

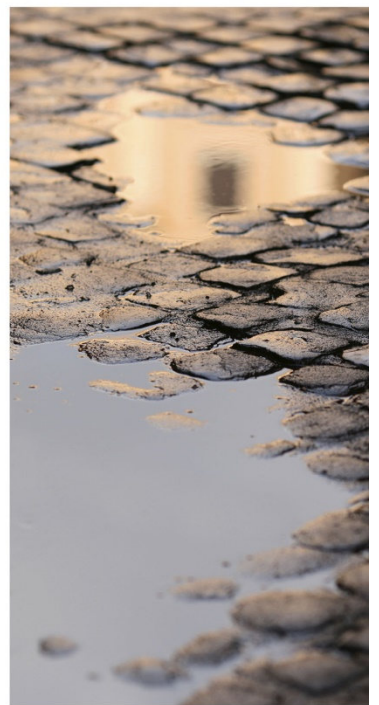
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Planning Commission Review



# CITY OF West Linn

## Storm Drainage Master Plan

DRAFT FINAL // SEPTEMBER 2019



**Brown AND Caldwell**



# West Linn Storm Drainage Master Plan

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Prepared for  
City of West Linn, Oregon  
September 2019

This is a draft and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.

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## List of Abbreviations

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ac	acre
BC	Brown and Caldwell
BMP	best management practice
C	Capacity projects (capital planning)
CCTV	closed-circuit television
CDC	Community Development Code
CIP	capital improvement project
City	City of West Linn
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
G	general/asset management (capital planning)
GIS	geographic information system
H/H	hydrologic and hydraulic
Highway 43	Oregon Highway 43
HSG	hydrologic soil groups
I&I	inflow and infiltration
I	Addition projects (capital planning)
IGAs	intergovernmental agreements
LF	linear foot/feet
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
ODOT	Oregon Department of Transportation
P	Planning projects (capital planning)
PCB	polychlorinated biphenyl
Plan	Storm Drainage Master Plan
R	Erosion projects (capital planning)
R/R	repair and replacement
SMP	Storm Drainage Master Plan
SOPs	standard operating procedures
SWMP	Stormwater Management Plan
TMDL	total maximum daily load
UGB	Urban Growth Boundary
WLMC	West Linn Municipal Code



# Executive Summary

In 2017, the City of West Linn (City) initiated development of a multi-objective storm drainage master plan to guide stormwater and drainage-related capital project, program, and policy needs over a 10-year planning period. Efforts were initiated due to the outdated nature of the City’s previous Surface Water Management Plan (dated 2006), an increased focus on water quality in conjunction with the changing regulations and observed system deficiencies warranting additional study.

This 2019 Storm Drainage Master Plan (Plan or SMP) [is a supporting document to the City’s Comprehensive Plan and](#) provides an overview of [stormwater-drainage system improvements needs](#) to address future growth, water quality, maintenance/system condition issues, and capacity issues. [The City’s overall storm drainage system is composed of piped and open channel \(e.g., ditches, creeks\) conveyances, in addition to collection, treatment, and detention facilities for stormwater management.](#) The [master](#) planning process included the following steps:

- Evaluate City code related to stormwater management, to define planning and design criteria and identify implementation gaps.
- Identify, investigate and study known problem areas.
- Create hydrologic and hydraulic (H/H) models to evaluate storm drainage system capacity for key problem areas.
- Identify implementation priorities and associated costs.
- Develop an integrated storm drainage capital improvement program to address capacity, water quality, and maintenance needs.
- Develop a Plan that is useful and easy to read, reference, and update.

## Master Plan Technical Analyses

Development of this SMP included the following technical analyses to evaluate stormwater system deficiencies and define project, program, and policy needs.



**Code Evaluation.** This effort included review of code and standards applicable to this SMP, as contained in the City’s Municipal Code (WLMC), Public Works Standards (PWDS), Construction Specifications, and Community Development Code (CDC). Elements of the code review included conveyance, water quality, erosion and sediment control, maintenance, and code enforcement.



**Project Needs Assessment.** This effort included the distribution of surveys to the City and public, a GIS data review, site visits, a maintenance assessment, and meetings/workshops with City staff. Information collected resulted in development of a robust inventory of problem areas specific to stormwater infrastructure and stormwater facilities. Problem areas were reviewed to identify locations in need of further analysis or study.



**Water Quality Assessment.** Water quality opportunity areas were initially identified using a desktop GIS analysis to assess high pollutant generating land use areas (i.e., industrial or commercial), existing stormwater facility placement, and publicly-owned areas with potential to incorporate water quality. Site visits were conducted, and water quality opportunity areas compared with problem areas to see if an integrated approach to stormwater management (i.e., installation of water quality facilities to mitigate stormwater runoff) could address a reported issue.



**Targeted Stormwater Drainage System Capacity Evaluation.** Hydrologic and hydraulic (H/H) modeling to simulate rainfall and runoff characteristics was conducted for targeted areas of the City. The models simulate stormwater flow through pipe networks, drainage ditches, and culverts to identify capacity limitations under current and future development conditions.

## General Recommendations

Project, program and policy recommendations in this SMP are proposed to improve and enhance drainage infrastructure and water resources throughout the City, as summarized by the following recommended actions.

- Implement identified system capacity improvements (i.e., reconfiguration, rerouting, upsizing) to manage more frequent, nuisance system flooding.
- Increase water quality treatment throughout the City by expanding treatment area coverage and enhancing the level of treatment provided in existing facilities.
- Incorporate LID or green infrastructure to expand water quality treatment in locations where utility improvements or transportation-related/pedestrian improvements are anticipated.
- Incorporate system configuration and condition data (i.e., stormwater facility inspection records, closed-circuit television [CCTV], survey) into a larger asset management program to allow for proactive maintenance, repair, and replacement of stormwater infrastructure.
- Conduct regular updates to the WLMC and PWDS to ensure clear guidance is provided to the development community and is consistent with regulatory requirements.
- Establish city policies to address beaver management as pertaining to local flooding issues.
- Clearly document capital project and program costs and schedule to inform future funding and rate analyses.

## Capital Improvement Program

Project, programmatic, and policy recommendations in this SMP represent an integrated strategy to address storm drainage needs in the City. Recommendations include 26 capital projects and 5 city-wide programmatic efforts. Policy recommendations are based on the code evaluation and support project and programmatic needs.

### Project and Program Summary

Capital projects address current and future stormwater infrastructure needs as a one-time project cost. Capital projects are categorized as capacity projects (C), infrastructure improvement and addition projects (I), water quality and erosion control projects (R), and planning projects (P).

Program recommendations address city-wide system repair and replacement (R/R) needs, routine system maintenance, and ongoing and opportunistic water quality retrofits. Program recommendations are categorized as general/asset management (G) and reflect an annual cost need.

Project and city-wide program objectives include:

- Increase system capacity (flood control)
- Improve system configuration
- Add infrastructure
- Increase water quality treatment (retrofit)
- Prevent erosion
- Address maintenance need

Table ES-1 summarizes the estimate cost and priority of identified capital projects and city-wide programs. Costs are provided for high and medium priority needs, which are anticipated for implementation over the 10-year SMP implementation timeframe. Lower priority project needs are listed for reference, but no cost provided.

Figure ES-1 shows the location of the proposed capital projects and programs, highlighting those considered a priority need.

### **Policy Recommendations**

Policy recommendations are provided to 1) support future updates to technical design standards for stormwater systems, and 2) outline beaver management strategies to address beaver activity as related to localized stormwater system flooding.

Updated technical design standards would help support water quality improvement efforts by specifying approved stormwater facility types and design criteria to address specific pollutants of concern for the City. Establishing and documenting beaver management strategies would help mitigate beaver activity in susceptible stream channels as it contributes to the deficiencies in the City's stormwater collection and conveyance system.

Policy recommendations should be addressed with future updates to the WLMC, CDC, PWDS, or addressed through internal directives.

<b>Table ES-1. Capital Project and Program Summary</b>				
Project Number	Project Name	Prioritization and Implementation Schedule		
		2019-2028 One-time Cost (High/Medium Priority)	2019-2028 Annual Cost (Medium Priority)	Future (Low Priority)
<b>Capacity Projects</b>				
C-1	Phase I Highway 43 Culvert Replacements	\$1,045,000		
C-2	5 <sup>th</sup> Avenue Culvert Replacement	\$847,000		
C-3	Sunset Creek at Willamette Falls Drive Culvert Replacement	\$282,000		
C-4	Maddox Creek at River Street Culvert Replacement	\$385,000		
C-5	Phase II Highway 43 Culvert Replacements			X
C-6	Kantara Way Capacity Deficiency			X
<b>Infrastructure Projects</b>				
I-1	Blankenship Road Improvements	\$856,000		
I-2	Mark Lane Improvements	\$1,092,000		
I-3	Buck Street Improvements	\$966,000		
I-4	Fairview Way Pipe Relocation	\$1,620,000		
I-5	Nixon Avenue Pipe Relocation	\$174,000		
I-6	Sunset Avenue Improvements	\$1,593,000		
<b>Retrofit Projects</b>				
R-1	Public Pond #22 Retrofit (Katherine Court)	\$89,000		
R-2	Mary S Young Park Parking Lot Retrofit	\$2,075,000		
R-3	West Linn Public Works Department Planters	\$174,000		
R-4	Mary S. Young Park Erosion Measures			X
R-5	Mary S. Young Park Trillium Creek Restoration			X
R-6	Mary S. Young Park Fish Restoration			X
R-7	Arbor Creek Culvert Hydromodification Improvements			X
R-8	Willamette Park Parking Lot Retrofit			X
R-9	Public Pond #18 Retrofit			X
<b>Planning Projects</b>				
P-1	Tannler <del>Open Ditch Drive</del> /Bernert Creek Basin Feasibility Study	\$20,000		
P-2	Fish Passage Evaluation	\$20,000		
P-3	<del>Surface Water</del> Storm Drainage Master Plan Update	\$300,000		
P-4	Asset Management Program Development	\$150,000		
P-5	Stormwater System Survey	\$300,000		
<b>City-wide Programs</b>				
G-1	CCTV Program		\$344,000	
G-2	Repair and Replacement (R/R) Program		\$750,000	
G-3	Inlet Installation and Replacement Program		\$25,000	
G-4	Public Pond Maintenance Program		\$100,000	
G-5	Green Street Pilot Program		\$50,000	
<b>TOTAL (One-time Project Cost)</b>		<b>\$11,988,000</b>		
<b>TOTAL (Annual Program Cost)</b>		<b>\$1,269,000</b>		

**Figure ES-1. Capital Improvement Program overview**

## Section 1

# Introduction

The City of West Linn (City) developed this Storm Drainage Master Plan (SMP or Plan) to guide stormwater and drainage-related capital project, program, and policy decisions over a 10-year planning period.

The City's overall storm drainage system includes piped and open channel (e.g., ditches, creeks) conveyances, in addition to collection, treatment and detention facilities for stormwater management. There are 21 tributary creeks and streams (surface water bodies) that convey a majority of stormwater runoff from developed portions of the City to the Willamette River and Tualatin River. Thus, this SMP collectively considers both piped and open channel conveyances as part of the overall storm drainage system. This SMP addresses water quantity and quality for constructed drainage systems under the City's management.

The City manages approximately 123 miles of piped and open channel storm drainage infrastructure. The City is primarily developed, with limited potential for growth (based on the current urban growth boundary [UGB]) and moderate potential for infill or redevelopment. As such, the City needs a proactive plan to address existing capacity deficiencies, failing infrastructure, and regulatory drivers related to water quality improvement.

This Plan documents the process and methods used to evaluate the City's storm drainage infrastructure. Results of the evaluation provide the City with projects, programs, and policies for implementation.

## 1.1 Storm Drainage Master Plan Objectives

The City's overarching goal for this SMP is to guide storm drainage infrastructure improvements over a 10-year implementation period. Improvements must address water quality, maintenance/system condition issues, and capacity issues into the future. Specific objectives of the City's SMP include the following:

- Establish a foundation for evaluating stormwater needs in West Linn.
- Solicit information from staff and stakeholders to inform the targeted and integrated identification of project needs and improvements.
- Identify known areas of storm drainage problems and flooding and provide project solutions related to collection, conveyance, treatment and detention.
  - Develop targeted hydrologic and hydraulic (H/H) models to evaluate system capacity based on current system information as obtained from the City's GIS and survey.
  - Assess the frequency of nuisance flooding based on developed H/H models.
- Enhance and expand water quality treatment throughout the City by improving existing treatment system functionality and implementing opportunistic retrofits to expand treatment area coverage within the City.
- Identify programmatic opportunities to address maintenance activities, system condition deficiencies, and water quality on a city-wide scale.

This Plan is intended to support regulatory directives under the City's Phase I National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) Permit (Permit). The City is required to meet stormwater-related permit obligations as documented in their Stormwater Management Plan (SWMP) and referenced in intergovernmental agreements (IGAs), standard operating procedures (SOPs) and technical documents.

## 1.2 Background and Related Studies

The City's last storm drainage master plan was completed in 2006 (2006 Plan). Since 2006, identified capital projects have not consistently been implemented. Per objectives at the time, projects were primarily identified based on modeled system capacity deficiencies, specifically culverts. Projects were not prioritized in conjunction with observed deficiencies or City maintenance objectives. Project needs identified in the 2006 Plan require validation and update.

Various planning-level reports and studies prepared since the 2006 Plan were obtained during the development of this SMP to help inform areas of observed stormwater problems and potential project needs. Reports and studies reviewed and considered for this SMP are listed in Table 1-1.

Table 1-1. Existing Stormwater Planning Documentation and Reports		
Report	Date	Summary and application to the SMP
West Linn Surface Water Management Plan	2006	Provides background information and historic basis for the need to update the SMP.
West Linn Stormwater Management Plan	2012	Summarizes programmatic and maintenance activities related to the implementation of the City's Phase I NPDES MS4 permit.
Stormwater Retrofit Plan for the City of West Linn	2015	Provides documentation of the City's retrofit strategy, which includes proposed stormwater pond retrofits and culvert retrofits.
Hydromodification Assessment	2015	Provides a summary of instream channel conditions and hydromodification indicators. Field notes and photo logs documenting system conditions are included. Project and policy needs are identified.
West Linn Transportation System Plan	2016	Identifies transportation improvement project needs including pedestrian improvements that may be coordinated with stormwater infrastructure or green street development activities.

## 1.3 SMP Development Process

The City developed this SMP using a collaborative approach with engineering and maintenance staff and the public to initially assess known storm drainage problem areas and identify areas where infrastructure addition, replacement, or retrofit is needed to address an issue. Individual assessment efforts to evaluate capacity limitations, water quality opportunities, and develop project concepts were conducted following this initial planning process. Capital project and program needs were prioritized prior to development of project and program costs. This overall process allowed the City to focus resources and develop information for areas and projects most likely to be prioritized in a capital improvement program.

Figure 1-1 outlines the approach used to develop this Plan. Detail related to specific assessment efforts can be found in the following technical memorandums, included in this Plan as appendices.

- Technical Memorandum #1 (TM1) - Stormwater Basis of Design and Code Review
- Technical Memorandum #2 (TM2) - Stormwater Basis of Planning
- Technical Memorandum # 3 (TM3) - Hydrology and Hydraulic Modeling Methods and Results

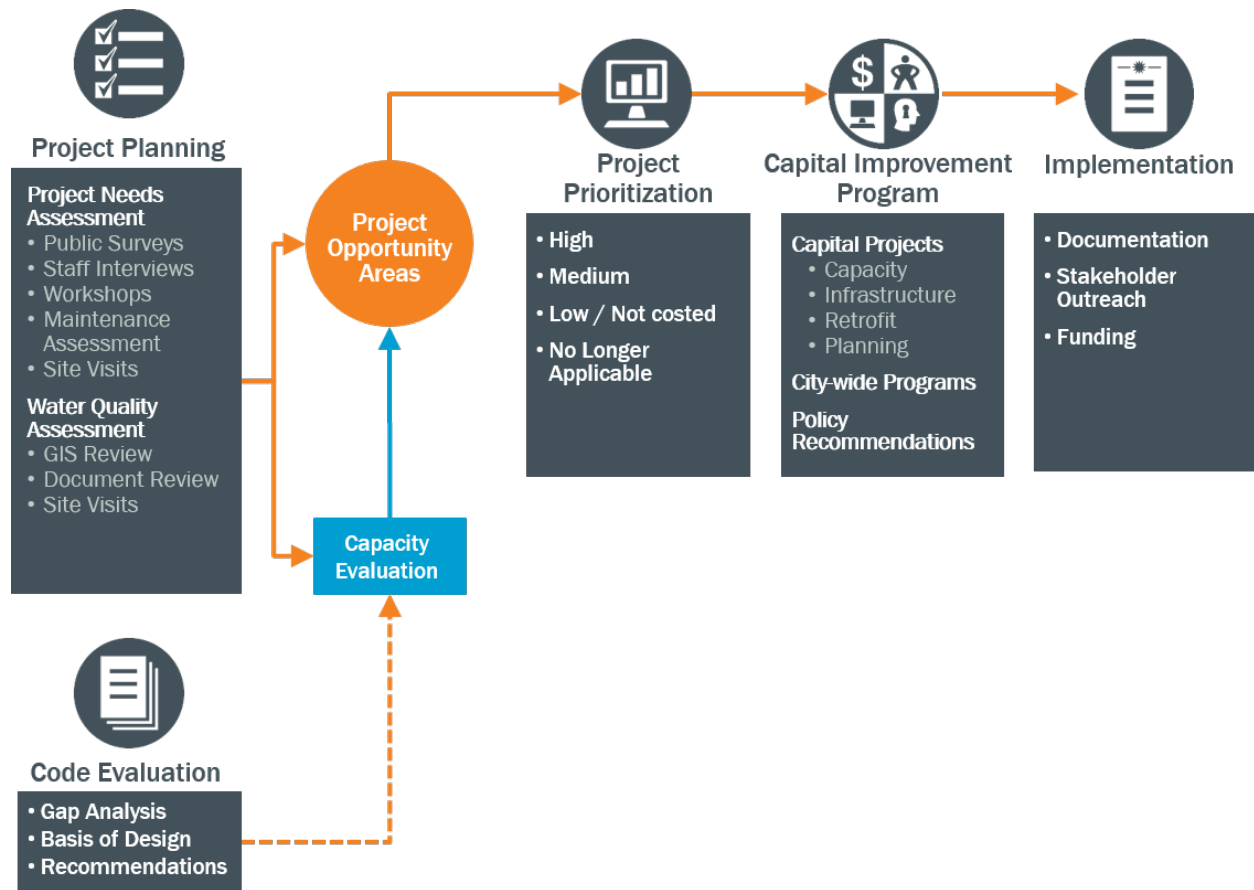


Figure 1-1. Storm Drainage Master Plan approach

## 1.4 Document Organization

Following this introductory Section 1, this SMP is organized as follows:

- Section 2 includes a description of the study area characteristics.
- Section 3 summarizes the stormwater code evaluation and determination of design criteria to serve as the basis of design.
- Section 4 summarizes the planning process including the project needs assessment (identification of stormwater problem areas) and the water quality assessment. Project Opportunity Areas stemming from the planning process are identified.
- Section 5 describes H/H modeling methods and results of the stormwater drainage system capacity evaluation, including qualification of capacity-related capital project needs.
- Section 6 summarizes the overall storm drainage capital improvement program recommendations including the final capital projects, city-wide programs, policies, and respective cost estimates.



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## Section 2

# Study Area Characteristics

This section provides an overview of study area characteristics, including location, topography, soils, land use, drainage system configuration, regulatory objectives, and current City stormwater program activities.

Referenced figures reflecting study area characteristics are located at the end of this section.

### 2.1 Location

The City of West Linn (City) is located 12 miles southwest of Portland, Oregon in Clackamas County. The City is approximately eight square miles in area, bounded on the north by the City of Lake Oswego, on the west by Unincorporated Clackamas County, and on the east by the Willamette River (Figure 2-1). Major transportation corridors of Interstate 205 (I-205) and Oregon Highway 43 (Highway 43) run through the City.



Figure 2-1. Location overview

There are several perennial streams within the City of West Linn that discharge to the Willamette and Tualatin Rivers (Figure 2-2) dividing the City into 24 major drainage basins that range in size from 40 to approximately 600 acres. Approximately 87 percent of the city area drains to Willamette River and the remainder is routed to the Tualatin River (West Linn TMDL Implementation Plan 2019).

## 2.2 Topography and Soils

West Linn's natural topography is characterized by steep hillsides to the west and relatively flat topography and floodplain area to the east and along the Tualatin and Willamette Rivers (Figure 2-3). Approximately 50 percent of the City has slopes exceeding 10 percent, including specific areas with slopes upwards of 25 percent. Topography can influence the conveyance capacity of channelized and piped infrastructure. Drastic slope changes can exacerbate ponding and backwater flow conditions. Significant grade changes are observed west of the Highway 43 corridor.

Soils are an important watershed characteristic for evaluating potential runoff rates and volumes. Soils are generalized into four categories, or hydrologic soil groups (HSG), which approximate soil runoff potential. These groups are A, B, C, and D, where A soils are characterized by high rates of infiltration and low runoff potential, and D soils are characterized by low rates of infiltration and high potential for runoff.

As shown in Figure 2-3, soils in the City are predominately silt loams with moderate to poor infiltration (HSG Type C, C/D, and D). Table 2-1 summarizes the NRCS hydrologic soil groups by percent coverage.

Hydrologic Soil Group	Percent Coverage (%)
A	2.2
B	7.4
B/D	0.2
C	59.4
C/D	10.2
D	13.1
Water	7.5
<b>Total</b>	<b>100.0</b>

## 2.3 Land Use and Population

West Linn has experienced moderate growth over the last 20 years. In 2000, the City's population was 22,429. In 2019, the City of West Linn's population<sup>1</sup> is estimated to be 26,703, reflecting an average annual increase of less than 1 percent.

The City is primarily composed of low-density residential land use, with areas of commercial and industrial land use along the Willamette River, I-205 and Highway 43 corridors. Vacant lands with potential for redevelopment are located sporadically throughout the City. Expansion of the outer city boundary is not anticipated within the 10 year planning horizon of the SMP, but there are pockets of unincorporated area (mostly single tax lots) within the City where annexation is eventually anticipated. A breakdown of area within the city limits, UGB and contributing drainage basins is summarized in Table 2-2.

<sup>1</sup> <http://worldpopulationreview.com/us-cities/west-linn-or-population/>

Designated Area	Area (ac)
West Linn City Limits	5,186
Urban Growth Boundary	5,245
Contributing Drainage Area (for hydrology)	5,273

Land use coverage was developed in GIS to evaluate stormwater drainage conditions in the City. Land use coverage was based on City-provided GIS coverage of zoning and parks/open space areas. Vacant lands coverage from METRO was refined by City staff to reflect development that has occurred since the GIS coverage was developed. Impervious coverage by land use was provided by City staff based on values assumed in the 2006 Plan, compared with values used by neighboring jurisdictions, and verified based on spot comparisons to aerial imagery. Impervious percentage by land use is shown in Table 2-3.

Land Use Category	Impervious Percentage	Percentage of City Area
Commercial	85	2.9
Industrial	85	2.7
Vacant	3	5.3
Open Space/Park	0	11.7
Mixed Use	85	0.3
Residential (High/Multi-family)	50	3.4
Residential (Medium Density)	35	6.1
Residential (Low Density)	30	56.9
Transportation (ODOT Corridor)	35	4.4
No zoning (waterbodies)	0	6.2
<b>TOTAL</b>	--	<b>100.0</b>

Figure 2-4 reflects land use coverage for purposes of hydrologic calculations.

## 2.4 Climate and Rainfall

The northern Willamette Valley climate is characterized by cool wet winters and warm dry summers. Most rainfall occurs between October and April. On average, November is the wettest month with an average of 9.3 inches of rainfall. July and August are the warmest and driest months with average high temperatures above 80 degrees Fahrenheit and less than 1 inch of rain per month. The average annual precipitation for the Portland metropolitan area ranges from 37 to 43 inches, with an average of 1.8 inches of snowfall annually. West Linn specifically averages 44 inches of rainfall a year and 1 inch of snowfall annually.

In December 2015, the Portland metro area experienced a large rainfall event that delivered more than 5 inches of rain over a 3-day period and 2.81 inches in one 24-hour period. This event was estimated to represent between a 50- and 100-year recurrence event because of the intensity and nature of the rainfall. Research suggests that these “severe” events are expected to occur more frequently as the earth undergoes climate change.

## 2.5 Storm Drainage Infrastructure

The City manages more than 113 miles (approximately 595,260 linear feet [LF]) of stormwater drainage pipe and culverts and approximately 10 miles (52,422 LF) of open channels/ drainage ditches. Table 2-4 summarizes pipe, culvert and open channel system assets by mapped (in GIS) size throughout the City.

Diameter	Length (LF)
N/A	8,570
0-6	29,130
8-12	431,490
14-18	77,950
20-24	28,030
27-30	6,470
36	10,990
40-42	890
48	920
54	310
60	230
66	100
72	220
>72	460
<b>Total (Pipe and Culvert)</b>	<b>595,260</b>
<b>Total (Open Channel)</b>	<b>52,422</b>
<b>Total (Mapped Stream/Creek)</b>	<b>159,491</b>

[In addition to the storm drainage system assets identified above, approximately 30 miles of stream channels flow within the city limits, conveying stormwater to the Willamette and Tualatin Rivers. Approximately 15 percent of the stream channels in the City are piped, and thus included as part of the City's asset inventory in Table 2-4.](#)

Table 2-5 summarizes major storm structures in the City, such as manholes, catch basins, clean outs, swales and ponds. Except for swales and ponds, [other water quality facilities \(i.e., raingardens, planters, porous pavement\)](#) are not mapped individually, [and thus not included in the storm infrastructure inventory. However, the City does maintain a GIS coverage of P](#)ublic and private water quality facility drainage areas, [s are mapped](#) for compliance with their [National Pollutant Discharge Elimination System \(NPDES\) municipal separate storm sewer \(MS4\)](#) permit. [The water quality facility drainage area coverage was developed to reflect development-specific areas that are collectively treated by green streets or other low impact development techniques including raingardens and planters.](#)

[Figure 2-5 shows mapped individual public and private water quality facilities and contributing water quality facility drainage areas in the City. Approximately 17% of the City area currently has some form of onsite or regional stormwater treatment.](#)

Facility	Number
Catch basin	2,977
Clean out	86
Ditch inlet/Inlet structure	665
Manholes/Pollution control manholes	1,543/142
Public ponds	47
Public wetlands	6
Swales (public and private)	203

*Note: Excludes identified county, ODOT and private infrastructure, unless specified.*

~~Figure 2-5 shows mapped individual public and private water quality facilities and contributing water quality facility drainage areas in the City. Approximately XX% of the City area currently has some form of onsite or regional stormwater treatment.~~

## 2.6 Regulatory Framework

The Oregon Department of Environmental Quality (DEQ) is responsible for implementing provisions of the federal Clean Water Act (CWA) pertaining to stormwater discharges and surface water quality. DEQ issues water quality permits related to surface water discharges, establishes water quality criteria for waterbodies based on designated use, and conducts studies and evaluations to determine whether a waterbody adheres to water quality standards.

Water quality regulations and improvement of instream (receiving water) quality are drivers for this SMP. As a result, a specific objective is identification of additional opportunities for water quality improvement and treatment facilities.

### 2.6.1 National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES Municipal Separate Storm Sewer (MS4) permit program regulates discharges of stormwater to receiving waters from urban areas and requires permitted municipalities to develop and implement stormwater control measures to address stormwater quality.

The City of West Linn is one of 13 co-permittees on the Clackamas County Phase 1 NPDES MS4 Permit for discharges from their stormwater system. Other co-permittees include the neighboring cities of Oregon City, Milwaukie, Lake Oswego, and Gladstone, as well as Clackamas County. The City's NPDES MS4 permit was last issued in 2012 and is currently in administrative extension. Stormwater program requirements, as documented in the City's effective (2012) SWMP address:

- Illicit Discharge Detection and Elimination
- Industrial and Commercial Facilities
- Construction Site Runoff Control
- Education and Outreach
- Public Involvement and Participation
- Post-Construction Stormwater Management
- Pollution Prevention for Municipal Operations
- Stormwater Management Facilities Operation and Maintenance Activities

The 2012 NPDES MS4 permit required the City to prepare and implement a stormwater retrofit strategy and a hydromodification assessment. These technical assessments identified the need for development of water quality-related capital projects and are referenced in Table 1-1.

