1861 Flood - Pringle Creek at Downtown

1964 Flood - Salem Hospital Evacuation

1996 Flood - NE Salem

2012 Flood - South Salem

CITY OF Salem AT YOUR SERVICE

Stormwater Master Plan

October 2020

1890 Flood - Willamette Bridge Collapse

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City of Salem Stormwater Master Plan

PREPARED BY:

CITY OF Salem
AT YOUR SERVICE
Public Works Department

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City of Salem, Oregon
Stormwater Master Plan

Adopted by Ordinance Bill No. 52-2000
Enacted September 25, 2000

Prepared by Montgomery Watson Americas, Inc.

Amended by Ordinance Bill No. 11-20
Enacted October 12, 2020

Prepared by Public Works Department, City of Salem

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October 2020

City of Salem, Oregon

Stormwater Master Plan

Montgomery Watson Americas, Inc.

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12/31/00

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September 2000

Adopted by Salem City Council on September 25, 2000

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Introduction and Background

OVERVIEW OF STORMWATER MASTER PLAN

This *Stormwater Master Plan* contains goals, objectives, and policies that will guide how the Salem community should address the many challenges associated with urban stormwater runoff. In addition, this plan provides direction on how to invest in stormwater programs and infrastructure to best meet current and future demands on the stormwater system.

This *Stormwater Master Plan* supersedes the City of Salem 2000 *Stormwater Master Plan* (City of Salem 2000a) and the two technical supplements to the 2000 plan—the Drainage System Improvement Plan (City of Salem 2000b) and the Stormwater Management Program Plan (City of Salem 2000c). Goals and policies have been revised to reflect changes in the regulatory environment and advances in stormwater management practices. The list of public stormwater facilities needed to support land uses has been updated based on current information and using new modeling methods. A central feature of Salem's Stormwater Management Plan is that it contains a chapter for each stormwater basin, which will facilitate periodic updates to the overall master plan as basin plans are revised and updated. The chapters summarize the material contained in more detailed basin plans, which serve as technical supplements to the *Stormwater Master Plan*.

This chapter provides an overview and sets the context for the Stormwater Master Plan. It includes a description of the planning area, a review of the regulatory context, and a brief history of stormwater master planning in Salem.

The *Stormwater Master Plan* includes the following elements:

Introduction and Background

This chapter provides an overview and sets the context for the *Stormwater Master Plan*. It includes a description of the planning area, a review of the regulatory context, a brief history of stormwater master planning in Salem, and an inventory of stormwater facilities.

Comprehensive Goals and Policies

The goals and policies presented in this chapter are organized under categories such as Capital Improvement Planning, Stormwater Quantity and Quality, and Flood Risk Reduction. The goals and policies apply system-wide and are designed to guide decisions regarding stormwater programs and projects.

Stormwater Facilities Plan

The Stormwater Facilities Plan identifies future stormwater capital projects necessary to support the land uses designated in *the Salem Area Comprehensive Plan*[1]. The projects are derived from the basin plans and include estimates of costs and recommended timeframes for construction.

Financial Plan

The Financial Plan describes the main sources of funding for stormwater services and provides a forecast of operating and capital project budgets.

Basin Plans

This *Stormwater Master Plan* includes nine detailed basin plans. Each basin plan describes the basin, summarizes modeling methodologies, and identifies facilities needed to accommodate current conditions and future growth. Facilities specified in each basin plan are collectively compiled in the Stormwater Facilities Plan (Chapter 3).

The 2000 *Stormwater Master Plan* originally evaluated 12 drainage basins, but concluded facilities plans were not required to accommodate current conditions and future growth in three basins—Lower Claggett Basin **(see Map 1.1)**, Pettijohn-Laurel Basin, and Willamette Slough Basin—a conclusion carried forward in this *Stormwater Master Plan*. The nine basin plans addressed in detail in this *Stormwater Master Plan* are:

(1) Battle Creek Basin

(2) Croisan Creek Basin

(3) East Bank Basin

(4) Glenn-Gibson Basin

(5) Little Pudding Basin

(6) Mill Creek Basin

(7) Pringle Creek Basin

(8) Upper Claggett Basin

(9) West Bank Basin

[1] *See https://www.cityofsalem.net/pages/salem-area-comprehensive-plan.aspx.*

Table 1.1 identifies which basin plans are carried forward from the 2000 *Stormwater Master Plan* and which are from more recent basin plans completed since 2000.

Table 1.1

Stormwater Basin Plans and Sources

BASIN	SOURCE
Battle Creek	Battle Creek Basin Plan (City of Salem 2019a)
Croisan Creek	2000 Stormwater Master Plan (City of Salem 2000a)
East Bank	2000 Stormwater Master Plan (City of Salem 2000a)
Glenn-Gibson Creek	2000 Stormwater Master Plan (City of Salem 2000a)
Little Pudding Creek	2000 Stormwater Master Plan (City of Salem 2000a)
Mill Creek	Mill Creek Basin Plan (City of Salem 2019b)
Pringle Creek	Pringle Creek Basin Plan (City of Salem 2019c)
Upper Claggett Creek	2000 Stormwater Master Plan (City of Salem 2000a)
West Bank	2000 Stormwater Master Plan (City of Salem 2000)

Supporting Information

Studies and reports used to develop the *Stormwater Master Plan* are referenced. Appendices are provided that contain modeling and basin planning methodologies, rainfall analysis, and other key supporting information used to produce the *Stormwater Master Plan*.

BACKGROUND: URBAN STORMWATER RUNOFF

When rain falls on natural landscapes typical in many parts of Oregon's Willamette Valley, most of the rainfall is intercepted by trees and vegetation where it evaporates or is transpired—a process known collectively as evapotranspiration—or it is absorbed into the ground through the process of infiltration. Only a relatively small portion of rainfall on natural landscapes becomes surface runoff (**Figure 1.1**).

