenue from benefited properties.

A local facilities charge (LFC) is a variation of the connection charge. It is a city-imposed charge to recover the cost related to service extension to local properties. Often called a front-footage charge and imposed on the basis of footage of the main "fronting" a particular property, it is usually implemented as a reimbursement mechanism to a city for the cost of a local facility that directly serves a property. It is a form of connection charge and thus can accumulate up to 10 years of interest. It typically applies in instances when no developer-installed facilities are needed through developer extension due to the prior existence of available mains already serving the developing property.

The developer extension is a requirement that a developer install on-site and sometimes off-site improvements as a condition of extending service. These are in addition to the connection charge required and must be built to City standards. Part of the agreement between the City and the developer planning to extend service might include a latecomer agreement, resulting in a latecomer charge to new connections for the developer extension.

Latecomer charges are a variation of developer extensions, whereby new customers connecting to a developer-installed improvement make a payment to the City based on their share of the developer's cost. The City passes this charge on to the developer who installed the facilities. As part of the developer extension process, this defines the allocation of costs and records latecomer obligations on the title of affected properties. No interest is allowed, and the reimbursement agreement cannot exceed 20 years in duration.

ULID/LID is another mechanism for funding infrastructure that assesses benefited properties based on the special benefit received by the construction of specific facilities. Most often used for local facilities, some ULIDs also recover related general facilities costs. Substantial legal and procedural requirements can make this a relatively expensive process, and there are mechanisms by which a ULID can be rejected.

10.4.2 Outside Resources

This section outlines various grant, loan, and bond opportunities available to the City through federal and state agencies to fund the CIP identified in the Plan.

10.4.2.1 Grants and Low-Cost Loans

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 grant programs are generally lightly funded and heavily subscribed. Nonetheless, the benefit of low-interest loans makes the effort of applying worthwhile.

Appendix L to this Plan contains a document entitled "Funding Programs for Drinking Water and Wastewater Projects; Updated 2-14-2022". This document is maintained by the State of Washington's Department of Commerce and contains details on government programs, eligibility requirements, and contact information, should the City wish to inquire about program offerings and eligibility requirements.

10.4.2.2 Bond Financing

General Obligation Bonds - General obligation (G.O.) bonds are bonds secured by the full faith and credit of the issuing agency, committing all available tax and revenue resources to debt repayment. With this high level of commitment, G.O. bonds have relatively low interest rates and few financial restrictions. However, the authority to issue G.O. bonds is restricted in terms of the amount and use of the funds, as defined by the Washington constitution and statute. Specifically, the amount of debt that can be issued is linked to assessed valuation.

Revised Code of Washington (RCW) 39.36.020 states:

- (2)(a)(ii) Counties, cities, and towns are limited to an indebtedness amount not exceeding one and one half percent of the value of the taxable property in such counties, cities, or towns without the assent of three-fifths of the voters therein voting at an election held for that purpose.
  (b) In cases requiring such assent counties, cities, towns, and public hospital districts are limited to a total indebtedness of two and one-half percent of the value of the taxable property therein.

While bonding capacity can limit the availability of G.O. bonds for utility purposes, these can sometimes play a valuable role in project financing. A utility rate savings may be realized through two avenues: the lower interest rate and related bond costs, and the extension of repayment obligation to all tax-paying properties (not just developed properties) through the authorization of an ad valorem property tax levy.

Revenue Bonds - Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility. With this limited commitment, revenue bonds typically bear higher interest rates than G.O. bonds and require security conditions related to the financial performance (added bond debt service coverage) and may require maintenance of dedicated reserves (a bond reserve). The City agrees to satisfy these requirements by resolution as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. There is no bonding limit, except perhaps the practical limit of the utility's ability to generate sufficient revenue to repay the debt and provide coverage. In some cases, poor credit might make issuing revenue bonds problematic.