Future permit compliance has been considered in the identification of capital projects and programs documented in this SMP. Outcomes from the technical assessments were also referenced as part of the planning process. As such, implementation of this SMP is anticipated to help address future permit requirements that stem from previous analyses.

## 2.6.2 Total Maximum Daily Load (TMDL) and 303(d) Listings

Section 303(d) of the CWA requires states to develop a list of water bodies that do not meet water quality standards. This list is used to identify and prioritize water bodies for development of TMDLs. A TMDL identifies the assimilation capacity of a water body for specific pollutants and establishes pollutant load allocations for sources of discharge to the water body. DEQ is responsible for both the periodic assessment and establishment of the 303(d) list in Oregon and development of TMDLs.

The Willamette and Tualatin Rivers are the major receiving waters for West Linn. These rivers and corresponding tributaries are on the 303(d) list for various parameters of concern and hold TMDLs for specific sources of pollutant loading. Table 2-6 summarizes the current TMDL and 303(d) parameters relevant to the City. The current 303(d) list reflects the addition of pesticides and metals not reflected in previous 303(d) listings. A TMDL for mercury is underway and expected to be finalized in 2019.

Watershed/ Major Basin	Sub-basin(s)	TMDL Year	Applicable TMDL Parameters	TMDL surrogate Parameters	Applicable 303(d) Parameters <sup>a</sup>
Willamette River	Lower Willamette	2006	Mercury Bacteria ( <i>E. coli</i> ) Temperature	Effective shade (surrogate for temperature)	<ul style="list-style-type: none"> <li>• Aldrin</li> <li>• Biological criteria</li> <li>• Chlordane</li> <li>• Chlorophyll a</li> <li>• Copper</li> <li>• Cyanide</li> <li>• DDT/DDE</li> <li>• Dieldrin</li> <li>• Iron</li> <li>• Lead</li> <li>• Polychlorinated biphenyls (PCBs)</li> <li>• Polynuclear Aromatic Hydrocarbons (PAHs)</li> </ul>
	Middle Willamette	2006	Mercury Bacteria ( <i>E. coli</i> ) Temperature	Effective shade (surrogate for temperature)	<ul style="list-style-type: none"> <li>• Aldrin</li> <li>• Biological criteria</li> <li>• Chlorophyll a</li> <li>• DDT/DDE</li> <li>• Dieldrin</li> <li>• Iron</li> <li>• PCBs</li> </ul>
Tualatin River	Tualatin	2001 and 2012 (update)	Bacteria ( <i>E. coli</i> ) Chlorophyll a pH Dissolved Oxygen (DO) Temperature	<ul style="list-style-type: none"> <li>• Total phosphorus (surrogate for chlorophyll a and pH)</li> <li>• Total suspended solids (equivalent parameter for SVS, a surrogate for DO)</li> <li>• Effective shade (surrogate for temperature)</li> </ul>	<ul style="list-style-type: none"> <li>• Ammonia</li> <li>• Biological criteria</li> <li>• Copper</li> <li>• Iron</li> <li>• Lead</li> <li>• Zinc</li> </ul>

a. The 2012 303(d) list for Oregon was approved by EPA in December 2018. It is the effective list for Oregon.

As a Phase I NPDES MS4 jurisdiction, the City is required to establish TMDL benchmarks, which are quantifiable pollutant load reduction estimates established to evaluate progress towards meeting TMDL requirements applicable to the City. Through this SMP effort, and because the City is primarily built out, identification of water quality opportunities focused on the retrofit of existing stormwater facilities and less on the installation of new, regional stormwater treatment facilities. Additional information is provided in Section 4.2.

## 2.7 Storm Drainage System Maintenance and Program Management

The maintenance of the City's storm drainage system assets is important to ensure that the full life expectancy is achieved and the system is functioning as constructed. As part of the project planning process, current stormwater maintenance activities and frequencies were considered in conjunction with stormwater problem areas to determine if programmatic improvements (i.e., increased frequency, expanded program coverage, new program development) may be more effective than a capital project to meet City needs (see Section 4.4).

Under the City's Phase I NPDES MS4 permit and 2012 SWMP, certain stormwater system maintenance activities are required to address water quality improvements. Maintenance activities typically occur on a scheduled basis but also in response to citizen and staff inquiries and requests. Current stormwater maintenance activities and frequencies are outlined in Table 2-7.

Activity	Frequency required	Annual target <sup>a</sup>	Annual effort <sup>a</sup>
TV inspection	As needed	Varies	100-200 ft
Pipeline cleaning	As needed	Varies	Varies
Ditch inspection/cleaning	As needed	Varies	Varies
CB inspection and cleaning (public)	Annual	All	2,853 inspected; 713 cleaned
MH cleaning (Pollution Control)	Annual	All	145 PCMH inspected; 145 cleaned
Street sweeping	3-6x/year	Varies	Varies
Public water quality pond inspections <sup>b</sup>	Annual	49	49
Public pond maintenance	As needed	--	262 hours
Private WQ facility inspections <sup>c</sup>	As needed	--	27 facility inspections

a. Based on the City's 2017-2018 annual report.

b. Inspection of public stormwater treatment and detention facilities is required per the SWMP. City efforts focus on pond inspection and maintenance activities.

c. Annual report indicates the number of new private maintenance agreements received. Approximately 30% of registered facilities report on maintenance compliance annually.



Specific to water quality facility inspections and maintenance, the City has guidance documents and program instructions to assist City staff and the public in performing maintenance activities.

Funded maintenance programs conducted by the City's Environmental Services Division are defined in Table 2-8 per the City's 2018-2019 budget. Existing (current) funding allocations must be considered with respect to proposed expanded programmatic efforts and activities (see Section 6.4).

<b>Table 2-8. Existing Program Funding (2018-19)</b>	
<b>Relevant Activity</b>	<b>Annual Budget</b>
Repair of Stormlines	\$100,000
Repair of MH/CBs	\$10,000
CCTV Inspection	Generally performed with in-house staff/equipment

Figure 2-2. Storm drainage system overview

**Figure 2-3. Soils and topography**

**Figure 2-4. Existing land use**

**Figure 2-5. Stormwater treatment facilities and drainage areas**

## Section 3



# Code Evaluation and Basis of Design

This section summarizes review of the City's current (as of October 2018) code and standards applicable to this SMP. Elements of the code review included conveyance, water quality, erosion and sediment control, maintenance, and code enforcement. Code review was limited to the following sections of City code and standards:

- West Linn Municipal Code (WLMC), Chapter 4 Utilities, Chapter 5 Nuisances, and Chapter 8.105 Building Permittee Responsible for Erosion Prevention and Sediment Control
- West Linn Public Works Design Standards (PWDS), Section 2, Storm Drain Requirements
- West Linn Public Works Standard Construction Specifications, Division 6, Storm Drain Technical Requirements
- West Linn Community Development Code (CDC), Chapter 55 Design Review, Chapter 56 Parks and Natural Area Design Review, and Chapter 92 Required Improvements

The initial code review was conducted in November 2017 and identified inconsistencies, implementation gaps, and technical recommendations. As a result, in October 2018, the City addressed select recommendations from the initial code review in an update of their PWDS. Outstanding (following the October 2018 update) recommendations and basis of design used to evaluate system deficiencies and develop capital projects for this SMP are detailed below.

The comprehensive code review, reflecting original recommendations and updates made to the PWDS in October 2018, is documented in Technical Memorandum #1 (TM1), included in this SMP as Appendix A.

### 3.1 Code Recommendations

The following outstanding code recommendations reflect: 1) potential modifications to the City's policies and technical design standards, and 2) adjustments to code to improve clarity, resolve discrepancies, and ease implementation of existing policy and standards.

Example language to address recommendations specific for PWDS 2.0040 and 2.0050 can be found in Appendix A, Attachment C.

### 3.1.1 Technical Standards and Stormwater Policy Changes

Recommendations listed are specific to the CDC and PWDS and intended to improve consistency with the NPDES MS4 permit requirements and guide developers implementing stormwater management in the City. Note that recommended changes may require a more in-depth review of current City practices and pending updates to the Portland Stormwater Management Manual (SWMM), to establish City policy prior to code development.

- **CDC:** Consider updating current floodplain management code sections to reflect floodplain standards consistent with the *Program Level Biological Assessment* for the National Floodplain Insurance Program for the State of Oregon (February 2013). In addition, floodplain management regulations should be moved from the CDC to the WLMC.
- **PWDS, Water Quality:** Modify PWDS 2.0013 to state specific design storms. Based on the site-specific analysis conducted for Clackamas County jurisdictions, the water quality design storm should be the 1 inch 24-hour design storm, resulting in capture of 80 percent of the annual runoff volume.
- **PWDS, Facility Selection:** Expand PWDS 2.0013 or 2.0040 and 2.0050 to list a City-specific facility selection hierarchy that prioritizes green infrastructure facilities and clarify which impervious area reduction techniques (e.g., green roofs, pervious pavers/pavements, tree planting, rainwater harvesting) are allowable in the City.

### 3.1.2 Clarity and Implementation Changes

Recommendations listed below are intended to improve clarity and ease implementation related to the referenced use of the Portland SWMM. Proposed revisions should not impact City policy or technical standards.

The PWDS currently references the entire Portland SWMM. Portland makes frequent updates to the SWMM and associated details and forms, which should be considered by the City. Recommended adjustments related to implementation of the Portland SWMM are listed below.

- **PWDS, Facility Selection:** Revise PWDS 2.0013 or 2.0040 and 2.0050 to include a City-specific list of allowable BMPs and BMP selection hierarchy. This would give the City more control over the types of facilities that are installed in West Linn. The PWDS could still refer to the Portland SWMM for a list of allowable proprietary treatment technologies.
- **PWDS, SWMM References:** Throughout the PWDS, revise general Portland SWMM references to instead refer to the “BMP sizing methodologies, design criteria, and typical drawings in the Portland Stormwater Management Manual” so that designers have clear guidance for the specific portions of the Portland manual that apply to West Linn.
- **PWDS, Technical Guidelines:** Consider adding detail to PWDS 2.0040 and 2.0050 to refer to specific technical guidelines in the Portland SWMM. These could include the Portland SWMM appendices related to infiltration testing, proprietary treatment technologies, source control standards, maintenance standards, and soil and plant lists.

Table 3-1 summarizes additional recommendations solely to improve clarity and minimize use of redundant or repetitive references in the City’s current standards.

**Table 3-1. Recommended Code and Standard Clarifications**

Section	Recommended Revision	Notes
WLMC4.063 General Discharge Prohibitions	Consider adding a list of permissible or conditionally allowable discharges, consistent with NPDES MS4 permit section A.4.a.xii.	
WLMC 4.065 City Responsibilities	Expand the list of drainage facilities to include "stormwater treatment and control facilities located on public property."	Current language indicates that the City is responsible only for flood control facilities.
WLMC 8.105 Erosion Prevention/Sediment Control	Add a reference to PWDS 2.0060 for erosion control permit types and applicable thresholds.	Erosion control permits are required only for projects that disturb over 1,000 sf. WLMC 8.105 indicates that all building permit projects require an erosion control permit.
PWDS 2.0011 Site Drainage Requirements	Delete items D and E	Items D and E relate to minimum requirements for detention and water quality facilities and are covered under the appropriate section (PWDS 2.0013).
PWDS 2.0045 Detention Facilities	Reformat for clarity: numbered items 3 and 5 should be C and D; numbered item 4 should be combined with item A.	Item A and item 4 have duplicate content.

## 3.2 Basis of Design

Table 3-2 lists applicable design criteria used to identify areas of the storm drainage system with capacity limitations and develop projects to address capacity deficiencies. Design criteria reflect the most recent update to the PWDS in October 2018. Expanded tables of drainage design criteria are included in Appendix A and Appendix C (TM3, *Hydrology and Hydraulic Modeling Methods and Results*).

**Table 3-2. Project Evaluation and Design Criteria**

Criteria	Source	Standard
Water Quality Facility Design	PWDS 2.0013	All water quality facilities shall meet the design requirements of the current edition of the City of Portland SWMM.
Conveyance Piping Design	PWDS 2.0013	<ul style="list-style-type: none"> <li>Design to convey the 10-year storm event.</li> <li>Minimum slope of 0.0055 (0.55%).</li> <li>Minimum velocity of 2 feet per second, when flowing full.</li> <li>Pipe roughness design coefficient shall not be less than 0.013.</li> </ul>
Culvert Design	PWDS 2.0014	Design to convey the 25-year storm event such that the headwater does not exceed 1.5 times the culvert diameter.
Open Channel Design	PWDS 2.0013	Control discharge so that the average velocity during the 10-year event is below the erosive velocity of the channel.
Pipe Size	PWDS 2.0012 PWDS 2.0033	12" minimum diameter for mains in the public right-of-way.
Pipe Material	PWDS 2.0012	<ul style="list-style-type: none"> <li>Concrete, PVC, HDPE smooth interior/corrugated exterior are allowable.</li> <li>Ribbed PVC is preferred for storm drains up to 24" in diameter.</li> <li>Reinforced concrete is preferred for storm drains over 24" in diameter.</li> <li>Ductile iron is allowed in areas where additional strength is required.</li> </ul>
Pipe Cover	PWDS 2.0023	Minimum cover shall be 30" above the top of the bell of the pipe in paved areas and 36" in all other locations. When minimum cover cannot be provided, implement additional strength measures.
Structure Spacing	PWDS 2.0031-2.0033	Maximum of 500 feet between manholes.



Design storms are precipitation patterns typically used to evaluate the capacity of storm drainage systems and design capital improvements for the desired level of service. Design storms evaluated in this SMP include the 2-, 10-, and 25-year recurrence interval 24-hour events. Design storms are not specified in the City's PWDS (see Section 3.1.1). As such, the rainfall depths were taken from Clean Water Services (CWS') *Design & Construction Standards*, Standard Detail Drawing No. 1280 (Table 3-3).

<b>Design storm event</b>	<b>Rainfall depth, inches</b>
2-year, 24-hour	2.50
10-year, 24-hour	3.45
25-year, 24-hour	3.90

## Section 4



# Project Planning Process

This section summarizes the project planning process and identification of Stormwater Project Opportunity Areas, which inform the capital project, program and policy development efforts. A project needs assessment and a water quality assessment were conducted as part of this collaborative process with city staff (engineering and maintenance) and the public. Proposed roadway improvements along Oregon Highway 43 (Highway 43) also informed the process.

This process allowed the City to focus resources and develop information for areas and projects most likely to be prioritized in a capital improvement program. This process qualified project needs in consideration of the SMP objectives, specifically: resolving known areas of stormwater drainage problems and flooding; enhancing and expanding water quality treatment; and identifying programs and policies to address stormwater needs on a city-wide scale.

The project planning process is described in additional detail in Technical Memorandum #2 (TM2), included in this SMP as Appendix B. The final Stormwater Project Opportunity list and figure depicting project opportunity locations recommended for the storm drainage capital improvement program is provided in Appendix C.

## 4.1 Project Needs Assessment

The project needs assessment included the identification of “stormwater problem areas” as areas of the City with reported and observed deficiencies. It also included the evaluation of whether a public infrastructure improvement, addition, replacement, or retrofit would address the deficiency. As the City is not anticipating significant growth or change in contributing stormwater runoff, city-wide hydraulic modeling, as conducted for the 2006 Plan, was not conducted to identify project needs.

The City typically receives few complaints regarding the storm drainage system function or capacity. The City also anticipates limited growth (annexations) and new development over the SMP planning period (i.e., 10 years). As such, a qualitative effort to evaluate the identified stormwater problem areas was used to validate the need for system improvements (projects or programs).

Data sources used for the project needs assessment included the following:

- System GIS data<sup>2</sup>
- Public and City staff surveys

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<sup>2</sup> Approximately 77% of the piped storm drainage system inverts were not reflected in GIS. This data gap was considered in the context of conducting city-wide hydraulic modeling.

- Planning documentation and reports
  - Stormwater Retrofit Plan (2015)
  - Hydromodification Assessment (2015)
- Previous Project List (per the City’s 2006 Plan)
- Site Visits
- Project Workshops with City staff (November 30, 2017 and February 15, 2018)

A total of 65 stormwater problem areas were originally identified, compiled and categorized in accordance with the following primary deficiency:

- Capacity
- System Configuration
- Infrastructure Needs
- Erosion
- Water Quality (related to existing system performance)
- Maintenance
- System Condition

Stormwater problem areas were documented in a matrix format and sorted based on whether a capital project or city-wide program would best address the deficiency. See Appendix B for detail.

## 4.2 Water Quality Assessment

A water quality assessment was conducted to identify additional project opportunities for consideration in the City’s SMP. This assessment addresses commitments outlined in the City’s Stormwater Retrofit Plan (2015), 2012 NPDES MS4 permit, and 2012 SWMP.

City charter (West Linn Charter, Chapter 11, Section 46) limits the use of park property for any “nonauthorized” use without voter approval as related to the construction of utilities. A regional stormwater treatment facility would be considered a utility subject to provisions of this charter. As described previously, the City is also primarily built out with limited available property for acquisition and/or use for construction of a regional stormwater treatment facility. As such, the water quality assessment focused on the “retrofit” of existing stormwater infrastructure, to minimize land use and administrative challenges related to the addition of new stormwater infrastructure in public property. The water quality assessment focused on the following objectives:

1. Expand treatment area coverage of existing stormwater treatment facilities or practices;
2. Improve the function of existing stormwater treatment facilities; and
3. Incorporate low impact development (LID) or green infrastructure applications where possible, as they promote infiltration and runoff volume reduction in addition to treatment.

A desktop GIS evaluation was conducted to comprehensively look at locations that would benefit from water quality improvements and facilities that could be retrofit to improve water quality. Areas of the City with anticipated relatively higher pollutant load generation based on land use and pollutants of concern (see Table 2-6) were targeted. Existing, mapped stormwater ponds were inventoried and evaluated to assess retrofit potential. Pond ownership condition (public, private), installation date, configuration (online vs offline), and potential for future development to occur upstream were considered as part of the pond inventory. Stormwater problem areas (Section 4.1) where collection system improvements are identified as



**Identified system deficiencies include failing infrastructure as well as capacity limitations.**

*(Photo: Culvert crossing at 5th Ave.)*

needed were targeted for incorporation of LID or green infrastructure applications. Opportunistic areas (i.e., vacant, public, or undeveloped areas) where regional treatment facilities may be located were reviewed, but minimal opportunities identified.

A total of 21 water quality opportunities were initially identified. Ten opportunities (locations) overlapped with results of the project needs assessment, and thus water quality was integrated into the project development process for those locations. Five opportunities were identified as potential new projects. Six opportunities were removed from consideration due to site constraints, limited potential for retrofit or land acquisition, or where water quality is already being addressed. See Appendix B for detail.

### 4.3 Highway 43 Drainage Evaluation

The City is currently partnering with ODOT under the Highway 43 Multimodal Transportation Project (Highway 43 Project) to construct a new bike lane and sidewalk along Highway 43. The project effort is divided into two phases, with Phase I extending from Arbor Drive to Hidden Springs Road. Phase II extends from Hidden Springs Road to I-205. The City entered into a Cooperative Maintenance Agreement with ODOT in February 2018 to initiate design and construction of Phase I. Construction of Phase I is anticipated to begin in 2020. Roadway improvements are anticipated to change the roadway grade and expand impervious surface area subject to water quality treatment requirements.

Given anticipated improvements to the roadway alignment and profile, five stormwater problem areas identified during the project needs assessment (Section 4.1) are likely to change or be addressed through the improvements to roadway drainage as part of this project. These areas are documented as a Stormwater Project Opportunity Area (Appendix C), but not directly addressed with a proposed project in this SMP.

There are currently 24 mapped crossings (culverts) under Highway 43 that convey upstream piped or open channel drainage systems. With timing of the Highway 43 project, the City opted to evaluate the conveyance capacity of the culvert crossings so that capital projects can be identified to address the upsizing and/or realignment of crossings and implementation can occur in conjunction with the scheduled roadway improvements. This hydraulic evaluation is summarized in Section 5.

New and replaced impervious area resulting from the Highway 43 Project are subject to the City design standards for stormwater treatment. Federal funding and anticipated Nationwide permitting requirements for this transportation project also make stormwater management subject to SLOPES V requirements. Opportunities for water quality treatment associated with Highway 43 improvements were evaluated as part of the water quality assessment (Section 4.2)<sup>3</sup>, but due to the unknown gradation and design of the roadway, water quality treatment needs are not directly addressed with proposed projects in this SMP.



**Green infrastructure incorporated into existing streetscapes can aid in stormwater collection as well as treatment.**

*(Photo: Stormwater “bubbler” applications on Buck St.)*

<sup>3</sup> The City received voter approval for the use of park property to support stormwater management associated with Highway 43 improvements, and therefore park property may be used to site stormwater facility installations for this purpose.

## 4.4 Results

Appendix C (Table C-1 and Figure C-1) summarizes the Stormwater Project Opportunity Areas identified through the project needs, water quality, and Highway 43 project assessment efforts. This information was originally compiled and documented as part of the project planning process (Appendix B). However, additional refinements during the project needs prioritization (Section 4.4.1) and capacity evaluation (Section 5) resulted in updates to the Appendix B documentation.

Table C-1 summarizes 22 capital project needs resulting from the assessments. Three of these capital project needs are proposed to be addressed as part of a planning study. Fourteen additional locations are proposed for consolidation, to be addressed as part of city-wide program development addressing city-scale maintenance needs and opportunistic water quality improvements. Additional detail on capital project and program development is provided in Section 6.

There were 28 originally-identified project needs that, upon additional review and discussion with the City, were not considered viable project or program opportunities. These locations are documented in Appendix C for reference.

### 4.4.1 Project Prioritization

Stormwater Project Opportunity Areas were reviewed by city staff to prioritize those areas requiring development of detailed project concepts and costs in accordance with a defined project implementation schedule. Project opportunities considered high or medium priority are anticipated to be initiated over the 10-year implementation period, and thus warranted a project concept and cost estimate. Program opportunities were collectively considered medium priority, thus warranting funding but not at the expense of high priority project needs.

Table 4-1 summarizes the prioritization criteria used to rank opportunities. Prioritization criteria applicable to specific Stormwater Project Opportunity Areas is reflected in Table C-1. Full results of the prioritization effort are described in Section 6.

Table 4-1. Prioritization Criteria			
Criteria	Scoring Definition		
	High (H)	Medium (M)	Lower (L)
Flooding Issue	<ul style="list-style-type: none"> <li>Addresses an area of known or significant capacity deficiency or erosion potential.</li> <li>Identified as currently flooding per hydraulic modeling efforts.</li> </ul>	<ul style="list-style-type: none"> <li>Addresses localized flooding issue.</li> </ul>	<ul style="list-style-type: none"> <li>No reported flooding concerns or safety issues associated with project location.</li> </ul>
Water Quality Improvement	<ul style="list-style-type: none"> <li>Project addresses pollutants of concern and may be classified as a retrofit per the City's 2015 Retrofit Plan.</li> </ul>		<ul style="list-style-type: none"> <li>Project moderately improves or doesn't improve water quality.</li> </ul>
Location	<ul style="list-style-type: none"> <li>Located on public property or within the public ROW</li> </ul>		<ul style="list-style-type: none"> <li>Located on private property in its entirety.</li> </ul>
Maintenance	<ul style="list-style-type: none"> <li>Project addresses failing infrastructure or a lack of infrastructure.</li> <li>Project provides increased longevity for facility function.</li> </ul>	<ul style="list-style-type: none"> <li>Project will reduce existing maintenance needs or complaints.</li> </ul>	<ul style="list-style-type: none"> <li>Project does not address existing maintenance deficiency.</li> </ul>
Concurrence with Transportation Projects	<ul style="list-style-type: none"> <li>Project is associated with a transportation project anticipated for construction in the next 5-years.</li> </ul>	<ul style="list-style-type: none"> <li>Project is associated with a transportation project anticipated for construction in the next 5 to 10 years.</li> </ul>	<ul style="list-style-type: none"> <li>Associated transportation project is not expected in the next 10 years or a pending transportation project will address deficiency without additional resources.</li> </ul>
Special Interest	<ul style="list-style-type: none"> <li>Project has City Council, city staff, or public interest/motivation.</li> </ul>	<ul style="list-style-type: none"> <li>Project has some public interest/motivation.</li> </ul>	<ul style="list-style-type: none"> <li>Project has no public driver or interest.</li> </ul>

#### 4.4.2 Modeling Needs

After identifying Stormwater Project Opportunity Areas and priorities, modeling needs were evaluated. The project needs assessment included the identification of six targeted areas of the city that would benefit from hydrologic and hydraulic modeling to confirm observed deficiencies and inform conceptual sizing of improvements:

1. 5th Avenue Culvert (Location ID 13)
2. Blankenship Road (Location ID 47)
3. Fairview Way (Location ID 56)
4. Sunset Creek Culvert at Willamette Falls Drive (Location ID 59)
5. Fern Creek at Kantara Way (Location ID 60)
6. Maddox Creek at River Street (Location ID 63)

In addition to the six locations listed above, the need to evaluate capacity of the 24 culvert crossings underneath Highway 43 was also identified.

Refer to Appendix C for description and map of modeling needs by Location ID. Detail related to the hydrologic and hydraulic (H/H) modeling methodology, model results and associated project development is included in Section 5.

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## Section 5



# Storm Drainage System Capacity Evaluation

Stormwater conveyance is the primary function of the City's storm drainage infrastructure. This section summarizes the H/H system modeling approach and results for targeted areas of the City, to verify observed capacity limitations and develop project solutions.

Existing and future system capacity was evaluated for six targeted areas of the City, as well as the 24 culvert crossings under Highway 43. Capital project recommendations were developed for each modeled area following verification of capacity limitations and assessment of project alternatives. Six capital project recommendations result from this H/H modeling effort (see Section 6.4).

The system capacity evaluation and H/H model results are described in additional detail in Technical Memorandum #3 (TM3), included in this SMP as Appendix D.

## 5.1 Modeling Approach

H/H modeling was conducted for areas of the City with known capacity limitations or where flooding is frequently observed. This targeted modeling approach focused resources on specific areas of the city where additional information is needed to quantify system flooding and develop project solutions.

For this SMP, the following modeling approach was used to evaluate conveyance capacity:

1. Compile a list of known and suspected problem areas and evaluate which areas will require modeling to inform corrective measures (see Section 4.1);
2. Assess modeling needs in terms of whether a detailed or more limited hydraulic model is required (refer to Section 5.3.1);
3. Review available data (via GIS, as-builts, etc.) to identify data gaps and data required for model development;
4. Document observed data gaps in a format to support the City-obtained collection of field survey information and updates to the City's GIS;
5. Refine delineated subbasins (per the City's 2006 Plan) and develop a city-wide hydrologic model to estimate stormwater runoff generated for existing and future development conditions;
6. Develop the hydraulic models;
7. Validate modeled flooding using anecdotal information (photographs, City records);
8. Verify capacity constraints and identify potential sources or causes of flooding with City staff; and
9. Use the validated hydraulic models to simulate alternative conveyance system designs and develop potential solutions to capacity problems.



## 5.2 Hydrologic Model Development and Results

A city-wide hydrologic model was developed using XP-Storm Water Management Model (XPSWMM) version 2016.1. Within the model, the RUNOFF method was used to estimate hydrology. The input parameters for the RUNOFF Method included subbasin area, slope, width, infiltration conditions, and impervious percentage. The hydrology routine in XPSWMM converts rainfall into stormwater runoff based on design storm parameters (e.g., volume and intensity of rainfall), the input parameters listed above, and the infiltration conditions of the soils based on soil type.

Hydrologic model methods are described in additional detail and results are tabulated in Appendix D. Overall, when compared to existing conditions, the hydrologic model results showed minimal increases in future flows for most subbasins, due to limited potential for new development activities (i.e., mapped vacant lands). The largest increases in flow were identified in subbasins with larger amounts of vacant land, such as in the Bernert Creek and Tanner Creek watersheds.