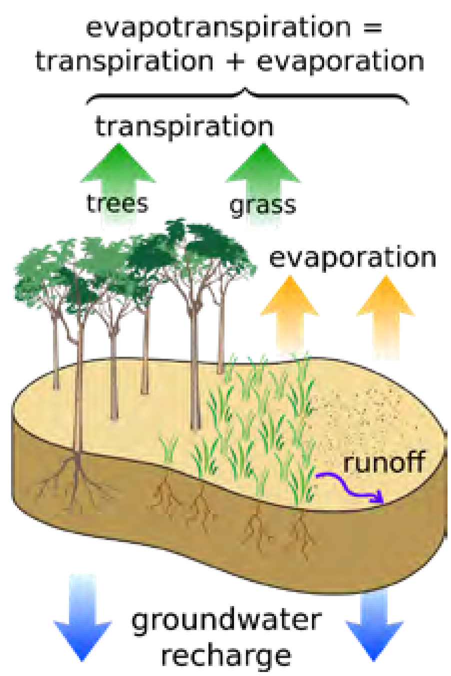


Figure 1.1

Rainfall in an Undeveloped Landscape

Source: "Evapotranspiration." Wikipedia. Web. 24 Aug. 2015.
"Surface water cycle" by Mwtoews - Own work. Licensed under CC BY 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Surface_water_cycle.svg#/media/File:Surface_water_cycle.svg

Urban stormwater runoff occurs as a consequence of development as vegetative cover is reduced, soils are compacted, and the amount of impervious surface area is increased. These alterations from natural landscapes result in increased stormwater flows that can damage urban creeks and waterways by eroding stream banks, cutting into stream channels, and injuring aquatic habitats. During more extreme storm events, stormwater runoff causes flooding that threatens property and puts public health and safety at risk. Stormwater also picks up pollutants such as oil, pesticides, fertilizers, pet wastes, and other contaminants that have been deposited on urbanized landscapes. This polluted stormwater is discharged—largely untreated—directly into Salem's creeks and wetlands, the groundwater, and the Willamette River (**Figure 1.2**).

Figure 1.2

Rainfall in an Urbanized Landscape

© Cate White, 2005. Source: WATERKEEPER Alliance (www.waterkeeper.org)

MASTER PLANNING HORIZON

As a planning document for capital project construction and programmatic implementation, the *Stormwater Master Plan* looks forward approximately 25 years. As a strategic document, the broader goals and policies contained in the plan are envisioned to extend well beyond the 25-year time frame, modified as appropriate as development continues, impacts of past investment are evaluated, additional information becomes available, new regulations emerge, and the state-of-the-practice of urban stormwater runoff management advances.

PLANNING AREA

The City of Salem

The capital of Oregon, Salem is located in the heart of the Willamette River valley about 50 miles south of Portland, 90 miles from the crest of the Oregon Cascades to the east, and 60 miles from the Oregon coast to the west. Spanning both sides of the Willamette River, Salem is located in Marion County on the east side of the river and Polk County on the west. Consisting of approximately 49 square miles, flat terrain dominates the eastern and northern portions of the city, with hilly terrain characterizing the western and southern areas.

As of the US census of 2010, there were 154,637 people, 57,290 households, and 36,261 families residing in Salem (US Census Bureau 2010). The population estimate as of July 1, 2019, is 167,220 people (Portland State University 2019). As shown in (**Figure 1.3**), Salem's population has shown a steady increase over the past 60 years.

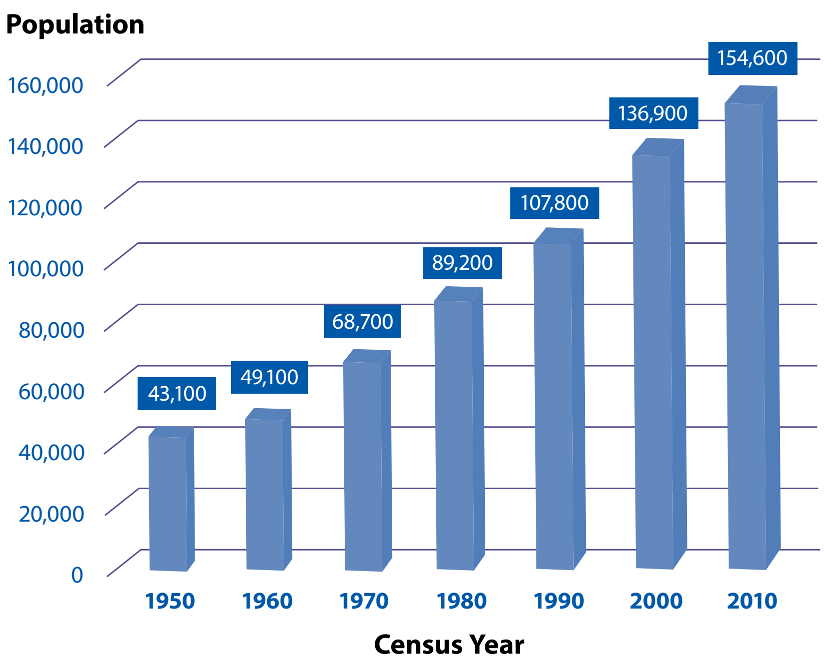


Figure 1.3

Population Growth in Salem from 1950 to 2010

The planning area for the *Stormwater Master Plan* consists of 12 stormwater basins (**Map 1.1**).

Of these 12 basins, only one, East Bank Basin, is located entirely within Salem's jurisdictional limits; the other 11 basins have boundaries that extend into Marion County, Polk County, or the city of Keizer. The Mill Creek basin, for example, encompasses approximately 110 square miles that span 24 miles from the foothills of the Cascade Range to the Willamette River and includes, in addition to Salem, the cities of Turner, Aumsville, Sublimity, and portions of Stayton (USACE 2002). Hydrologic and hydraulic modeling conducted in support of the plan included data and analysis that extended, to varying degrees, beyond the city limits and to the outer boundaries of the basins. However, the *Stormwater Master Plan* generally focuses on issues and action items within the Salem city limits and, for evaluating future stormwater facility needs, on planned land uses within the Urban Growth Boundary.