10.4.2.3 Capital Financing Strategy

An ideal capital financing strategy would include the use of grants and low-cost loans when debt issuance is required. However, these resources are very limited and competitive in nature and do not provide a reliable source of funding for planning purposes. It is recommended that the City pursue these funding avenues but for planning purposes assume revenue bond financing to meet the needs which can't be met by available cash resources. The capital financing strategy developed to fund the CIP identified in this Plan assumes the following funding resources:

- Accumulated cash reserves, which may include proceeds from previously issued bonds,
- Transfers of excess cash (over minimum balance targets) from the Operating Fund,
- System development charge revenues, and
- Interest earned on Construction Fund balances and other miscellaneous capital resources.

The cash resources described above are anticipated to fund 61.29 percent of the 10-year CIP and 78.59 percent of the 20-year CIP. The remaining funding is assumed to come from new debt obligations. Table 10.5 presents the 10-year and 20-year capital financing strategy.

Table 10.5 10-Year and 20-Year Capital Financing Strategy

Year	Capital Expenditures Escalated	Revenue Bond Financing	Cash Funding	Total Financial Resources
2022	$2,846,250	-	$2,846,250	$2,846,250
2023	8,923,304	2,500,000	6,423,304	8,923,304
2024	3,668,747	-	3,668,747	3,668,747
2025	8,166,921	6,900,000	1,266,921	8,166,921
2026	3,445,478	-	3,445,478	3,445,478
2027	2,174,553	-	2,174,553	2,174,553
2028	3,056,015	-	3,056,015	3,056,015
2029	9,010,924	9,000,000	10,924	9,010,924
2030	5,183,099	-	5,183,099	5,183,099
2031	1,057,949	-	1,057,949	1,057,949
Subtotal	**$47,533,240**	**$18,400,000**	**$29,133,240**	**$47,533,240**
2032 - 2041	38,425,499	-	38,425,499	38,425,499
Total	**$85,958,739**	**$18,400,000**	**$67,558,739**	**$85,958,739**

10.5 Financial Forecast

The financial forecast, or revenue requirement analysis, forecasts the amount of annual revenue that needs to be generated by user rates. The analysis incorporates operating revenues, O&M expenses, debt service payments, rate-funded capital needs, and any other identified revenues or expenses related to operations. The objective of the financial forecast is to evaluate the sufficiency of the current level of rates. In addition to annual operating costs, the revenue needs also include debt covenant requirements and specific fiscal policies and financial goals of the City.

The analysis determines the amount of revenue needed in a given year to meet that year's expected financial obligations. For this analysis, two revenue sufficiency tests have been developed to reflect the financial goals and constraints of the City: cash needs must be met; and debt coverage requirements must be realized. In order to operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

Cash Test: The cash flow test identifies all known cash requirements for the City in each year of the planning period. Typically, these include O&M expenses, debt service payments, rate-funded system reinvestment funding or directly funded capital outlays, and any additions to specified reserve balances. The total annual cash needs of the City are then compared to projected cash revenues using the current rate structure. Any projected revenue shortfalls are identified and the rate increases necessary to make up the shortfalls are established.

Coverage Test: The coverage test is based on a commitment made by the City when issuing revenue bonds and some other forms of long-term debt. For the purposes of this analysis, revenue bond debt is assumed for any needed debt issuance. As a security condition of issuance, the City would be required per covenant to agree that the revenue bond debt would have a higher priority for payment (a senior lien) compared to most other expenditures; the only outlays with a higher lien are O&M expenses. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. For example, a 1.00 coverage factor would imply that no additional cushion is required. A 1.25 coverage factor means revenue must be sufficient to pay O&M expenses, annual revenue bond debt service payments, and an additional 25 percent of annual revenue bond debt service payments. The excess cash flow derived from the added coverage, if any, can be used for any purpose, including funding capital projects. Targeting a higher coverage factor can help the City achieve a better credit rating and provide lower interest rates for future debt issues.