## 5.3 Hydraulic Model Development and Results

To evaluate flood hazards and stormwater infrastructure capacity, the XPSWMM computer model was used to simulate select pipe and open-channel systems and calculate peak flows, water surface elevations, and velocities within the modeled infrastructure for select design storms. Hydraulic model input parameters included conduit (pipe or open channel) name, upstream (US) and downstream (DS) node information (name, invert elevation, rim elevation), conduit length, conduit slope, conduit shape, and pipe diameter.

### 5.3.1 Model Development

For purposes of this SMP, hydraulic model development was categorized as either detailed hydraulic modeling or limited hydraulic modeling.

Detailed hydraulic modeling incorporated the use of multiple nodes and links to evaluate performance of a collection system network. Two areas of the City were selected for detailed hydraulic modeling due to reported flooding frequency and the need to understand the potential cause(s) and extents of flooding:

1. Blankenship Road (Location ID 47)
2. Fairview Way (Location ID 56)

Limited hydraulic modeling included the assessment of capacity of a single link (i.e., culvert), accounting for the contributing upstream drainage but not incorporating hydraulic modeling of the upstream collection system. Five areas of the City were selected for limited hydraulic modeling:

1. 5th Avenue Culvert (Location ID 13)
2. Sunset Creek Culvert at Willamette Falls Drive (Location ID 59)
3. Fern Creek at Kantara Way (Location ID 60)
4. Maddox Creek at River Street (Location ID 63)
5. Highway 43 Culvert Crossings (24 total)



**Flat topography and an insufficient stormwater collection system along Blankenship Road frequently results in ponded water and road closures during storms.**

*(Photo: Blankenship Road at I-205)*

Figure 5-1 provides an overview of the hydraulic modeling locations (with the exception of the Highway 43 culverts) and contributing drainage area. Figure 5-2 provides the same overview specific for the Highway 43 culverts.

### 5.3.2 Results and Capital Project Development

The hydraulic model results show very little increase in future flows for areas that are fully developed. The hydraulic model results confirmed stormwater problem areas/capacity limited areas as identified by City staff or in the 2006 Plan and provided additional information about potential sources of the flooding problems.

For the detailed hydraulic model areas, flooding was identified when water exited the closed conveyance system, or for open channels, when the maximum water surface elevation at any modeled node was equal to or greater than the ground elevation of the node. For the limited hydraulic model locations, flooding was identified for culverts based on whether the headwater was above 1.5 times the culvert diameter (see Table 3-2). A secondary design criterion for culverts (headwater was less than 1 foot below the roadway subgrade) was also evaluated, but not used to determine system deficiencies due to the unknown accuracy of the roadway elevations.

Detailed hydraulic modeling results are provided in Appendix D, including tables reflecting maximum water surface elevations and maximum peak flows for each modeled conduit.

Table 5-1 below summarizes the model estimated frequency of flooding for each modeled system and resulting capital project development approach.

**Table 5-1. Capacity Evaluation Results**

Model Area	Modeling Approach	Frequency of Flooding	Capital Project Development (Y/N)
5th Avenue Culvert (Location ID 13)	Limited	2-year, existing condition	Y – High Priority Project Need
Blankenship Road (Location ID 47)	Detailed	2-year and 10-year, existing condition for select pipes	Y – High Priority Project Need
Fairview Way (Location ID 56)	Detailed	10-year, existing condition for select pipes	Y – High Priority Project Need
Sunset Creek Culvert at Willamette Falls Drive (Location ID 59)	Limited	2-year, existing condition	Y – High Priority Project Need
Fern Creek at Kantara Way (Location ID 60)	Limited	2-year, existing condition	Y – Low Priority Project Need <sup>a</sup>
Maddox Creek at River Street (Location ID 63)	Limited	2-year, existing condition	Y – High Priority Project Need
Phase I Highway 43 Culverts <sup>b</sup> (Crossings A – M)	Limited	<ul style="list-style-type: none"> <li>• 2-year, existing condition (Crossings A, B, C, H, L, M)</li> <li>• 10-year, existing condition (Crossing D)</li> <li>• 25-year, existing condition (Crossing J)</li> </ul>	Y – High Priority Project Need
Phase II (Future) Highway 43 Culverts <sup>b</sup> (Crossings N - X)	Limited	<ul style="list-style-type: none"> <li>• 2-year, existing condition (Crossing P)</li> <li>• 10-year, existing condition (Crossings O, S, W)</li> <li>• 25-year, existing condition (Crossing R)</li> </ul>	Y – Low Priority Project Need <sup>c</sup>

a. This location is considered low priority following review with the City. The culvert location is in a ravine with no reported flooding or potential for property damage. It is still considered a capital project need but has not been costed under this SMP.

b. Refer to Figure 5-2 for crossing locations and naming.

c. These crossings are considered low priority following review with the City. Timing of the future, Phase II construction is unknown. These crossings are still considered a capital project need but have not been costed under this SMP.

Figure 5-1. Hydraulic system overview (Targeted hydraulic model locations)

Figure 5-2. Hydraulic system overview (Highway 43 crossing)

## Section 6



# Capital Improvement Program

This section summarizes the capital project, program, and policy recommendations identified through the master planning process, collectively comprising the City's Storm Drainage Capital Improvement Program.

A total of 26 capital projects, including 5 planning-related studies, were identified to address current and future storm drainage infrastructure needs related to capacity/flooding, water quality, and system condition and repair. Capital project recommendations are considered a one-time cost and are categorized (numbered) as follows:

- Capacity Projects (C)
- Infrastructure Improvements/Addition Projects (I)
- Water Quality Retrofit/Erosion Prevention and Control Projects (R)
- Planning Projects (P)

Five programmatic recommendations addressing city-wide system repair and replacement (R/R) needs, routine system maintenance, and ongoing water quality retrofits were also identified. Program recommendations are intended to support ongoing asset management efforts and are considered annual costs. These city-wide programs are categorized as:

- General/Asset Management Programs (G)

Table 6-1 provides a comprehensive summary of the storm drainage capital improvement program, including project and program costs and schedule. Costs are provided for high and medium priority project needs. The SMP schedule is based on a 10-year implementation timeframe and is associated with identified project priorities. Program recommendations are considered medium priority and associated costs are annual. Policy recommendations are detailed in Section 6.5 but not reflected in Table 6-1, due to no cost being associated with the policies.

Figure 6-1, at the end of this section, provides an overview of project locations throughout the City by priority and category.

### 6.1 Summary of Recommended Actions

Project, program and policy recommendations in this SMP are proposed to improve and enhance drainage infrastructure and water resources throughout the City, as summarized by the following recommended actions.

- Implement identified system capacity improvements (i.e., reconfiguration, rerouting, upsizing) to manage more frequent, nuisance system flooding.
- Increase water quality treatment throughout the City by expanding treatment area coverage and enhancing the level of treatment provided in existing facilities.

- Incorporate LID or green infrastructure to expand water quality treatment in locations where utility improvements or transportation-related/pedestrian improvements are anticipated.
- Incorporate system configuration and condition data (i.e., stormwater facility inspection records, CCTV, survey) into a larger asset management program to allow for proactive maintenance, repair, and replacement of stormwater infrastructure.
- Conduct regular updates to the WLMC and PWDS to ensure clear guidance is provided to the development community and is consistent with regulatory requirements.
- Establish city policies to address beaver management as pertaining to local flooding issues.
- Clearly document capital project and program costs and schedule to inform future funding and rate analyses.

## 6.2 Cost Assumptions

Project costs are based on the total capital investment necessary to complete a project (i.e., engineering through construction). Program costs are more subjective in nature, qualified based on the City's current maintenance activities and annual expenditures.

Unit costs for project (construction) elements are based on recent bid tabs and stormwater master planning efforts, adjusted for 2018 based on a historical cost index. Cost estimates presented in this SMP are Association for the Advancement of Cost Engineering (AACE) Class 5 Conceptual Level or Project Viability Estimates. Actual costs may vary from these estimates between -50 percent to +100 percent, although changes to design may result in cost differences outside of this anticipated range.

Project cost estimates use unit cost information for construction elements and apply a 30 percent construction contingency, a 20 percent planning contingency, and multipliers to account for traffic control/utility relocation (5–10 percent) and erosion control (2 percent). Additional multipliers to account for engineering and permitting (15–35 percent) and construction administration (10 percent) are applied to the total construction cost with contingencies. The range in engineering and permitting costs is based on the anticipated permitting level of effort, such as whether in-water work is anticipated. For planning purposes, costs were rounded to the nearest \$1,000.

Appendix E includes unit costs developed for this SMP and presents the planning-level cost estimates for high and medium priority capital projects. Cost assumptions related to program recommendations are described in Section 6.5.

Land acquisition and easements are not included in the cost estimates, as most projects are located on City property or within the City right-of-way.

**Table 6-1. Storm Drainage Capital Project and Program Summary <sup>c</sup>**

Project No. <sup>a</sup>	Stormwater Project Opportunity Area Location ID	Project Name	Project Objectives	Location	Basin/Waterbody	Contributing Drainage Area, Acres	Project Summary	Estimated Cost <sup>b</sup>	SDC Eligible Cost <sup>b</sup>	Project Timing			
										Annual (2019-2028)	High Priority (2019-2023)	Medium Priority (2024-2028)	Low Priority/Not costed (2029-2038)
<b>Capacity Projects</b>													
C-1	N/A	Phase I Highway 43 Culvert Replacements	• Increase system capacity	Various crossings along Highway 43	Varies	930	<ul style="list-style-type: none"> <li>• City is partnering with ODOT on widening and pedestrian improvements along Highway 43.</li> <li>• Phase I extends from Arbor Drive to Hidden Springs Road.</li> <li>• Eight capacity deficient culvert crossings to be upsized in conjunction with the current roadway improvements (see Appendix F for detail).</li> </ul>	\$1,045,000	\$28,000		X		
C-2	13	5 <sup>th</sup> Avenue Culvert Replacement	<ul style="list-style-type: none"> <li>• Increase system capacity</li> <li>• Improve system configuration</li> <li>• Prevent Erosion</li> </ul>	5 <sup>th</sup> Avenue just east of 4 <sup>th</sup> Street	Bernert Creek	461	<ul style="list-style-type: none"> <li>• Install approximately 160 LF of 4' x 9' reinforced concrete box culvert and relocate existing utilities as needed.</li> <li>• Align new box culvert with existing stream alignment.</li> </ul>	\$847,000	\$106,000		X		
C-3	59	Sunset Creek at Willamette Falls Drive Culvert Replacement	• Increase system capacity	Sunset Creek crossing under Willamette Falls Drive southeast of Sunset Avenue and Imperial Drive intersection	Sunset Creek	69	<ul style="list-style-type: none"> <li>• Replace approximately 92 LF of existing 18" diameter pipe with two parallel 30" diameter HDPE pipe.</li> </ul>	\$282,000	\$2,000		X		
C-4	63	Maddox Creek at River Street Culvert Replacement	• Increase system capacity	Western end of River Street, west of the Burns Street intersection.	Maddox Creek	84	<ul style="list-style-type: none"> <li>• Replace approximately 165 LF of existing 18" diameter culverts with two parallel 36" diameter HDPE pipe.</li> </ul>	\$385,000	\$7,000		X		
C-5	N/A	Phase II Highway 43 Culvert Replacements	• Increase system capacity	Various crossings along Highway 43	Varies	789	<ul style="list-style-type: none"> <li>• City is partnering with ODOT on widening and pedestrian improvements along Highway 43.</li> <li>• Phase II extends from Hidden Springs Road to the Interstate 205 overpass.</li> <li>• Five capacity deficient culvert crossings identified per hydraulic modeling (see Appendix D).</li> <li>• Phase II design to be initiated after 2020</li> </ul>	---	---				X
C-6	60	Kantara Way Capacity Deficiency	• Increase system capacity	Kantara Way	Fern Creek	141	<ul style="list-style-type: none"> <li>• Hydraulic evaluation indicates existing culvert is capacity deficient. Culvert grade results in scour and erosion.</li> <li>• Project location is in a canyon with no reported complaints or potential for property damage.</li> <li>• Potential project solution may require reconfiguration as an open channel and modification to existing water line near this location.</li> </ul>	---	---				X
<b>Infrastructure Projects</b>													
I-1	47	Blankenship Road Improvements	<ul style="list-style-type: none"> <li>• Increase system capacity</li> <li>• Improve system configuration</li> </ul>	Blankenship Road between Debok Road and Johnson Road intersections.	Summerlinn Creek	159	<ul style="list-style-type: none"> <li>• Install approximately 300 LF of 24" diameter HDPE storm sewer.</li> <li>• Install approximately 356 LF of 30" diameter HDPE storm sewer.</li> <li>• Install new field ditch inlet in the ditch north of Blankenship Rd.</li> <li>• Replace approximately 23 LF of 24" diameter storm sewer outfall with 30" diameter HDPE.</li> </ul>	\$856,000	\$97,000		X		
I-2	4	Mark Lane Improvements	<ul style="list-style-type: none"> <li>• Add infrastructure</li> <li>• Increase water quality treatment (retrofit)</li> </ul>	Mark Lane (east of Lowell Ave)	Mary S. Young Creek	6	<ul style="list-style-type: none"> <li>• Install approximately 1,050 LF of new 12" main line pipe along Mark Ln.</li> <li>• Install flow-through stormwater planters along Mark Ln ROW to convey overflow to the main line via lateral piping.</li> </ul>	\$1,092,000	\$5,000		X		





**Table 6-1. Storm Drainage Capital Project and Program Summary <sup>c</sup>**

Project No. <sup>a</sup>	Stormwater Project Opportunity Area Location ID	Project Name	Project Objectives	Location	Basin/Waterbody	Contributing Drainage Area, Acres	Project Summary	Estimated Cost <sup>b</sup>	SDC Eligible Cost <sup>b</sup>	Project Timing			
										Annual (2019-2028)	High Priority (2019-2023)	Medium Priority (2024-2028)	Low Priority/ Not costed (2029-2038)
I-3	5	Buck Street Improvements	<ul style="list-style-type: none"> <li>• Add infrastructure</li> <li>• Increase water quality treatment (retrofit)</li> <li>• Prevent Erosion</li> </ul>	Buck Street (east of Greer Street)	Bolton Creek	5	<ul style="list-style-type: none"> <li>• Install approximately 750 LF of new 12" main line pipe along Buck St.</li> <li>• Install flow-through stormwater planters along Buck St ROW to convey overflow to the main line via lateral piping.</li> <li>• Install new curb and gutter system for unimproved section of Buck St.</li> <li>• Replace existing outfall at the end of Buck St and provide outlet protection.</li> </ul>	\$966,000	\$89,000		X		
I-4	56	Fairview Way Pipe Relocation	<ul style="list-style-type: none"> <li>• Increase system capacity</li> <li>• Improve system configuration</li> </ul>	Fairview Way between Highway 43 and Robinwood Creek.	Robinwood Creek Fern Creek	29	<ul style="list-style-type: none"> <li>• Install new storm pipe alignment along Fairview Way from manhole RW-CB-0144.1 to manhole RW-CB-0126.1 and ultimately discharges to Robinwood Creek.</li> <li>• Install approximately 1,174 LF of 18" HDPE; approximately 253 LF of 30" RCP; and approximately 325 LF of 36" HDPE.</li> <li>• Install 11 manholes associated with the proposed conveyance system in Fairview Way.</li> </ul>	\$1,620,000	\$40,000			X	
I-5	1	Nixon Avenue Pipe Relocation	<ul style="list-style-type: none"> <li>• Improve system configuration</li> </ul>	Nixon Ave (between 18730 and 18740 Nixon Ave)	Willamette River	10	<ul style="list-style-type: none"> <li>• Relocate existing pipe currently under resident's garage.</li> <li>• Install new 12" piping to convey drainage north along Nixon Ave ROW and east between 18730 and 18740 Nixon Ave parcels to a new outlet structure.</li> </ul>	\$174,000	\$2,000			X	
I-6	10	Sunset Avenue Improvements	<ul style="list-style-type: none"> <li>• Add infrastructure</li> <li>• Prevent Erosion</li> </ul>	Sunset Ave (between Cornwall St and Walnut St)	Tanner Creek Sunset Creek McLean Creek Willamette River	35	<ul style="list-style-type: none"> <li>• Project to be constructed in conjunction with transportation system improvement project, which will install curb/gutter, bike lane, and sidewalk along Sunset Ave.</li> <li>• Install new 12" piping along Sunset Ave ROW from Cornwall St to Walnut St to replace to existing piping and open channel sections.</li> <li>• Install manholes and catch basins at intersections along the upper portion of Sunset Ave, where main line is in the middle of the road.</li> </ul>	\$1,593,000	\$32,000			X	
<b>Retrofit Projects</b>													
R-1	70	Public Pond #22 Retrofit	<ul style="list-style-type: none"> <li>• Increase water quality treatment (retrofit)</li> </ul>	25545 Katherine Court	Willamette River	8	<ul style="list-style-type: none"> <li>• Rehabilitate the existing water quality pond by clearing trees and invasive vegetation, removing accumulated sediment, replacing with amended soils, regrading, and planting of water quality appropriate vegetation.</li> <li>• Pond outflow structure to be inspected and replaced if needed.</li> </ul>	\$89,000	\$1,000		X		
R-2	67	Mary S. Young Park Parking Lot Retrofit	<ul style="list-style-type: none"> <li>• Increase water quality treatment (retrofit)</li> </ul>	Mary S. Young Park Parking Lot	Mary S. Young Creek	2	<ul style="list-style-type: none"> <li>• Replace existing impervious parking lot with 67,000 ft<sup>2</sup> of pervious pavers.</li> <li>• Connect pervious pavers drain layer to existing catch basin in northeast corner of parking lot.</li> </ul>	\$2,075,000	NA			X	
R-3	68	West Linn Public Works Department Planters	<ul style="list-style-type: none"> <li>• Increase water quality treatment (retrofit)</li> </ul>	West Linn Public Works Department (4100 Norfolk St)	Tanner Creek	1	<ul style="list-style-type: none"> <li>• Install one stormwater planter on West Linn Public Works Department property to treat drainage from northern portion of site and one planter along Norfolk St ROW to treat drainage from the southern portion of site.</li> <li>• Remove existing bubbler within Norfolk St ROW and connect to new 12" piping to stormwater planter in Norfolk St ROW.</li> <li>• Connect stormwater planter overflow to existing catch basin along Norfolk St via 12" piping.</li> </ul>	\$174,000	NA			X	
R-4	40	Mary S. Young Park Erosion Measures	<ul style="list-style-type: none"> <li>• Prevent Erosion</li> </ul>	Mary S. Young Park	Heron Creek	TBD	<ul style="list-style-type: none"> <li>• Install in-stream bank erosion measures to minimize erosion issues along park trail and bridge.</li> <li>• Bridge repair related to washout is currently funded; remaining work is restoration and a potential mitigation project.</li> <li>• Potential grant funding opportunity.</li> </ul>	---	---				X



**Table 6-1. Storm Drainage Capital Project and Program Summary <sup>c</sup>**

Project No. <sup>a</sup>	Stormwater Project Opportunity Area Location ID	Project Name	Project Objectives	Location	Basin/Waterbody	Contributing Drainage Area, Acres	Project Summary	Estimated Cost <sup>b</sup>	SDC Eligible Cost <sup>b</sup>	Project Timing			
										Annual (2019-2028)	High Priority (2019-2023)	Medium Priority (2024-2028)	Low Priority/ Not costed (2029-2038)
R-5	43	Mary S. Young Park Trillium Creek Restoration	<ul style="list-style-type: none"> <li>Prevent Erosion</li> <li>Increase water quality treatment (retrofit)</li> </ul>	Trillium Creek in Mary S. Young Park	Trillium Creek	TBD	<ul style="list-style-type: none"> <li>Restore channel connectivity with floodplain and improve bed material and channel meander for habitat improvement.</li> <li>Conduct other creek stabilization measures.</li> <li>Potential grant funding opportunity (see previous work completed).</li> </ul>	---	---				X
R-6	45	Mary S. Young Park Fish Restoration Measures	<ul style="list-style-type: none"> <li>Increase water quality treatment (retrofit)</li> </ul>	Mary S. Young Creek	Mary S. Young Creek	TBD	<ul style="list-style-type: none"> <li>Remove culvert at Mary S. Young Creek to improve water quality and provide fish restoration measures in accordance with the Mary S. Young Creek Restoration Concept Plan.</li> <li>Potential grant funding opportunity.</li> </ul>	---	---				X
R-7	49	Arbor Creek Culvert Hydromodification Improvements	<ul style="list-style-type: none"> <li>Prevent Erosion</li> </ul>	Downstream of Arbor Creek culvert at Hillside Drive, near Skye Parkway	Arbor Creek	246	<ul style="list-style-type: none"> <li>Realign existing culvert crossing Arbor Creek to minimize drop.</li> <li>Add bank protection and energy dissipation structure to alleviate existing scour hole and bank erosion.</li> </ul>	---	---				X
R-8	66	Willamette Park Parking Lot Retrofit	<ul style="list-style-type: none"> <li>Increase water quality treatment (retrofit)</li> </ul>	Willamette Park Parking Lot	Willamette River	2	<ul style="list-style-type: none"> <li>Replace existing impervious parking lot with pervious pavers.</li> </ul>	---	---				X
R-9	69	Public Pond #18 Retrofit	<ul style="list-style-type: none"> <li>Increase water quality treatment (retrofit)</li> </ul>	Public Pond #18 (BC ID)	Bemert Creek	TBD	<ul style="list-style-type: none"> <li>Rehabilitate the existing water quality pond by clearing trees and invasive vegetation, removing accumulated sediment, replacing with amended soils, regrading, and planting of water quality appropriate vegetation.</li> <li>Pond outflow structure to be inspected and replaced if needed.</li> </ul>	---	---				X
<b>Planning Projects</b>													
P-1	16	Tannler Drive/Bemert Creek Basin Feasibility Study	<ul style="list-style-type: none"> <li>Add infrastructure</li> </ul>	Tannler Drive	Bemert Creek	N/A	<ul style="list-style-type: none"> <li>Closed stormwater system adjacent to Tannler Drive could be an opportunity to daylight the pipe for aesthetics and water quality.</li> <li>Conduct feasibility study to identify project concept and estimated cost.</li> </ul>	\$20,000	N/A		X	X	
P-2	54, 57	Fish Passage Evaluation	<ul style="list-style-type: none"> <li>Add Infrastructure</li> </ul>	East of Willamette Drive (Highway 43)	Varies	N/A	<ul style="list-style-type: none"> <li>The 2006 MP reported that there are variable needs to replace culverts throughout the City for fish passage.</li> <li>Conduct evaluation and coordinate with ODFW to confirm culvert replacement needs.</li> </ul>	\$20,000	N/A			X	
P-3	N/A	Surface Water Master Plan Update	<ul style="list-style-type: none"> <li>Increase system capacity</li> <li>Add infrastructure</li> <li>Increase water quality treatment (retrofit)</li> </ul>	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Update the City's Surface Water Master Plan in the next 10+ year timeframe.</li> </ul>	\$300,000	N/A			X	
P-4	N/A	Asset Management Program	N/A	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Develop an asset management program to assess current practices, review software and tools, identify gaps in current practices, and prepare/ implement an asset management program.</li> <li>Cost assumes coordinated effort with sanitary asset management program (50% cost share)</li> </ul>	\$150,000	N/A			X	
P-5	N/A	Stormwater System Survey	N/A	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Conduct city-wide survey of storm system assets including establishment of consistent datum, horizontal and vertical survey of structures including inverts and rim elevations, and GIS processing to incorporate results into asset database.</li> <li>Data to be used to populate asset management program.</li> <li>Does not assume survey of open channel systems or cross sections.</li> </ul>	\$300,000	N/A	X			



**Table 6-1. Storm Drainage Capital Project and Program Summary <sup>c</sup>**

Project No. <sup>a</sup>	Stormwater Project Opportunity Area Location ID	Project Name	Project Objectives	Location	Basin/Waterbody	Contributing Drainage Area, Acres	Project Summary	Estimated Cost <sup>b</sup>	SDC Eligible Cost <sup>b</sup>	Project Timing			
										Annual (2019-2028)	High Priority (2019-2023)	Medium Priority (2024-2028)	Low Priority/ Not costed (2029-2038)
<b>Programs</b>													
G-1	N/A	CCTV Program	N/A	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Complete city-wide inspection over a 10-year planning period (assumes 60,000 LF of pipe inspected annually)</li> <li>Evaluate results to inform asset management program and repair/ replacement needs.</li> <li>Annual cost includes contingency (30%) and engineering multiplier (15%)</li> </ul>	\$344,000	N/A	X			
G-2	N/A	Repair and Replacement Program	<ul style="list-style-type: none"> <li>Add infrastructure</li> <li>Address maintenance need</li> </ul>	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Assume replacement of one mile of deficient pipe annually (due to age and failure risk).</li> <li>Consider opportunities to realign pipe within the ROW.</li> <li>Cost excludes contingency and multipliers.</li> </ul>	\$750,000	N/A	X			
G-3	20, 28, 32, 37, 42, 48	Inlet Installation/ Replacement Program	<ul style="list-style-type: none"> <li>Add Infrastructure</li> <li>Address maintenance need</li> </ul>	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Install curb inlets to alleviate localized drainage issues in high-traffic or heavily vegetated roadways.</li> <li>Cost assumes 10 inlets/ year.</li> <li>Cost excludes contingency and multipliers.</li> </ul>	\$25,000	N/A	X			
G-4	52	Public Pond Maintenance Program	<ul style="list-style-type: none"> <li>Increase water quality treatment (retrofit)</li> <li>Address maintenance need</li> </ul>	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Conduct extensive maintenance of ponds and/or retrofit detention ponds for water quality improvement.</li> <li>Target facility locations in residential neighborhoods and those facilities installed pre-2004.</li> <li>Cost assumes one facility per year.</li> </ul>	\$100,000	N/A	X			
G-5	11, 15, 18, 19, 23, 25, 35	Green Street Pilot Program	<ul style="list-style-type: none"> <li>Increase water quality treatment (retrofit)</li> </ul>	City-wide	Varies	N/A	<ul style="list-style-type: none"> <li>Install green street retrofits in residential neighborhoods in conjunction with other utility or transportation-related improvements.</li> <li>Identify sites based on local drainage concerns.</li> </ul>	\$50,000	N/A	X			

Notes: N/A: Not Applicable

TBD: To be Determined in conjunction with refined CIP development.

a. CIP numbering reflects the following project type designations: C = Capacity; I = Infrastructure Improvement/ Addition; R = Retrofit/ Erosion Prevention and Control; P = Planning; and G = General/ Annual Maintenance

b. Estimated costs and SDC eligible costs are based on detailed cost summaries provided in Appendix E. Costs and associated drainage areas were not developed and calculated for low priority (unfunded) CIPs.

c. Policy recommendations are not included due to no associated project number and/or cost.



## 6.3 Sizing and Design Assumptions

Capital project sizing generally followed the City's PWDS and design criteria summarized in Table 3-2.

- **Capacity Projects.** Projects to construct or replace stormwater infrastructure referred to the City's PWDS (dated October 2018). Conveyance-related projects were sized for the 10-year, 24-hour design event. Culvert sizing was based on maintaining a headwater elevation less than 1.5 times the diameter of the culvert. System surcharging was considered permissible.
- **Water Quality Projects.** Water quality projects were generally sized in accordance with the 2016 Portland SWMM. LID and green infrastructure (Projects I-2 and I-3) were sized based on a 6 percent sizing factor applied to contributing impervious area. However, it should be noted that retrofit project applications were typically unable to meet applicable design criteria due to area constraints. During final project design an attempt should be made to size facilities to maximize water quality treatment within the available area.
- **New Infrastructure.** Several capital projects require new infrastructure in locations where no storm system exists. New infrastructure alignments are in the public ROW only. However, it should be noted that final design may require additional structures, alternate alignments, or deeper/shallower infrastructure than assumed for the conceptual project design to address utility conflicts and other constraints not identified as part of this SMP. Survey will be required to verify elevations and locations. Conceptual layouts for select capital projects are illustrated in Appendix F.

