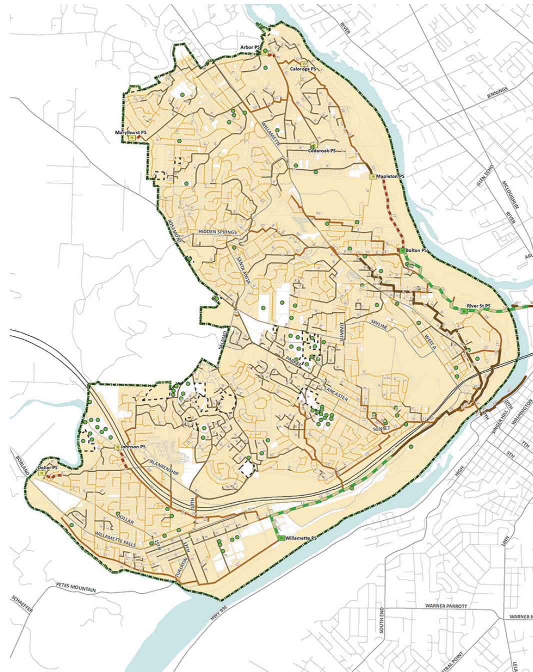
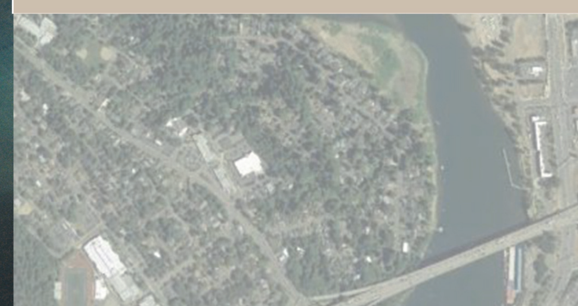


City of West Linn

Sanitary Sewer Master Plan Update

DRAFT



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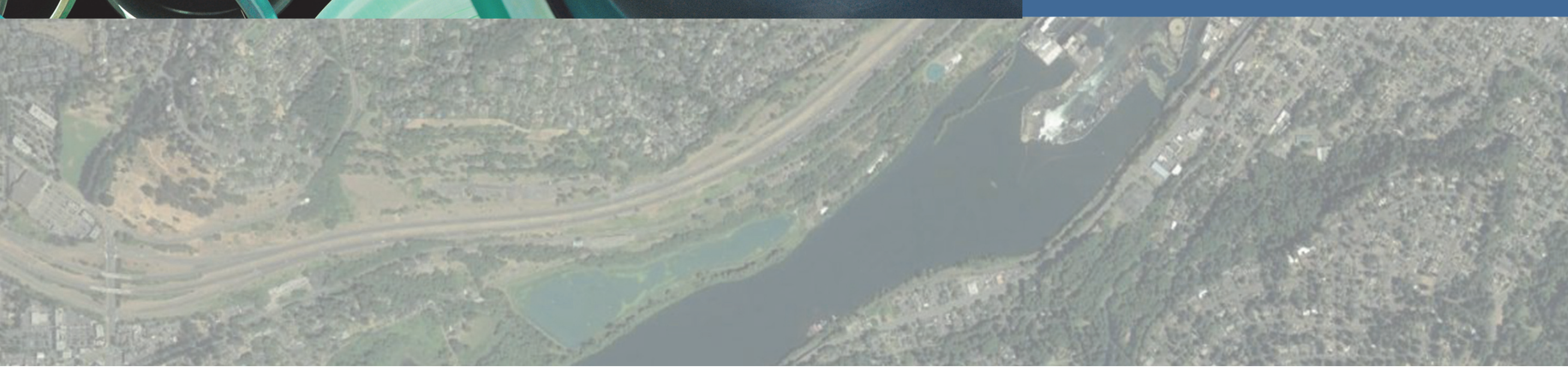

City of West Linn
Sanitary Sewer Master Plan Update

SANITARY SEWER MASTER PLAN

DRAFT | March 2019

This document is released for the purpose of information exchange review and planning only under the authority of Matthew M. Huang, March 25, 2019, State of Oregon, P.E. No. 91512.

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EXECUTIVE SUMMARY

The City of West Linn (City) is located in Clackamas County, near Portland, Oregon. It is surrounded by the Clackamas River, Willamette River, and City of Lake Oswego. The City owns and operates most of the sewer collection system within the City limits. The City discharges wastewater to Clackamas County's Water Environment Services (WES)'s Regional Treatment Plant.

The City has prepared this Sanitary Sewer Master Plan (SSMP) to document the status of the City's sewer system and analyze the system to anticipate future needs. In order to provide effective, reliable, and safe sewer service, this SSMP will be used as a guide for operation, maintenance, and expansion of the sewer system for the next 20 years and beyond. This SSMP serves as the framework on which to evaluate future growth and system replacement and rehabilitation over the next 20 years, and estimate system capacity, ultimately leading to an updated Capital Improvement Plan (CIP) as part of the Sanitary Sewer Master Plan (SSMP). This SSMP covers the following main topics:

- Basis of Planning
- Existing System
- Model Development and Calibration
- Capacity Evaluation and Inflow/Infiltration Reduction
- Capital Improvement Program

This SSMP is a planning level document utilizing the best practices in the industry. The SSMP is a living document, and will allow for amendment as conditions change. This SSMP is inherently flexible to allow the City to respond to opportunities and changing conditions as they develop. In particular, Water Environment Services (WES) will complete their SSMP after the City's SSMP has been completed and the results of their SSMP may change the Capital Improvement Program recommended in this document. Beyond this, the City should be prepared to update the model to incorporate changes within the community and the collection system at approximately 10-year intervals.

Table 1 below summarizes the City's recommended Capital Improvement Program.

Table 1 CIP Overview Costs

	High Priority Cost ($)	Medium Priority Cost ($)	Low Priority Cost ($)	Total Cost ($)
Pipeline (P)	$ 2,363,000	$ 2,330,000	$ 1,320,000	$ 6,013,000
Gravity Main	$ 2,363,000	$ 1,113,000	$ 1,320,000	$ 4,796,000
Force Main	$ –	$ 1,217,000	$ –	$ 1,217,000
Pump Station (PS)	$ 1,049,000	$ 4,254,000	$ –	$ 5,303,000
Planning (PL)	$ 100,000	$ 200,000	$ 300,000	$ 600,000
General (G)	$ 5,947,000	$ 5,947,000	$ 11,895,000	$ 23,789,000
Total	**$ 9,459,000**	**$ 12,731,000**	**$ 13,515,000**	**$ 35,705,000**

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

- Erich Lais, City of West Linn, Assistant City Engineer
- Amy Pepper, City of West Linn, Senior Engineer
- Lara Kammereck, Carollo Engineers, Inc., Principal-in-Charge
- Matt Huang, Carollo Engineers, Inc., Project Manager
- Aurelie Nabonnand, Carollo Engineers, Inc., Project Engineer
- Angela Wieland, Brown and Caldwell, Project Manager
- Karen Hooge, Carollo Engineers, Inc., Document Processor
- Jackie Silber, Carollo Engineers, Inc., GIS Analyst

Section 1

BASIS OF PLANNING

The Study Area, shown as a dashed green line in Figure 1, is the currently agreed-upon service boundary. The Study Area contains area that coincide with the City limits and urban growth boundary (UGB).

Three planning periods are evaluated in this SSMP:

- Existing system.
- 5-year Planning Period.
- Build-out.

Evaluations are performed for both average dry weather flow (ADWF) and peak wet weather flows (PWWF).

ADWF is the average flow that occurs on a daily basis during the dry weather season, and is representative of routine wastewater discharges into the collection system from customers as well as baseline groundwater infiltration. PWWF is the highest observed hourly flow that occurs following the selected design storm event.

Estimated ADWFs for each basin were estimated using data from the Flow Monitoring Program for each of the flow monitoring basins. Flows were monitored at ten locations in the collection system. Future ADWF were estimated using an area based methodology using wastewater flow factors for the different land use categories. Peak wet weather flows in a sewer system can be more than ten times the base flow, causing utilities to construct high-capacity infrastructure to convey and treat these extraneous flows. Existing and projected PWWFs are predicted using the hydraulic model and design storm used for this SSMP. This analysis uses a 5-year, 24-hour design storm, accounting for climate change, with a maximum intensity of 0.5 inches/hour. To represent typical winter Pacific Northwest winter rainfall conditions, antecedent rainfall was added from historical data, as shown in Figure 2. Further detail on the development of the design storm can be found in Attachment A of this SSMP (Technical Memorandum (TM) 1 – Basis of Planning).