In determining the annual revenue requirement, both the cash and coverage sufficiency tests must be met, and the test with the greatest deficiency drives the level of needed rate increase in any given year.

10.5.1 Current Financial Structure

The City maintains a fund structure and implements financial policies that target management of a financially viable and fiscally responsible sewer system.

10.5.1.1 Fiscal Policies

A summary of the key financial policies employed by the City, as well as those recommended and incorporated in the financial program, are discussed below.

Operating Fund: Operating reserves are designed to provide a liquidity cushion to ensure that adequate cash working capital will be maintained to deal with significant cash balance fluctuations, such as seasonal fluctuations in billings and receipts, unanticipated cash expenses, or lower than expected revenue collections. Like other types of reserves, operating reserves also serve another purpose: they help smooth rate increases over time. Target funding levels for an operating reserve are generally expressed as a certain number of days of O&M expenses, with the minimum requirement varying with the expected revenue volatility. Industry practice for utility operating reserves ranges from 30 days (8 percent) to 120 days (33 percent) of O&M expenses, with the lower end more appropriate for utilities with stable revenue streams and the higher end more appropriate for utilities with significant seasonal or consumption-based fluctuations.

This financial plan targets a minimum balance in the sewer utility Operating Fund equal to 60 days of O&M expenses.

Capital Fund: A utility capital contingency reserve is an amount of cash set aside in case of an emergency should a piece of equipment or a portion of the utility's infrastructure fail unexpectedly. The reserve also could be used for other unanticipated capital needs, including capital project cost overruns. Industry practices range from maintaining a balance equal to 1 to 2 percent of fixed assets, an amount equal to a five-year rolling average of CIP costs, or an amount determined sufficient to fund equipment failure (other than catastrophic failure). The final target level should balance industry standards with the risk level of the City.

The City currently aims to maintain a capital fund balance target of $750,000 and is the target used in this financial plan.

System Reinvestment: System reinvestment funding promotes system integrity through ongoing repair and replacement of system infrastructure. Ideally, a detailed asset management plan would guide the level of rate funded system reinvestment, however, in absence of this level of effort, annual depreciation expense is commonly used as a measure of the decline in asset value associated with routine use of the system. Particularly for utilities that do not already have an explicit system reinvestment policy in place, implementing a funding level based on full depreciation expense could significantly impact rates. An alternative benchmark is annual depreciation expense net of debt principal payments on outstanding debt. This approach recognizes that customers are still paying for certain assets through the debt component of their rate and intends to avoid simultaneously charging customers for an asset and its future replacement. The specific benchmark used to set system reinvestment funding targets is a matter of policy that must balance various objectives, including managing rate impacts, keeping long-term costs down, and promoting "generational equity" (i.e., not excessively burdening current customers with paying for facilities that will serve a larger group of customers in the future).

The City does not currently have a policy in place for system reinvestment funding. No dedicated system reinvestment funding is assumed in this financial plan; however, on average, the City is able to fund approximately $2.0M annually through rates from 2022 through 2041. Dedicated system reinvestment funding is recommended for consideration during future policy review and rate planning.

Debt Management: It is prudent to consider policies related to debt management as part of a broader utility financial policy structure. Debt management policies should be evaluated and formalized, including the level of acceptable outstanding debt, debt repayment, bond coverage, and total debt coverage targets. The City has one outstanding sewer revenue bond, which will be fully redeemed in 2035. This bond carries a coverage requirement of 1.25. In addition to revenue bonds, the City has four junior lean debt obligations without a coverage requirement. While not an official policy, the City should target debt coverage ratio of 1.00 or greater on total debt to make sure enough cash is generated for the repayment of all debt.

10.5.1.2 Financial Forecast

The financial forecast is primarily based upon the City's 2022 budget and takes into consideration other key factors and assumptions needed to develop a complete portrait of the City's annual sewer utility financial obligations. The following is a list of the key revenue and expense factors and assumptions used to develop the financial forecast.