## 6.4 Capital Projects

Capital projects are identified as one of four categories: capacity, infrastructure, retrofit, or planning.

Through an integrated project development approach (see Section 4), capital project needs and opportunities were consolidated by location and defined as Stormwater Project Opportunity Areas. As such, identified capital projects address multiple objectives in a single project. Project objectives included:

- Increase system capacity (flood control)
- Improve system configuration
- Add infrastructure
- Increase water quality treatment (retrofit)
- Prevent erosion
- Address maintenance need

High and medium priority capital projects that compose this capital improvement program are summarized below by category. Additional detail related to project layout and configuration used to inform cost estimating is provided in Appendix F.

### 6.4.1 Capacity Projects

**Phase 1 Highway 43 Culvert Replacement (C-1).** In 2018, the City and ODOT initiated design efforts to widen and construct pedestrian improvements along Highway 43 through West Linn. There are 24 mapped culvert crossings under Highway 43, of which 13 are identified as deficient under existing development conditions based on hydraulic modeling conducted for this SMP. Culvert upsizing and/or reconfiguration is recommended to occur in conjunction with the roadway improvements.

Project C-1 includes upsizing eight crossings located in Phase 1 (Arbor Drive to Hidden Springs Road) of the Highway 43 project alignment. Other utility improvement and replacement efforts are currently underway (water system replacement). This was identified as a high priority project need.

**5th Avenue Culvert Replacement (C-2).** This project need was identified in the City's 2006 Plan and confirmed based on recent site visits, City staff input, and hydraulic modeling. Project C-2 includes upsizing the existing 30-inch-diameter culvert under 5th Avenue with a 4 ft x 9 ft box culvert and realigning the culvert along the existing stream alignment to minimize bank erosion and degradation of existing infrastructure in its proximity. This was identified as a high priority project need.

**Sunset Creek at Willamette Falls Drive Culvert Replacement (C-3).** This project need was identified in the City's 2006 Plan and confirmed based on recent site visits, City staff input, and hydraulic modeling. Project C-3 includes upsizing the existing 18-inch-diameter culvert with two parallel, 30-inch-diameter pipes while maintaining the existing drainage patterns and point of discharge. Parallel pipes are proposed due to limited depth of cover in the project proximity. This was identified as a high priority project need.

**Maddox Creek at River Street Culvert Replacement (C-4).** This project need was identified during the project needs assessment and confirmed based on recent site visits, City staff input, and hydraulic modeling. Project C-4 includes upsizing the existing 18-inch-diameter culvert with two parallel, 36-inch-diameter pipes while maintaining the existing drainage patterns and point of discharge. The current system configuration is inconsistent with the City's GIS and will require field survey to confirm configuration and connectivity. This was identified as a high priority project need.

#### 6.4.2 Infrastructure Projects

**Blankenship Road Improvements (I-1).** This project need was identified during the project needs assessment and confirmed based on recent site visits, City staff input, and hydraulic modeling. Previous efforts to address roadway flooding at this location have not been successful.

Project I-1 includes installation and/or upsizing of approximately 800' of stormwater conveyance pipe along Blankenship Road east of Interstate 205 (I-205). Reconfiguration of the system is required to divert flow from the drainage ditch along the I-205 right-of-way (ROW). Due to the flat grade of the open channel collection system and overland flow contribution, additional site survey is recommended to verify drainage patterns and contributing areas. Project sizing assumes that ODOT infrastructure is conveying drainage from the north/northeast of the project location. This was identified as a high priority project need.

Figure 6-2, located at the end of this section, shows the proposed project alignment.

**Mark Lane Improvements (I-2).** This project need was identified during the project needs assessment, water quality assessment, and confirmed based on recent site visits and City staff input. A lack of drainage infrastructure at this location results in localized flooding. This area was identified to have high inflow and infiltration (I&I), potentially related to the limited stormwater infrastructure.

Project I-2 includes installation of 1,050 feet of 12-inch-diameter storm pipe down Mark Lane and approximately 5,000 square feet (ft<sup>2</sup>) of stormwater planters within the public ROW. Planter locations are considered conceptual and will need to be confirmed in conjunction with the final pipe alignment. This was identified as a high priority project need.

**Buck Street Improvements (I-3).** This project need was identified during the project needs assessment, water quality assessment, and confirmed based on recent site visits and City staff input. A lack of drainage infrastructure and presence of stormwater bubblers results in localized flooding in this area.

Project I-3 includes installation of 750 feet of 12-inch-diameter storm pipe down Buck Street and approximately 3,750 ft<sup>2</sup> of stormwater planters within the public ROW. Planter locations are considered conceptual and locations will need to be confirmed in conjunction with the final pipe alignment. Due to reported erosion concerns, this project also includes replacement of the stormwater outfall and inclusion of outfall protection. This was identified as a high priority project need.

**Fairview Way Pipe Relocation (I-4).** This project need was identified during the project needs assessment and confirmed based on recent site visits, City staff input, and hydraulic modeling. Much of the existing system is configured on private property and the system condition is questionable.

Project I-4 includes rerouting the existing collection system east of Highway 43 to the public ROW within Fairview Way and installation of approximately 1,780 feet of stormwater conveyance pipe ranging in diameter from 18 to 36 inches. The project includes abandoning the existing outfall to Robinwood Creek and relocating/rerouting localized drainage further downstream on Robinwood Creek. This was identified as a high priority project need.

Figure 6-3, located at the end of this section, shows the proposed project alignment.

**Nixon Avenue Pipe Relocation (I-5).** This project need was identified during the project needs assessment and confirmed based on recent site visits and City staff input. The existing system is configured on private property and the system condition is questionable. Project I-5 includes installation of 325 feet of 12-inch-diameter storm pipe within a public stormwater easement between 18730 and 18740 Nixon Avenue. This was identified as a medium priority project need.

**Sunset Avenue Improvements (I-6).** This project need was identified during the project needs assessment and confirmed based on recent site visits and City staff input. A lack of drainage infrastructure results in localized flooding and erosion of the adjacent roadside ditch. This area was also identified to have high I&I, potentially related to limited stormwater infrastructure in the area.

Project I-6 includes installation of 3,620 feet of 12-inch-diameter storm pipe down Sunset Avenue from Cornwall Street to Walnut Street. Water quality retrofits using green infrastructure were not considered along the project alignment due to grade constraints. This was identified as a medium priority project need.

### 6.4.3 Retrofit Projects

**Public Pond #22 Retrofit (R-1).** This project need was identified during the water quality assessment and confirmed based on recent site visits and City staff input. Project R-1 includes extended maintenance and retrofit of an existing detention pond to improve water quality function. Maintenance activities required include tree removal and sediment removal. To enhance treatment function, amended soils and vegetation will need to be installed and the outlet structure reconfigured to promote increased retention time. Expansion of the pond footprint may be considered to treat additional flows from upstream development. This was identified as a medium priority project need.

**Mary S. Young Park Parking Lot Retrofit (R-2).** This project need was identified during the water quality assessment and confirmed based on recent site visits and City staff input. Project R-2 includes the installation of approximately 1.5 acres of permeable pavers at the public parking lot at Mary S. Young Park. Existing pavement is in poor condition. Recent permeable paver applications have been successfully implemented at other public parking areas in the City (i.e., Willamette Park). This was identified as a medium priority project need.

**West Linn Public Works Department Planters (R-3).** This project need was identified during the water quality assessment and confirmed based on recent site visits and City staff input. This project need was also identified as part of the City's 2015 Stormwater Retrofit Plan. Project R-3 includes the installation of approximate 1,175 ft<sup>2</sup> of stormwater planters to improve water quality treatment of the City's Public Works Yard along Norfolk Street. Planter locations are considered conceptual and locations will need to be confirmed in conjunction with final pipe alignment. This was identified as a medium priority project need.



**Pavement restoration and asphalt resurfacing needs present opportunities to incorporate alternative surface water management strategies**

*(Photo: Mary S. Young Park Parking Lot Retrofit location)*

#### 6.4.4 Planning Projects

**Tannler ~~Open Ditch Drive~~/Bernert Creek Basin Feasibility Study (P-1).** This project need was identified during the project needs assessment. City staff and the public identified an opportunity to daylight a portion of the piped storm system, adjacent to Tannler Drive. Daylighting the pipe may improve aesthetics and water quality in the area. The reported pipe depth may result in geotechnical challenges and limit the ability to daylight the system without encroaching on adjacent natural resources (trees). Project P-1 is budgeted as a \$20,000 planning study to evaluate the feasibility of the proposed project. This was identified as a medium-high priority project need, based on feedback from the public.

**Fish Passage Evaluation (P-2).** This project need was identified during the project needs assessment. The 2006 Plan identified multiple culverts requiring replacement for fish passage. Project P-2 is budgeted as a \$20,000 planning study to evaluate existing culverts east of Highway 43, coordinate with the Oregon Department of Fish and Wildlife to confirm species presence, and confirm which culverts require replacement for fish passage. This was identified as a medium priority project need.

**Storm Drainage Master Plan Update (P-3).** Project P-3 assumes the City will update this Storm Drainage Master Plan within the next 10-15-year planning period. An estimated budget of \$300,000 is included for the update. This was identified as a medium priority project need.

**Asset Management Program (P-4).** Project P-4 reflects development of an asset management program to aid in the prioritization of repair and replacement (R/R) activities due to condition deficiencies. Implementation of an asset management program will help reduce reactionary operations and maintenance activities and result in development of proactive scheduled R/R activities based on system condition, age, and performance.

An asset management program requires assessment of current practices and procedures, review of software applications and tools, integration/refinement of GIS data, and development of procedures and documentation. Program development efforts will be coordinated with the sanitary utility. An estimated budget of \$150,000 was included in this plan, assuming coordination with the sanitary system (see 2019 Sanitary Sewer Master Plan (SSMP), Project PL-1). Projects stemming from the asset management program will be addressed as part of the City's annual R/R budget (see Project G-2). This was identified as a medium priority project need.

**Stormwater System Survey (P-5).** Current stormwater system GIS information for the City is incomplete. Approximately 70 percent of mapped stormwater infrastructure is missing elevation or size related information. In addition, stormwater treatment facilities have not been routinely mapped in GIS. Project P-5 reflects development of a city-wide stormwater system survey to inform development of the asset management program (see Project P-4). An estimated budget of \$300,000 is included, based on the need to survey approximately 4,500 structures (excluding open channel conveyances). This was identified as a high priority project need.



## 6.5 Program Descriptions

City-wide program development efforts also stemmed from the integrated project development approach. During the project planning process (Section 4), select maintenance-related project needs were consolidated into larger program opportunities instead of developed as multiple, stand-alone individual projects. Table 6-1 reflects specific opportunity areas by Location ID that are applicable to the identified programs.

Development of city-wide programs can be advantageous for a City as they can be used to establish dedicated funding sources in support of priority, multi-year and multi-objective efforts. Programs (with a dedicated annual funding source) can also provide additional flexibility with respect to project implementation schedules and allow projects to be conducted on an opportunistic basis.

Five programs were identified to address routine system maintenance needs and the opportunistic installation of water quality improvements. All programs are considered medium priority and require annual funding. The City's annual stormwater system maintenance budget should be referenced and considered when establishing programs so that existing funds are allocated accordingly. Program recommendations and cost assumptions are summarized below for each recommended program.

### 6.5.1 CCTV Program (G-1)

This program includes expanding the existing CCTV efforts to inspect the City's stormwater mainlines. This program will help the City determine pipeline condition as part of the larger asset management program (see Project P-4) and help determine R/R needs. It is assumed that the City will inspect approximately 10 percent of the system per year (or approximately 60,000 LF). An annual cost of \$344,000 is estimated, which includes construction contingency (30 percent), traffic control, and an engineering multiplier of 15 percent to cover review of the results.

### 6.5.2 Repair and Replacement (R/R) Program (G-2)

This program includes allocating an annual cost of \$750,000 to the R/R of aging and failing pipe, structures, and relocation of the public storm system into the public ROW. This estimate is consistent with the 2019 SSMP R/R Program effort, which assumes replacement of one mile of deficient pipe per year. Because the City's stormwater system is primarily composed of plastic pipe, the actual life span is unknown. Locations should be prioritized based on CCTV efforts and consider the schedule of other utility system improvements or projects to minimize construction impacts.

### 6.5.3 Inlet Installation and Replacement Program (G-3)

This program stemmed from the project needs assessment. It involves the relocation of existing inlets to address localized flooding and ponding. It may require replacement of grated inlets with curb inlets in high traffic roads where debris accumulates and clogs the inlets. Six locations were identified during the project needs assessment effort (refer to Table C-1 for descriptions of each location). Locations include:

- Failing Street (Location ID 20)
- Sinclair Street (Location ID 28)
- Summit Street between Apollo Avenue and Causey Street (Location ID 32)
- Elmran Drive near Old River Road (Location ID 37)
- Lower Midhill Road (Location ID 42)
- Debok Road (Location ID 48)

An annual cost of \$25,000 was estimated.

#### 6.5.4 Public Pond Maintenance Program (G-4)

This program stemmed from the project needs assessment and water quality assessment. It involves the routine and restorative maintenance of public stormwater ponds, based on inspection results. It may include the rehabilitation or retrofit of existing stormwater detention ponds (constructed prior to 2004) to promote increased water quality treatment function and/or coverage. Ponds located in or near residential neighborhoods may be prioritized, as they provide both aesthetic and water quality benefits.

As part of the water quality assessment, a pond inventory was conducted to identify: 1) ponds installed prior to 2004 (and likely installed without treatment function); and 2) ponds located near vacant lands (and could be retrofit to provide water quality treatment for new development). The pond inventory resulted in the identification of two ponds meeting both criteria, which were included as Stormwater Project Opportunity Areas. However, additional ponds may benefit from inclusion in an ongoing maintenance program. Potential locations include:

- Remington Drive and Rogue Way (Public Pond #68)
- Cascade Summit Apartments Pond at Weatherhill Road (Public Pond #49)
- Public Ponds at Sabo Lane and Beacon Hill Lane (Public Pond #54, 48, 52)

An annual cost of \$100,000 was estimated and based on major maintenance of one public pond per year.

#### 6.5.5 Green Street Pilot Program (G-5)

This program stemmed from the project needs assessment and water quality assessment. It involves the opportunistic incorporation of green street and LID features in conjunction with scheduled transportation improvements (i.e., unimproved streets requiring installation of curb and sidewalk) or other utility improvement projects. Sites may be prioritized based on the presence of local drainage issues. Installations will address NPDES MS4 requirements related to stormwater retrofits. Seven locations were identified during the project needs assessment effort (refer to Table C-1 for descriptions of each location). Locations include:

- Exeter Street and Lancaster Street (Location ID 11)
- Willamette Neighborhood between 14th and 16th Avenues (Location ID 15)
- Suncrest Avenue, Valleyview Drive, and Hillcrest Street (Location ID 18)
- LaFave Street, Jolie Point Road, Munger Drive, and Lowell Avenue (Location ID 19)
- Kenthorpe Way (Location ID 23)
- Cornwell Road and York Street (Location ID 25)
- Dillow Drive at Larson (Location ID 35)

An annual cost of \$50,000 was estimated.

## 6.6 Policy Recommendations

The following policy recommendations were considered for potential incorporation into future updates to the West Linn Municipal Code (WLMC), West Linn Community Development Code (CDC), West Linn Public Works Design Standards (PWDS), or addressed through internal directives.

### 6.5.1 Technical and Editorial Stormwater Code Updates

As described in Section 3.1, results of the code review identified recommended modifications to the WLMC, CDC, and PWDS to: 1) update the City's policies and technical design standards related to stormwater management; and 2) adjust code to improve clarity, resolve discrepancies, and ease implementation of existing policy and standards. Such refinements would help support water quality improvement efforts by specifying facility types and design criteria to address specific pollutants of concern for the City.

Code recommendations are detailed in Section 3.1.1 and 3.1.2 and in Appendix A.

### 6.5.2 Beaver Management Requirements

The project needs assessment identified significant beaver activity contributing to localized flooding along investigated stream reaches (see Table C-1, Location ID 12). Beavers provide many benefits to stream ecology and habitat, but in urban areas, beaver activity can also result in localized flooding and backwater effects in stream channels.

Beavers are classified as "Protected Furbearers" in Oregon, and thus excluded from take (Oregon Administrative Rule 498.012) (Portland 2010). Oregon Department of Fish and Wildlife (ODFW) encourages public and private landowners to first use beaver exclusion and habitat modification techniques to minimize beaver activity in locations that are susceptible to impacts from beaver activity. Live trapping of beavers is legal, but relocation is illegal without a permit from ODFW.

The City may choose to implement/codify beaver management techniques to selectively encourage/discourage beaver activity based on the characteristics of the stormwater drainage systems, topography and vegetation. The City of Portland and King County both implement actions and management strategies outlined in guidance documents to deter beaver activity on public property. Such management strategies the City may consider include:

- Selective planting: Encourage/discourage beaver activity through planting of preferred plant species. To minimize or deter beaver activity, avoid use of alder, birch, cottonwood, willow, and other preferred deciduous plants in riparian restoration projects. Use non-desirable plant species including Sitka spruce, elderberry, cascara, and osoberry, as they are not preferred food plants for beavers.



**Beaver activity can result in system clogging and backwater conditions in stormwater infrastructure**

*(Photo: Clogged stormwater conveyance pipe due to beaver activity at Johnson Road)*

- Fencing/tree barriers: Install fencing to isolate one or groups of trees from beaver foraging. Fencing should extend between 2 feet and 4 feet in height. Install fencing around inlets of culverts or spillways to prevent inlets from being blocked by beavers.
- Tree painting: Paint the bottom (2 feet to 4 feet) of trunk with latex paint/sand mixture.
- Flood/Flow Control: Install a flexible pond leveler (a pipe through the beaver dam) to control water levels. Beaver dam removal can also be conducted to lower water levels, but this activity is time intensive and generally only a temporary solution.
- Relocation: Relocate beavers to intentionally create ponds/wetlands in desired locations. ODFW permitting is required.

## 6.7 Project and Program Cost Summary

A summary of capital project and program costs comprising this surface water capital improvement program is provided in Table 6-2 below. Low priority project needs scheduled outside of the 10-year implementation timeframe are not reflected.

Table 6-2. Summary of Capital Project and Program Cost and Schedule

Project Number	Project Name	Schedule		
		2019-2023 (High Priority)	2024-2028 (Medium Priority)	Annual Cost (Medium Priority)
<b>Capacity Projects</b>		<b>\$2,559,000</b>		
C-1	Phase I Highway 43 Culvert Replacements	\$1,045,000		
C-2	5 <sup>th</sup> Avenue Culvert Replacement	\$847,000		
C-3	Sunset Creek at Willamette Falls Drive Culvert Replacement	\$282,000		
C-4	Maddox Creek at River Street Culvert Replacement	\$385,000		
<b>Infrastructure Projects</b>		<b>\$2,914,000</b>	<b>\$3,387,000</b>	
I-1	Blankenship Road Improvements	\$856,000		
I-2	Mark Lane Improvements	\$1,092,000		
I-3	Buck Street Improvements	\$966,000		
I-4	Fairview Way Pipe Relocation		\$1,620,000	
I-5	Nixon Avenue Pipe Relocation		\$174,000	
I-6	Sunset Avenue Improvements		\$1,593,000	
<b>Retrofit Projects</b>		<b>\$89,000</b>	<b>\$2,249,000</b>	
R-1	Public Pond #22 Retrofit (Katherine Court)	\$89,000		
R-2	Mary S Young Park Parking Lot Retrofit		\$2,075,000	
R-3	West Linn Public Works Department Planters		\$174,000	
<b>Planning Projects</b>		<b>\$320,000</b>	<b>\$4790,000</b>	
P-1	Tannler <del>Open Ditch Drive</del> / Bernert Creek Feasibility Study	<u>\$20,000</u>	<u>\$20,000</u>	
P-2	Fish Passage Evaluation		\$20,000	
P-3	Surface Water Master Plan Update		\$300,000	
P-4	Asset Management Program Development		\$150,000	
P-5	Stormwater System Survey	\$300,000		
<b>Programs</b>				<b>\$1,269,000</b>
G-1	CCTV Program			\$344,000
G-2	Repair and Replacement (R/R) Program			\$750,000
G-3	Inlet Installation and Replacement Program			\$25,000
G-4	Public Pond Maintenance Program			\$100,000
G-5	Green Street Pilot Program			\$50,000
<b>TOTAL</b>		<b>\$5,886,000</b>	<b>\$6,1026,000</b>	<b>\$1,269,000</b>

**Figure 6-1. CIP overview map**

**Figure 6-2. Blankenship Road improvements**

**Figure 6-3. Fairview Way pipe relocation**



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## Section 7

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### *Limitations*

*This document was prepared solely for City of West Linn in accordance with professional standards at the time the services were performed and in accordance with the contract between City of West Linn and Brown and Caldwell dated May 9, 2017. This document is governed by the specific scope of work authorized by City of West Linn; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of West Linn and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.*

## **Appendix A: TM1: Stormwater Basis of Design and Code Review**

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## **Appendix B: TM2: Stormwater Basis of Planning**

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# Technical Memorandum

# FINAL

Prepared for: City of West Linn

Project Title: Storm Drainage Master Plan

Project No.: 150752

## Technical Memorandum #2

Subject: Stormwater Basis of Planning

Date: September 8, 2018

September 9, 2019 (Updated)

To: Amy Pepper, P.E., City of West Linn

From: Angela Wieland, P.E.  
Jessica Christofferson

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### Limitations:

*This document was prepared solely for West Linn in accordance with professional standards at the time the services were performed and in accordance with the contract between West Linn and Brown and Caldwell dated May 15, 2017. This document is governed by the specific scope of work authorized by West Linn; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by West Linn and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.*

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## Section 1: Introduction

The City of West Linn (City) is developing a ~~Surface Water~~Storm Drainage Master Plan (SMP) to improve understanding of stormwater system characteristics and infrastructure in the city. The SMP will support the prioritization of capital improvement projects (CIPs) and programmatic activities to address conveyance, capacity, and water quality for both existing and future development.

This Technical Memorandum #2 (TM#2) has been developed to document the following:

- Regulatory background and framework related to the development of CIPs and programs
- Methods and outcomes from the preliminary identification of stormwater problem areas and stormwater modeling needs
- Methods and outcomes from the identification of water quality opportunity areas
- Identification of proposed stormwater project opportunity areas for further consideration and refinement as CIPs or programmatic activities in the SMP

Through data collection and planning efforts to date, a total of 44 project opportunity areas have been identified for possible project development as part of this master planning effort. The stormwater project opportunity matrix (Attachment A, Table A-1) will be used to prioritize project development efforts and cost estimation needs for those project opportunities that are needed to ensure an acceptable level of service is maintained for West Linn residents.

Planning criteria and applicable stormwater design standards related to the sizing and design of stormwater infrastructure has been previously documented under TM#1: Stormwater Basis of Design and Code Review.

### 1.1 Objectives and Background

Key objectives of the City's SMP and associated stormwater project development efforts are to resolve known areas of stormwater drainage problems and flooding; enhance and expand water quality treatment; and identify programmatic opportunities to address stormwater needs on a city-wide scale.

The City opted to develop their SMP using a collaborative approach with engineering and maintenance staff to initially assess known stormwater problem areas and identify areas where infrastructure addition, replacement, or retrofit is needed to address an issue. Problem areas were identified through a combination of public and City staff surveys, interviews with City engineering and maintenance staff, site visits, literature review, and project workshops. A separate water quality assessment was conducted to ensure that water quality-related project opportunities were also identified. Portions of the stormwater system requiring a modeling approach to evaluate capacity limitations and project concepts were identified through this process.

This overall process allowed the City to focus resources and develop information for areas and projects most likely to be prioritized in a capital improvement program.

### 1.2 Data Compilation and Review

In May 2016, Brown and Caldwell (BC) provided a list of data needs to the City to initiate the SMP effort. Data needs included geographic information system (GIS) information, background data and reports, City organizational information, and maintenance program information and procedures. Data needs were reviewed and discussed in detail during the project kick-off meeting (May 25, 2017) and clarification was provided as necessary.

BC's data request was primarily fulfilled over the course of 6 months (July through December 2017) as part of 12 separate data packages.



One primary data gap that was identified was the availability of the hydrologic and hydraulic modeling files used in development of the 2006 *Surface Water Management Plan* (2006 Plan). However, GIS shapefiles reflecting subbasin delineations, select model input parameters (i.e., lag time, effective impervious area, etc.) and output results (i.e., modeled flows for defined design storms) were available for use and referenced in the development of new models for this SMP.

### 1.2.1 GIS Data Compilation and Preliminary Mapping

Most GIS data were provided to BC between July and August 2017. GIS data were provided as both individual shapefiles and geodatabases. Data reflect existing city limits, basin and subbasin boundaries, zoning and natural areas/parks coverage, stormwater collection system features (pipes, culverts, manholes), and water quality and flood control facilities.

Limited stormwater collection system attribute data (i.e., inverts, rim elevations, pipe diameters, age) were available. Approximately 77 percent of the stormwater collection system inverts and 68 percent of the rim elevations were not reflected in the GIS. Pipe sizes were missing for about 16 percent of the piped collection system. Open channel system dimensions (i.e., cross sections) were unavailable. As a result, a targeted modeling approach to address specific areas of known conveyance or capacity limitations was proposed. A targeted modeling approach requires less survey work to collect missing data.

In conjunction with review of the GIS system data, BC prepared preliminary maps identifying study area extents, topography and soils, land use, and stormwater drainage system features. The effective date of mapped system information is August 2017. Preliminary mapping is included in Attachment B and was used to support the identification of stormwater project opportunity areas discussed in this TM.

### 1.2.2 Existing Planning Documentation and Reports

The City’s last stormwater master plan was completed in 2006 (2006 Plan). Since 2006, identified CIPs have not consistently been implemented. The identified projects were solely based on modeled system capacity deficiencies, specifically culverts. Projects were not prioritized, nor were validated by City staff in conjunction with observed deficiencies or City maintenance objectives. Project needs identified in the 2006 Plan are considered outdated due to the limited City feedback and qualification of project locations in conjunction with development of the 2006 Plan and the lack of reported capacity deficiencies associated with the modeled system since the 2006 Plan was developed.

BC obtained copies of various planning-level reports and studies prepared since the 2006 Plan to help inform areas of observed stormwater problems and potential stormwater project needs. Reports and studies reviewed and considered for this SMP are listed in Table 1. Additional detail related to the content and use of selected reports is included in Sections 3 and 4.

**Table 1. Existing Stormwater Planning Documentation and Reports**

Report	Date	Summary and application to the SMP
West Linn Surface Water Management Plan	2006	Provides background information and historic basis for the need to update the SMP.
Stormwater Retrofit Plan for the City of West Linn	2015	Provides documentation of the City’s retrofit strategy, which includes proposed stormwater pond retrofits and culvert retrofits.
Hydromodification Assessment	2015	Provides a summary of instream channel conditions and hydromodification indicators. Field notes and photo logs documenting system conditions are included. Project and policy needs are identified.
West Linn Transportation System Plan	2016	Identifies transportation improvement project needs including pedestrian improvements that may be coordinated with stormwater infrastructure or green street development activities.



## Section 2: Regulatory Background

One objective of the City's SMP is to enhance and expand water quality treatment. The City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit, as well as the provisions of the total maximum daily load (TMDL) program and current 303(d) listings for receiving waters, provide a regulatory framework to guide project development.

### 2.1.1 NPDES MS4 Permit

The City is a co-permittee on the Phase 1 Clackamas County NPDES MS4 permit, along with 12 other jurisdictions in Clackamas County, for the management of stormwater runoff. The City's effective NPDES MS4 permit was issued in 2012 and expired in March 2017. The permit is currently under administrative extension until the Oregon Department of Environmental Quality (DEQ) reissues the permit. During administrative extension, jurisdictions are required to continue implementing their expired permit via their effective Stormwater Management Plan (SWMP).