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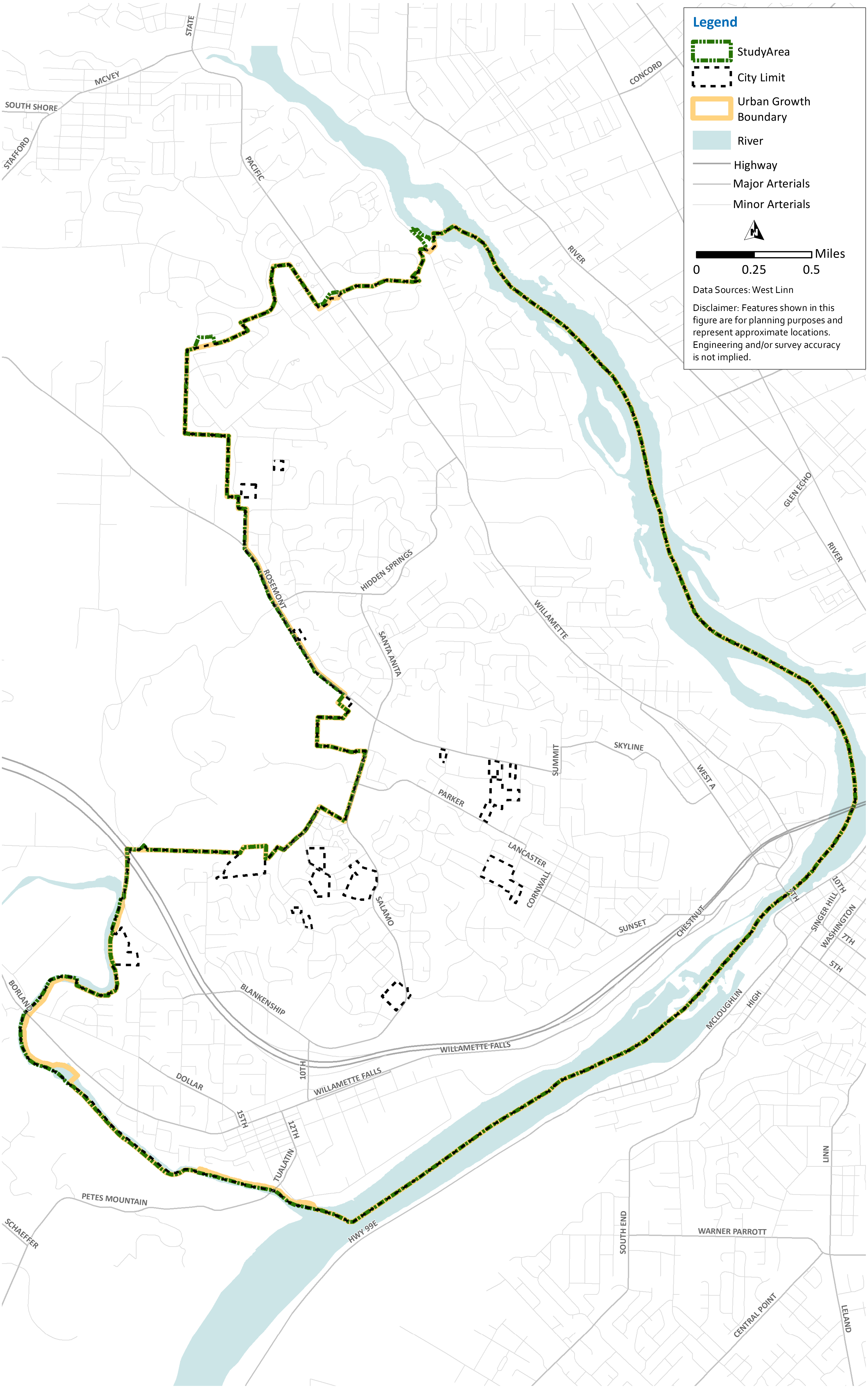

Figure 1 Study Area

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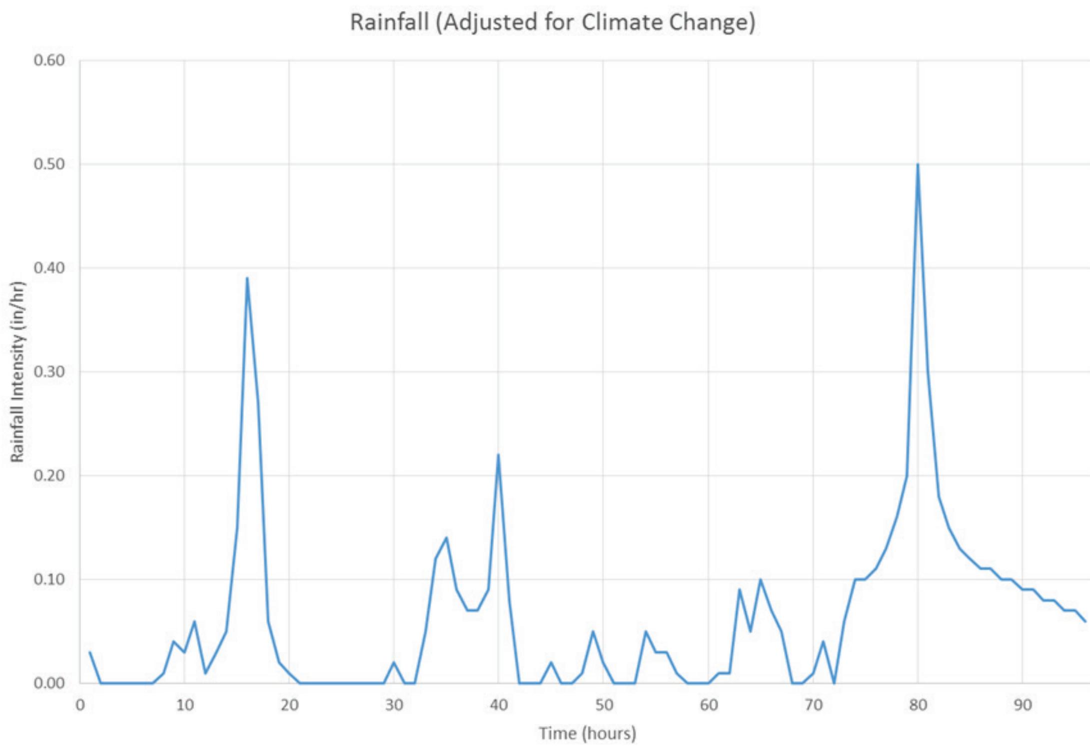

Figure 2 Design Storm Hyetograph

A summary of the predicted ADWF and PWWF flows for each planning period is shown in Table 2.

Table 2 Existing and Projected Wastewater Flows

Flow Condition	Existing Conditions	5-year Planning Period	Build-out Conditions
ADWF (mgd)	3.34	3.42	3.74
PWWF (mgd)	20.17	21.26	23.68
Peaking Factor (PF)	6.0	6.2	6.3

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

Carollo performed a high-level review of the City's existing policies against similar policies developed for other wastewater agencies to identify potential missing policies or clarifications to better meet the City's current sewer management needs. While not comprehensive, this review provides recommended direction for future policy revisions. Recommended modifications and additions to these policies are shown in Tables 3, 4, 5, and 6.

Further information on the Basis of Planning can be found in Technical Memorandum (TM) 1 – Basis of Planning, which is in Attachment A of this SSMP.

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Table 3 Recommended Service & Extensions Policies

Subject	Policy	Source
Service Area	Clarify future service area extend.	Recommended Policy
Lateral Ownership	Future Recommendation (Example Text Provided): Laterals shall be owned and maintained by the property owner up to and including the connection to the City-owned sewer main.	Recommended Policy
Sewer Extensions	Future Recommendation (Example Text Provided): 1) The extension of the sanitary sewer system may be initiated as follows: a) Any person may request that the City extend the sanitary sewer system in order to serve property owned by that person. b) The City may initiate the extension of the sanitary sewer system. 2) A request to extend the sanitary sewer system shall be in writing and shall consist of the following information: a) A map of the property to be served by the extension of the system identifying the property by address and tax map and lot number; b) A written report containing the reasons for the extension to the sanitary sewer system; and c) Any other relevant information required by the City Engineer. 3) The City Engineer shall review each request for extension of the system and determine if it is in the City's interest to proceed with extension of the system. The review shall consider the following factors: a) The potential health hazard if the system is not extended; b) Whether the properties to be served by the extension are within the City limits at the time of the request, are likely to connect to the system and agree to be annexed within a reasonable period, or are slated to receive service from the City pursuant to a valid intergovernmental between the City and another governmental unit. c) The number of properties that will benefit if the system is extended and whether those properties are currently developed; and d) The potential water quality benefits if the system is extended. e) Adequacy of the available funding source. f) Availability of public right-of-way or easements. If the City Engineer determines that it is in the City's interest to proceed with extension pursuant to subsection 3 of this section, the extension shall be scheduled for construction. Persons who apply to connect to the extended line shall pay the line charge established prior to and as a condition of connection.	Recommended Policy
Annexations	Future Recommendation (Example Text Provided): Unincorporated property shall be required to annex prior to the receipt of City sanitary sewer service, or as set forth below: Each of the following conditions must be met to provide unincorporated property with City sanitary sewer service prior to annexation: 1) The property shall be located within the Urban Growth Boundary; 2) Existing sanitary sewer line operated by the City to which connection can be made in accordance with subsection (4) below is within 300 feet of the property; 3) The City has found that the septic system serving the property is failing and the City has directed connection to a sanitary sewer system; 4) The extension of a sanitary sewer line to be connected to the City sanitary sewer line shall be subject to acceptance of an approved plan by the City Engineer.	Recommended Policy
Sewer Study For Oversizing	Future Recommendation (Example Text Provided): A sanitary sewer study will be required when an 8-inch diameter gravity sewer is inadequate to serve the current or future development or when the City Engineer determines that a recently annexed area situated outside the limits of the currently adopted Plan warrants a study. The study shall incorporate the proposed design system including features as the pipe slope, cover, and size; the study shall include, but not be limited to, a detailed map of the sanitary sewer service, sewage flow calculations, and pipe hydraulic calculations.	Recommended Policy
Oversizing Pipes	Future Recommendation (Example Text Provided): When land outside a new development will logically direct flow into a storm drain or sanitary sewer within the new development, the system shall be "public" and shall be extended to one or more of the upstream development boundaries. The pipes shall be sized to accommodate all off-site flows, based on a fully developed condition using the current Comprehensive Plan.	Recommended Policy
Sewer Drainage Basins	Future Recommendation (Example Text Provided): Each facility system serves different geographic sub-areas of the City. While facilities such as parks and schools relate more to neighborhoods defined by population size and travel time/distance, systems such as sewers, water, and storm water drainage are more logically defined by topography, soils, and other natural constraints. Such disparities can interfere with coordination of planning for public facilities, affecting different client populations. To help overcome these barriers, the "Public Facilities Element" should be organized, where possible, in relation to a common set of geographic sub-areas.	Recommended Policy
Use of Public Sewers Required	Future Recommendation: Modify policy in Municipal Code 4.005 to require connection to sanitary sewer system from 200 feet to 300 feet. This modification is recommended to match policies from other agencies in the Portland metropolitan area.	Recommended Policy