This *Stormwater Master Plan* provides detailed plans for nine basins: Battle Creek Basin, Croisan Creek Basin, East Bank Basin, Glenn-Gibson Basin, Little Pudding Basin, Mill Creek Basin, Pringle Creek Basin, Upper Claggett Basin, and West Bank Basin. Maps are provided but detailed basin plans are not presented for three basins: Lower Claggett Basin, Pettijohn-Laurel Basin, and Willamette Slough Basin. The conclusion of the 2000 *Stormwater Master Plan* that detailed analyses and facilities plans were not required to accommodate current and future demands in these basins is carried forward in this *Stormwater Master Plan*.

Descriptions and additional details are provided in the basin chapters and accompanying basin plans, which are incorporated by reference into this *Stormwater Master Plan*.

Climate Characteristics

Like much of the Willamette Valley area, Salem's climate is characterized by few extremes of temperature. Based on data collected at Salem's McNary Field Airport (Western Region Climate Center 2016), only 21° F separate the average annual maximum temperature of 63.1°F from the average annual minimum temperature of 42.1°F. Snowfall has occurred in Salem between October and March, but major snows are rare. For the period 1892 through 2012, Salem's mean annual temperature is 52.6°F and its annual precipitation is 39.38 inches, with an annual average of 7.1 inches of snowfall (ibid.). **Table 1.2** provides a summary of general climate characteristics for Salem.

Climate Change

In the *Fourth National Climate Assessment*, in the chapter focusing on the Northwest (May, et al. 2018), the authors note:

There is a growing body of evidence suggesting that climate change will likely increase the frequency and/or intensity of extreme events such as flooding, landslides, drought, wildfire, and heat waves... Hydrologic change will likely be an important driver of future climate stress on infrastructure. As higher temperatures increase the proportion of cold season precipitation falling as rain rather than snow, higher streamflow is projected to occur in many basins, raising flood risks (ibid. p. 1074).

Accelerated trends in snowfall, snow pack, temperature, and rainfall may require flood studies to use shorter term historic data when modeling future conditions, stormwater flows, inundation areas, and base flood elevations. This will remain an area needing further research.

Table 1.2

General Climate Characteristics of Salem

Source: Western Region Climate Center (2016)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temp. (ºF)	46.0	50.6	55.5	61.2	67.7	73.8	81.8	81.8	75.5	64.2	52.6	46.7	63.1
Average Min. Temp. (ºF)	33.4	34.8	36.8	39.6	44.2	49.1	52.0	51.9	48.1	42.5	37.9	34.8	42.1
Average Total Precip. (in.)	6.11	4.72	4.14	2.57	2.07	1.32	0.39	0.52	1.53	3.21	6.12	6.69	39.38
Average Total Snowfall (in.)	2.90	1.60	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	1.80	7.10

Notes:

(1) Based on data from McNary Field Airport

(2) Period of Record is 1892 to 2012

Rainfall is heaviest during the late fall through winter months of October through March, but precipitation is spread from October through May, with only July and August having an average annual rainfall of less than one inch. Rainfall varies within the seasons. The average annual monthly rainfall during the months of October through April during the 50-year period between 1953 and 2012 was 4.85 inches, but maximum and minimum individual monthly averages ranged from 15.23 inches in November 1973 to 0.24 inches in January 1985. Similarly, the average monthly rainfall during the months of May through September during the same 50-year period was 1.20 inches, with the maximum individual monthly average of 9.98 inches in March 2012. There were 14 months that recorded no rainfall during this 50-year period (ibid.).

REGULATORY CONTEXT

Salem's *Stormwater Master Plan* is affected by several federal, state, and local regulations and policies. The federal Clean Water Act[1] and its associated amendments provide regulations related to discharges from the City's stormwater system and to the quality in Salem's receiving water bodies. The federal Endangered Species Act is aimed at protecting certain species that are in danger of extinction. The National Flood Insurance Act and its associated amendments addresses flood insurance for properties at risk of flooding. Oregon statewide planning goals contain requirements with which the *Stormwater Master Plan* must comply. The *Salem Revised Code* contains local regulations for stormwater discharges, erosion prevention, and floodplain management. Additional details of these regulations are provided below.

[1] *The term "Clean Water Act" as used in this document includes all the associated federal acts, including the 1972 Federal Water Pollution Control Act (PL 92-500), the 1977 Clean Water Act Amendments to the Water Pollution Control Act (PL 95-217), and the Water Quality Act of 1987 (PL 100-4).*

Federal Clean Water Act

In 1990, the United States Environmental Protection Agency (EPA) published regulations governing discharges from a municipal separate storm sewer system (MS4) under the National Pollutant Discharge Elimination System (NPDES) of the federal Clean Water Act. In Oregon, EPA has delegated permitting authority for NPDES permits to the Oregon Department of Environmental Quality (DEQ). Phase I implementation of the NPDES MS4 permit program applied to municipalities having populations greater than 100,000 based on the 1990 Census; Salem's population in 1990 was 107,786. Salem was issued its initial NPDES MS4 Permit in December 1997, with an expiration date of September 2002. In April 2002, Salem submitted an application to renew its NPDES MS4 Permit and DEQ issued Salem a renewed NPDES permit in March 2004. On September 2, 2008, Salem submitted its NPDES permit renewal application to DEQ and received a renewed MS4 permit on December 30, 2010 (DEQ 2010).

Total Maximum Daily Loads

Under Section 303(d) of the federal Clean Water Act, states are required to develop lists of impaired water bodies. Impaired water bodies are waters for which technology-based regulations and other required controls are not stringent enough to meet the water quality standards set by each state. The Clean Water Act requires that states establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards. Table 1.3 shows the water bodies in the planning area currently listed by DEQ as impaired (DEQ 2006).