- Growth - Rate revenue escalation is based on the forecast of annual average flow provided in Chapter 3 of this PLAN. On average, annual growth for the forecast period is 2.14 percent.
- Revenue - The City has two general revenue sources: 1) sewer service charges (rate revenue); and 2) miscellaneous (non-rate) revenue. In the event of a forecasted annual shortfall, rate revenue can be increased to meet the annual revenue requirement. For the purpose of this financial forecast, rate revenues are forecasted to increase with customer growth. Non-rate revenues are forecasted to increase with either customer growth or general cost inflation.

- System Development Charge Revenue - The current SDC is forecast to generate revenue between $1.1M in 2022 and $1.7M in 2041 collected from an average of 424 new meter capacity equivalents per year.
- Expenses - O&M expense projections are based on the City's 2022 budget and forecast to increase with general cost inflation of 2.0 percent, labor cost inflation increases of 3.0 percent, and benefit cost inflation increases of 5.0 percent in subsequent years. Budget figures were used for taxes in 2022; future taxes are calculated based on forecasted revenues and prevailing tax rates.
- Existing Debt - The City's sewer utility currently has five outstanding debt issues, including one revenue bond, three PWTF loans, and one Department of Ecology loan. The revenue bond payments are on average $1.5M per year 2022 through 2035. PWTF payments range from $816,000 in 2022 to $190,000 in 2032. DOE loan payments range from $350,000 in 2021 to $175,000 in 2032. The total annual existing debt service obligations begin 2022 at $2.7M and are reduced to $1.5M in 2035, the year of final existing debt redemption.
- Future Debt - The capital financial strategy developed for this PLAN forecasts the need for $18.4M in new debt proceeds in three separate instances throughout the twenty-year forecast. The analysis performed assumes all new debt is through revenue bond financing. Annual new debt service obligations begin in 2023 at $221,000 increasing to $1.6M by 2029.
- Transfers to Capital - Operating fund balance above the minimum requirement is assumed to be available to fund capital projects and projected to be transferred to the Capital Fund each year. On average, the utility transfers $2.2M to the Capital Fund annually from 2022 to 2041.

Although the financial plan is completed through 2041, the rate strategy focuses on the shorter-term planning period of 2022 through 2031. It is recommended that the City revisit the proposed rates every 2 to 3 years to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates should be adjusted as needed.

Table 10.6, following, summarizes the annual revenue requirements based on the forecast of revenues, expenditures, fund balances, and fiscal policies.