Table 4 Recommended System Reliability Policies

Subject	Policy	Source
Security	Future Recommendation (Example Text Provided): The City shall make reasonable attempts to protect the security of its sewer collection system. The City shall determine what information about the system should remain unavailable to the general public.	Recommended Policy
Reliability	Future Recommendation (Example Text Provided): The City shall manage the sewer collection system through developing design standards, overseeing construction, operating, and maintaining the system such that service to areas in the Urban Services Boundary is adequate and reliable. Whenever possible, the City shall anticipate system interruptions, such as power outages, and design and operate the system to minimize the impact of such interruptions on its customers and the environment.	Recommended Policy
Resiliency	Carollo can provide example text to reference Oregon Resilience Plan.	Recommended Policy
Maintenance	Future Recommendation (Example Text Provided): Unless specifically directed otherwise by the City, all facilities and equipment shall be maintained in accordance with manufacturers' specifications. The City adheres to maintenance and replacement schedules for all facilities and equipment.	Recommended Policy
Equipment Inventory	Future Recommendation (Example Text Provided): The City shall maintain a complete inventory of all City-owned equipment, supplies, parts, and service vehicles used for maintenance of sewer facilities. The inventory should include planned replacement dates as applicable.	Recommended Policy
Emergency Response Plan	Future Recommendation (Example Text Provided): On a regular basis, the City shall update their Emergency Operations Plan focusing on responding to emergencies and disasters.	Recommended Policy
Natural Hazards Mitigation Plan	Future Recommendation (Example Text Provided): On a regular basis the City shall update and maintain their Natural Hazards Mitigation Plan addressing risks associated with natural hazards.	Recommended Policy

Table 5 Recommended Environmental Policies

Subject	Policy	Source
Sustainability	Future Recommendation (Example Text Provided) The City will manage the sewer collection system, including monitoring and adapting plans, policies, and practices to collect and convey wastewater from its customers in a safe and sustainable manner in accordance with the City’s Environmental element of the Comprehensive Plan.	Recommended Policy
Overflows	Future Recommendation (Example Text Provided) The City has implemented programs to prevent overflows of wastewater in the existing system, and requires all new construction to convey peak flows and storm events without overflowing the sewer during the design storm event.	Recommended Policy
Infrastructure Siting	Future Recommendation (Example Text Provided) New wastewater infrastructure will be sited outside of stream corridors, wetlands, and significant tree groves whenever feasible.	Recommended Policy

Table 6 Recommended Design Policies & Criteria

Subject	Policy	Source
Design Approach - Storm	Action Item: Update design storm requirement In accordance with all applicable federal, state, and local regulations, the City should design its sewer facilities to adequately and reliably convey peak hour flows associated with a 24-hour, 5-year recurring storm event without overflowing or discharging to any water bodies.	Action item
Surcharging	Action Item: Update surcharging requirement • New facilities shall be designed to prevent the hydraulic grade line from exceeding the crown of pipe during Peak Wet Weather Flow (PWWF). Allowable depth to full depth (d/D) ratios for new pipes can be based on a graduated criteria according to pipe size, as shown in the following: – <=12-inch; d/D = 0.5 – >=15-inch; d/D = 0.75 • The existing system shall be evaluated for two conditions of surcharging, as follows: – Under Peak Dry Weather Flow (PDWF), pipes can flow full with a depth to full depth (d/D) ratio of 0.90 – Under Peak Wet Weather Flow (PWWF), the Hydraulic Grade Line (HGL) may not rise above one feet above any pipe invert.	Action item
Manholes - Locations	Modify criteria such that cleanouts are never permitted at any location.	Recommended modifications to existing policy
Piping – Allowable Size	Future Recommendation: Modify policy from "A 6 in. diameter sewer will be allowed with the City Engineer's approval." To ". A 6 in. diameter sewer may be allowed with the City Engineer's approval."	Recommended modifications to existing policy
Pump Stations - Operability During Design Storm	Future Recommendation (Example Text Provided): Provisions shall be included in the design of any pump station to allow the station to remain fully operational and accessible during the design storm.	Recommended additions to existing policy
Pump Stations - Flow Meters	Future Recommendation (Example Text Provided): Permanent flow meters shall be provided in a separate vault for all new pump stations.	Recommended policy
Pump Stations - Reliability	Future Recommendation (Example Text Provided): In order to reduce the risk of overflows during power outages or when performing routine maintenance, the City shall install emergency back-up power generators, receptacles for portable generators and/or bypass pump connections at all of its pump stations. For pump stations without telemetry, it is recommended to install telemetry. The telemetry system shall have back-up battery power that allows the telemetry system to continue to operate for up to seven days.	Recommended additions to existing policy
Pump Station - Sizing	Future Recommendation: Wet well sizing can be achieved in stations with low influent flow rates, but would likely result in oversized wet wells for larger stations. We would recommended for the standard of 4 hours of storage above high water alarm to be respected whenever possible, but that a reduced duration be acceptable if approved by the City.	Recommended additions to existing policy
Pump Stations - Bypass Pumping Requirements	Future Recommendation (Example Text Provided): The City's pump stations shall be designed with bypass pump connections that will allow the City to pump directly from the wet well into the pump station's force main with a portable pump, thus bypassing the pumps in the dry well. This feature should allow the City to manage wet well levels during power outages and routine maintenance.	Recommended additions to existing policy
Pump Stations - DEQ Documentation	Future Recommendation (Example Text Provided): Design engineers shall provide to the City and DEQ all documentation required by OAR 340-052-0040 including the final O&M Manuals and certification that the construction was inspected by the design engineer and found to be in accordance with the plans and specifications.	Recommended policy
Design Approach - Design Flows	Future Recommendation (Example Text Provided) Sewer flows are composed of residential, institutional, commercial, and industrial sewage, along with infiltration and inflow. Sewers must be capable of conveying the peak hourly flows of these wastewater sources as estimated using the design storm.	Recommended policy
Testing	Future Recommendation: The existing policy requires an air test for gravity sanitary sewer testing. The City should also permit a water test.	Recommended modifications to existing policy

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Section 2

EXISTING SYSTEM

The City's collection system consists of approximately 115 miles of gravity mains, 1.5 miles of force mains, and 10 pump stations that collect and convey wastewater to the Tri-City Water Pollution Control Plant. Figure 3 presents the City's existing collection system, and shows the currently connected and contributing tax lots as provided by the City.

The City owns and maintains six small pump stations and one larger pump station, the Mapleton Pump Station. The remaining three pump stations (Bolton, River Street, and Willamette Pump Station) are operated and maintained by Clackamas County's Water Environment Services (WES). County customers contribute flow both upstream and downstream of the City collection system. This SSMP only discusses the City's system and does not cover WES' system.

The City's gravity mains are approximately 25 percent (%) clay pipe, 25% polyvinyl chloride (PVC) pipe, and 50% concrete pipe. A summary of the gravity pipelines are listed in Table 7 by diameter size. The City owns seven pump stations and their associated force mains; a summary of the pump stations are in Table 8 and the force mains in Table 9.

The City's collection system is divided into 25 wastewater basins that are denoted alphabetically. Figure 4 shows the wastewater basins, showing which areas contribute flows to which pipelines.

Further information on the Existing System can be found in TM 2 – Existing System, which is in Attachment B of this SSMP.

Table 7 Collection System Gravity Main Inventory

Diameter (inch)	Length (LF)	Percentage of System
Unknown	293,629	48.6%
4	164	0.03%
6	16,704	2.8%
8	212,131	35.1%
10	25,278	4.2%
12	15,798	2.6%
14	1,765	0.3%
15	15,107	2.5%
18	11,149	1.8%
21	7,898	1.3%
24	5,123	0.8%
Total (feet)	**604,747**	**100%**
Total (miles)	**114.5**	**100%**

Notes:
(1) System only includes gravity mains and excludes private sewers and WES pipes.

Table 8 Existing Pump Stations Inventory Summary (City Owned)

Pump Station	Sewer Basin	Address	Number of Pumps	Horsepower (hp)	Flow (gpm)	Head (ft)	Pump Station Capacity		Year Constructed / Rehabilitated
							Total[1] (gpm)	Firm[2] (gpm)	
Arbor PS	5A	3609 Arbor Dr	2	10	190	70	380	190	1990
Calaroga PS	4A	3831 S Calaroga Dr	2	7.5	80	44	160	80	1993
Cedaroak PS	7A	3964 Cedar Oak Dr	2	2	150	21.5	300	150	1990
Dollar (River Heights) PS	9D	2220 Brandon Pl	2	18	118	112	236	118	1992
Johnson PS	10A	23701 S Johnson Rd	2	6.5	175	64	350	175	1998
Mapleton PS	3C	19050 Nixon Ave	2		1,000	125	2,950	1,950	1998
			1		950	115			
Marylhurst PS	3A	900 Marylhurst Cir	2	3	160	28	320	160	1990

Notes:
Total capacity corresponds to the capacity of the station with all pumps running.
Firm capacity corresponds to the capacity of the station with largest pump out of service.