Clean Water Act Section 404

The Clean Water Act Section 404 relates to the placement of fill into waters of the United States. A permit from the U.S. Army Corps of Engineers is required to place fill into any stream or wetland. The permitting requirements include evaluation of alternatives that do not involve fill and could involve mitigation for unavoidable impacts. Permitting is often an integral part of the construction of any stormwater facility.

Table 1.3

Impaired Water Bodies

Source: DEQ 2006

Water Body	Listed River Miles	Parameter
Clark Creek	0 to 1.9	E coli
Glenn Creek	0 to 7	Dissolved Oxygen
Mill Creek	0 to 25.7	Fecal Coliform
Pringle Creek	0 to 6.2	Copper
		Dieldrin
		E Coli
		Lead
		Temperature
		Zinc
Willamette River (Middle Willamette Subbasin)	26.6 to 108	Bacteria
		Mercury
		Temperature

Federal Endangered Species Act

The Endangered Species Act of 1973 (ESA) was signed on December 28, 1973. The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. The Department of the Interior's U.S. Fish and Wildlife Service (FWS) and the Commerce Department's National Marine Fisheries Service (NMFS) administer the ESA. The FWS has primary responsibility for terrestrial and freshwater organisms, while the responsibilities of NMFS are mainly marine wildlife such as whales and anadromous fish such as salmon. Under the ESA, species may be listed as either endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future (FWS 2013). Threatened species within the planning area include spring Chinook salmon, steelhead trout, Oregon chub, and Coho salmon (FWS 2014, NMFS 2014).

Federal Flood Insurance and the ESA

To settle a lawsuit by environmental groups, the Federal Emergency Management Agency (FEMA) consulted with NOAA Fisheries under Section 7 of the Endangered Species Act (ESA) to determine whether implementation of its National Flood Insurance Program (NFIP) in Oregon impacts the survival of listed species. Throughout the state, 15 salmon and steelhead species are listed under the ESA, and each of these species depends on healthy, functioning floodplain habitat.

The Salem Area Comprehensive Plan is the long-range plan for guiding development in the Salem-Keizer urban area.

Development in floodplains can disconnect this important area from river channels and destroy natural riparian and wetland vegetation. Altering the natural processes that allow habitat to form and recover from disturbances, such as floods, can affect multiple stages of the salmon life cycle and impede their survival and long-term recovery.

In 2011, FEMA consulted with NOAA Fisheries to determine whether implementation of its National Flood Insurance Program in Oregon impacts the survival of 18 listed species. Through the consultation process, NOAA Fisheries' determined that the NFIP in Oregon reduces the quantity and quality of floodplain and in-channel habitat, which jeopardizes 17 marine species (15 salmon and steelhead species, as well as eulachon and Southern Resident killer whales), and adversely modifies critical habitat for 16 of these species. NOAA Fisheries' provided an RPA to ensure FEMA's implementation of the NFIP avoids harming these species—recommending that FEMA improve floodplain mapping and limit development in the areas of highest flood hazard, as well as mitigation for the loss of floodplain habitat.

DLCD Role in NFIP Response to ESA

As Oregon's NFIP coordinating agency, DLCD promotes and supports communication between NFIP communities and FEMA. DLCD provides assistance to local governments as FEMA implements NFIP revisions in Oregon. This assistance may include workshops and presentations, guidance, model codes, grants, and technical assistance.

FEMA Region 10 is developing new guidance for NFIP communities. The guidance will describe new NFIP floodplain permit review standards to ensure that local permits do not authorize activities that contribute to the loss of salmon habitat. FEMA's mechanism for assessing compliance with NFIP minimum requirements will not change. Conformance with any new NFIP standards or guidance on the part of NFIP communities will be evaluated during periodic community assistance visits.

Ultimately, NFIP communities in the 31 Oregon counties with ESA listed salmonids will need to increase habitat protections. Development that degrades floodplain functions includes: clearing of native riparian vegetation; increases in impervious surface; displacement or reduction of flood storage via fill or structures; interruption of habitat forming process; and increases of pollutant loading in receiving water bodies.

Federal Flood Insurance Reforms

Prior to 1968, flood insurance was provided by the private insurance industry. Following significant flood losses from natural disasters in the mid-1960s, the federal government initiated a nationwide flood insurance program.

The National Flood Insurance Act of 1968

In 1968, Congress passed the National Flood Insurance Act, which created the Federal Insurance Administration and the National Flood Insurance Program (NFIP). Managed by the Federal Emergency Management Agency (FEMA), the NFIP offers flood insurance to homeowners, renters, and business owners if their local community participates in the NFIP. Salem's residents are eligible for flood insurance because the City has adopted ordinances that meet or exceed FEMA requirements to reduce the risk of flooding. A number of laws have been passed since the National Flood Insurance Act (FEMA 2014a).

The Flood Insurance Protection Act of 1973

The Flood Insurance Protection Act of 1973 mandated that lenders require flood insurance on loans secured by properties located within high-risk flood areas.

The National Flood Insurance Reform Act of 1994

The National Flood Insurance Reform Act of 1994 strengthened the NFIP with a number of reforms that included: increasing the focus on lender compliance; creating mitigation insurance; and developing a mitigation assistance program to further reduce the costly and devastating impacts of floods.

The Flood Insurance Reform Act of 2004

The Flood Insurance Reform Act of 2004 further strengthened the NFIP with a number of reforms that included: reducing losses to properties for which repetitive flood insurance claim payments have been made; creating policyholder awareness about individual flood insurance policies; increasing policyholder information on guidance about the flood insurance claims process; and establishing a minimum flood insurance training and education requirement for insurance professionals.