The City's effective SWMP was developed in 2012, and describes the stormwater activities or best management practices (BMPs) designed to address the following permit elements:

- Illicit Discharge Detection and Elimination
- Industrial and Commercial Facilities
- Construction Site Runoff Control
- Education and Outreach
- Public Involvement and Participation
- Post-Construction Stormwater Management
- Pollution Prevention for Municipal Operations
- Stormwater Management Facilities Operation and Maintenance Activities

In addition to the permit elements listed above, the 2012 NPDES MS4 permit also required the City to prepare a stormwater retrofit strategy, prepare a hydromodification assessment (to address instream channel erosion and channel modifications), and develop TMDL pollutant load reduction benchmarks. These technical assessments were documented and submitted to DEQ and included program, policy, and/or project recommendations.

Current SWMP implementation and results of these technical assessments have been considered in the identification of project opportunities documented in this TM. Resulting water quality projects and identified program modifications may be used by the City to address anticipated future permit requirements.

### 2.1.2 TMDL and 303(d) Applicability

The city of West Linn is located in the Willamette River watershed, adjacent to both the Willamette and Tualatin Rivers. A majority of the city (approximately 85 percent) discharges to the Willamette River and its tributaries including Arbor Creek, Robinwood Creek, Trillium Creek, Tanner Creek, and Salamo Creek. Approximately 15 percent of the city's drainage area, located in the southwest portion of the city, discharges directly to the Tualatin River, which flows to the Willamette River at the city's southern boundary.

Water quality impairment and exceedance of water quality standards in the Willamette and Tualatin Rivers have prompted these rivers and corresponding tributaries to be placed on the State 303(d) list for various parameters of concern. TMDLs have been developed to address specific sources of pollutant loading for select parameters. TMDLs have been developed for pollutants with direct links to stormwater runoff (e.g., metals, nutrients) and pollutants not typically associated with urban stormwater runoff in the Willamette Valley (e.g., temperature). Table 2 outlines the TMDL and 303(d) parameters applicable to the City.



Addressing TMDL and 303(d) parameters will be considered with development of stormwater project concepts. Implementation of water quality projects and programs will allow the City to document progress toward TMDL pollutant load reduction benchmarks and fulfill obligations under the City’s TMDL Implementation Plan for the Willamette and Tualatin watersheds.

<b>Table 2. Applicable TMDL and 303(d) Parameters</b>		
<b>Waterbody</b>	<b>TMDL Parameters</b>	<b>303(d) Parameters (2012)</b>
Tualatin River	Bacteria ( <i>E. coli</i> ) Total phosphorus DO (TSS as a surrogate) Temperature Mercury	Ammonia <sup>a</sup> Biological criteria Copper <sup>a</sup> Iron Lead <sup>a</sup> Manganese Dissolved oxygen (spawning beneficial use) Zinc <sup>a</sup>
Willamette River (Lower Willamette subbasin)	Bacteria ( <i>E. coli</i> ) Temperature Mercury	Chlorophyll a Aldrin <sup>b</sup> Biological criteria Chlordane <sup>b</sup> Copper <sup>a</sup> Cyanide DDT and DDT metabolite (DDE) <sup>b</sup> Dieldrin <sup>b</sup> Hexachlorobenzene <sup>b</sup> Iron Lead <sup>a</sup> Manganese PCBs Pentachlorophenol Polynuclear aromatic hydrocarbons (PAH)
Willamette River (Middle Willamette subbasin)	Bacteria ( <i>E. coli</i> ) Temperature Mercury	Aldrin <sup>b</sup> Biological criteria Copper <sup>a</sup> DDT and DDT metabolite (DDE) <sup>b</sup> Dieldrin <sup>b</sup> Iron Lead <sup>a</sup> PCBs

a. Parameter added in 2012.  
b. Organochlorine compound.

## Section 3: Identification of Stormwater Problem Areas

As described previously, the City opted to develop their SMP by initially assessing known stormwater problem areas and identifying those areas where infrastructure improvement, addition, replacement, or retrofit is needed to address the problems. The City historically receives limited complaints regarding stormwater system capacity deficiencies. The City also anticipates limited growth (annexations) and new development over the SMP planning period (i.e., 10 years). As such, a qualitative effort to evaluate identified problem areas was used to validate the need for system improvements. City-wide hydraulic modeling, as conducted for the previous master planning effort, to inform stormwater project development is not proposed. Targeted system modeling will be conducted, however, to evaluate select infrastructure or drainage basins where modeling can help inform observed deficiencies and needed improvements.

From September 2017 to March 2018, BC and City staff reviewed anecdotal data (see Section 3.1 below) to identify locations (i.e., stormwater problem areas) with observed or reported performance issues for additional review and evaluation under this SMP. Typical performance issues were related to conveyance system function and operation, conveyance system capacity, water quality impairment, maintenance needs (due to system clogging, etc.), and erosion.

### 3.1 Data Sources

Data sources used in the identification of stormwater problem areas included the following:

- Public and City staff surveys
- Hydromodification Assessment (2015)
- Previous CIP List (per the City's 2006 West Linn Surface Water Management Plan)

More detail regarding each of these three information sources is described in in the following subsections.

#### 3.1.1 Public and City Staff Surveys

In June 2017, BC and City staff prepared questionnaires (surveys) for distribution to the public and to City staff. The public survey reflected general questions about observed stormwater-related problems in respective neighborhoods. The City survey reflected more detailed questions targeting specific locations of reported capacity deficiencies, system condition issues, and frequent maintenance needs. Surveys were distributed to the public and City staff in July 2017.

The public survey closed after 6 weeks (September 7, 2017). A total of 40 responses were received. Typical problems reported in the public survey included ponding water (resulting from a lack of existing stormwater infrastructure) and locations where catch basins should be installed or relocated. Two City surveys were received between August and September 2017, one from Public Works staff and one from Parks staff. The survey received from Public Works identified areas with system configuration issues and reported flooding on private property. The survey received from Parks reflected areas of known instream erosion. The survey identified potential stream restoration project opportunities in conjunction with conceptual planning activities that are in progress on Parks property.

The City met internally on October 18, 2017, to review the public and City staff survey responses and discuss identified locations in conjunction with goals of the SMP and CIP development. Key findings and assumptions included:

- Installation of a stormwater collection system within the public right-of-way where one does not already exist may be a reasonable approach to address areas of ponding on private property. However, stormwater system improvements would likely be driven by the Transportation System Plan (TSP) and the need for pedestrian access (i.e., installation of curb and sidewalk). The TSP should be referenced and considered when prioritizing stormwater infrastructure needs.



- The City is currently implementing a strict interpretation of Chapter 46 (Parks Charter) and proposed projects on park property may need to go to a public vote. Such policy may constrain project development.
- Many reported problem areas associated with the need for catchbasin relocation or installation are already being addressed by Public Works.

The public and City survey resulted in the identification of 43 individual problem areas to be further evaluated as stormwater project opportunities.

### **3.1.2 Hydromodification Assessment**

A hydromodification assessment was completed in June 2015 to address a NPDES MS4 permit requirement. The objective of the hydromodification assessment was to evaluate whether the City's stream channels were susceptible to hydromodification impacts associated with urbanization and MS4 discharges. Policy, program, and project needs were proposed to address areas of observed impacts. The assessment relied on a combination of desktop (GIS) analysis and field observations.

For West Linn, the hydromodification assessment resulted in a finding that most observed stream channels are composed of bed and bank materials that appear to provide a natural resistance to hydromodification. There were minor hydromodification impacts observed in locations of concentrated flow (i.e., at culverts and at discharges from stormwater outfalls).

The hydromodification assessment resulted in the identification of six potential project locations to address localized hydromodification impacts. The proposed projects included stream stabilization, retrofit of an existing flow control facility, and/or outfall reinforcement efforts. One location (O19) is on private property and was thus excluded from consideration under this SMP. The other five locations were carried forward for additional follow up (i.e., site visits) and consideration as stormwater project opportunities.

### **3.1.3 2006 Plan CIP List Review**

The City's 2006 Plan identified 79 project needs, generally pipe or culvert segments requiring upsizing to meet current or future modeled flows. As mentioned, there is no accompanying prioritization or detailed description of the project needs or cost assumptions in the 2006 Plan. Limited coordination with City staff occurred during the 2006 Plan development so there is limited historic reference related to the relevance or need for the projects. There is also no record of which proposed projects have been constructed in accordance with findings of the 2006 Plan.

In December 2017, BC and City engineering and operations staff reviewed the 79 project needs and compared them with current GIS information to determine which proposed projects had been constructed since 2006 to address the modeled capacity deficiency identified in the 2006 Plan. The review included comparison with public and City staff survey results and hydromodification assessment results to identify any overlap with current, reported problem areas. City staff also discussed, based on routine maintenance activities conducted to date, whether the original project needs were still warranted. Of those original 79 project needs:

- 10 projects had been "completed" (based on GIS review)
- 27 projects were deemed unnecessary by City staff (no observed flooding or maintenance related)
- 14 projects had potential ownership issues (i.e., ODOT, PGE), and would likely be addressed in conjunction with future Highway 43 roadway improvements (and were proposed not to be considered as stormwater project opportunities for this SMP)
- 9 projects overlapped with existing problem areas, and would therefore be carried forward for evaluation and consideration as stormwater project opportunities
- 19 project locations were added to the existing problem area list





### 3.1.4 Documentation of Findings

Stormwater problem areas based on results of the public and City staff surveys, the hydromodification assessment and the 2006 Plan CIP List were compiled into an initial matrix and mapped to help inform site visit needs.

A total of 65 problem areas were compiled and categorized as follows:

- Capacity–Areas experiencing flooding or backwater conditions due to existing stormwater conveyance capacity
- System Configuration–Existing stormwater system needs to be redesigned or reconfigured to promote drainage
- Infrastructure Needs–Areas lacking stormwater infrastructure (i.e., stormwater main, catch basins, inlets) and experiencing ponding or drainage impacts to private property
- Erosion–Areas with reported instream erosion (i.e., failing slopes, channel incision)
- Water Quality–Existing water treatment facilities that appear to be failing
- Maintenance–Areas of regular or frequent maintenance needs (i.e., clogged catch basins)
- System Condition–Areas with reported aging infrastructure at risk of failure (i.e., failing pipes, rusted pipes)

Figure 1 reflects identified stormwater problem areas in accordance with the categories listed above. Each location is identified by a Location ID number, carried forward for the documentation of stormwater project opportunities in Attachment A, Table A-1.

## 3.2 Site Visits (November 2017 and March 2018)

BC and City staff conducted two site visits to verify stormwater problem areas and assess potential project concepts and approaches. Each site visit began with a meeting to finalize site visit locations, verify schedule, and discuss accessibility constraints. Maps were distributed detailing the upstream and downstream stormwater conveyance systems. Site visits were documented via field notes and photo logs.

The first site visit was held November 30, 2017. A total of 13 problem areas were visited. These locations were prioritized during an initial 2-hour meeting with City operations and engineering staff prior to the site visit. Locations experiencing regular capacity deficiencies and areas with infrastructure needs were targeted during this site visit. During this initial meeting, 22 of the 65 initial stormwater problem areas were removed from consideration as project opportunities (and thus from the site visit schedule), due to the fact that efforts were currently being conducted to address the reported problem, or the problem was related to an instream conveyance issue outside of the scope for this SMP.

A follow up site visit was conducted March 6, 2018, to review capacity limited stormwater problem areas potentially requiring modeling. These locations were identified following the Stormwater Modeling Needs Workshop (Section 3.3).

## 3.3 Stormwater Modeling Needs Workshop

BC met with the City on February 15, 2018, to review data compilation efforts and the identification of 65 stormwater problem areas. The objective of the workshop was to refine problem areas by CIP development approach and discuss locations where modeling would be warranted to better understand an identified problem.

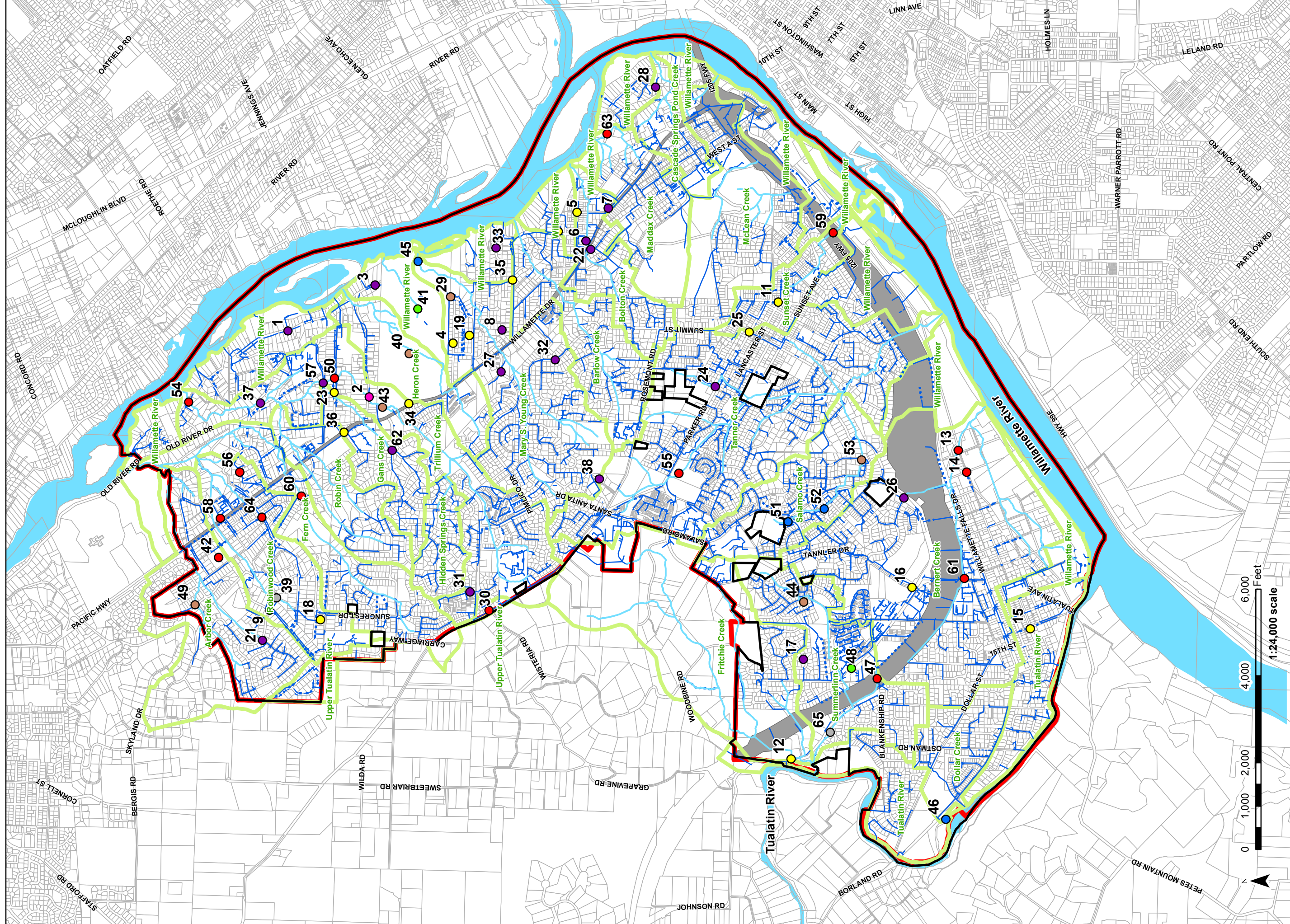
Four modeling approaches were presented to City staff reflecting varying levels of effort and survey needs. This allowed staff to consider schedule and cost implications related to obtaining data with the abilities and benefits of a model to reduce uncertainty regarding reported problems. Because some stormwater project opportunities could be developed without a detailed model, the City could prioritize locations where survey and a hydraulic model would provide additional benefit to the City. Based on need, problem areas were sorted into the following four categories:

- Category 1: Detailed hydraulic modeling is needed. Hydraulic modeling is required to determine the problem sources and solutions. Survey is needed to obtain system information upstream and downstream of the problem location.
- Category 2: Hydrology modeling to inform system sizing. Hydrology modeling will be used to size new infrastructure (i.e., pipes). These locations generally include those areas without existing infrastructure to evaluate. No survey is required.
- Category 3: Limited hydraulic modeling need. Hydraulic modeling is required to evaluate culvert or pipe capacity in areas with reported capacity deficiencies. Survey is needed to verify existing culvert/ pipe size and slope.
- Category 4: No modeling required.

Each stormwater problem area was discussed in conjunction with the defined categories. Two locations (Location ID 47 and 56) were identified for detailed hydraulic modeling (Category 1). Five locations (Location ID 13, 55, 59, 60, and 63) were identified for limited hydraulic modeling (Category 3).

As an outcome of the workshop, the City identified the need to hydraulically evaluate all stormwater system crossings along Highway 43 to confirm capacity (Category 3) and determine whether upsizing is needed in conjunction with the future Highway 43/ ODOT roadway widening project. There are 24 identified crossings. Results from this modeling effort will be documented in the SMP independent from CIP needs.

Stormwater problem areas and proposed modeling approaches are documented in the final stormwater project opportunity matrix (Attachment A, Table A-1), described in Section 5. Originally identified problem areas that upon additional review and discussion with the City are not anticipated to translate to a project opportunity have been maintained in the matrix for reference.



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Figure 1: Stormwater Problem Areas

- Stormwater Problem Areas (by Location ID)**
  - Capacity
  - System Configuration
  - Infrastructure Needs
  - Erosion
  - Water Quality
  - Maintenance
  - System Condition
  - Other
- Stormwater Pipe**
  - Open Channel
  - Streams
- Major Basin Boundaries**
- ODOT ROW**
- City Limits**
- UGB**

Data Source: City of West Linn GIS and Metro RLIS  
 Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.  
 Map Publication/Print Date: June 2018 Produced by Brown and Caldwell

## Section 4: Water Quality Assessment

As a Phase I NPDES MS4 permit holder, retrofit of the stormwater system to improve water quality is a primary objective for this SMP. In accordance with the City's Stormwater Retrofit Plan (2015), stormwater retrofits, specifically the installation of water quality treatment in areas not otherwise treated, will allow the City to reduce TMDL and 303(d) pollutants, show continued progress towards meeting TMDL benchmarks, and improve water quality in the Willamette and Tualatin watersheds. Future NPDES MS4 permit requirements are anticipated to include additional focus on water quality treatment and facility installation.

BC conducted a separate water quality assessment to identify additional water quality project opportunities for consideration in the City's SMP. Objectives of the water quality assessment were to expand coverage of stormwater treatment facilities and improve the function of existing stormwater treatment facilities. Low impact development (LID) or green infrastructure applications were targeted, as they promote infiltration and runoff volume reduction in addition to treatment.

### 4.1 Water Quality Assessment Strategies

BC developed four strategies to help categorize identified water quality project opportunities in accordance with objectives of the water quality assessment:

- Strategy 1a. Green Infrastructure in the public right-of-way as a standalone project (i.e., replacing bubblers and adding in a collection system).
- Strategy 1b. Green Infrastructure in the public right-of-way as part of a programmatic activity (i.e., to be completed with larger TSP).
- Strategy 2. Installation of new water quality facilities on public properties to provide treatment for areas that have no treatment. Strategy 2 directly addresses the City's water quality assessment objectives, and evaluation was limited to existing, developed public properties.
- Strategy 3. Installation of new water quality facilities to manage runoff associated with Highway 43 improvements.
- Strategy 4. Retrofit existing public stormwater ponds to increase capacity or treatment capabilities. This strategy would include the retrofit of ponds constructed solely for detention in order to add treatment and increase capacity.

Strategy 1 (green infrastructure in the public ROW) was subdivided into those areas where a standalone project would be initiated (Strategy 1a) as opposed to areas where green infrastructure could be added, but likely because of a larger TSP-initiated project (Strategy 1b). City staff confirmed that areas with existing curb and gutter should be classified as Strategy 1a, and areas without existing curb and gutter should be classified as Strategy 1b. A programmatic initiative would likely be funded to address Strategy 1b.

Strategy 3 stems from the fact that water quality treatment will be required in conjunction with the future Highway 43 roadway improvements. City charter (West Linn Charter, Chapter 11, Section 46) limits use of park property for any "nonauthorized" use without voter approval to be used for construction of utilities, which could limit the use of parks property for large regional stormwater detention facilities. However, the City has received voter approval for stormwater management, grading and drainage associated with Highway 43 improvements as an authorized use, and therefore park property may be used to site stormwater facility installations for this purpose. In addition, parks and open space are key locations for water quality as improved water quality is one of the primary functions of park and open space areas.

## 4.2 Methodology

A combination of a desktop GIS assessment and a site visit was used to develop and refine water quality opportunity areas in conjunction with the strategies listed above.

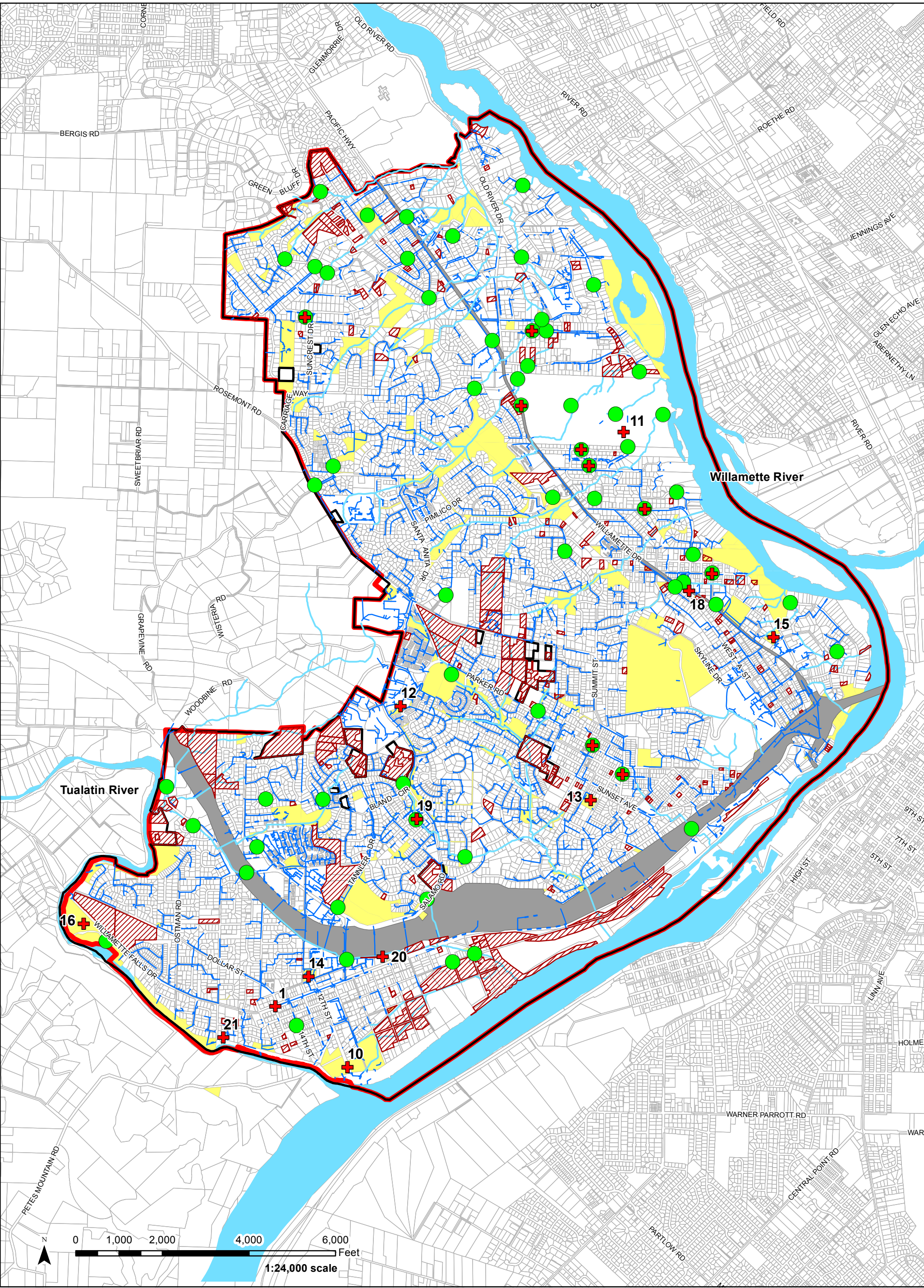
### 4.2.1 Desktop Assessment

A desktop GIS evaluation was conducted to comprehensively look at locations of high pollutant load generation (based on land use) and opportunistic areas (i.e., vacant, public, or undeveloped areas) where treatment facilities could potentially be located. Preliminary mapping (Attachment B) was used to support this effort. As part of the desktop assessment, the following data was reviewed:

- Existing Land Use–Existing land use was evaluated for areas of higher pollutant loading (i.e., commercial and industrial lands). See Attachment B, Figure B-3
- Vacant Lands: Vacant lands were reviewed to identify potential areas for easement or property acquisition to construct regional water quality treatment facilities. Vacant lands in conjunction with Highway 43 alignment were specifically targeted.
- Public Facilities (i.e., City Hall, Public Works Maintenance Facility, public parking lots at parks)–Parking areas associated with public facilities and parks properties were reviewed to evaluate whether water quality facility coverage already exists or could be expanded. See Attachment B, Figure B-1.
- Existing Stormwater Problem Areas–Mapped stormwater problem areas (Figure 1) were reviewed to evaluate whether a water quality project could be implemented to address an identified stormwater problem area. Locations with identified infrastructure needs were targeted, as there is the potential to incorporate green infrastructure into the streetscape in these areas to address reported drainage problems.
- Public Parks–Existing park property downstream (east) of Highway 43 was reviewed to evaluate potential treatment locations in conjunction with the Highway 43 roadway improvements.
- Water Quality Facilities–Existing water quality facility locations and associated drainage areas were reviewed to identify areas lacking existing facility coverage. See Attachment B, Figure B-4.

Stormwater ponds, contained within the City’s GIS water quality facility shapefile, were evaluated independently to address Strategy 4. Pond attributes were reviewed to identify ownership (public, private), installation date, configuration (online vs offline), and the potential for future development to occur upstream for each pond. City staff provided as-built information and recent inspection feedback to support identification of public ponds that may be targeted for retrofit. The City currently has 53 public stormwater ponds recorded in their inventory. Thirty public ponds were installed prior to 2004 (the date associated with NPDES MS4 permit requirements targeting maintenance of water quality facilities), and 8 public ponds are located inline and downstream of vacant property. Two existing public ponds met both the installation date and proximity to vacant property objectives and were identified for consideration as stormwater quality project opportunities ([see Table A-3 for reference](#)).

The desktop assessment identified a total of 21 water quality opportunity areas, 10 of which overlap with identified stormwater problem areas. Figure 2 shows the water quality opportunity area locations in conjunction with identified stormwater problem areas. Locations are mapped by Water Quality Opportunity ID (see Table A-2 for reference).



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**Figure 2: Water Quality Opportunity Areas**

- + Water Quality Opportunity Areas (by WQ Opportunity ID)
- Stormwater Problem Areas
- Stormwater Pipe
- - - Open Channel
- Vacant
- Public Property
- Streams
- City Limits
- UGB

Data Source: City of West Linn GIS and Metro RLIS  
 Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.  
 Map Publication/Print Date: June 2018 Produced by Brown and Caldwell

The Water Quality Assessment Matrix (Attachment A, Table A-2) documents each water quality opportunity area and provides a description of the project concept, rationale, and associated strategy number per Section 4.1. Relevant background information (i.e., soil type, land use) is also provided. In summary, the following water quality opportunity areas were identified in accordance with defined strategies:

- Two Strategy 1a projects
- Seven of Strategy 1b projects
- Seven Strategy 2 projects
- Two Strategy 3 projects
- Three Strategy 4 projects

[A summary of the pond inventory, conducted in support of the overall Water Quality Assessment effort, is provided in Attachment A, Table A-3.](#)

#### **4.2.2 Site Visit**

On June 21, 2018, BC and City staff conducted a site visit to confirm the configuration of select stormwater quality opportunity areas. Eight areas were visited to identify site conditions and discuss project/solution details. Results of the site visit are documented in Table A-2. Following the site visit, six areas were removed from consideration as future stormwater project opportunities. Namely, identified vacant properties near Highway 43 were removed given significant site constraints and limited retrofit potential.