Table 9 Collection System Force Main Inventory

Pump Station	4-inch	8-inch	12-inch	16-inch	18-inch	Total (ft)	Percent System (%)
Arbor PS	628					**628**	**2.8%**
Bolton PS				6,380		**6,380**	**28.3%**
Calaroga PS	213					**213**	**0.9%**
Cedaroak PS	234					**234**	**1.0%**
Dollar PS	926					**926**	**4.1%**
Johnson PS	987					**987**	**4.4%**
Mapleton PS			3,746			**3,746**	**16.6%**
Marylhurst PS		394				**394**	**1.8%**
River Street PS			2,675			**2,675**	**11.9%**
Willamette PS					6,322	**6,322**	**28.1%**
Grand Total (ft)	**2,988**	**394**	**6,421**	**6,380**	**6,322**	**22,505**	**100%**

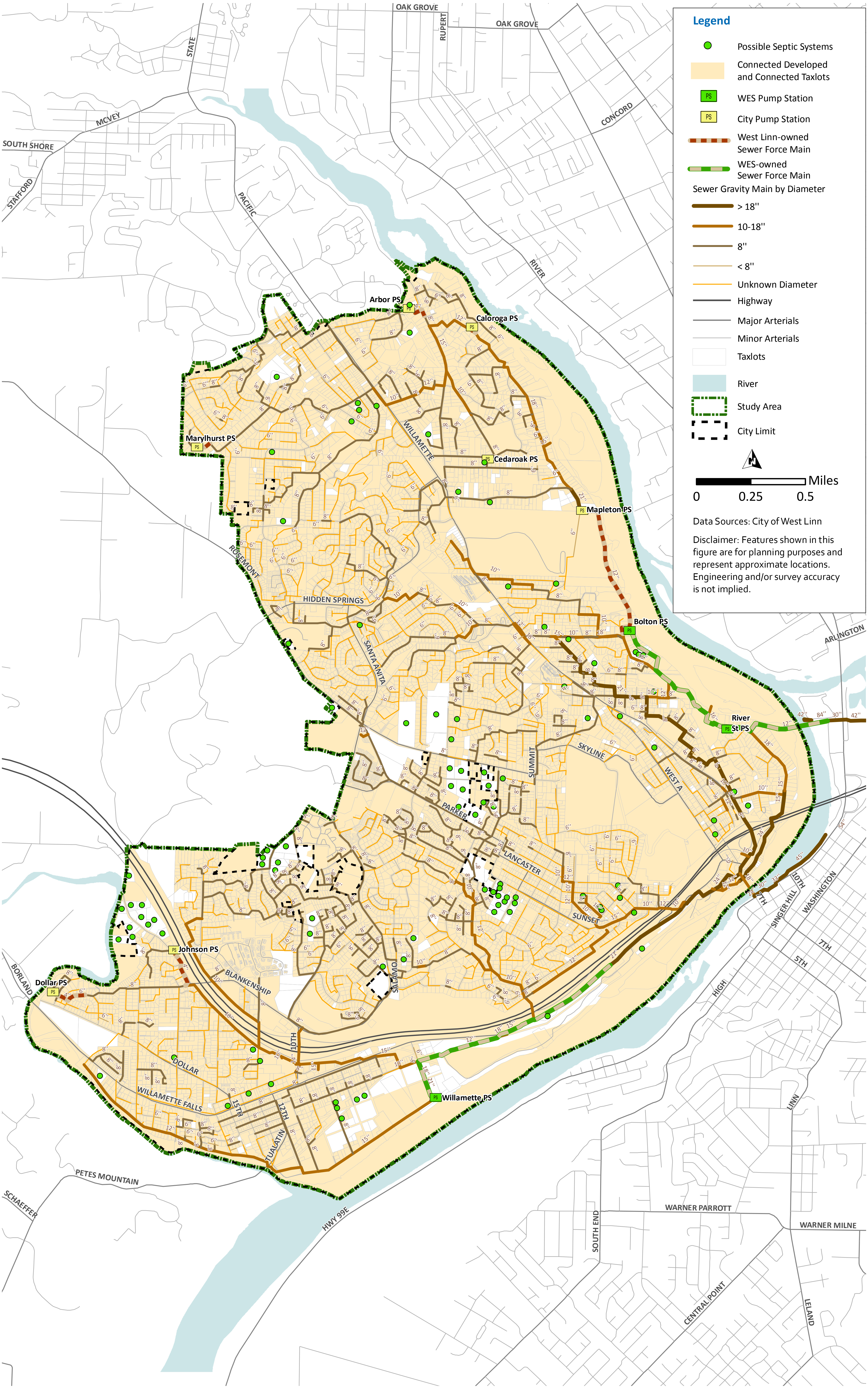

Figure 3 Existing System

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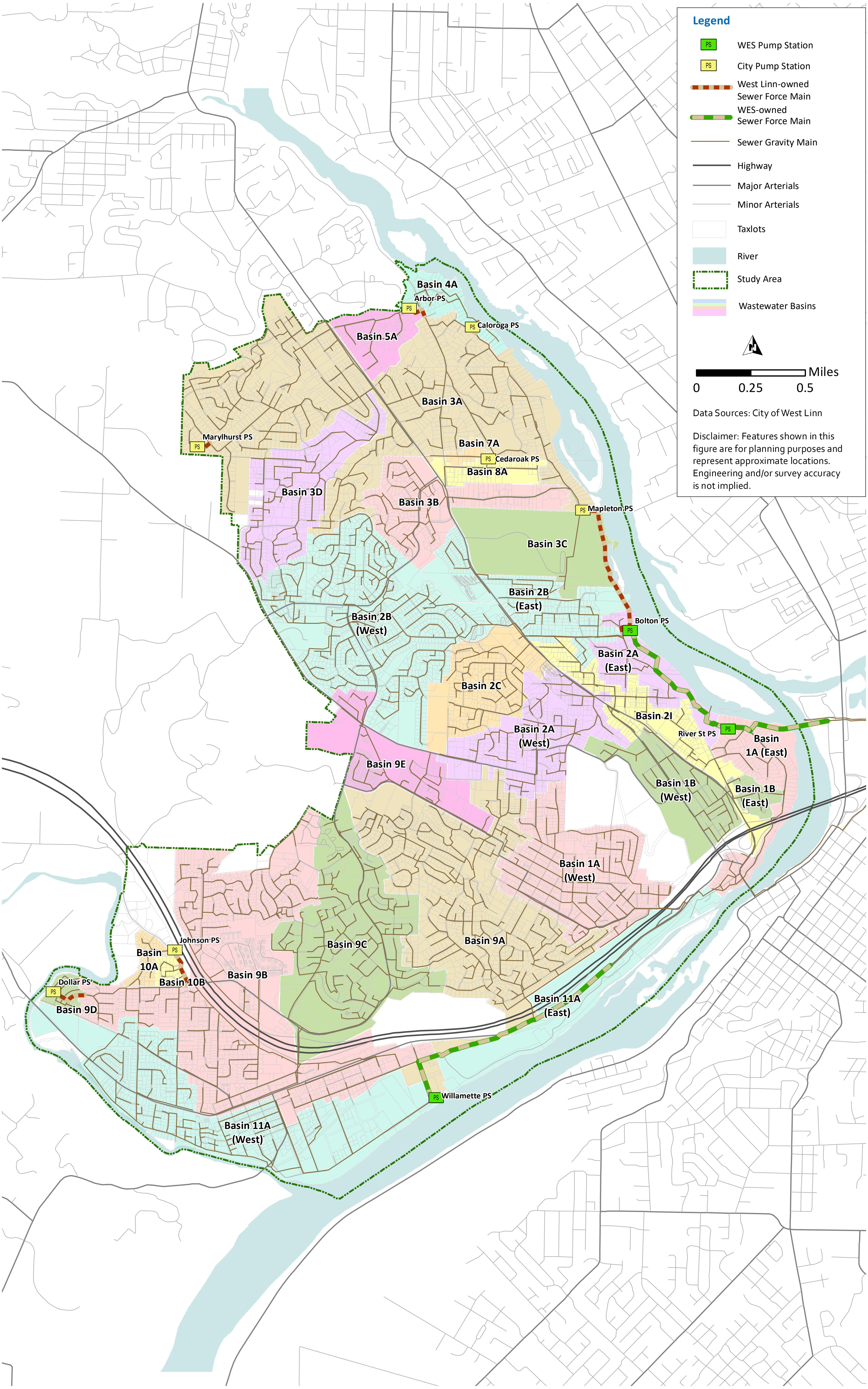

Figure 4 Wastewater Basins

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Section 3

HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

Wastewater collection system models are valuable tools used to assess the performance of collection systems during dry and wet weather conditions, and to plan for future improvements. These models provide a means to simulate the impact of different sized storms on the collection system, and determine where future system deficiencies are likely to occur. In addition, a well-calibrated model provides a method for testing alternative improvement scenarios.

A sewer collection system model is a simplified representation of the real sewer system. Sewer system models can assess the conveyance capacity for a collection system. In addition, sewer system models can perform "what if" scenarios to assess the impacts of future developments and land use changes. The City's collection system hydraulic model was constructed using a multi-step process utilizing data from a variety of sources. A hydraulic model was developed to evaluate the sanitary sewer system, with the model consisting of the City's main gravity pipelines, and all pump stations and force mains. The model was constructed in InfoSWMM, a hydraulic modeling software package, and the part of the collection system modeled is shown in Figure 5.

For this project, flow monitoring was conducted at 10 meter sites for a period of approximately nine weeks from January 2016 to March 2016. Dry weather flow (DWF) calibration ensures an accurate depiction of base wastewater flow generated within the study area. The wet weather flow (WWF) calibration consists of calibrating the hydraulic model to specific storm events to accurately simulate the peak and volume of infiltration/inflow (I/I) into the sewer system. The model was calibrated to field flow measurements. Further information on the hydraulic modeling can be found in TM 3, which is in Attachment C of this SSMP.