The Biggert-Waters Flood Insurance Reform Act of 2012

The Biggert-Waters Flood Insurance Reform Act of 2012 authorized and funded the national mapping program and instituted certain rate increases to ensure the fiscal soundness of the program. Over time, this act will transition the federal flood insurance program from subsidized rates, to full actuarial rates that are reflective of actual risks.

Homeowner Flood Insurance Affordability Act of 2014

This law repeals and modifies certain provisions of the 2012 Biggert-Waters Flood Insurance Reform Act and makes additional program changes to other aspects of the National Flood Insurance Program. The act lowers the recent rate increases on some policies, prevents some future rate increases, and implements a surcharge on all policyholders. (See FEMA 2014b.)

State Land Use Planning Goals

In 1973, Oregon established a statewide program for land use planning. The current program consists of 19 Statewide Planning Goals. Oregon´s statewide goals are achieved through local comprehensive planning that must be consistent with the Statewide Planning Goals. Salem's *Stormwater Master Plan* must be consistent with all of the goals, which express the state's policies on land use and related topics, such as: citizen involvement, housing, and natural resources. Plans are reviewed for such consistency by the Oregon Land Conservation and Development Commission (DLCD 2010).

Oregon Administrative Rule 660-011

Salem's *Stormwater Master Plan* must comply with Oregon Administrative Rule (OAR) 660-011 (Public Facility Planning). The purpose of this rule is to aid jurisdictions in achieving the requirements of Goal 11, Public Facilities and Services, and to implement *Oregon Revised Statute* (ORS) 197.712(2)(e), which requires that a city or county containing a population greater than 2,500 persons develop and adopt a public facility plan for areas within an urban growth boundary. Per OAR 660-011, the purpose of a public facility plan is to help assure that urban development inside urban growth boundaries is guided and supported by types and levels of urban facilities and services appropriate for the needs and requirements of the urban areas to be serviced, and that those facilities and services are provided in a timely, orderly, and efficient arrangement, as required by Goal 11. OAR 660-011 contains definitions relating to a public facility plan, procedures and standards for developing, adopting, and amending such a plan, the date for submittal of the plan to the Commission, and standards for Department review of the plan (ORS Division 11, 2014).

Salem Revised Code

There are several chapters of the *Salem Revised Code* (SRC) that contain requirements directly related to stormwater management and floodplain management. Key chapters are summarized below. To view the entire ordinances, see City of Salem (2019d):

SRC Chapter 70 (Utilities General)

This chapter requires the Public Works Director to prepare and update master plans for expanding, constructing, or reconstructing stormwater systems. SRC Chapter 70 also includes requirements related to constructing, operating, and maintaining private stormwater systems and facilities.

SRC Chapter 71 (Stormwater)

This chapter regulates discharges into stormwater systems and receiving waters. It contains minimum requirements for stormwater source controls and establishes post-construction requirements for development and redevelopment projects.

SRC Chapter 75 (Erosion Prevention and Sediment Control)

This chapter requires temporary and permanent measures be taken for all construction, land development projects, and ground disturbing activities to prevent the adverse effects of site erosion and sediment runoff.

SRC Chapter 601 (Floodplain Overlay Zone)

This chapter regulates development in the floodplain and authorizes the Director of Public Works to grant, deny, suspend, and revoke floodplain development permits.

COMPREHENSIVE PLANNING

Urban Growth Boundary and Urban Service Area

Under Oregon law, Salem and Keizer have created an Urban Growth Boundary (UGB) to guide zoning and land use decisions. The UGB includes land necessary for Salem and Keizer's growth needs for the next 20 years. Land inside the UGB is to be used for higher density urban development and land outside the UGB for lower density development. The two jurisdictions have also created an Urban Service Area (USA). The Salem Urban Service Area comprises approximately 61 square miles within the Urban Growth Boundry and includes areas inside and outside the city limits. The USA is the area in which required facilities for water, wastewater, stormwater, transportation, and parks are all in place or committed in the capital improvement plan. (**Map 1.2**) shows the Salem-Keizer UGB. (**Map 1.3**) shows the Salem-Keizer USA and its relationship to the UGB.

Salem Area Comprehensive Plan

The *Salem Area Comprehensive Plan* is the long-range plan for guiding development in the Salem-Keizer urban area. The overall goal of the plan is to accommodate development with a timely, orderly, and efficient arrangement of land uses and public facilities and services that meet the needs of present and future residents of the Salem urban area.

The *Stormwater Master Plan* is a component of the Salem Area Comprehensive Plan. Much of the analysis conducted to produce the *Stormwater Master Plan* is based on land uses designated in the Comprehensive Plan Map (**Map 1.4**) and policies contained in the *Salem Area Comprehensive Policies Plan* (City of Salem 2015).

Certain elements of the *Stormwater Master Plan*, including those describing the stormwater facilities needed to support the land uses designated in Salem's Comprehensive Plan Map (City of Salem 2019e), constitute the public facilities plan for stormwater under *Oregon Administrative Rule* 660-011 (Public Facility Planning) and *Salem Revised Code* Chapter 64 (Comprehensive Planning). Other elements of the *Stormwater Master Plan*, such as the comprehensive policies, are considered a Public Facilities Support Plan under SRC Chapter 64.

CITY OF SALEM STORMWATER MANAGEMENT PLAN

For many years, Salem has implemented a stormwater management plan to address issues related to stormwater quantity and stormwater quality. Salem's stormwater program includes a suite of activities, such as: stormwater system operation and maintenance; stormwater quality monitoring; public education and involvement; street sweeping; stream cleaning; municipal regulations; stormwater quality complaint response; inspections and enforcement; long-range planning; capital project construction; and more.