Table 10.6 11-Year Financial Forecast

Revenue Requirement	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Revenues										
Rate Revenues Under Existing Rates	$8,497,745	$8,679,362	$8,864,860	$9,054,322	$9,247,834	$9,445,482	$9,647,354	$9,853,541	$10,064,134	$10,279,228
Non-Rate Revenues	371,282	358,954	358,973	376,704	380,896	347,830	359,665	364,879	384,018	221,005
Total Revenues	**$8,869,027**	**$9,038,316**	**$9,223,833**	**$9,431,026**	**$9,628,730**	**$9,793,312**	**$10,007,019**	**$10,218,420**	**$10,448,152**	**$10,500,233**
Expenses										
Cash Operating Expenses	$5,281,720	$5,468,388	$5,624,604	$5,786,121	$5,952,570	$6,123,721	$6,301,205	$6,484,319	$6,673,633	$6,865,930
Existing Debt Service	2,695,128	2,695,053	2,690,328	2,688,603	2,684,627	2,678,403	2,629,788	2,074,276	2,074,528	2,071,804
New Debt Service		220,505	220,505	829,100	829,100	829,100	829,100	1,622,920	1,622,920	1,622,920
Total Expenses	**$7,976,848**	**$8,383,946**	**$8,535,438**	**$9,303,824**	**$9,466,298**	**$9,631,224**	**$9,760,093**	**$10,181,515**	**$10,371,080**	**$10,560,654**
Total Surplus (Deficiency)	**$892,179**	**$654,369**	**$688,395**	**$127,202**	**$162,432**	**$162,088**	**$246,926**	**$36,905**	**$77,071**	**$(60,421)**
Annual Rate Adjustment	**3.30%**	**3.30%**	**1.75%**	**1.75%**	**1.75%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
Cumulative Annual Rate Adjustment	**3.30%**	**6.71%**	**8.58%**	**10.48%**	**12.41%**	**12.41%**	**12.41%**	**12.41%**	**12.41%**	**12.41%**
Rate Revenues After Rate Increase	$8,778,171	$9,261,651	$9,625,137	$10,002,888	$10,395,465	$10,617,641	$10,844,564	$11,076,338	$11,313,066	$11,554,853
Additional Taxes from Rate Increase	7,206	14,964	19,537	24,376	29,492	30,122	30,766	31,423	32,095	32,781
Net Cash Flow After Rate Increase	**$1,165,398**	**$1,221,696**	**$1,429,135**	**$1,051,392**	**$1,280,572**	**$1,304,125**	**$1,413,371**	**$1,228,279**	**$1,293,908**	**$1,182,423**
Coverage After Rate Increases	3.54	3.25	3.38	2.55	2.68	2.69	2.74	2.03	2.08	1.98

The financial forecast indicates that at existing rate levels the utility becomes deficient in 2031 as new debt is added to fund the capital program. This financial analysis recognizes the annual 3.30 percent adopted rate increases in 2022 and 2023. In addition to the adopted increases annual increases of 1.75 percent are needed starting in 2024 through 2026 to meet the forecast annual operating and capital needs of the system.

10.5.2 City Funds and Reserves

Table 10.7 shows a summary of the projected Operating Fund and Capital Fund ending balances through 2031 based on the rate forecasts presented above. The Operating Fund is maintained at a minimum of 60 days of O&M expenses, and the Capital Fund balance continues to exceed the annual $750,000 target.

Table 10.7 Ending Cash Balance Summary

Ending Fund Balances	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Operating Fund	$868,228	$898,913	$924,592	$951,143	$978,505	$1,006,639	$1,035,814	$1,065,915	$1,097,036	$1,128,646
Capital Fund	5,976,844	1,934,563	860,365	1,826,388	883,982	1,249,973	878,759	3,387,097	865,896	2,335,899
Total	**$6,845,072**	**$2,833,476**	**$1,784,957**	**$2,777,531**	**$1,862,487**	**$2,256,612**	**$1,914,574**	**$4,453,012**	**$1,962,931**	**$3,464,545**

10.6 Current and Projected Rates

10.6.1 Current Rates

The City's current rate structure consists of a fixed monthly charge based on customer class and a variable charge per hundred cubic feet (ccf) for all use. Customer located outside the City limits have an outside City multiplier of 1.50 added to both the fixed monthly charge and the variable charge of their rates. Table 10.8 shows the existing rate schedule.

Table 10.8 Existing Schedule of Rates

2021 Monthly Rates	
Base Rate	**per Account**
Residential	
Inside City	$27.26
Outside City	40.89
Commercial / Industrial	
Inside City	$13.07
Outside City	19.62
Volume Charge	**per ccf**
Residential	
Inside City	$4.15
Outside City	6.24
Commercial / Industrial	
Inside City	$5.55
Outside City	8.33

10.6.2 Projected Rates

The financial forecast discussed above indicates that while the sewer utility is covering all financial obligations in the near term, with the addition of new debt, rate increases are needed to satisfy all future financial responsibilities. In addition to the adopted 3.3 percent rate increase in 2022 and 2023, a rate strategy of 1.75 percent annually from 2024 through 2026 is recommended to satisfy this forecast deficiency. Table 10.9 shows the projected rates with increases applied uniformly to all rate components in all classes.