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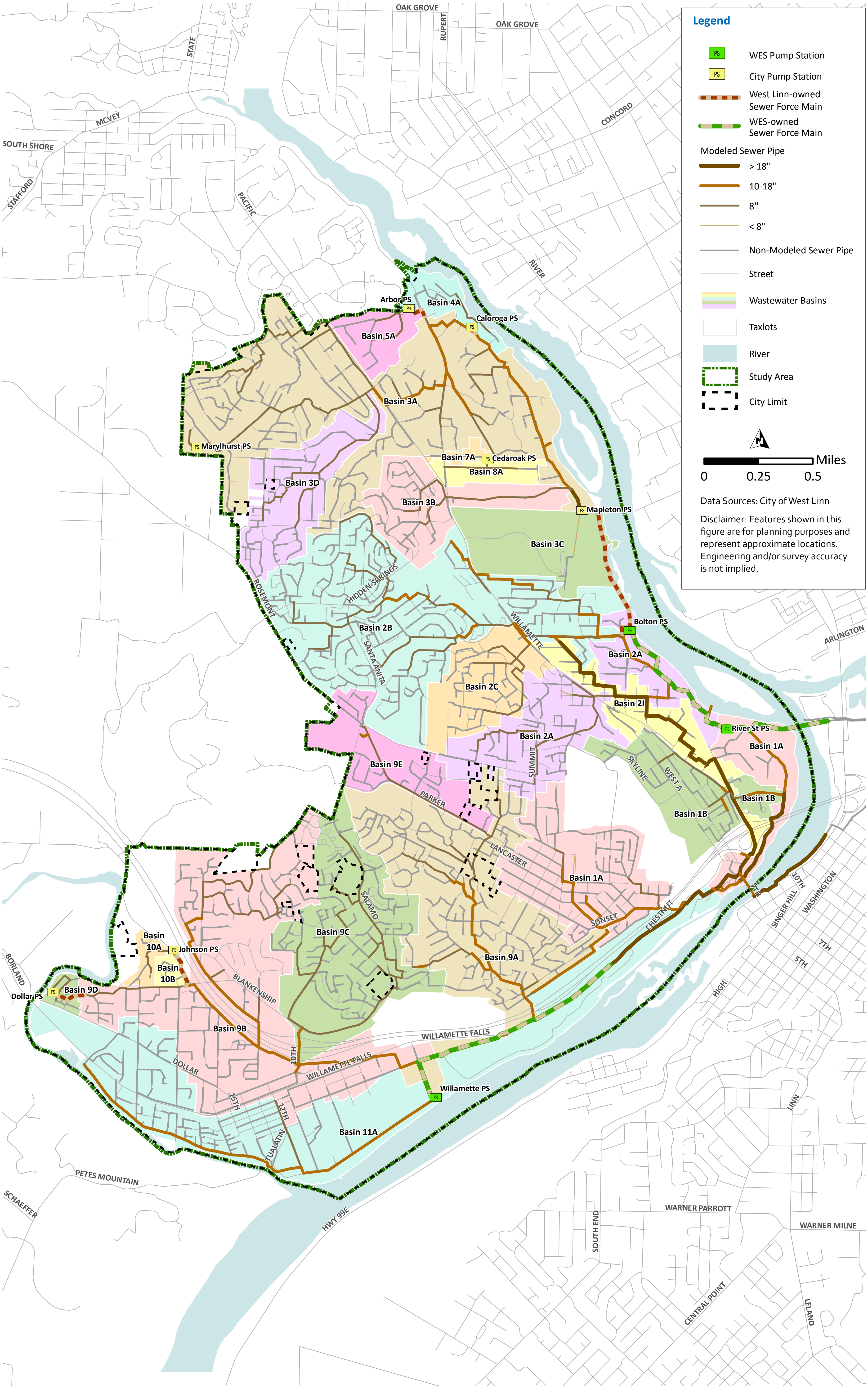

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Figure 5 Modeled Sanitary Sewer Collection System

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Section 4

CAPACITY EVALUATION AND INFLOW/INFILTRATION REDUCTION

As the City continues to grow and age, some of the City's sewer infrastructure may reach capacity for adequately handling flows. Capacity evaluation of the wastewater collection system was performed in accordance with the following criteria, using the hydraulic model developed for this SSMP:

- During Peak Wet Weather Flow (PWWF), water levels were allowed to rise no more than 1 foot above the pipe crown. Sewers were allowed to surcharge under these maximum flow conditions during the design storm. Additionally, no surcharging was allowed for shallow manholes (the difference between the manhole rim and top of pipe was less than four feet).
- Pump capacity shall be sized to handle PWWF from a tributary area with the largest pump out of service.
- The existing force mains shall have a maximum pipe velocity of 8 feet per second (ft/sec) during pumping of PWWF.
- The 5-year, 24-hour desSection4.1ign storm is used for sizing the City's sewer infrastructure. Essentially, this design storm has a five percent chance (1/20) that 3.2 inches of rain will fall in any 24-hour period in a given year, and accounts for climate change assumptions.
- It was assumed that degradation (increase in peak I/I rate) would be 7 percent per decade.

4.1 Capacity Evaluation

A capacity analysis of the modeled collection system was performed with the City's calibrated hydraulic model using the system performance criteria outlined above. I/I degradation (increase in peak I/I rate) of 7 percent per decade was the assumption used for this analysis, allowing for a conservative scenario system outcome in 20 years.

The capacity analysis identified areas in the sewer system where flow restrictions may occur or where the pipe does not have capacity to convey design flows. Sewers that lack sufficient capacity to convey design flows could produce backwater effects in the collection system that increase the risk of Sanitary Sewer Overflows (SSOs). Potential system deficiencies were identified for PWWF for existing and build-out conditions and are highlighted in Figure 6.

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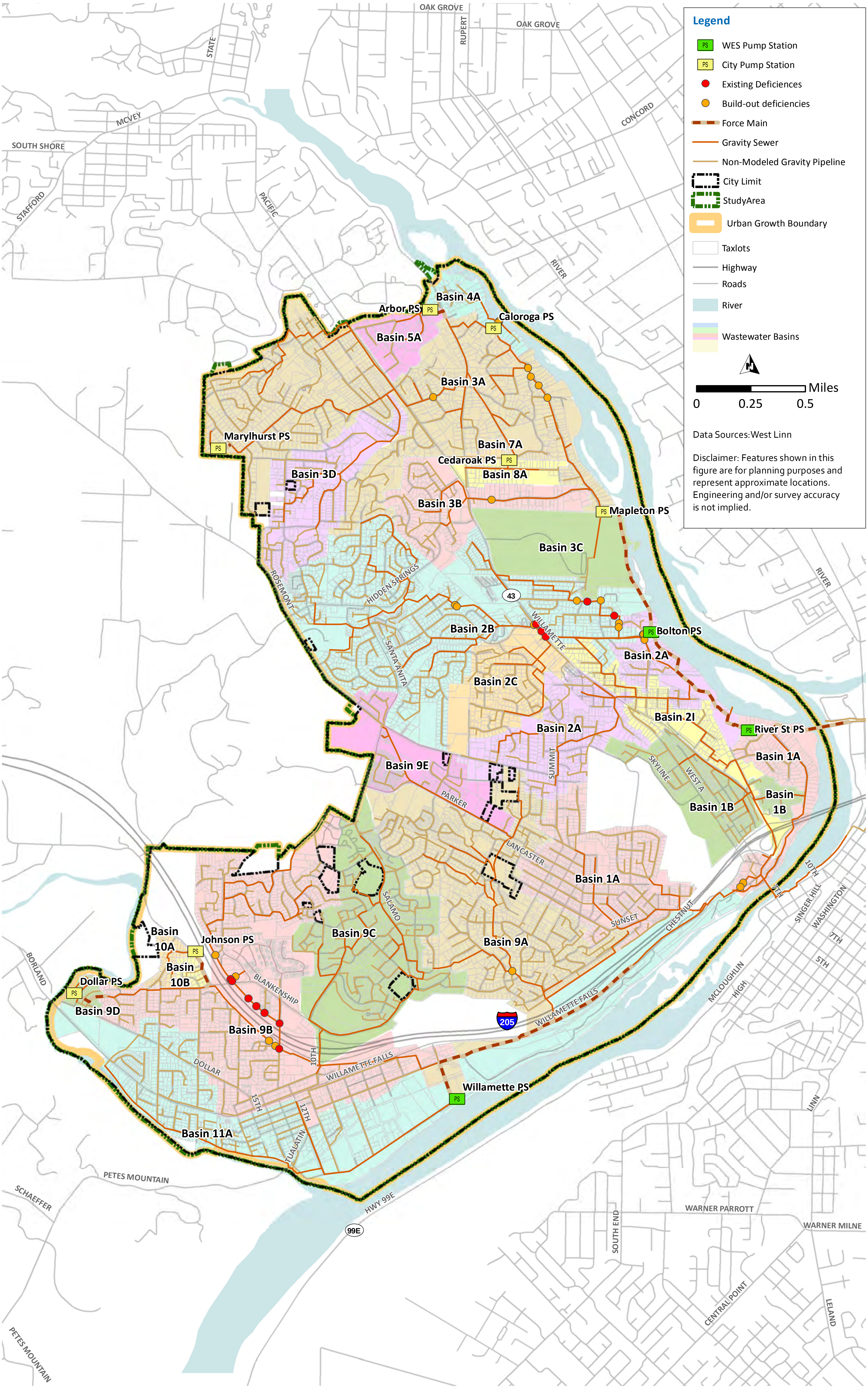

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Figure 6 Potential System Deficiencies

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Table 10 summarizes the results of the City owned pump station capacity evaluation. The total capacity and firm capacity of each pump station is compared to the projected PWWFs for both existing and build-out conditions.

As seen in Table 9, all pump stations, except for the Mapleton and Calaroga pump stations, have adequate capacity for existing and build-out conditions. Calaroga is deficient by 0.07 mgd for total capacity and 0.13 mgd for firm capacity under existing conditions.

Mapleton has adequate total capacity for existing conditions, but is deficient by 1.1 mgd under firm capacity and does not meet the City's redundancy criteria. By build-out, Mapleton will be deficient by 0.62 mgd for total capacity and 2.06 mgd for firm capacity.

In conjunction with the pump station analysis, City-owned force mains were analyzed using the hydraulic model. All force mains are adequately sized, with the exception of Mapleton. At build-out, modeled velocity in the existing force main was 8.7 fps, greater than the City's 8 fps velocity criteria. This Mapleton force main deficiency should be addressed in conjunction with capacity improvements to the Mapleton pump station.