Many facets of Salem's stormwater managment plan are mandated by the federal Clean Water Act, which requires cities like Salem to have a permit under the National Pollutant Discharge Elimination System (NPDES) for discharges of runoff from its municipal stormwater system. This permit is administered on behalf of the federal Environmental Protection Agency through the Oregon State Department of Environmental Quality. (See the "Regulatory Context" section in this chapter.) Programmatic requirements of the NPDES municipal stormwater permit include the following:

Illicit Discharge Detection and Elimination

An illicit discharge is any discharge to a stormwater system that is not composed entirely of stormwater or that is not otherwise permitted by local regulations (for example, SRC 71 allows discharges of irrigation runoff, firefighting water, and foundation drains, among others). The purpose of the illicit discharge detection and elimination program is to detect, remove, and eliminate illicit discharges into the stormwater system. The program includes ordinances and rules prohibiting illicit discharges; an inspection program to identify potential illicit discharges; an enforcement response plan for when an illicit discharge has occurred; and a system for documenting illicit discharge complaints, referrals, and investigation activities.

Industrial and Commercial Facility Inspection

This program is designed to reduce pollutants in stormwater discharges from industrial and commercial facilities that have the potential to contribute a significant pollutant load to the stormwater system. The program includes screening of existing and new industrial and commercial facilities and conducting follow-up activities to determine whether a facility should be regulated under the industrial stormwater NPDES permit program.

Construction Site Runoff Control

This program reduces pollutants in stormwater runoff from construction activities and includes: ordinances and rules requiring erosion prevention and sediment control; requirements for implementing an erosion and sediment control plan; permitting processes that ensure erosion and sediment control plans are properly implemented; and inspection and enforcement procedures to ensure construction activities are in compliance with all regulatory requirements.

Education and Outreach

The education and outreach program (1) promotes pollutant source control and a reduction of pollutants in stormwater discharges; (2) provides educational materials describing the impacts of stormwater discharges on water bodies and identifying steps to reduce pollutants in stormwater runoff; (3) provides public education on the proper operation and appropriate maintenance of privately owned or operated stormwater facilities; and (4) evaluates the success of public education activities.

Public Involvement and Participation

Salem is required to provide opportunities for the public to participate in developing, implementing, and modifying the City's stormwater management program.

Post-Construction Site Runoff Control

The post-construction site runoff pollutant and runoff control program includes ordinances and rules applicable to new development and redevelopment projects that are required to install stormwater flow control and treatment facilities. The program includes plan review, inspection, and enforcement procedures.

Pollution Prevention for Municipal Operations

This pollution prevention program is designed to reduce discharges of pollutants from properties owned or operated by the City, such as parks, open spaces, fleet facilities, building maintenance facilities, and transportation systems. The program includes: actions to minimize discharging stormwater pollutants during road and street maintenance activities; minimize use of pesticides, herbicides, and fertilizers; and assess projects to identify potential impacts on the water quality of receiving water bodies and to determine the feasibility of retrofitting structural flood control devices for additional stormwater pollutant removal.

Structural Stormwater Controls Operation and Maintenance Activities

This program includes developing an inventory and map of stormwater facilities and conducting inspection, operation, and maintenance activities to ensure the facilities are functioning properly.

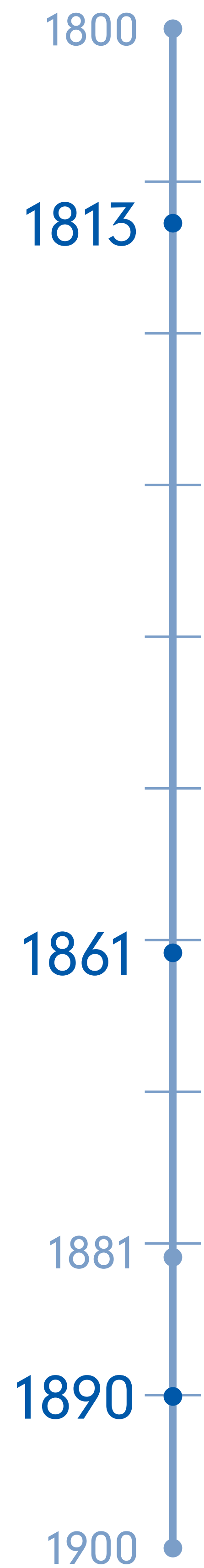
Monitoring

Salem's stormwater monitoring program provides data and information that supports stormwater management decisions. It includes: continuous instream monitoring to help identify potential illicit discharge incidents; storm event monitoring at outfalls and in select creeks to evaluate possible trends and program effectiveness; monitoring of stormwater facilities to evaluate pollutant removal effectiveness; and receiving water monitoring to evaluate the chemical, biological, and physical effects of stormwater discharges on receiving waters.

Salem also conducts real-time monitoring and reporting of water levels at key locations in creek basins to provide an early warning system for regional emergency management staff and for public awareness of flood risks.

Annual Reporting

Reports are submitted each year to the DEQ to document, for example: the status of implementing stormwater management program elements; the results of programmatic activities such as public education; monitoring results, including any assessments and evaluations; any enforcement actions taken and the results; and the annual stormwater program expenditures and funding sources.



INVENTORY OF STORMWATER FACILITIES IN SALEM

The Salem stormwater system is comprised of pipes, ditches, culverts, creeks, and a set of stormwater treatment and flow control facilities. The stormwater system includes both private and public facilities. A general inventory of key stormwater facilities would show that the City of Salem's stormwater system includes approximately:

- 91 miles of creeks
- 482 miles of drain pipes
- 68 miles of roadside ditches
- 858 public detention basins
- 1,069 private detention basins
- 16,100 catch basins