### **4.3 Results**

City staff provided final input and verification of stormwater quality opportunity areas that should be maintained for consideration.

Of the 21 stormwater quality opportunities identified, 10 overlapped with existing stormwater problem areas, and water quality will have to be integrated into the project development process. Five stormwater quality opportunity areas were added as potential new projects (see Section 5 for more details). Six areas were removed from consideration due to site constraints, limited potential for retrofit or land acquisition, or water quality had already been addressed for the area.

## **Section 5: Stormwater Project Opportunity Areas**

Identified stormwater problem areas (Section 3) and stormwater quality opportunity areas (Section 4) were compiled into a comprehensive stormwater project opportunity matrix (Attachment A, Table A-1). This matrix documents preliminary project concepts that will be carried forward in the development of CIPs and city-wide programmatic activities under this SMP.

There are a total of 27 potential standalone CIP locations and 17 locations anticipated to be addressed as part of a city-wide programmatic effort. Five CIP locations are identified as “Project (Highway 43 Evaluation)”. Drainage problems associated with these locations will likely be addressed in conjunction with the Highway 43 roadway project. Capacity modeling to inform these Highway 43 crossings may support project development if warranted.

As mentioned, 23 stormwater problem areas are referenced in this matrix but have been shaded in gray and are not considered as opportunities to carry forward due to initial input from City staff during the November 30, 2017 site visit.

Information contained in the matrix includes the project objective(s), project source, and project background and summary of problem (if applicable). Project development status including proposed modeling approach, site visit status, and survey needs are also included. Locations are identified by Location ID, which is consistent with the numbering used to identify stormwater problem areas in Figure 1. Locations are mapped in Figure 3 in accordance with their “Location ID”.

## 5.1 Programmatic Opportunities

Five city-wide programmatic activities, covering 17 identified stormwater project opportunity areas per Table A-1, were identified to support ongoing assessment and maintenance of existing infrastructure and water quality. Identification of these activities as a programmatic opportunity means that an annual budget allocation (as opposed to a one-time budget allocation) will be needed to support these efforts. The identified programmatic opportunities include:

- Beaver Management Initiative (Location ID 12)–This program would involve ongoing management efforts to mitigate beaver dam construction to eliminate flooding in susceptible areas with public safety concerns.
- Fish Passage Evaluation (Location ID 54, 57)–This program would involve a larger study to evaluate culvert replacement needs to address fish passage. Coordination with state and federal agencies may be required to confirm whether fish are inhabiting selected stream reaches. This initiative may also be defined as a standalone project (planning study).
- Green Street Pilot Program (Location ID 11, 15, 18, 19, 23, 25, 35)–This program would target public right-of-way areas without curbs, sidewalks, and gutters where improvements in accordance with the TSP may be initiated. Funding could be set aside for installation of green street features associated with roadway improvements.
- Inlet Replacement and Installation Program (Location ID 20, 28, 32, 37, 42, 48)–This program would add or replace inlets throughout the city in areas experiencing localized drainage issues. Efforts may include replacement of grated inlets with curb inlets, the addition of new inlets, or relocation of inlets in conjunction with grading or tree coverage (where leaves routinely clog the inlet).
- Pipe Replacement Program (Location ID 16)–This program would include replacing pipes with condition deficiencies. Asset age is not widely documented in the City’s GIS (only 18 percent of the features are populated with an as-built year). The City could establish a system lifetime age and assume city-wide replacement/rehabilitation of piped infrastructure over a defined timeframe.

Additional programmatic opportunities may include, but are not limited to, a public pond maintenance program or an annual pipe inspection program (CCTV inspections).

If these programmatic initiatives are confirmed by the City, the scope and scale can be further refined and annual costs developed during the CIP development process.

## 5.2 Modeling Status

BC and City staff met March 7, 2018, to finalize survey needs for locations identified as requiring detailed or limited hydraulic modeling (see Table A-1). Data collection tables reflecting required storm structure information (rim elevations, invert elevations, and size) were distributed for each modeling location. For open channel portions of the conveyance system, the data collection tables included cross section information needs including surveyed points reflecting the bottom width of the channel and the top width of the channel. Stormwater system features and cross section locations requiring survey were presented in maps.



Highway 43 crossings (24 crossings total) are considered part of the limited hydraulic modeling needs and survey information is required for those locations as well (locations are not reflected in Table A-1).

City staff completed survey, QA/QC, and documentation on July 18, 2018, and provided the information to BC as a geodatabase for incorporation into the XP-SWMM model. Model assumptions and results will be documented in TM #3.

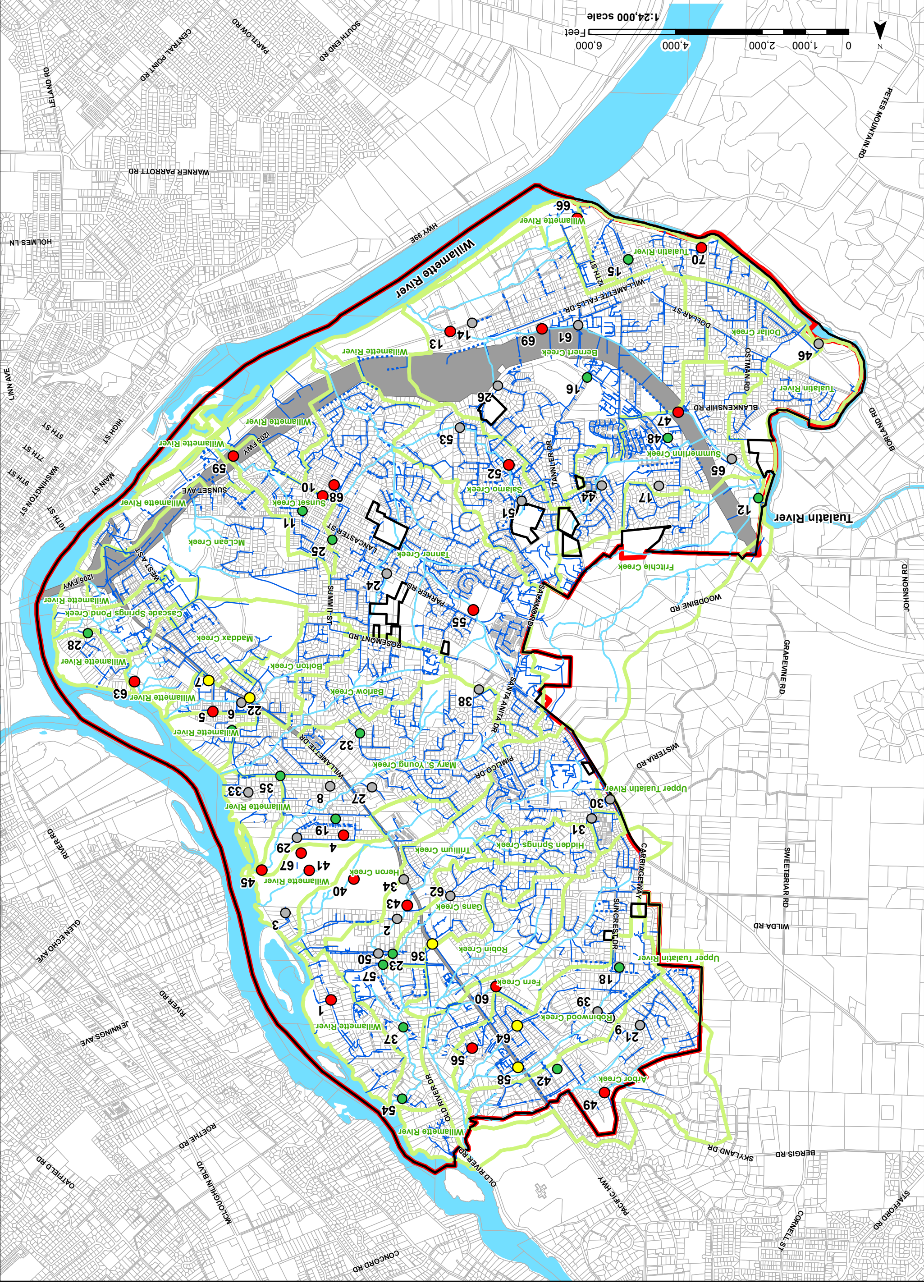
### **5.3 Next Steps**

Stormwater project development will occur based on the preliminary project concepts outlined in Table A-1.

City staff will participate in a workshop following completion of the hydraulic modeling efforts. The workshop will be used to review preliminary results from the hydraulic modeling effort and facilitate discussion of the proposed project concepts including programmatic concepts. The outcome from this workshop will include a final stormwater project matrix for costing and inclusion in the SMP.

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Figure 3: Stormwater Project Opportunity Areas

- Project Opportunity Category
- Stormwater Pipe
- Open Channel
- Streams
- Watershed Boundaries
- Proposed Project (Hwy 43)
- Proposed Programmatic
- City Limits
- Removed from Consideration



Map Publication/Print Date: July 2018 Produced by Brown and Caldwell  
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 Data Source: City of West Linn GIS and Metro RLIS

## Attachment A: Matrices

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**Table A-1: Stormwater Project Opportunity Areas**

							Project Development					
Opportunity Category	Location ID	Project Objectives	Project Source	Location	Major Basin	Project Background	Modeling Approach	WQ Opportunity	Site Visit	Survey	TSP Driver	Notes
Project	1	Improve System Configuration	Staff Summary	18780 Nixon	Willamette River	Public storm pipe under house (garage) required relocation. Potential to move pipe to the southern location with easement. No survey required.	Hydrology to inform system sizing		Still Required	NA		
Project	4	Add Infrastructure Water Quality Retrofit	Staff Summary Public Survey	Mark Lane	Mary S. Young Creek	Poor drainage and reported flooding. No infrastructure and City uses bubblers, which City wants to discontinue.  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.	Hydrology to inform system sizing	Y	Y (6-26-18)	NA		See Water Quality Opportunity ID #3
Project	5	Add Infrastructure Water Quality Retrofit	Staff Summary Public Survey	Buck Street/ Upper Buck Street	Bolton Creek	Poor drainage and reported flooding. No infrastructure and City uses bubblers, which City wants to discontinue. City maintenance staff installed a new curb inlet at end of Buck St to alleviate flooding, which has helped but not eliminated flooding. Downstream outfall erosion observed. Project scope may include trunkline down Buck Street from fire station to outfall and green street facilities.	Hydrology to inform system sizing	Y	Y (11-30-17)	NA		See Water Quality Opportunity ID #2
Project	10	Add Infrastructure	Staff Summary Staff Survey	Sunset Avenue (between 4345 and 2413)	Sunset Creek	Deep ditches along road are eroding. Current eye sore. Flooding is generally not a concern but the geometry of the ditches is a safety concern. Steep grade may prohibit green infrastructure. Trunkline proposed for installation with road repairs.  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.	Hydrology to inform system sizing		Y (11-30-17)	NA	High	
Project	13	Increase System Capacity (Flood Control, 40" Concrete) Improve System Configuration	Staff Summary 2005 CIP	5th Avenue culvert	Bernert Creek	Undersized culvert identified in 2005 MP. Site visit 11-30-17 indicates debris and exposed corrugated metal sanitary line. City installed a concrete overlay on County-owned sanitary SMP that could present a safety concern. Culvert orientation results in 90 degree bend in channel. CIP may require reorienting culvert inline with channel configuration. Potential utility conflicts. Not anticipated to be a fish bearing waterway in proximity.	Capacity Check		Y (11-30-17)	Y		
Project	40	Erosion Prevention	Staff Survey	Mary S Young Park	Heron Creek	Reported land slides and erosion trail/bridge washout in Mary S Young Park. Project opportunity to add in stream bank erosion measures to minimize the trail and bridge washout in the park.			Still Required	NA		
Project	41	Address Maintenance Need Repair Infrastructure	Staff Survey	Turkey Creek in Mary S Young Park	Willamette River	Replace culvert at Turkey Creek in Mary S Young Park and rebuild the trail that has been washed out. Design measure to slow down the stormwater runoff in this area to avoid further erosion of trail. Continue ongoing maintenance of culverts to ensure no blockage.			Maybe Needed	NA		
Project	43	Erosion Prevention Water Quality Retrofit	Staff Survey	Trillium Creek in Mary S Young Park	Trillium Creek	Demonstration project opportunity at Trillium Creek in Mary S Young Park to restore channel incision with large woody debris and other creek stabilization measures.		Y (stream restoration)	Still Required	NA		Project location in area where sanitary system is having issues with calibration.
Project	45	Water Quality Retrofit	Staff Survey	Mary S Young Creek	Mary S. Young Creek	Remove culvert at Mary S. Young Creek to improve water quality and provide fish restoration measures in the creek in accordance with the Mary S Young Creek Restoration Concept Plan.		Y (stream restoration)	Still Required	NA		
Project	47	Increase System Capacity (Flood Control)	Staff Survey 2005 CIP	Blankenship Road under I-205 overpass	Summerlinn Creek	Blankenship Road consistently floods, even with recent site improvements to the swale and ditch along Blankenship. Area is flat. The 12-inch concrete pipe in Blankenship Drive near the intersection with Johnson Road was specifically mentioned in the 2005 CIP.  Drainage infrastructure and drainage patterns seems inconsistent with mapped GIS (recent surveying confirms need for subbasin delineation). Northern side of Blankenship under the overpass is unimproved and drains to a ditch inlet in middle of filled-in ditch. Inlet elevation is too high to function properly. Site visit 3-6-18 reveals a lack of inlets along Debok RD and upper Blankenship. Survey extents expanded to account for questions on drainage patterns and contributing area.	Detailed		Y (11-30-17, 3-16-18)	Y	High	
Project	49	Erosion Prevention	Hydromodification Assessment (009)	Downstream of Arbor Creek culvert at Hillside Drive, near Skye Parkway	Arbor Creek	Scour hole at culvert outlet resulting in bank erosion was observed during hydromod assessment. Project needs may include stream stabilization project to reduce channel drop or outfall reinforcement.			Maybe Needed	NA		
Project	52	Water Quality Retrofit	Hydromodification Assessment (007)	In-line stormwater facility upstream of Remington Drive	Bernert Creek	Potential opportunity to increase storage and flow control and enhance water quality treatment was observed during hydromod assessment.		Y	Maybe Needed	NA		See Water Quality Opportunity ID #19

**Table A-1: Stormwater Project Opportunity Areas**

							Project Development					
Opportunity Category	Location ID	Project Objectives	Project Source	Location	Major Basin	Project Background	Modeling Approach	WQ Opportunity	Site Visit	Survey	TSP Driver	Notes
Project	55	Increase System Capacity (Flood Control, 15" CMP)	2005 CIP	Tanner Creek Park	Tanner Creek	Reported capacity deficiency in 2005 MP (should be 30"). There have been multiple complaints by park staff as the culvert is located under the walking path.	Capacity Check		Maybe Needed	Y		
Project	56	Increase System Capacity (Flood Control, 12" Concrete) Improve System Configuration	2005 CIP	Fairview Way to Vista Ct	Fern Creek	City previously replaced failing 12" pipe that crosses Fairview Way. The new 15" appears to have corrected the flooding problem, but may have relocated issue. All upstream pipes are 12" based on GIS and should be modeled prior to HWY 43 work. Project extents from node RW-CB-0144 on west side of HWY 43 to outfall RW-OF-0122 as DS pipe is 18".  GIS updates needed.	Detailed		Y (3-16-18)	Y		
Project	59	Increase System Capacity (Flood Control, 24" Concrete)	2005 CIP	Sunset Creek at I-205 (2005 MP indicated under Willamette Falls Dr)	Willamette River	Reported capacity deficiency in 2005 MP (should be 30").  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.	Capacity Check		Maybe Needed	Y		
Project	60	Increase System Capacity (Flood Control, 24" CMP and Concrete)	2005 CIP	Kantara Way	Fern Creek	Reported capacity deficiency in 2005 MP (should be 30"). There is a water line crossing near this location and the culvert was connected to a piped creek so the water line could be installed.	Capacity Check		Maybe Needed	Y		
Project	63	Increase System Capacity (Flood Control, 21" CMP)	2005 CIP	Maddox Creek at River Street	Maddox Creek	Flooding reported at this location. 2005 MP recommends 36" diameter pipe installed.	Capacity Check		Maybe Needed	Y		
Project	66	Water Quality Retrofit	BC Water Quality Assessment	Willamette Park Parking Lot Retrofit	Willamette River	Limited water quality treatment in vicinity. Opportunity to treat a large square footage of impervious area on public property. City prefers use of pervious pavers, consistent with overflow lots.		Y	Y (6-26-18)	NA		
Project	67	Water Quality Retrofit	BC Water Quality Assessment	Mary S. Young Park Parking Lots Retrofit	Willamette River	Limited water quality treatment in area. Opportunity to treat a large square footage of impervious area on public property. City prefers use of pervious pavers, consistent with overflow lots at other parks.		Y	Y (6-26-18)	NA		
Project	68	Water Quality Retrofit	BC Water Quality Assessment	West Linn Public Works Department	Tanner Creek	Opportunity to incorporate water quality treatment to treat additional area not currently being treated. City identified opportunity to install a small rain garden along Norfolk Street frontage for parking lot at front of building. Project location referenced in Retrofit Assessment (2015).		Y	Y (6-26-18)	NA		
Project	69	Water Quality Retrofit	BC Water Quality Assessment	Public Pond #18 (BC ID)	Bernert Creek	Retrofit existing public pond to enhance water quality treatment in areas of the City. This pond was installed in 1997, which is pre-2004 which was when the NPDES MS4 Permit Requirements for pond maintenance began. This pond is also located downstream of a vacant site. Retrofit in conjunction with development of adjacent parcel.		Y	Y (6-26-18)	NA		
Project	70	Water Quality Retrofit	BC Water Quality Assessment	Public Pond # 22 (BC ID), 25545 Katherine Court	Tualatin River	Retrofit existing public pond to enhance water quality treatment in areas of the City that are not currently being treated. This pond was installed in 1999, which is pre-2004 which was when the NPDES MS4 Permit Requirements for pond maintenance began. This pond is also located downstream of vacant sites. Pond located upstream of outfall to the Willamette River.		Y	Y (6-26-18)	NA		
Project (Highway 43 Evaluation)	7	Improve System Configuration	Staff Summary 2005 CIP	Bolton Primary School	Bolton Creek	Localized flooding/ runoff from Hwy 43 causes flooding. Steep slope and embankment to existing parking area. Complaints occur when freezing temperatures result in icy conditions. The 27-inch concrete pipe from Hwy 43 to the Holmes St outfall to Bolton Creek was specifically mentioned in the 2005 CIP.  Problem likely addressed with Hwy 43 improvements. Evaluation to confirm capacity of crossings under Hwy 43 to be conducted, but specific CIP need in this location may not be warranted.	Capacity Check		Y (6-26-18)	Y (Hwy 43)	High	See Water Quality Opportunity ID #18 for more detail on site.
Project (Highway 43 Evaluation)	22	Improve System Configuration	Public Survey	Hwy 43/ A Street	Bolton Creek	Ponding on road during rain events.  Problem likely addressed with Hwy 43 improvements. Evaluation to confirm capacity of crossings under Hwy 43 to be conducted, but specific CIP need in this location may not be warranted.	Capacity Check		N	Y (Hwy 43)	High	
Project (Highway 43 Evaluation)	36	Add Infrastructure Improve System Configuration	Public Survey	Hwy 43 at Hidden Springs	Gans Creek	Ponding on road during rain events.  Problem likely addressed with Hwy 43 improvements. Evaluation to confirm capacity of crossings under Hwy 43 to be conducted, but specific CIP need in this location may not be warranted.	Capacity Check		N	Y (Hwy 43)		Project location in area where sanitary system is having issues with calibration.

**Table A-1: Stormwater Project Opportunity Areas**

							Project Development					
Opportunity Category	Location ID	Project Objectives	Project Source	Location	Major Basin	Project Background	Modeling Approach	WQ Opportunity	Site Visit	Survey	TSP Driver	Notes
Project (Highway 43 Evaluation)	58	Increase System Capacity (Flood Control, 27" Concrete) Improve System Configuration	2005 CIP	Robinwood Creek at Shady Hallow Drive	Robinwood Creek	Flooding has been reported at this location in the past. Two drainage ditches converge at this location and enter a culvert. It is unclear if the issue is maintenance of the ditches or culvert capacity. Site visit 3-6-18 indicates three pipes: 18" and 24" culverts and a 12" pipe that originate near HWY 43 (actual location could not be verified). No flooding reported in original problem area location. The culvert under HWY 43 discharges to ODOT ROW and daylight. Sand bags and a corrugated plastic pipe redirect the water south where a junction redirects the water via another corrugated plastic pipe. The outfall of the plastic pipe is unknown but appears to discharge to a space between two homes.  Problem area is associated with Hwy 43 crossing. Problem likely addressed with Hwy 43 improvements. Evaluation to confirm capacity of crossings under Hwy 43 to be conducted, but specific CIP need in this location may not be warranted.	Capacity Check		Y (3-16-18)	Y (Hwy 43)		
Project (Highway 43 Evaluation)	64	Increase System Capacity (Flood Control, 18" Concrete)	2005 CIP	Lower Marylhurst Drive from Lower Midhill	Robinwood Creek	Reported capacity deficiency in 2005 MP. Current GIS indicates 24" CMP crossing at Highway 43 so may need to confirm pipe size.  Problem likely addressed with Hwy 43 improvements. Evaluation to confirm capacity of crossings under Hwy 43 to be conducted, but specific CIP need in this location may not be warranted.	Capacity Check		N	Y (Hwy 43)		
Programmatic (Beaver Management)	12	Address Maintenance Need	Staff Summary Staff Survey 2005 CIP	23350 Johnson Road; 23212 Johnson Road	Fritchie Creek	Flooding issues reported by City Staff and identified in the 2005 CIP list. The 2005 CIP list specially mentioned the 15 and 36-inch pair of concrete culverts along Johnson Road. There is no existing stormwater system. Site visit 11-30-17 identified beaver dams observed in culvert under Johnson Road and upstream (north) on Fritchie that appear to cause the flooding.			Y (11-30-17)	NA	Medium	
Programmatic (Fish Passagability Evaluation)	54	Increase System Capacity Improve System Configuration	2005 CIP	Trillium Creek Crossing Under Calaroga Drive	Trillium Creek	The 2005 CIP list indicated a capacity deficiency at the Trillium Creek crossing under Calaroga Drive. City staff reports need for fish passagable culvert. Seperate planning effort proposed to coordinate with ODFW and determine fish passageability need.			Maybe Needed	NA		
Programmatic (Fish Passagability Evaluation)	57	Improve System Configuraiton	2005 CIP	Trillium Creek at Cedar Oak Drive	Trillium Creek	The 2005 CIP list indicated three culverts under Cedar Oak Drive area fish crossings. City staff reports need for fish passagable culvert. Seperate planning effort proposed to coordinate with ODFW and determine fish passageability need.			Maybe Needed	NA		
Programmatic (Green Street)	11	Add Infrastructure Water Quality Retrofit	Staff Summary	Exeter St, Lancaster St	Sunset Creek	Poor drainage and reported flooding. No curb and gutter in a majority of the ROW. Piped conveyance to Sunset Creek through private parcel (not in ROW).  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.		Y	Y (11-30-17)	NA	High	See Water Quality Opportunity ID #5
Programmatic (Green Street)	15	Add Infrastructure	Staff Summary	Willamette Neighborhood	Bernert Creek	Limited water quality treatment in area. Wide Right-of-Way. No existing curb and sidewalk. Opportunity for a green street project. Target locations 14-16th Avenues.		Y	Y (11-30-17)	NA	Medium/High	See Water Quality Opportunity ID #1
Programmatic (Green Street)	18	Add Infrastructure Water Quality Retrofit	Public Survey	Suncrest, Valleyview Dr, and Hillcrest between Suncrest and Marylhurst Drive	Robinwood Creek	Reported stormwater flooding down Suncrest, Valley View Drive and Hill Crest between Suncrest and Marylhurst Drive. There are existing open drainage ditches and no curb or side walk. There are no signs of visible signs of erosion. A local resident hand dug a small trench to direct flow from a spring in front of 1779 Hillcrest Dr. (approx. address).  Project opportunity to build a green street infrastructure project or a new piped stormwater conveyance system to mitigate stormwater flooding on the roadways. During design evaluate the downstream capacity of the stormwater system.		Y	Y (11-30-17)	NA	High	See Water Quality Opportunity ID #7
Programmatic (Green Street)	19	Add Infrastructure Water Quality Retrofit	Public Survey Staff Survey	LaFave Street, Jolie Point Road, Munger Drive, Lowell Avenue	Mary S. Young Creek	Poor drainage and reported flooding. System currently composed of driveway culverts and ditches. No curb and gutter.  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.		Y	N	NA		See Water Quality Opportunity ID #4
Programmatic (Green Street)	23	Add Infrastructure Water Quality Retrofit	Public Survey 2005 CIP	Kenthorpe Way	Trillium Creek	No existing stormwater system (uneven ditches) near the Fire Station and along Kenthorpe Way. Public stormwater runoff is flooding private yards in the area. There is a pair of culverts along Gans Creek at Kenthorpe Way were identified in the 2005 CIP List as a project need.  Project opportunity to add in a new piped stormwater conveyance system near the Fire Station and on Kenthorpe Way to mitigate flooding. Upsize/ replace the culverts at Gans Creek.		Y		NA		See Water Quality Opportunity ID #9

**Table A-1: Stormwater Project Opportunity Areas**

							Project Development					
Opportunity Category	Location ID	Project Objectives	Project Source	Location	Major Basin	Project Background	Modeling Approach	WQ Opportunity	Site Visit	Survey	TSP Driver	Notes
Programmatic (Green Street)	25	Add Infrastructure Water Quality Retrofit	Public Survey	Cornwell Road and York Street	Tanner Creek	No infrastructure and City uses bubblers, which City wants to discontinue.  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.		Y	Y (11-30-17)	NA	High	See Water Quality Opportunity ID #6
Programmatic (Green Street)	35	Add Infrastructure Water Quality Retrofit	Public Survey	Dillow Drive at Larson	Barlow Creek	Limited water quality treatment in area. Ponding water possibly due to undersized ditch inlet. Project opportunity to add additional inlets and potential green street improvements. Only partially curbed street. Opportunity for Highway 43 management if green street installed.  High I&I reported in area (significant R value) in the public survey, indicating that high proportion of precipitation enters sanitary system. This could be caused by an undersized ditch inlet.		Y	Y (11-30-17, 6-26-18)	NA		See Water Quality Opportunity ID #8
Programmatic (Inlet Replacement/ Installation)	20	Infrastructure Need	Public Survey	6343 Failing Street	Willamette River	The public survey identified no stormwater system near 6343 Failing Street and stormwater runoff enters yards. Homes sit below grade which results in yards flooding. Roadway has steep slopes  Potential projects to solve flooding include increased inlets with a trench drain system upstream of the yards that are being flooded.			Y (11-30-17)	NA		
Programmatic (Inlet Replacement/ Installation)	28	Improve System Configuration	Public Survey	5550 Sinclair Street	Cascade Springs Pond Creek	The existing storm drain inlet near 5550 Sinclair Street is not located at the low point. Project opportunity to remove existing inlet and install a new inlet at the low spot near the address noted.			N	NA		
Programmatic (Inlet Replacement/ Installation)	32	Improve System Configuration	Public Survey	Summit Street between Apollo and Causey	Mary S. Young Creek	Reported stormwater bypass from catchbasins on Apollo. Per site visit 11-30-18, catch basin spacing seems adequate but high leaf accumulation. May consider replacement with curb inlets for debris control.			Y (11-30-17)	NA	High	
Programmatic (Inlet Replacement/ Installation)	37	Improve System Configuration	Public Survey	Elmran Dr near Old River Road	Fern Creek	Ponding water reported at Elmran Dr near Old River Road. This problem will be addressed with new curb inlets to alleviate ponding.			N	NA	Medium	
Programmatic (Inlet Replacement/ Installation)	42	Improve System Configuration	Staff Survey	Near Midhill Park	Arbor Creek	Reported sheet flows from lower portion of Midhill Park results in downstream flooding of neighbors. City follow up identified drainage issues on Lower Midhill Road (inadequate catchbasins).			N	NA		
Programmatic (Inlet Replacement/ Installation)	48	Improve System Configuration Address Maintenance Need	Staff Survey	Rose Linn Care Center (2330 Debok Rd)	Summerlinn Creek	Staff survey reports Debok Road floods the bike lane when it rains. Flooding is due to clogged catch basins. May consider replacement with curb inlets for debris control.			N	NA		
Programmatic (Pipe Replacement)	16	Add Infrastructure	Staff Summary, Public Survey	Tannler open ditch	Bernert Creek	The public identified a closed stormwater system at Tannler Creek adjacent to Tannler Drive (2425/2445 Tannler) that may be an opportunity to daylight the pipe for aesthetics and water quality.  The Creek is very deep in this location which would present structural and geotechnical design challenges if daylighted. May consider project opportunity if pipe condition deteriorates.			N	NA	Medium	
	2	Improve System Condition	Staff Summary	3843 Mapleton	Trillium Creek	The staff summary indicates a corrugated metal pipe in poor condition. This pipe is privately owned but conveys Trillium Creek. Per City staff, this is a private property issue. Environmental overlays at the site would require fix with development. No project need.			N	NA		Project location in area where sanitary system is having issues with calibration.
	3	Improve System Configuration	Staff Summary, Public Survey	Mapleton Drive/ S side of Mapleton	Willamette River	The public survey and staff summary identified poor drainage and lack of infrastructure that causes house to floods t the end of the cul-de-sac at Mapleton Drive. Per City staff, issue recently addressed. No project need.			N	NA		