Table 10 Pump Station Evaluation

Pump Station Name	Total Capacity (mgd)	Firm Capacity (mgd)	Existing Maximum PWWF (mgd)	Build-out Maximum PWWF (mgd)	Existing Condition Deficiency (Total/Firm) (mgd)	Build-out Condition Deficiency (Total/Firm) (mgd)
Arbor	0.55	0.27	0.13	0.14	- / -	- / -
Calaroga	0.12	0.06	0.19	0.19	0.07 / 0.13	0.07 / 0.13
Cedar Oak	0.43	0.22	0.10	0.11	- / -	- / -
Johnson	0.50	0.25	0.11	0.12	- / -	- / -
Mapleton	4.25	2.81	3.91	4.87	- / 1.1	0.62 / 2.06
Marylhurst	0.46	0.23	0.02	0.02	- / -	- / -
River Heights	0.34	0.17	0.06	0.07	- / -	- / -

4.2 Inflow and Infiltration Reduction Program

Inflow and infiltration (I/I) into the sanitary sewer system increases as degradation of the system occurs, reducing total available capacity in pipelines, pump stations, and treatment facilities. The rainfall-dependent I/I is seen immediately (inflow) or within hours after a storm (infiltration).

An important factor in the reduction of I/I in the City's system is Water Environment Services (WES)' collection system. Flows and I/I from the City and neighboring partners may trigger capacity issues for WES's pump stations, pipelines, and treatment facility. The City's capacity analysis presented above did not show significant capacity deficiencies that would trigger the need for an extensive I/I program.

WES is currently developing its sanitary sewer master plan. As part as this effort, preliminary data and flow targets were provided by WES as guidance when investigating I/I status. The preliminary data from WES correspond to peak flow estimates in 2040, assuming a 65-percent I/I reduction in select sub-basins.

I/I reduction goals for the City to meet WES' preliminary data were developed using an iterative process with the City's calibrated hydraulic model. Several iterations were simulated using a range of wastewater basins and I/I percent reduction goals.

Based on modeling results, preliminary data available from WES at the time of the development of this SMMP and high expense ($99.3 M – see details in TM No.4) to implement an I/I program to meet WES' preliminary flow targets, it is not recommended that the City pursue an extensive I/I program at this time with a full Sanitary Sewer Evaluation Survey (SSES).

Further collaboration between the City and WES to refine and clarify future assumptions and I/I reduction goals is highly recommended. The City's capacity analysis presented in Section 4.1 did not show significant capacity deficiencies in the collection system that would trigger an extensive I/I program need. Further coordination should confirm flow reduction targets and assumptions. Further investigation of the cost of treatment and conveyance versus the cost of implementing I/I reduction strategies is needed.

In the meantime, it is recommended that the City focus its CCTV and repair and replacement program in the following basins:

- Basin 1A West
- Basin 2B East
- Basin 1B West
- Basin 1A East
- Basin 2A West
- Basin 2I

Given the relatively elevated I/I parameters identified in these basins, especially Basin 1A West, it is recommended that the City prioritize these wastewater basins for condition and repair and replacement (Project G-1 in the CIP). CCTV and repair and replacement in these basins will ultimately decrease flows from I/I.

Further information on the capacity reduction and I/I reduction evaluation can be found in TM 4, which is in Attachment D of this SSMP.

Section 5

CAPITAL IMPROVEMENT PROGRAM

The purpose of the CIP is to provide the City with a guideline for planning and budgeting for improvements to its sanitary sewer system. The CIP consists of cost estimates and timing for each project. Capital projects were categorized by the nature of infrastructure:

- Pipeline Projects (P)
- Pump Stations (PS)
- General (G)

CIP projects were prioritized based on the urgency to mitigate existing deficiencies and to service anticipated growth. The CIP projects were separated into three phases based on project priority:

- High Priority (2019-2023)
- Medium Priority (2024-2028)
- Low Priority (2029-2038)

5.1 Cost Estimating Assumptions

Association for the Advancement of Cost Engineering (AACE) Class 4 estimates were used for this SSMP. Class 4 cost estimates of this type are order of magnitude estimates; actual costs may vary from these estimates by minus 30 percent to plus 50 percent.

Baseline construction costs were calculated by multiplying estimated project quantities by the unit cost.

The Estimated Construction Cost consists of the Baseline Construction Cost and the following multipliers applied to Baseline Construction Cost:

- Construction Contingency (30 percent)
- Planning Contingency (20 percent)
- Traffic Control/Utility Relocation (5 – 10 percent)

The Capital Improvement Cost consists of the Estimated Construction Cost with the following multipliers applied on top of the Estimated Construction Cost:

- Engineering/Permitting/Project Administration (25 percent)
- Construction Administration (10 percent)

5.2 Capital Improvement Program

The CIP cost estimates were developed from cost curves, information obtained from previous studies, and experience from other projects. Estimated project quantities were developed in TM 4. These costs were determined based on the City's and Carollo Engineers, Inc.'s (Carollo's) understanding of current conditions at the project locations.

All cost estimates were made using September 2018 dollars. The Engineering News-Record (ENR) U.S. 20-City Construction Cost Index for September 2018 is 11,170. Cost estimates are subject to change as the project design matures. Cost of labor, materials, and equipment may vary in the future. Details on cost estimating and assumptions can be found in TM No. 5 – CIP (Attachment E).

Table 11 summarizes the City's recommended Capital Improvement Program. The CIP is graphically shown in Figures 7 and 8.

As per Section 4.2 discussion, an extensive I/I reduction program is not recommended at this time, therefore, no I/I reduction costs are included in this CIP. It is recommended that the City target higher I/I areas as part of its ongoing pipeline replacement program (included in General (G) project costs). Further collaboration between the City and WES to refine and clarify future assumptions and I/I reduction goals is highly recommended. The City's capacity analysis presented in Section 4.1 did not show significant capacity deficiencies in the collection system that would trigger an extensive I/I program need. Further coordination should confirm flow reduction targets and assumptions. Further investigation of the cost of treatment and conveyance versus the cost of implementing I/I reduction strategies is needed.

Further information on the capacity reduction and inflow/infiltration reduction program can be found in TM 4, which is in Attachment D of this SSMP.

Table 11 CIP Overview Costs

	High Priority Cost ($)	Medium Priority Cost ($)	Low Priority Cost ($)	Total Cost ($)
Pipeline (P)	$ 2,363,000	$ 2,330,000	$ 1,320,000	$ 6,013,000
Gravity Main	$ 2,363,000	$ 1,113,000	$ 1,320,000	$ 4,796,000
Force Main	$ –	$ 1,217,000	$ –	$ 1,217,000
Pump Station (PS)	$ 1,049,000	$ 4,254,000	$ –	$ 5,303,000
Planning (PL)	$ 100,000	$ 200,000	$ 300,000	$ 600,000
General (G)	$ 5,947,000	$ 5,947,000	$ 11,895,000	$ 23,789,000
Total	**$ 9,459,000**	**$ 12,731,000**	**$ 13,515,000**	**$ 35,705,000**

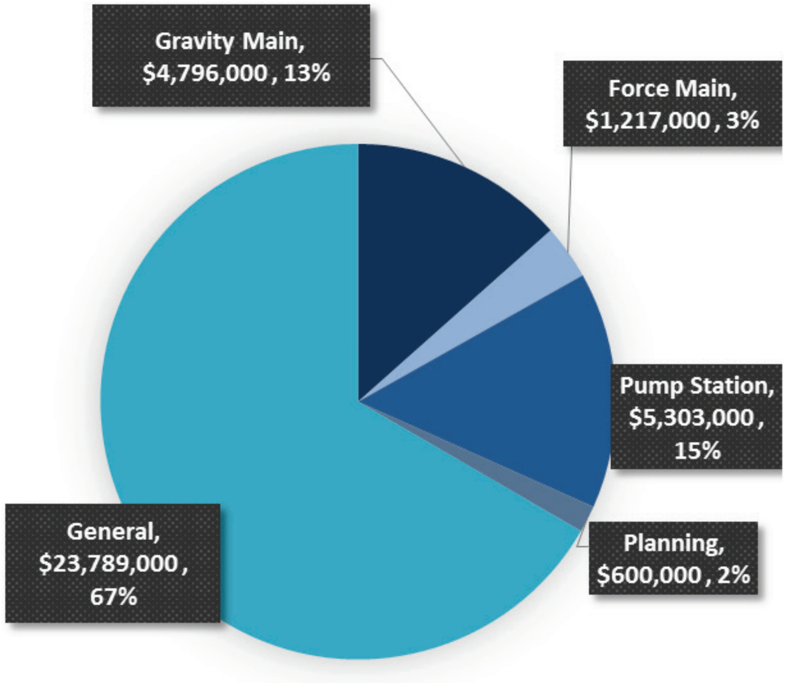

Figure 7 CIP Costs by Project Type

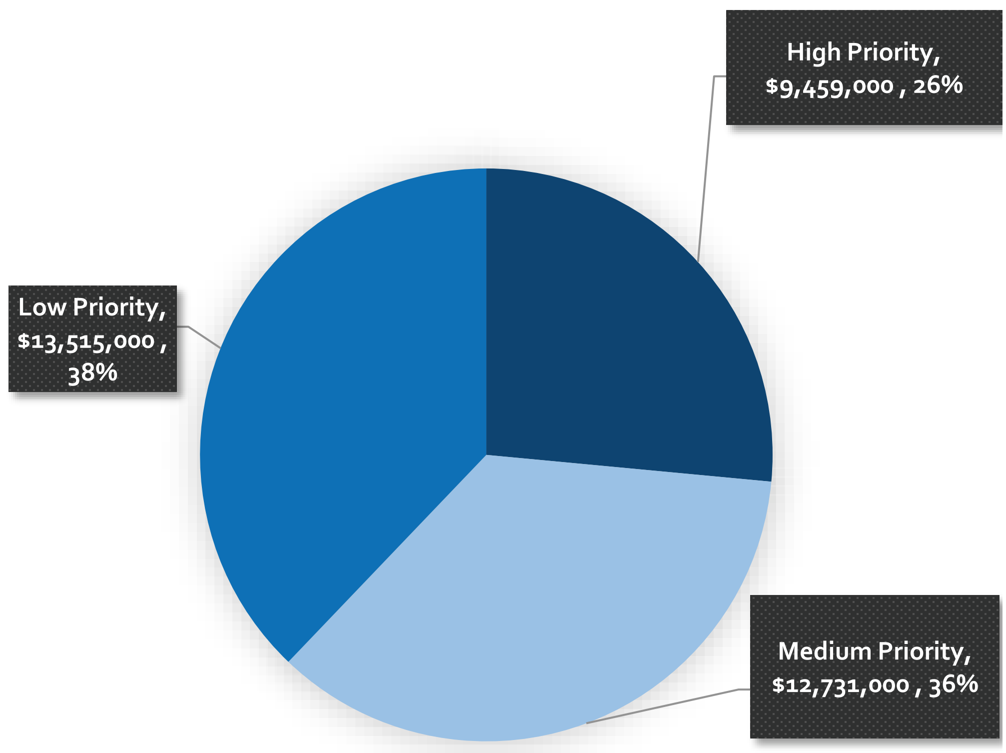

Figure 8 CIP Costs by Project Priority

5.3 Pipeline Projects

Pipeline projects are broken down into two categories: gravity main projects and force main projects. Details on both types of projects are provided below. The locations of all CIP projects are shown in Figure 9, with project prioritization shown in Figure 10.