KEY DATES IN STORMWATER MANAGEMENT IN SALEM

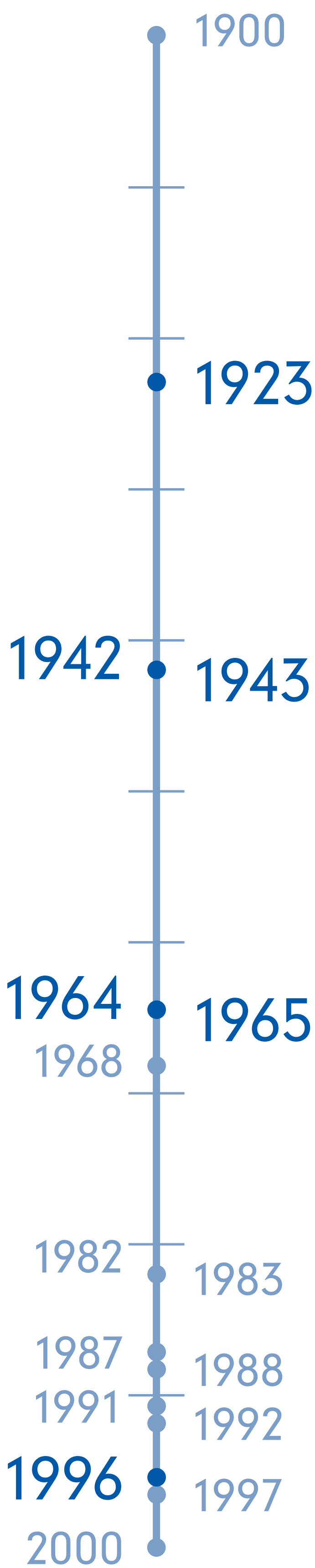
Important dates in Salem's stormwater management history include the following:

1813 There is evidence of a major flood in 1813 that was likely as significant as the floods of 1861 and 1890 (Taylor and Hatton 1999).

1861 Known as "The Great Flood," this was the largest flood on record for the Willamette River at the time, inundating the town of Champoeg under as much as 30 feet of water and cresting in Salem on December 4, 1861, at approximately 47 feet, five feet above the highest earlier recorded water level (Miller 1999, Taylor and Hatton 1999, NWS 2014).

1881 Salem's first sewer system, which carried both wastewater and stormwater, is constructed. Salem continued constructing combined wastewater/stormwater systems until 1927.

1890 A major flood takes place in the Willamette River Valley. Contemporary reports compared it to the 1861 flood (Oregonian 1890a, Oregonian 1890b). At least five people were killed and almost every large bridge in the Willamette Valley was washed downstream. The Willamette River crested at 45.10 feet on February 5 (Taylor and Hatton 1999, NWS 2014).



1923 This January 1 through January 8 flooding event was caused by large amounts of rain, mild weather, and unusually high temperatures. It was the most serious flooding of the Willamette River since 1890. In Salem, the river crested on January 8 at 30.30 feet (Taylor and Hatton 1999, NWS 2014).

1942/1943 Flooding occured over days between December 30, 1942, and January 4, 1943. The flooded Willamette River crested in Salem at 30.6 feet on Jan. 2, 1943 (NWS 2014). There was extensive damage throughout the valley, nearly 150,000 acres were inundated, and several lives were lost (Oregon Statesman 1943, Gregory et al. 2002).

1964/1965 One of the worst floods in the Willamette Valley occurred between December 18, 1964, and January 7, 1965. This flood has been rated by the National Weather Service as one of the most destructive weather events in Oregon in the 20th century (NWS 1999). The Willamette River at the Salem gauge crested at 30.6 feet, portions of downtown Salem were under nearly 10 feet of water, and Salem General Hospital was evacuated (NWS 2014, Carlson 2006).

1968 *Storm Drain Master Plan: Trunk and Interceptor System for the Salem Metropolitan Area* (City of Salem 1968), essentially Salem's first comprehensive *Stormwater Master Plan*, is completed.

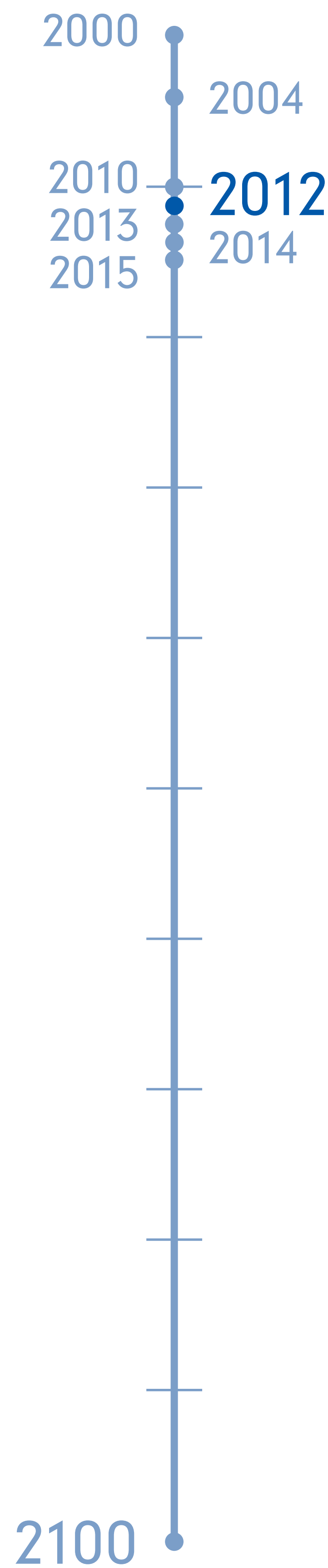
1982/1983 A new *Stormwater Master Plan* is developed, updating the 1968 *Storm Drain Master Plan*. It consisted of four volumes: *Salem Urban Area Water Quality Plan* (City of Salem 1982), *Stormwater Management Plan* (City of Salem 1983a), *Stormwater Management Financing Plan* (City of Salem 1983b), and *Stormwater Management Design Standards* (City of Salem 1983b).

1987 On June 22, 1987, Salem's City Council unanimously passes an ordinance establishing a stormwater utility.

1988 On March 14, 1988, City Council passes an ordinance repealing the stormwater utility with a retroactive effective date of March 1, 1988.