**Table A-1: Stormwater Project Opportunity Areas**

Opportunity Category	Location ID	Project Objectives	Project Source	Location	Major Basin	Project Background	Project Development				TSP Driver	Notes
							Modeling Approach	WQ Opportunity	Site Visit	Survey		
	6	Improve System Configuration	Staff Summary 2005 CIP	Bolton Fire Station (old)	Bolton Creek	Sinkhole developed along Bolton Creek downstream of crossing under Hwy 43. Per site visit, sinkhole appeared disconnected from culvert conveyance. The 24-inch concrete pipe from Hwy 43 to the Falling St outfall to Bolton Creek was specifically mentioned in the 2005 CIP.  Evaluation to confirm capacity of crossings under Hwy 43 to be conducted, but specific CIP need in this location is not warranted. No project need.			Y (11-30-17)	NA	Medium	
	8	Improve System Configuration	Staff Summary	Magone Ln, Tulane Street	Mary S. Young Creek	The staff summary indicates that runoff from Hwy 43 causes flooding on a private street (Magone Lane). Per City staff, given private road issue, no project need.  High I&I reported in area (significant R value), indicating that high proportion of precipitation enters sanitary system.			N	NA		
	9	Address Maintenance Need	Staff Summary	Marylhurst headwall (near 1694 Skye Parkway)	Robinwood Creek	The staff summary identifies a headwall is needed upstream of the portion of a culvert under Marylwood Ct for trash and debris control. Per City staff, location is not high risk. No project need.			Y (11-30-17)	NA		
	14	Increase System Capacity	Staff Summary	4th Street culvert	Bernert Creek	The staff summary identifies an undersized culvert at 4th Street (same locations as the 5th Avenue culvert - see Location ID 13). No project need.			N	NA		
	17	Improve System Configuration	Staff Summary	Donegal Ct	Summerlinn Creek	The staff summary indicates a home floods at the end of a cul-de-sac. The home was built below the road grade and there is no existing catch basin on the property. Per City staff, improvements are in progress. No project need.			N	NA		
	21	Improve System Configuration	Public Survey 2005 CIP	Skye Parkway and Stonehaven Drive	Arbor Creek	The public survey and the 2005 CIP list identified this location as an area of poor drainage. The 18-inch concrete pipe section upstream of Braemar Court was specifically mentioned in the 2005 CIP list.  Per discussions with City staff, the stormwater conveyance system issues will be addressed as an inhouse project to install new curb inlets. No project need.			N	NA		
	24	Improve System Configuration	Public Survey	Chinook Ct and Parker Rd (4709 Chinook Ct)	Tanner Creek	The Public Survey indicates ponding water near Chinook Ct and Parker Road. The roof drain associated with Chinook Court property is undersized. Per City staff, this is deemed a private property issue. No project need.			N	NA	Medium	
	26	Improve System Configuration	Public Survey	Greene Street and Salamo Road	Bernert Creek	Identified flooding issue due to infrequent/ undersized catchbasins on Greene Street and Salamo Street. This issue will be resolved through the Salamo Road project (per City staff), which is in progress. No project need.			N	NA	High	
	27	Improve System Configuration	Public Survey	Pimlico between Hwy 43 and Summit	Mary S. Young Creek	The public survey indicated that there is a serious of poorly located catchbasins on Pimlico between Hwy 43 and Summit. Per City staff, there is a future sidewalk project in area and drainage will be evaluated then. No project need.			Y (11-30-17)	NA	Medium	
	29	Erosion Prevention	Public Survey	Mary S Young Park at Mark Ln.	Mary S. Young Creek	The public survey reported stormwater runoff from Mark Lane is causing significant erosion above Mary's Creek. Project opportunity to retain/ infiltrate runoff and/or add in a new stormwater pipe to bypass some of the stormwater from Mark Lane downstream of Mary's Creek. Project need addressed per Location ID #4. No additional project need.			Y (6-26-18)	NA		See Water Quality Opportunity ID #3
	30	Increase System Capacity	Public Survey	Hidden Springs Rd near Rosemont	Upper Tualatin River	Public survey results indicate poor drainage at Hidden Springs Road near Rosemont, possible due to undersized infrastructure. City staff have no reports of flooding. No project need.			N	NA	Medium	
	31	Improve System Configuration	Public Survey	Suncrest Dr and Aztec Ct	Trillium Creek	The public survey indicates there is a deficiency in the number of catch basins at Suncrest Dr and Aztec Court. Per City staff, this is being addressed via an in house project. No project need.			N	NA		
	33	Improve System Configuration	Public Survey	End of Maple Terrace cul-de-sac	Willamette River	The public survey indicates there are poorly located catchbasins at the end of Maple Terrace cul-de-sac. Per City staff, this is being addressed via an in house project. No project need.			N	NA		

**Table A-1: Stormwater Project Opportunity Areas**

Opportunity Category	Location ID	Project Objectives	Project Source	Location	Major Basin	Project Background	Project Development				TSP Driver	Notes
							Modeling Approach	WQ Opportunity	Site Visit	Survey		
	34	Improve System Configuration	Public Survey	Hwy 43/ Mary S Young Park entrance and Pimlico/ Hwy 43	Trillium Creek	The public survey indicates pond water at the entrance of Mary S Young Park near Pimlico and Hwy 43. Per City staff, there is a future sidewalk project in area and drainage will be evaluated then. No project need.			N	NA		
	38	Improve System Configuration	Public Survey	1255 Rosemont	Mary S. Young Creek	The public survey indicated that water doesn't flow into the catch basins located near 1255 Rosemont. Per City staff, Rosemont Road improvements will be resolving the issue. No project need.			N	NA		
	39	Improve System Configuration	Public Survey	1715 and 1694 Marylhurst Drive	Robinwood Creek	The public survey indicates there was an alteration of the stormwater system at Robinwood Street corridor adjacent to a private property owner. The private property owner has encroached on the channel downstream of Location ID #9. Per City staff, deemed an enforcement issue. No project need.			Y (11-30-17)	NA	High	
	44	Erosion Prevention	Staff Survey	2181 Alpine Dr (Tanner Open Space)	Summerlinn Creek	The staff survey indicates the upper portion of Summerlinn Creek is channelized near the Tanner Open Space. Per City staff, the channel is normalizing and channel adjustment is not problematic. No project need.			N	NA		
	46	Water Quality Retrofit	Staff Survey	821 Willamette Falls Drive	Tualatin River	The staff survey indicates that the existing causeways trap water near 821 Willamette Falls Drive and result in elevated temperatures during summer low flows. Per City staff, increased temperature is not a stormwater master planning objective. No project need.			N	NA		
	50	Increase System Capacity Erosion Prevention	Hydromodification Assessment (017) 2005 CIP	Trillium Creek at Kenthorpe Way	Trillium Creek	The hydromodification assessment (017) and the 2005 CIP list identified bank erosion and limited channel capacity/culvert capacity at Trillium Creek at Kenthorpe Way. Per City staff, there was a recent roadway project conducted in location and no project would be necessary in the near term. No project need.			N	NA		
	51	Water Quality Retrofit	Hydromodification Assessment (006)	Stormwater pond at Bland Circle	Salamo Creek	The hydromodification assessment (006) results showed a potential opportunity to increase storage and flow control and enhance water quality treatment at a stormwater pond at Bland Circle. Per City staff, pond was recently retrofit with new development. No project need.		Y	N	NA	Medium	
	53	Erosion Prevention Increase System Capacity	Hydromodification Assessment (008)	Culvert at Theresa's Vineyard	Salamo Creek	The hydromodification assessment (008) results showed a bridge was not installed correctly and doesn't align with flow patterns at Theresa's vineyard. Per City staff, channel is normalizing and project is on private property. No project need.		Y (stream restoration)	N	NA		
	61	Increase System Capacity	2005 CIP	10th Street	Bernert Creek	The 2005 CIP list identified this as a project location; however there is no known flooding in the this area. The terrain is very flat and pipe ownership is unknown. Further issues may existing because of the close proximity to the road base. Per City staff, given ownership questions and no reported flooding, no project need.			N	NA		
	62	Increase System Capacity (18" Concrete) Improve System Configuration	2005 CIP	Cottonwood Court	Gans Creek	The 2005 CIP list indicated a capacity deficiency (need for 24" pipe).  Per discussion with City staff, system was reconfigured about 10 years ago to not be located under a house. An overflow was constructed in an existing manhole to reduce backwater conditions. No current issues. No project need.			Y (3-6-18)	NA		Project location in area where sanitary system is having issues with calibration.
	65	Increase System Capacity	2005 CIP	Culvert Under Meadowview Court	Summerlinn Creek	The 2005 CIP List indicates the location of this project is downstream of the Johnson and Blankenship, which may warrant evaluation. No capacity deficiencies of the 60" CMP were reported in 2005. Per City staff, no separate project need.			N	NA		May tie into upstream model

Strategies

- 1a. Green Infrastructure in the public right-of-way (ROW) as a standalone project (i.e., replacing bubblers and adding in a collection system).
- 1b. Green Infrastructure in the public ROW in conjunction a programmatic basis/a TSP (i.e., no curb and gutter, completed with larger TSP).
- 2. Install New Water Quality (WQ) Facilities on Public Properties to provide treatment to areas that have no treatment.
- 3. Install New Regional WQ Facilities to Treatment on Hwy 43 (reviewed vacant lands and pipe system in conjunction with Hwy 43 alignment).
- 4. Retrofit Existing Public Stormwater Pond Locations (reviewed vacant lands and pond locations) to increase capacity or treatment capabilities.

Table A-2: Water Quality Assessment Matrix

WQ Opportunity ID	Project Name	Project Concept and Location	Project Rationale	Strategy # (See above)	Identified Problem Area (Y/N)	Soil Type	Land Use	Site Visit Notes and Findings	City Input	WQ Project Recommended (Y/N)?	WQ Project Description	Location ID	Other Notes
1	Willamette Neighborhood Green Street	Install green street in existing ROW in the Willamette Neighborhood between 14th-16th Aves.	Limited WQ treatment in area. Wide Right-of-Way. No existing curb and sidewalk. Opportunity for a green street project. Target locations 14-16th Aves.	1b	Y	Type C Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low and Medium Density Residential. Not a high pollutant loading area.	11-30-17 - Windshield survey conducted. No curb and sidewalk. Wide ROW. Opportunity for green infrastructure. Target locations 14-16th Aves.	Pair with Street Improvement Project.	Y	Green Street	15	Programmatic Opportunity
2	Buck Street/ Upper Buck Street Green Street	Add a stormwater trunkline down Buck Street and green street facilities to provide WQ treatment.	Limited WQ treatment in area. Poor drainage. Needs storm main installed from Fire Station to end, outfall repairs. Cbs are bubblers with no connection to main. City wants to discontinue use of bubblers.	1a	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Medium Density Residential	11-30-17 - Bubblers are ineffective. Public confirmed flooding due to leaf accumulation during site visit. City maintenance staff installed a new curb inlet at end of Buck St to alleviate flooding, which has helped but not eliminated flooding. Downstream outfall erosion observed. Project scope may include trunkline down Buck Street and Green Street facilities.	Standalone Green Street Project.	Y	Green Street	5	Project extents are from the fire station to outfall on Buck Street.
3	Mark Lane Green Street	Add stormwater trunkline down Mark Lane and green street facilities to provide WQ treatment.	Limited WQ treatment in area. Green street facilities and new piped infrastructure to remove bubblers as they are connected to the main.	1a	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	6-21-18 - Curb and sidewalk on both sides of street. Wide ROW. Per City, benefit to narrowing street for speed control (many kid signs). Green street opportunities along both sides of street (no crown) and full length, to minimize parking impacts. Bubblers located at intersection of Lowell Ave (location for curb bump out).	Standalone Green Street Project.	Y	Green Street	4	Project extents along full Mark Lane alignment
4	LaFave Street, Jolie Point Road, Munger Drive, Lowell Avenue Green Street	Green street facilities and new piped infrastructure (as applicable) to remove bubblers.	Limited WQ treatment in area. Poor drainage - system currently composed of driveway culverts and ditches. No existing curb and gutter.	1b	Y	Type C/D Soils. Infiltration Capacity should be confirmed, if infiltration is used for WQ treatment.	Low Density Residential	No further action required.	Pair with Street Improvement Project.	Y	Green Street	19	Programmatic Opportunity
5	Exeter St, Lancaster St Green Street	Green street facilities and new piped infrastructure.	Limited WQ treatment in area. Flooding Issue. Limited curb and sidewalk and grated catch basins get plugged routinely. Piped conveyance to Sunset Creek through private parcel (not in ROW), steep slope - need to verify easement. No existing curb and gutter.	1b	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low and Medium Density Residential	11-30-17 - No curb and sidewalk in a majority of the ROW. Potential for green street improvements in conjunction with roadway improvements. No further action required.	Pair with Street Improvement Project.	Y	Green Street	11	Programmatic Opportunity
6	Cornwall Street and York Street Green Street	Green street facilities and new piped infrastructure to remove bubblers.	Limited WQ treatment in area. No storm improvements in neighborhood. Cbs are bubblers with no connection to a main. City wants to discontinue use of bubblers. No existing curb and gutter.	1b	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Medium Density Residential	11-30-17 - No curb and sidewalk in a majority of the ROW. Potential for green street improvements in conjunction with roadway improvements. No further action required.	Pair with Street Improvement Project.	Y	Green Street	25	Programmatic Opportunity
7	Suncrest, Valleyview Dr, and Hillcrest between Suncrest and Marylhurst Drive Green Street	Green street facilities and new piped infrastructure (as applicable).	Limited WQ treatment in area. High volume of water flowing down roadways, property erosion from open drainage ditches. No existing curb and gutter.	1b	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	11-30-17 - Windshield survey conducted. No curb and sidewalk. Wide ROW. Opportunity for green infrastructure with infrastructure install. Local resident hand dug small trench to direct flow from a spring in front of 1779 Hillcrest Drive (approximate address). No visible signs of erosion along roadway further downstream. No further action required.	Pair with Street Improvement Project.	Y	Green Street	18	Programmatic Opportunity

Strategies

- 1a. Green Infrastructure in the public right-of-way (ROW) as a standalone project (i.e., replacing bubblers and adding in a collection system).
- 1b. Green Infrastructure in the public ROW in conjunction a programmatic basis/a TSP (i.e., no curb and gutter, completed with larger TSP).
- 2. Install New Water Quality (WQ) Facilities on Public Properties to provide treatment to areas that have no treatment.
- 3. Install New Regional WQ Facilities to Treatment on Hwy 43 (reviewed vacant lands and pipe system in conjunction with Hwy 43 alignment).
- 4. Retrofit Existing Public Stormwater Pond Locations (reviewed vacant lands and pond locations) to increase capacity or treatment capabilities.

Table A-2: Water Quality Assessment Matrix

WQ Opportunity ID	Project Name	Project Concept and Location	Project Rationale	Strategy # (See above)	Identified Problem Area (Y/N)	Soil Type	Land Use	Site Visit Notes and Findings	City Input	WQ Project Recommended (Y/N)?	WQ Project Description	Location ID	Other Notes
8	Dillow Drive at Larson Ave Green Street	Green street facilities	Limited WQ treatment in area. Ponding water possibly due to undersized ditch inlet. Additional inlets and potential green street improvements. Only partially curbed street. Opportunity for Hwy 43 management.	1b and 3	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	11-30-17 - Windshield survey conducted. Curb and catch basins only located on one side of street with entire street width sloped to curbed side.  6-21-18 - No curb and sidewalk from Hwy 43 to Lowry (programmatic or opportunity to manage Hwy 43 runoff). Partial curb and sidewalk with infill from Lowry to Will View Ct. Steep slope after Will View Ct. Cbs are piped together which could reduce green street costs (overflow to tie into pipe).	Pair with Street Improvement Project.	Y	Green Street	35	Programmatic Opportunity. Project extents from Hwy 43 to Lowry and from Lowry to Willamette View Ct.  Note: If Hwy 43 runoff routed to Dillow Drive, may present opportunity to treat Hwy 43 runoff.
9	Kenthorpe Way Green Street	Green street facilities and new piped infrastructure (as applicable).	Add in WQ treatment along Kenthorpe Way where no existing stormwater system or WQ treatment existing. No existing curb and gutter. Fire Station east down the road .No existing ditches on both sides of the street to take runoff. No stormwater system along Kenthorpe. Water flows off side of road into front yards. Green street installation as part of a programmatic or targeted green street pilot project.	1b	Y	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	No further action required. Recent roadway projects conducted. Active neighborhood citizen group that would want input. City confirmed that area would not have a project in the near term.	Pair with Street Improvement Project.	Y	Green Street	23	Programmatic Opportunity.  Note: The pair of culverts along Gans Creek at Kenthorpe Way were specifically mentioned in the 2005 CIP.
10	Willamette Park Parking Lot Retrofit	Add stormwater WQ treatment to the parking lot.	Limited WQ treatment in vicinity. Treat a large square footage of impervious area on public property.	2	N	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Parks	6-21-18 - Flat parking area with observed pavement cracks. Without regrading, may be difficult to divert runoff to specific locations (potential swale between car and trailer parking stalls). Option to use pervious pavers (similar to overflow parking areas).	Standalone Water Quality Retrofit project.	Y	New Water Quality Facility	66	City prefers use of pervious pavers, consistent with overflow lots.
11	Mary S. Young Park Parking Lots Retrofit	Add stormwater WQ treatment to the two parking lots.	Limited WQ treatment in area. Treat a large square footage of impervious area on public property.	2	N	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Parks	6-21-18 - Large parking area graded towards NE corner of lot (no observed catchbasins) except in NE corner. Pavement cracking observed. Option to install raingarden in corner of property (removes ~ 5 parking stalls) or use pervious pavers.  Additional potential for swales along driveway approach.	Standalone Water Quality Retrofit project.	Y	New Water Quality Facility	67	City prefers use of pervious pavers, consistent with overflow lots.
12	West Linn City Hall	Add stormwater WQ facility on public property to treat additional area not currently being treated on the West Linn City Hall property.	Limited WQ treatment in area. Treat a large square footage of impervious area on public property. Could be a showcase project for the City to show that City Hall is promoting the use of green infrastructure.	2	N	Type C Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Commercial	6-21-18 - Parking lot drains to two catchbasins and manhole located along adjacent trail. Limited opportunity to daylight pipe in trail. Potential option to reconfigure parking lot and incorporate swales between parking stalls or retrofit catchbasins with filter cartridge CBs. Adjacent property owners complain of city visitors parking on their portion of lot so parking reconfiguration may be a benefit.  Roofdrains appear to discharge directly off back side of property.  Parking lot runoff discharges offsite to Bland Circle (pond #11), Roof drains discharge offsite to pond #19.	Drainage area already treated by facilities. No project recommended.	N	N/A	N/A	

Strategies

- 1a. Green Infrastructure in the public right-of-way (ROW) as a standalone project (i.e., replacing bubblers and adding in a collection system).
- 1b. Green Infrastructure in the public ROW in conjunction a programmatic basis/a TSP (i.e., no curb and gutter, completed with larger TSP).
- 2. Install New Water Quality (WQ) Facilities on Public Properties to provide treatment to areas that have no treatment.
- 3. Install New Regional WQ Facilities to Treatment on Hwy 43 (reviewed vacant lands and pipe system in conjunction with Hwy 43 alignment).
- 4. Retrofit Existing Public Stormwater Pond Locations (reviewed vacant lands and pond locations) to increase capacity or treatment capabilities.

Table A-2: Water Quality Assessment Matrix

WQ Opportunity ID	Project Name	Project Concept and Location	Project Rationale	Strategy # (See above)	Identified Problem Area (Y/N)	Soil Type	Land Use	Site Visit Notes and Findings	City Input	WQ Project Recommended (Y/N)?	WQ Project Description	Location ID	Other Notes
13	West Linn Public Works Department	Add stormwater WQ facility on public property to treat additional area not currently being treated on the West Linn Public Works Department property.	Ensure WQ treatment is provided for all pollutant generating impervious surface at the West Linn Public Works Facility. Ensure all components of the City's municipal and storage BMPs are in place.	2	N	Type C Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Medium Density Residential	Not visited.	City has identified opportunity to install a small rain garden along Norfolk Street frontage for parking lot at front of building	Y	New Water Quality Facility	68	
14	West Linn Police Station	There are no additional opportunities for WQ treatment at this site.	This site was reviewed to ensure no additional WQ opportunities were available at this location.	2	N	Type C Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Commercial	No further action required.	There is a nearby vacant land that was reviewed as an opportunity depending on drainage patterns/slopes in the area; however, there are no additional opportunities for WQ treatment in the area. See as-built drawings for more information.	N	N/A	N/A	
15	West Linn Public Library	There are no additional opportunities for WQ treatment at this site.	This site was reviewed to ensure no additional WQ opportunities were available at this location.	2	N	Type C Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Commercial	No further action required.	Parking lots to NE is made of permeable pavers. Main parking areas uses mechanical treatment. Limited opportunity for additional WQ treatment due to creek proximity.	N	N/A	N/A	
16	Fields Bridge Park Parking Lot Retrofit	There are no additional opportunities for WQ treatment at this site.	This site was reviewed to ensure no additional WQ opportunities were available at this location.	2	N	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Parks	No further action required.	The parking lot was constructed with permeable pavers. No further opportunities are available at this site.	N	N/A	N/A	
17	Mary S. Young Park - Hwy 43 Treatment	Construct a WQ facility along the eastside of Hwy 43 between Trillium Creek and Hemon Creek to mitigate new/replaced impervious surface from Hwy 43.	Water quality treatment facility (i.e. WQ swale or WQ treatment pond) would be constructed during the Hwy 43 construction project to provide treatment of impervious surface.	3	N	Type C and C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Parks	6-21-18 - Site visit included walking trail alignment along Hwy 43. Area is at crest of Hwy 43 and most has steep slope from Hwy 43 shoulder. Reviewed outfall locations. Potential retrofit (vegetation management) at furthest north outfall location and at entrance to Mary S Young Park. However, limited space for regional solution.  No large project opportunities in this area.	Grade issues and limited available area without tree removal. No project recommended at this location.	N	N/A	N/A	The City has approved Mary S. Young Park a location for WQ treatment facility for HWY 43 runoff.
18	Hwy 43 Treatment near Failing Street	Install a small WQ treatment facility (swale or raingarden) to treat a small portion of Hwy 43 on an existing vacant land (0.054 acres) located on the eastside of Hwy 43.	Water quality treatment facility (i.e. WQ swale or WQ treatment pond) would be constructed during the Hwy 43 construction project to provide treatment of impervious surface.	3	N	Type C/D Soils. Infiltration Capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	6-21-18 - Small parcel downslope, close to Bolton elementary school. Location is too small for regional detention and too low below road grade to provide Hwy 43 treatment without compromising road bank stability. May be used to provide treatment or drainage for Bolton Elementary driveway (Problem Area #7).	Property acquisition required. Grade issues and limited available area. No project recommended at this location.	N	N/A	N/A	
19	Stormwater Facility Upstream of Remington Drive	Retrofit in-line stormwater facility upstream of Remington Drive. Add storage or treatment capacity to existing facility.	Opportunity to increase storage and flow control and enhance WQ treatment to an existing facility.	4	Y	Type C, Infiltration capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	Site visit still required.	Maintain as an opportunity pending site visit.	Y	Existing Public Facility Retrofit	52	Confirm cross streets and area available for expansion. Project opportunity identification per hydromodification assessment.

Strategies

- 1a. Green Infrastructure in the public right-of-way (ROW) as a standalone project (i.e., replacing bubblers and adding in a collection system).
- 1b. Green Infrastructure in the public ROW in conjunction a programmatic basis/a TSP (i.e., no curb and gutter, completed with larger TSP).
- 2. Install New Water Quality (WQ) Facilities on Public Properties to provide treatment to areas that have no treatment.
- 3. Install New Regional WQ Facilities to Treatment on Hwy 43 (reviewed vacant lands and pipe system in conjunction with Hwy 43 alignment).
- 4. Retrofit Existing Public Stormwater Pond Locations (reviewed vacant lands and pond locations) to increase capacity or treatment capabilities.

Table A-2: Water Quality Assessment Matrix

WQ Opportunity ID	Project Name	Project Concept and Location	Project Rationale	Strategy # (See above)	Identified Problem Area (Y/N)	Soil Type	Land Use	Site Visit Notes and Findings	City Input	WQ Project Recommended (Y/N)?	WQ Project Description	Location ID	Other Notes
20	Public Pond #18 (BC ID)	<p>Opportunity to retrofit existing public stormwater pond #18 for new or additional WQ treatment. This pond was installed in 1997, which is pre-2004 which was when the NPDES MS4 Permit Requirements for pond maintenance began. This pond is also located downstream of a vacant site.</p> <p>Pond is located at 2240 Willamette Falls Drive.</p>	Use existing publicly owned pond to enhance WQ treatment in areas of the City that are not currently being treated.	4	N	Type C, Infiltration capacity should be confirmed if infiltration is used for WQ treatment.	Commercial	6-21-18 - Access to location is limited. Redevelopment (Shari's Restaurant) will be occurring and will have to provide additional onsite treatment. Location is next to a hoarder property and contributing open channel is covered with invasives.	Maintain as an opportunity pending site visit. Retrofit opportunity in conjunction with development of adjacent parcel.	Y	Existing Public Facility Retrofit	69	
21	Public Pond # 22 (BC ID)	<p>Opportunity to retrofit existing public stormwater pond #22 for new or additional WQ treatment. This pond was installed in 1999, which is pre-2004 which was when the NPDES MS4 Permit Requirements for pond maintenance began. This pond is also located downstream of a vacant site.</p> <p>Pond is located at 25545 Katherine Court.</p>	Use existing publicly owned pond to enhance WQ treatment in areas of the City that are not currently being treated.	4	N	Type C, Infiltration capacity should be confirmed if infiltration is used for WQ treatment.	Low Density Residential	6-21-18 - Access to pond is good. Trees are growing in the pond and should be removed. Neighboring resident indicates pond functions during rainfall events. Potentially incorporate swale in pond bottom for WQ and conduct pond maintenance to remove trees.	The neighborhood where the pond is located is mostly developed with two upstream vacant parcels (redevelopment). May be good location to add WQ treatment to an existing pond to treat the neighborhood before the outfall to the Willamette River.	Y	Existing Public Facility Retrofit	70	

Table A-3. Pond Inventory and Review Matrix

City of West Linn  
 Public Pond Inventory Review - Water Quality Assessment  
 Prepared by Brown and Caldwell, J. Christofferson  
 Last Updated: May 8, 2018

Review Criteria

1. Prioritize Ponds installed pre-2004 (NPDES MS4 Permit Requirements - Began in 2004. )
2. Ponds is downstream of a vacant property. Ponds may be retrofitted to address new development.
3. Criteria 1 and Criteria 2
4. Identify other constraints for Ponds in Category 3.