5.3.1 Gravity Main Projects

5.3.1.1 I-205 Crossing (P-1)

The existing I-205 crossing acts as a bottleneck in the collections system due to inadequately sized pipes in the area. Hydraulic deficiencies were identified under existing conditions, and are amplified with additional flow in the basin under build-out conditions. Project P-1 is located in wastewater basin 9B and consists of upsizing 2,520 feet of existing 10-inch gravity main to 15 inch gravity main running parallel to 1-205 southwest of the Willamette Terrace Apartments and crossing I-205 at 13th Street. This includes 617 feet of highway crossing with 15-inch pipe and a 30-inch casing. This is a high priority project and is estimated to cost $2,363,000.

5.3.1.2 Wellington Drive (P-2)

Project P-2 is located in wastewater basin 9A and consists of upsizing 425 feet of existing 10-inch gravity main to 12-inch gravity main crossing Wellington Drive near the intersection of Wellington Drive and Wellington Court. This project resolves a deficiency identified under the build-out condition. This section of pipe is identified as deficient mainly due to a relatively flat slope section, which causes the hydraulic grade line (HGL) to rise above the one-foot above pipe crown criteria. No deficiencies are identified under existing condition, therefore, it is recommended that the City monitor this area as flows increase and system degrades in the future.

This is a low priority project to be addressed in the long-term and is estimated to cost $147,000.

5.3.1.3 Willamette Drive (P-3)

Project P-3 is located in wastewater basin 2B and consists of upsizing 614 feet of existing 12-inch gravity main to 15-inch gravity main along Willamette Drive between Magone Lane and Pimlico Drive. In addition, 69 feet of 15-inch gravity main is to be upsized to 18-inch gravity main along Dillow Drive from Willamette Drive to Tulane Street. This project resolves deficiencies identified under existing conditions due to relatively flat slopes for both sections of pipe. Both sections of pipe are surrounded by steeper sections upstream and downstream, a configuration that typically triggers the HGL to rise in the flat portions of the system.

This is a medium priority project and is estimated to cost $269,000. Note, this project is located in a basin (wastewater basin 2B), where an I/I reduction program might mitigate the need for this improvement.

5.3.1.4 Palomino Circle (P-4)

Project P-4 is located in wastewater basin 2B and consists of upsizing 508 feet of existing 8-inch gravity main running northwest of Palomino Circle and north of Pimlico Drive to the main southeast of Bronco Court to 12-inch gravity main. This section of pipe was identified as deficient under build-out conditions, with the deficiency caused mainly by a relatively flat slope section that causes the HGL to rise above the one-foot above pipe crown criteria.

This is a low priority project to be addressed in the long-term and is estimated to cost $175,000.

5.3.1.5 Larson Ave (P-5)

Project P-5 is located in wastewater basin 2B and consists of upsizing 1,162 feet of existing 8-inch gravity main to 12-inch gravity main along Larson Avenue from Tulane Street to Jolie Point Road and along Jolie Point Road to Munger Drive. This section of pipe was identified as deficient under existing conditions, with the deficiency caused mainly by a relatively flat slope section that causes the HGL to rise above the one-foot above pipe crown criteria. Additionally, modeling shows that the entire section is capacity deficient based on PWWF. I/I degradation and development are anticipated to amplify this problem.

This is a medium priority project and is estimated to cost $401,000. Note, this project is located in a basin (wastewater basin 2B), where an I/I reduction program might be recommended that could mitigate the need for this improvement.

5.3.1.6 Dillow Drive and Maple Terrace (P-6)

Project P-6 is located in wastewater basin 2B and consists of upsizing 351 feet of existing 10-inch gravity main to 15-inch gravity main between Dillow Drive and Maple Terrace. This project is triggered by deficiencies highlighted in the existing condition, and deficiencies are anticipated to be amplified once project P-5 is completed and with the addition of flows caused by growth and system aging. Additionally, this section of pipe is relatively flat, which causes the HGL to rise up quickly.

This is a medium priority project and is estimated to cost $132,000. Note, this project is located in a basin (wastewater basin 2B), where an I/I reduction program might be recommended that could mitigate the need for this improvement.

5.3.1.7 Nixon Ave (P-7)

Project P-7 is located in wastewater basin 3A and consists of upsizing 1,522 feet of existing 18-inch gravity main to 24-inch gravity main along Nixon Avenue from north of Island View Way to Calaroga Court. This project is triggered by deficiencies identified under build-out conditions. The City's effort to relining sewer lines in wastewater basin 3A decreased I/I rates in the northern part of the system significantly. The previous Master Plan, completed prior to these upgrades, showed high I/I and deficiencies in this area. It is recommended that the City monitor this area as the system degrades over time.

This low priority project is recommended for the long-term and is estimated to cost $876,000.

5.3.1.8 Fairview Way (P-8)

Project P-8 is located in wastewater basin 3A and consists of upsizing 160 feet of existing 10-inch gravity main to 12-inch gravity main along Fairview Way between Rose Way and Chippewa Court. This project addresses deficiencies identified under build-out conditions.

This is a low priority project and is estimated to cost $55,000.

5.3.1.9 Failing Street (P-9)

Project P-9 is located in wastewater basin 2A and consists of upsizing 160 feet of existing 12-inch gravity main to 18-inch gravity main from Failing Street to the Bolton Pump Station. This project addresses deficiencies identified under build-out conditions. It is recommended the City monitor this area as the system grows and degrades over time.

This low priority project is estimated to cost $67,000.

5.3.1.10 Mill Street (P-10)

Project P-10 consists of relocating the sewer line in the vicinity of Mill Street, as shown in Figure 9. As the properties between WFD and Mill Street redevelop, this section of sewer line needs to be upgraded and realigned to the street right-of-way. This project will be part of the waterfront line project. Modeling shows no capacity issues with the existing pipe diameter, therefore, the recommendation is to replace it with the same diameter. However, when this project is triggered, this project should be evaluated in more detail and confirm pipe size and alignment. This project is anticipated as a medium priority project and is estimated to cost $311,000.

5.3.2 Force Main Projects

5.3.2.1 Mapleton Force Main (P-11)

Project P-11 is located in wastewater basin 3A and consists of constructing 3,750 linear feet of 8-inch force main running parallel to the existing 12-inch force main from the Mapleton Pump Station to the Bolton Pump Station. Under build-out, velocities in the force main exceed the City's criteria of 8 fps under PWWF conditions, and is considered to be deficient.

This is a medium priority project, to be completed in conjunction with the Mapleton PS improvements, and is estimated to cost $1,217,000.