Table 10.9 Proposed Schedule of Rates

Monthly Rates	Existing	Adopted		Proposed							
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Base Rate (per Account)											
Residential											
Inside City	$27.26	$28.16	$29.09	$29.60	$30.12	$30.65	$30.65	$30.65	$30.65	$30.65	$30.65
Outside City	40.89	42.24	43.63	44.39	45.17	45.96	45.96	45.96	45.96	45.96	45.96
Commercial / Industrial											
Inside City	13.07	13.50	13.95	14.19	14.44	14.69	14.69	14.69	14.69	14.69	14.69
Outside City	19.62	20.27	20.94	21.31	21.68	22.06	22.06	22.06	22.06	22.06	22.06
Volume Charge (per cfs)											
Residential											
Inside City	$4.15	$4.29	$4.43	$4.51	$4.59	$4.67	$4.67	$4.67	$4.67	$4.67	$4.67
Outside City	6.24	6.45	6.66	6.78	6.90	7.02	7.02	7.02	7.02	7.02	7.02
Commercial / Industrial											
Inside City	5.55	5.73	5.92	6.02	6.13	6.24	6.24	6.24	6.24	6.24	6.24
Outside City	8.33	8.60	8.88	9.04	9.20	9.36	9.36	9.36	9.36	9.36	9.36

10.7 Affordability

The Washington State Department of Health and the Department of Commerce Public Works Board use an affordability index to prioritize low-cost loan awards depending on whether rates exceed 2.00 percent of the median household income for the service area. The median household income for the City, expressed in 2019 dollars, was $111,584 between 2015 and 2019 according to the U.S. Census Bureau. The 2019 value is escalated based on the 2020 and 2021 Employment Cost Index Wages and Salaries index and utilizes the 2020 and 2021 two-year average of 2.15 percent to project the median household income in future years starting in 2022. Table 10.10 presents the City's monthly sewer bill projected to 2031, tested against the 2.00 percent monthly affordability threshold.

Table 10.10 Community Affordability Test

Year	Inflation	Median HH Income	2% Monthly Threshold	Projected Monthly Bill(1)	% of Median HH Income
2019		$111,584	$185.97	$52.78	0.57%
2020	2.22%	114,065	190.11	54.53	0.57%
2021	2.08%	116,439	194.07	56.31	0.58%
2022	2.15%	118,945	198.24	58.19	0.59%
2023	2.15%	121,506	202.51	60.10	0.59%
2024	2.15%	124,121	206.87	61.17	0.59%
2025	2.15%	126,793	211.32	62.25	0.59%
2026	2.15%	129,522	215.87	63.34	0.59%
2027	2.15%	132,310	220.52	63.34	0.57%
2028	2.15%	135,157	225.26	63.34	0.56%
2029	2.15%	138,067	230.11	63.34	0.55%
2030	2.15%	141,038	235.06	63.34	0.54%
2031	2.15%	144,074	240.12	63.34	0.53%

Notes:
(1) Average monthly bill assumes 7ccf water use.

Applying the 2.00 percent test, the City's rates are forecasted to remain within the indicated affordability range through 2031.

10.8 Conclusion

The results of this analysis indicate that rates must increase to provide revenue sufficient to cover all utility financial obligations, including the addition of new debt and partial cash funding of the capital program through 2031. In addition to the adopted annual increases of 3.30 percent in 2022 and 2023, annual 1.75 percent adjustments from 2024 through 2026 should provide for continued financial viability while maintaining generally affordable rates.

It is important to remember that the analysis performed in this chapter assumes growth rates from Chapter 3 of this Plan. If the future growth rates change, the existing rate strategy may need to be updated and revised.

It is recommended that the City regularly review and update the key underlying assumptions that compose the multi-year financial plan to ensure that adequate revenues are collected to meet the City's total financial obligations.