Totals

30  
 8  
 2

BC_ID	TYPE	DESC_	OWNER	Initial Public Pond Review Water Quality Assessment Notes (3/14/18)			City Assessment Review (5/3/18)	Criteria Category (5/8/18)
				Vacant Land in Proximity	Pond is Downstream or Upstream of Vacant Property	Other Notes	Year Installed	
29	WETLAND	18418 River Woods PL	PUB	Yes	Upstream	Upstream of two private ponds (27, 28). Pond 27 is on private property. Wetland existing in 1990 plat	1990	1
23	WETLAND	Tualatin River Bluff - Near 1312 Evah Lane	PUB	Yes	N/A		1992	1
1	DT/TREATMENT	Near 3558 VistaRidge DR	PUB	No	N/A		1994	1
56	DT/TREATMENT	Cascade Summit #6 - 3390 Beacon Hill	PUB	No	N/A	Pond is located in a park in line with Ponds 56, 57 and 63.	1994	1
57	DT/TREATMENT	Cascade Summit #6	PUB	No	N/A	Pond is located in a park in line with Ponds 56, 57 and 63.	1994	1
63	DT/TREATMENT	Cascade Summit #6	PUB	No	N/A	Pond is located in a park in line with Ponds 56, 57 and 63.	1994	1
65	DT/TREATMENT	Cascade Summit #3 - near 3349 Coeur D'Alene Dr	PUB	No	N/A	Pond is located in a park.	1994	1
24	WETLAND	2070 (M) Volpp ST (Park)	PUB	No	N/A	In City park just upstream of Willamette River. Identified as existing in 1994 as-builts	1994	1
35	DT/TREATMENT	2115 Windham Oaks CT	PUB	No	N/A		1995	1
68	WETLAND	Remington DR & Rogue Way	PUB	Yes	N/A	Pond 94 is partially on a vacant lot. Ponds 67 and 68 are downstream of Pond 94.	1995	1
8	DT/TREATMENT	Tanner Creek Estates -near 2125 Fairhaven Ct	PUB	Yes	Upstream		1997	1
12	DT/TREATMENT	Near 2655 CouerDALene DR	PUB	Yes	Upstream		1997	1
13	DT/TREATMENT	Near 2355 Tannler DR	PUB	Yes	Upstream	On City Property	1997	1
18	DT/TREATMENT	2240 Willamette Falls DR	PUB	Yes	On Vacant Property		1997	3
50	DT/TREATMENT	Parker Summit - 4700 Parker Rd	PUB	No	N/A		1997	1
37	WETLAND	4400 (M) Horton RD	PUB	No	N/A	1997 enhancement project (City)	1997	1
9	DT/TREATMENT	Near 2345 Rogue WAY	PUB	No	N/A		1998	1
49	DT/TREATMENT	Cascade Summit Apts - 22910 Weatherhill Rd	PUB	Yes	Upstream	Public Pond on Private Property. Vacant Lot in closer proximity.	1998	1
7	DT/TREATMENT	3000 Kensington CT	PUB	No	N/A		1999	1
22	DT/TREATMENT	25545 Katherine CT	PUB	Yes	Downstream	Just upstream of a Willamette River Outfall	1999	3
46	DT/TREATMENT	3100 Parker RD	PUB	No	N/A	Near Tanner Creek Park	1999	1

Table A-3. Pond Inventory and Review Matrix

BC_ID	TYPE	DESC_	OWNER	Initial Public Pond Review Water Quality Assessment Notes (3/14/18)			City Assessment Review (5/3/18)	Criteria Category (5/8/18)
				Vacant Land in Proximity	Pond is Downstream or Upstream of Vacant Property	Other Notes	Year Installed	
54	DT/TREATMENT	Sabo LN & Beacon Hill LN	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land.	1999	1
67	DT/TREATMENT	Near 3051 Kensington CT	PUB	Yes	N/A	Pond 94 is partially on a vacant lot. Ponds 67 and 68 are downstream of Pond 94.	2000	1
47	WETLAND	Maxfield - near 3128 Winkel Way	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land. 2000 mitigation project.	2000	1
43	DT/TREATMENT	Between Rosemont Salamo	PUB	Yes	Upstream	Just upstream of Wetland 42 (Private) which is on a vacant land. Water Quality treatment provided by Wetland?	2001	1
45	DT/TREATMENT	Rosemont Summit 3 - near 3821 Wild Rose	PUB	Yes	Upstream	Vacant Lot is just downstream and Tanner Creek runs through the lot.	2001	1
64	DT/TREATMENT	Near 2688 Beacon Hill LN	PUB	No	N/A		2001	1
48	DT/TREATMENT	Near 3258 Sabo LN	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land.	2003	1
52	DT/TREATMENT	Near 3017 Sabo LN	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land.	2003	1
66	DT/TREATMENT	23160 (M) Bland CIR	PUB	No	N/A		2003	1
39	DT/TREATMENT	Gegory Estates - 5149 Gregory Ct	PUB	Yes	Downstream	Downstream of Vacant Land, no real opportunity here.	2004	2
14	DT/TREATMENT	Fields Park	PUB	Yes	Upstream		2005	
69	DT/TREATMENT	FieldsParkNo2	PUB	Yes	Upstream	Upstream of Pond 14 and a nearby vacant lot.	2005	
2	DT/TREATMENT	4738 (M) Gardner LN	PUB	Yes	Downstream	Downstream of Vacant Land, but just upstream of Tanner Creek.	2006	2
3	DT/TREATMENT	4774 (M) Coho LN	PUB	On Vacant Property	On Vacant Property		2006	2
4	DT/TREATMENT	2720 (M) Ridge LN	PUB	Yes	Upstream		2006	
19	DT/TREATMENT	2091 Winkel WAY	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land.	2006	
5	DT/TREATMENT	Near 3010 Winkel WAY	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land.	2007	
6	DT/TREATMENT	Maxfield	PUB	Yes	Upstream	Numerous other ponds in the area (6, 47, 48, 5, 19, 52, 54 and 55). Pond 55 is on vacant land.	2007	
20	DT/TREATMENT	SiennasEstates - Near 4713 Parker	PUB	No	N/A		2008	
21	DT/TREATMENT	SiennasEstates - Near 4703 Parker	PUB	No	N/A		2008	
70	DT/TREATMENT	ArborCove -1024 Epperly Way	PUB	Yes	Upstream	Adajent and downstream of a vacant lot.	2008	
71	DT/TREATMENT	Near 1848 Manchester CT	PUB	No	N/A		2008	
72	DT/TREATMENT	RosemontCrossing - Corner of Rosemont/Salamo	PUB	No	N/A		2008	
81	DT/TREATMENT	Debok Estates	PUB	Yes	Upstream	Upstream of large amount of vacant lots.	2011	
82	DT/TREATMENT	Parker_Road_Subdivision: Near Chinook Ct?	PUB	Yes	Downstream	Adajent and downstream of a vacant lot.	2011	2
83	DT/TREATMENT	2811 Coeur D Alene Dr	PUB	No	N/A		2012	



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BC_ID	TYPE	DESC_	OWNER	Initial Public Pond Review Water Quality Assessment Notes (3/14/18)			City Assessment Review (5/3/18)	Criteria Category (5/8/18)
				Vacant Land in Proximity	Pond is Downstream or Upstream of Vacant Property	Other Notes	Year Installed	
84	DT/TREATMENT	1025 Rosemont Rd	PUB	No	N/A		2013	
	DT/TREATMENT	23150 (M) Bland CIR	PUB		N/A	Adjacent to pond 29	2015	
10	DT/TREATMENT	Tanner Creek Estates	PRIV					
11	DT/TREATMENT	2030 Tanner Creek LN	PRIV					
15	DT/TREATMENT	1855 Blankenship RD	PRIV					
16	EFFLUENT	West Linn Paper WFD	PRIV					
17	DT/TREATMENT	1990 8TH AVE	PRIV					
25	WETLAND	1236 14th ST	PRIV					
26	EFFLUENT	Blue Heron Paper 4th ST	PRIV					
27	LANDSCAPE	18200 River Edge CT	PRIV					
28	WETLAND	18400 Old River Landing	PRIV					
30	FISH	North end of Nixon Ave	PRIV					
31	DT/TREATMENT	18850 Willamette DR	PRIV					
33	WETLAND	3845 Mapleton DR	PRIV					
34	WETLAND	1850 Carriage WAY	PRIV					
36	FISH	21305 Shannon Ln	PRIV	Yes				
38	DT/TREATMENT	6283 Haverhill CT	PRIV					
40	DT/TREATMENT	RRMS 20001 Salamo RD	PRIV					
41	DT/TREATMENT	RRMS 20001 Salamo RD	PRIV					
42	WETLAND	Between Rosemont Salamo	PRIV	Yes				
44	POND	3637 Parker RD	PRIV					
51	DT/TREATMENT	WLHS 5290 West A	PRIV					
53	DT/TREATMENT	WLHS 5290 West A	PRIV					
55	FISH	4340 S Parker RD	PRIV	Yes				
58	FISH	4340 S Parker RD	PRIV	Yes				
59	DT/TREATMENT	6200 SummerLinn WAY	PRIV	Yes	Downstream			
60	DT/TREATMENT	6000 SummerLinn WAY	PRIV	Yes	Downstream			
61	DT/TREATMENT	5800 SummerLinn WAY	PRIV	Yes	Downstream			
62	DT/TREATMENT	5600 SummerLinn WAY	PRIV	Yes	Downstream			
73	DT/TREATMENT	19066 Willamette Dr	PRIV					
74	DT/TREATMENT	3153 S Brandywine DR	PRIV					
75	DT/TREATMENT	3153 S Brandywine DR	PRIV					
77	DT/TREATMENT	1800 Valley View Dr	PRIV					
78	DT/TREATMENT	1800 Valley View Dr	PRIV					
79	DT/TREATMENT	Douglas Park (Park)	PRIV					
80	DT/TREATMENT	Douglas Park (Park)	PRIV					
32	WETLAND	Near Island Way	PUB	No	N/A	In Cedaroak Boat Ramp Park. This pond is just upstream of the Willamette River.		
85	WETLAND	Camassia Natural Area	PRIV					
86	WETLAND	Camassia Natural Area	PRIV					
76	DT/TREATMENT	64 Dollar ST	PUB	Yes	Downstream			2
88	DT/TREATMENT	CedaroakParkSchool	PRIV					
87	LANDSCAPE	12th & Volpp in the park	PUB	No	N/A	Just upstream of the Willamette River and located in a park.		
90					N/A			
91					N/A			

Table A-3. Pond Inventory and Review Matrix

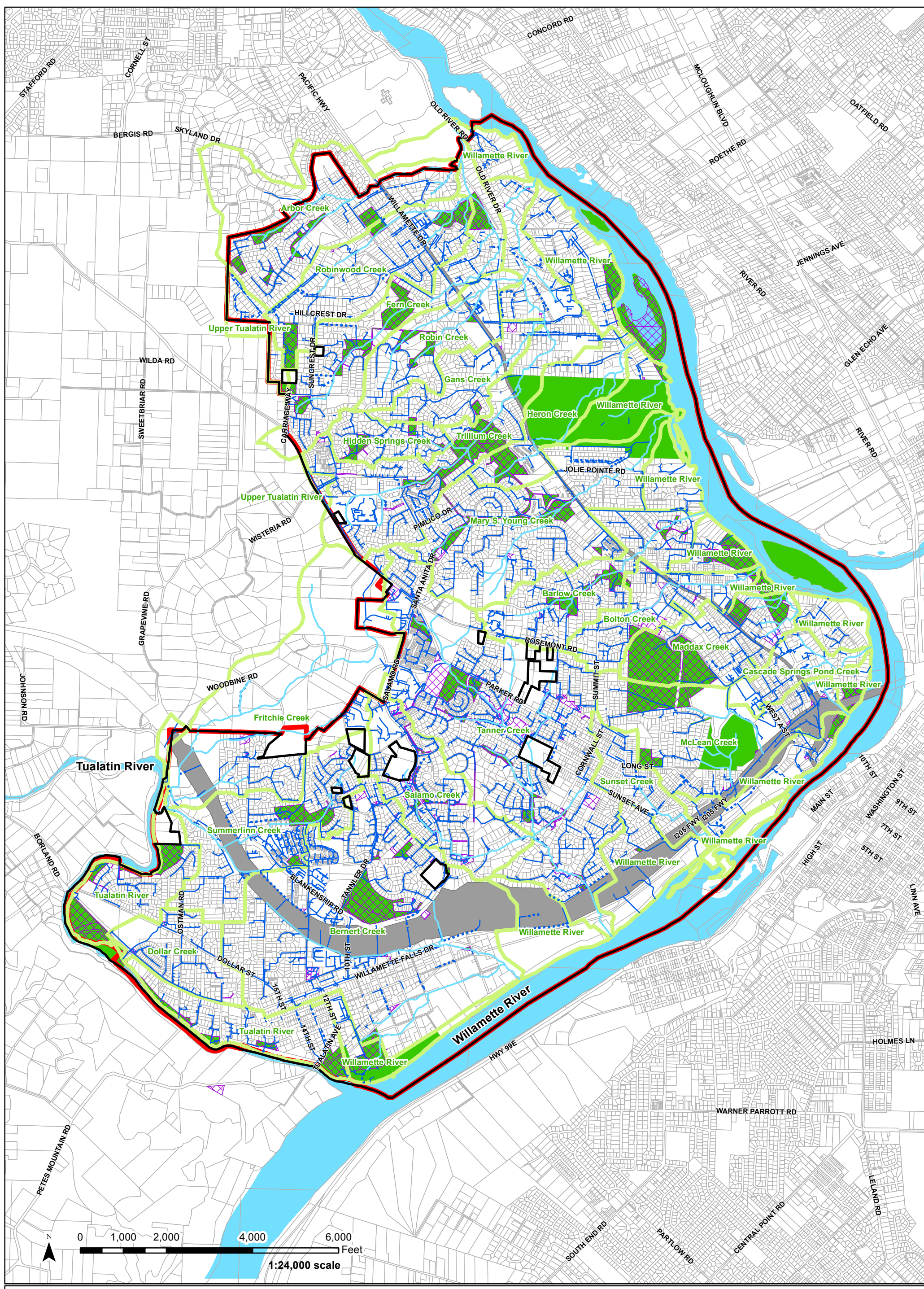
BC_ID	TYPE	DESC_	OWNER	Initial Public Pond Review Water Quality Assessment Notes (3/14/18)			City Assessment Review (5/3/18)	Criteria Category (5/8/18)
				Vacant Land in Proximity	Pond is Downstream or Upstream of Vacant Property	Other Notes	Year Installed	
92					N/A			
93					N/A			
89	DT/TREATMENT	22111 Bland Dir	PUB	No	N/A			
94	DT/TREATMENT	Bland CIR & Salamo RD	PUB	Yes	Downstream	Pond 94 is partially on a vacant lot. Ponds 67 and 68 are downstream of Pond 94.		2

## Attachment B: Preliminary Maps

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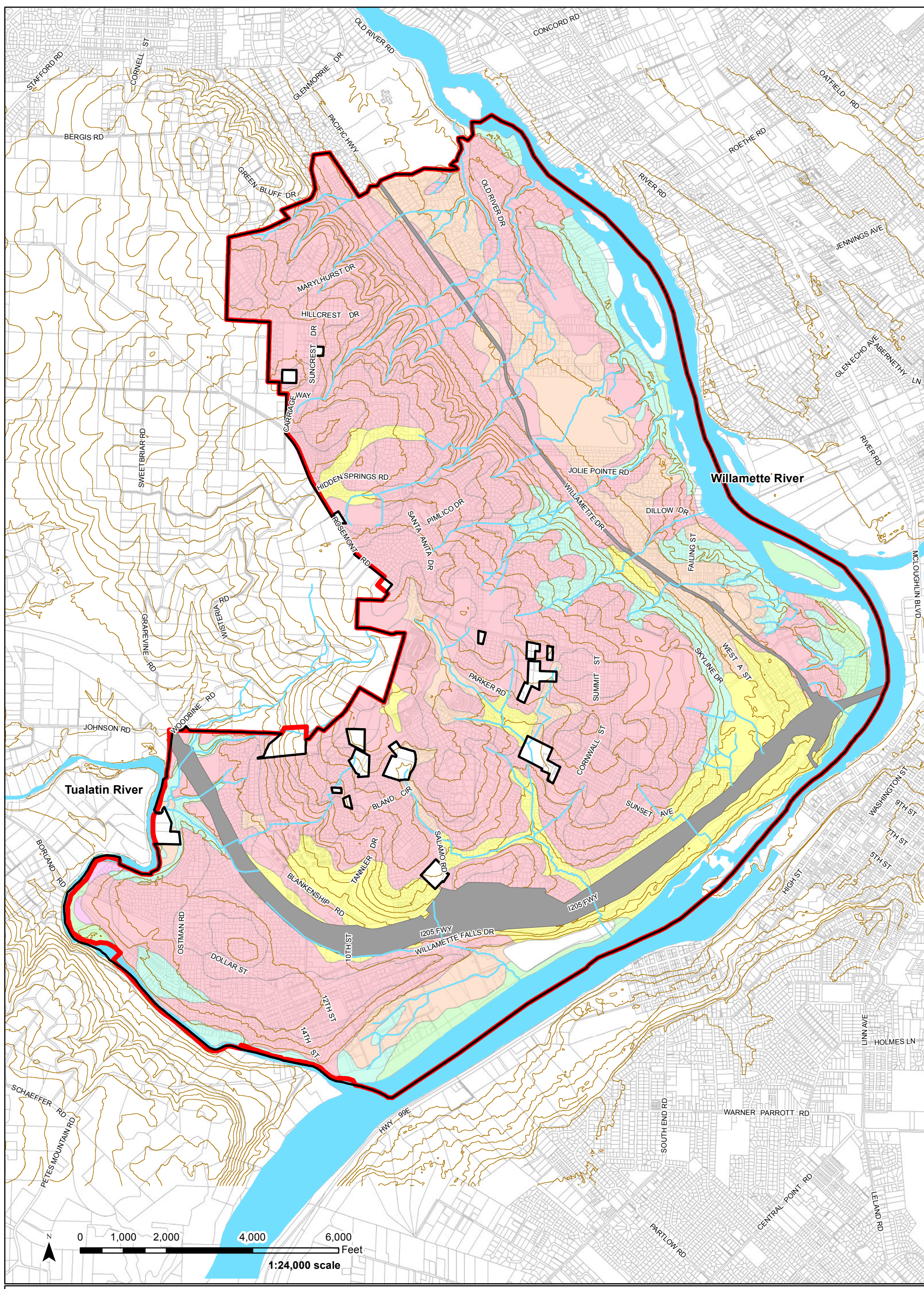


**CITY OF WEST LINN, OREGON**  
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Figure B-1: Stormwater System Overview

- Public Property
- Parks & Open Spaces
- Stormwater Pipe
- Open Channel
- Streams
- Watershed Boundaries
- ODOT ROW
- City Limits
- UGB

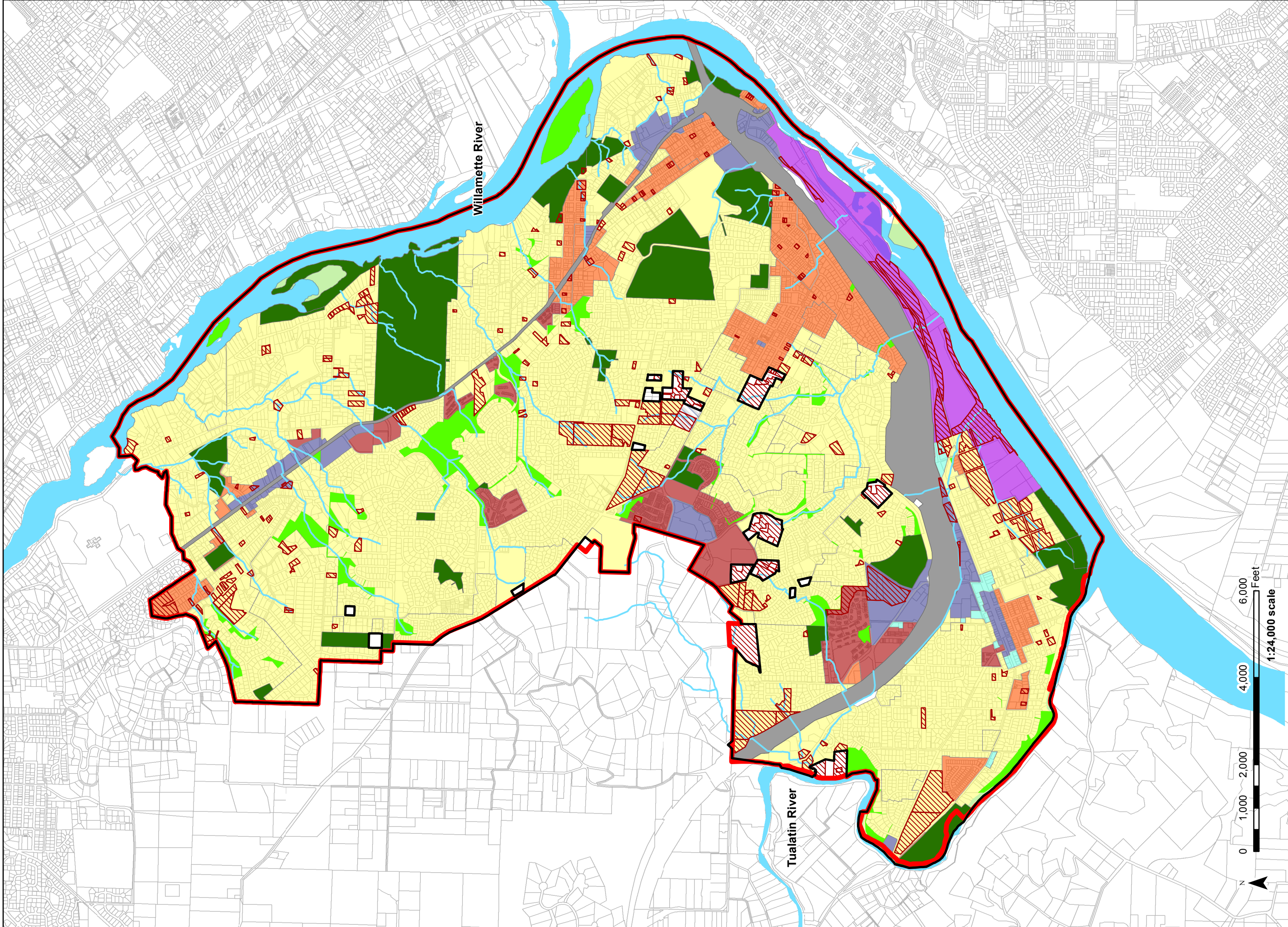
Data Source: City of West Linn GIS and Metro RLIS  
 Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.  
 Map Publication/Print Date: July 2018 Produced by Brown and Caldwell



**CITY OF WEST LINN, OREGON**  
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 Figure B-2: Soils and Topography

- Hydrologic Soil Group**
- A
  - B
  - B/D
  - C
  - C/D
  - D
- Contours (50 ft)  
 — Streams  
 — ODOT ROW  
 — City Limits  
 — UGB

Data Source: City of West Linn GIS and Metro RLIS  
 Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.  
 Map Publication/Print Date: June 2018 Produced by Brown and Caldwell



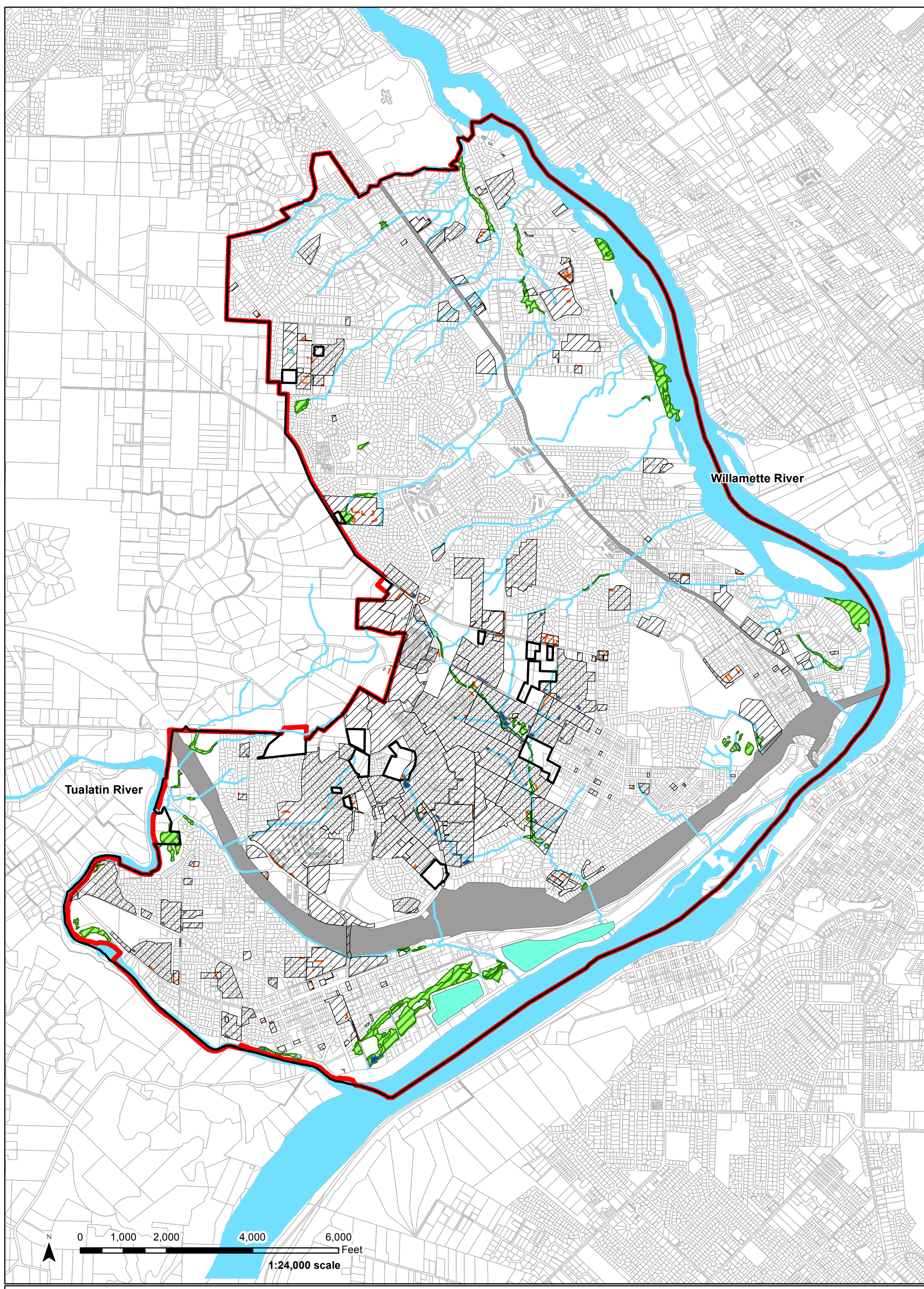
- Parks
- Open Spaces
- Streams
- Commercial
- Industrial
- Low Density Residential
- Medium Density Residential
- Medium High Density Residential
- Mixed Use
- No Zoning (Unzoned)
- Vacant
- City Limits (2017)
- UGB

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Figure B-3: Existing Land Use



Data Source: City of West Linn GIS and Metro RLIS  
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Figure B-4: Stormwater Treatment Facilities and Drainage Area

- Private Ponds
- Public Ponds
- Water Quality Facility Drainage Areas
- Wetlands
- Swale
- Streams
- ODOT ROW
- City Limits
- UGB

Data Source: City of West Linn GIS and Metro RLIS  
 Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.  
 Map Publication/Print Date: June 2018 Produced by Brown and Caldwell



## Appendix C: Final Stormwater Project Opportunity Areas

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## **Appendix D: TM3: Hydrology and Hydraulic Modeling Methods and Results**

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## Appendix E: Detailed Cost Estimates

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## **Appendix F: Capital Project Descriptions and Figures**