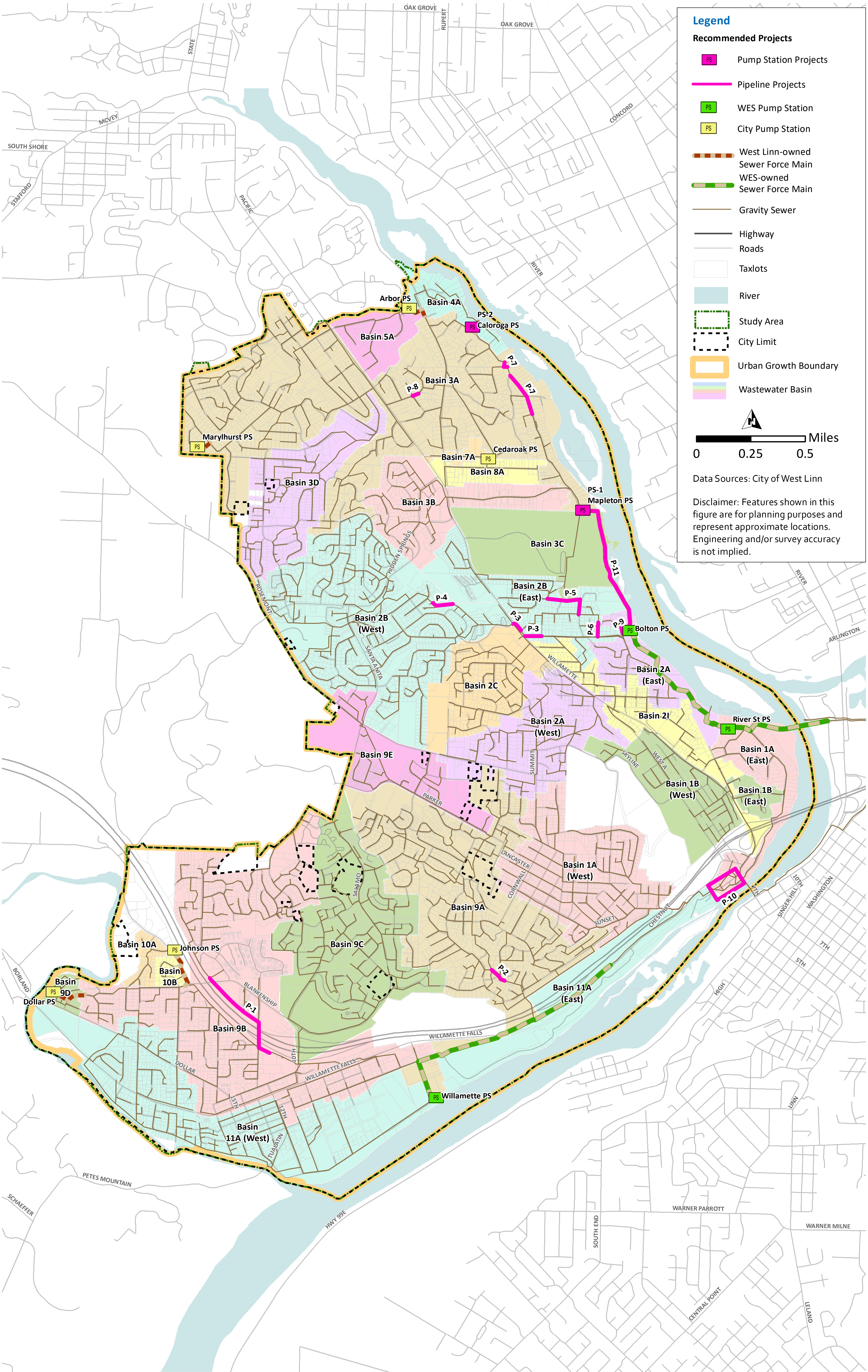

Figure 9 Recommended CIP Projects

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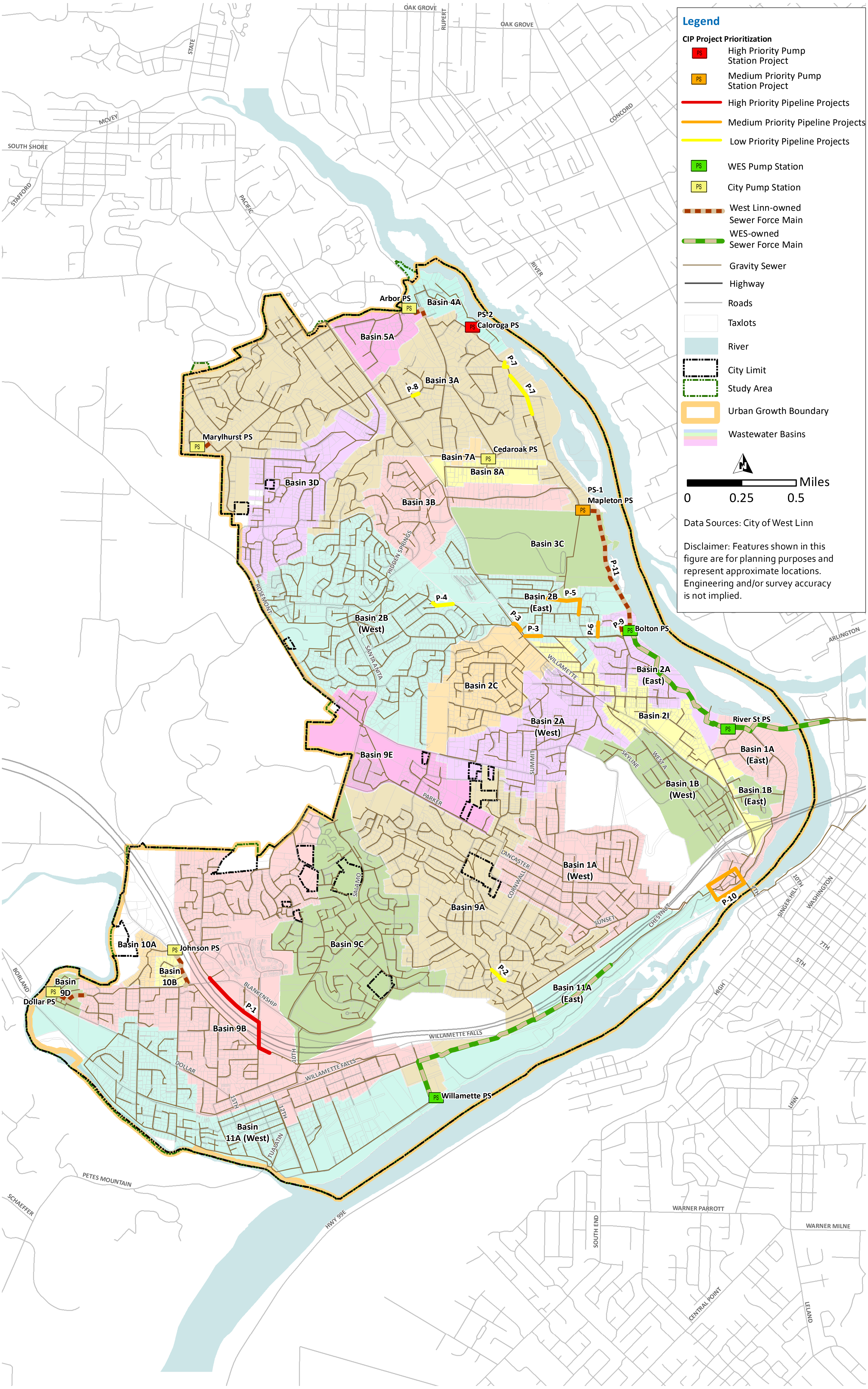

Figure 10 CIP Project Prioritization

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5.4 Pump Station Projects

5.4.1 Mapleton Pump Station (PS-1)

Project PS-1 consists of upgrading Mapleton Pump Station capacity from an existing 2.81 mgd (firm)/4.25 mgd (total) to 4.87 mgd firm capacity. This medium priority project is needed for the City to meet an existing firm capacity deficiency of 1.1 mgd and to provide sufficient capacity for build-out. Prior to completing this project, the City should evaluate the condition of this pump station and install a flow meter to better understand flow trends.

It is assumed this project will be completed in conjunction with the Mapleton force main project, and is estimated to cost $4,254,000.

5.4.2 Calaroga Pump Station (PS-2)

Project PS-2 consists of constructing a new pump station to increase Calaroga Pump Station capacity from an existing 0.06 mgd (firm)/0.12 mgd (total) to 0.19 mgd (firm)/0.40 mgd (total). A new pump station is recommended to address existing firm and total capacity deficiencies and existing issues with this pump station.

This project is estimated to cost $1,049,000.

5.5 Planning Projects

5.5.1 Asset Management Program (PL-1)

The City should develop an Asset Management Program (AMP) to assist in prioritizing repair and replacement of its aging wastewater infrastructure. Developing an asset management plan will help the City find the optimal timing for repair or replacement (R&R) of assets by weighing the costs of continued maintenance against the cost of R&R. Development of this SSMP will help prioritize projects to reduce operation and maintenance risks resulting in lower overall costs burdened by ratepayers.

It is recommended the City take the following initial steps to prepare for implementing an AMP:

- Continue to update data such as pipe material, year installed, and invert elevations, in the City's Geographic Information Systems (GIS) and Computerized Maintenance Management Software.
- Standardize condition assessments and closed-circuit television (CCTV) reports using the Pipeline Assessment and Certification Program (PACP). This may entail working with non-City contractors performing CCTV inspections. City staff could be trained on PACP scoring.
- Take the Strategic Asset Management Gap (SAM-GAP), a free, online utility self-assessment tool.

No project costs are included for these recommendations, as they are assumed to be performed by current City staff. In addition to these steps, the following strategy is recommended for the City to develop and implement an AMP:

1. Assess the City's Current Asset Management Practices.
2. Review Appropriate Asset Management Tools.
3. Identify and Prioritize Gaps in Current Asset Management Practices.
4. Prepare an Asset Management Plan.
5. Implement the Asset Management Plan.

It is anticipated full development and implementation of steps 1 through 5 will cost between $75,000 and $200,000. The more conservative estimate of $200,000 was used for planning in the CIP. Costs for implementing the projects prioritized by the AMP are assumed to come from other annual repair budgets. Development of the AMP was assumed to a medium priority project.

5.5.2 Sanitary Sewer Master Plan Update (PL-2)

This project assumes the City will update this Sanitary Sewer Master Plan one time in the long-term planning period. A long-term budget placeholder of $300,000 was included, with no contingencies or cost multipliers applied.

5.5.3 Pump Station Condition Evaluation (PL-3)

Although a capacity assessment was completed as part of this SSMP effort, it is recommended that the City perform a condition assessment on the City's pump stations. This project is recommended for the short-term, and a budget cost of $100,000 was assumed with no contingencies or cost multipliers applied.

5.6 General Projects

5.6.1 Repair and Replacement Program (G-1)

This project allocates an annual budget of $750,000 to be used for pipeline R&R projects to effectively replace aging or failing pipe, which equates to approximately one mile of pipe per year. Projects will be identified by City staff annually, including projects identified as part of the AMP. To more cost-effectively address pipeline R&R projects, the City should consider geographically concentrated projects that address multiple concerns and incorporate other utilities, such as water main projects or roadway resurfacing, and focus on areas with high inflow/infiltration.

5.6.2 CCTV Program (G-2)

It is recommended that the City implement an Annual program for CCTV inspection of the City's gravity mains. This program will help the City determine pipeline condition and identify potential sources of I/I. It is assumed that the City will inspect 10 percent of the system per year, approximately 60,000 linear feet of pipeline per year. An annual budget of $440,000 was allocated throughout the planning period for this effort, assuming a unit cost of $3.50/LF for CCTV.

Further information on the capital improvement program can be found in TM 5, which is in Attachment E of this SSMP.