1991/1992 During this period, City Council approves funding stormwater services through the Sewer Utility Fund.

1992 A 20-year plan was initiated that included provisions to update master plans for water, wastewater, and stormwater systems.



1996 Salem initiates a project to update the 1982/1983 *Stormwater Master Plan*.

1996 In February, the region experienced a major flooding event that caused damage in both rural and urban areas. The combination of powerful rains, warm temperatures, and a deep snowpack led to severe flooding throughout northern sections of the state (Taylor and Hatton 1999). The river crested in Salem at 35.09 feet on February 8, a level comparable in magnitude to the December 1964 flood crest at the same location (NWS 2014).

1997 Salem was issued its first NPDES stormwater discharge permit by DEQ.

2000 City of Salem *Stormwater Master Plan* (City of Salem 2000a) is completed, updating the 1982/3 master plan.

2004 Salem's NPDES stormwater discharge permit is renewed by the DEQ.

2010 On December 6, City Council adopts amendments to *Salem Revise Code* and creates a stormwater utility (Chandler 2012).

2010 Salem's NPDES stormwater discharge permit is renewed by the DEQ.

2012 In January, areas of south Salem receive over nine inches of rain within a five-day period, causing flooding in the Battle Creek, Mill Creek, Pringle Creek, and Croisan Creek basins. The Willamette River crested at 29.42 feet on January 21 (NWS 2014).

2013 City Council adopts the *Floodplain Management Plan*, which identifies flood-related hazards and establishes an action plan for options for mitigating those hazards (City of Salem 2014b).

2013 City Council adopts *Salem Revised Code* Chapter 71, Salem's first stormwater-specific ordinance (Chandler 2014).

2016 Salem's stormwater utility is fully implemented in January.

HISTORY OF STORMWATER MASTER PLANNING IN SALEM

Between December 18, 1964, and January 7, 1965, climatic conditions produced a major flood affecting the entire Willamette Valley. Following the flood, the City Council directed that an extensive study be made of Salem's stormwater problems. This study produced the first of what would be three Stormwater Master Plans completed over the next three decades.

Storm Drain Master Plan of 1968

In June 1968, Salem's first "Storm Drain Master Plan" was completed (City of Salem 1968). Prepared by the Engineering Division of the Department of Public Works, the report contained a planning-level layout and design for trunk line drains for various drainage areas in Salem. The scope and intent of this first master planning effort was "to provide an integrated overall plan which will serve as a planning guide and a basis for future detailed construction designs" (*ibid*., p. 1).

Stormwater Master Plan of 1982/1983

Growth patterns that occurred after completion of the 1968 *Storm Drain Master Plan* was completed, as well adoption of a *Salem Area Comprehensive Plan* and *Urban Growth Management Plan*, created a need to update the plan. In 1982 and 1983, Salem produced a set of documents that collectively formed a new Stormwater Master Plan. These documents included:

- *Salem Urban Area Water Quality Plan:* This element presented findings on water quality within the Salem Urban Growth Boundary and establishing policies that provide for the continuation of certain water quality maintenance programs (City of Salem 1982).
- *Stormwater Management Plan:* This element contained recommendations for drainage system improvements needed within each of Salem's drainage basins to address stormwater runoff problems (City of Salem 1983a).
- *Stormwater Management Financing Plan:* This element analyzed options for financing needed improvements to the drainage system and to existing—and underfunded—programs of system operation and maintenance. Among the recommendations of the *Stormwater Management Financing Plan* was to establish a Stormwater Drainage Utility to collect and administer a citywide service charge based upon each property's contribution to the runoff problem (City of Salem 1983b).
- *Stormwater Management Design Standards:* This element provided guidelines for designing and constructing public and

private drainage facilities and addressing the need for erosion and sedimentation control when developing areas adjacent to waterways (City of Salem 1983c).

Stormwater Master Plan of 2000

In 2000, City Council adopted a new *Stormwater Master Plan* that superceded the 1983 plan. The 2000 *Stormwater Master Plan* (City of Salem 2000a) characterized the study area, described the public involvement in developing the plan, presented policies for a Salem stormwater management program, and summarized the results of a *Drainage System Improvement Plan* for basins located within the study area. Two supporting documents were produced as technical supplements to the 2000 *Stormwater Master Plan*. The Drainage *System Improvement Plan* (City of Salem 2000b) was developed using a planning-level XP-SWMM hydraulic/hydrologic model to evaluate locations and determine sizing requirements for stormwater facilities. The *Stormwater Management Program Plan* (City of Salem 2000c) contained a set of recommendations for managing stormwater and implementing capital improvement projects.

The *Drainage System Improvement Plan* included basin data and listed proposed future capital projects with a cost estimate for each project. Stormwater facility costs were estimated using unit prices with added allowances for design, permitting, administration, management, and contingencies. The *Drainage System Improvement Plan* conducted detailed analysis and provided project lists for nine of the 12 drainage basins. Three basins—Lower Claggett Basin, Pettijohn-Laurel Basin, and Willamette Slough Basin—were determined to not have development opportunities of significance; no facilities were identified and no hydraulic/hydrologic modeling was conducted for these three basins. For the remaining nine basins, a total of 288 projects were listed, 41 of which were identified as Early Action Items to be completed within five years. The total estimated cost (in 2000 dollars) for all 288 projects was $203,562,628. This value includes allowances for conveyance-related expenses (5%), permitting, acquisition, pre-design, and final design (15%), administration (6%), construction management (9%), and contingency (40%). In 2019 dollars, the total estimated cost for projects identified in the 2000 *Stormwater Master Plan* is approximately $340,000,000. As of December 2018, of the 288 project listed in the 2000 *Stormwater Master Plan*, 40 have been completed, eight of which were Early Action Items.

UPDATES TO THE STORMWATER MASTER PLAN

As a matter of policy, the *Stormwater Master Plan* will be reviewed and amended as required and at least every five years (see Chapter 2).

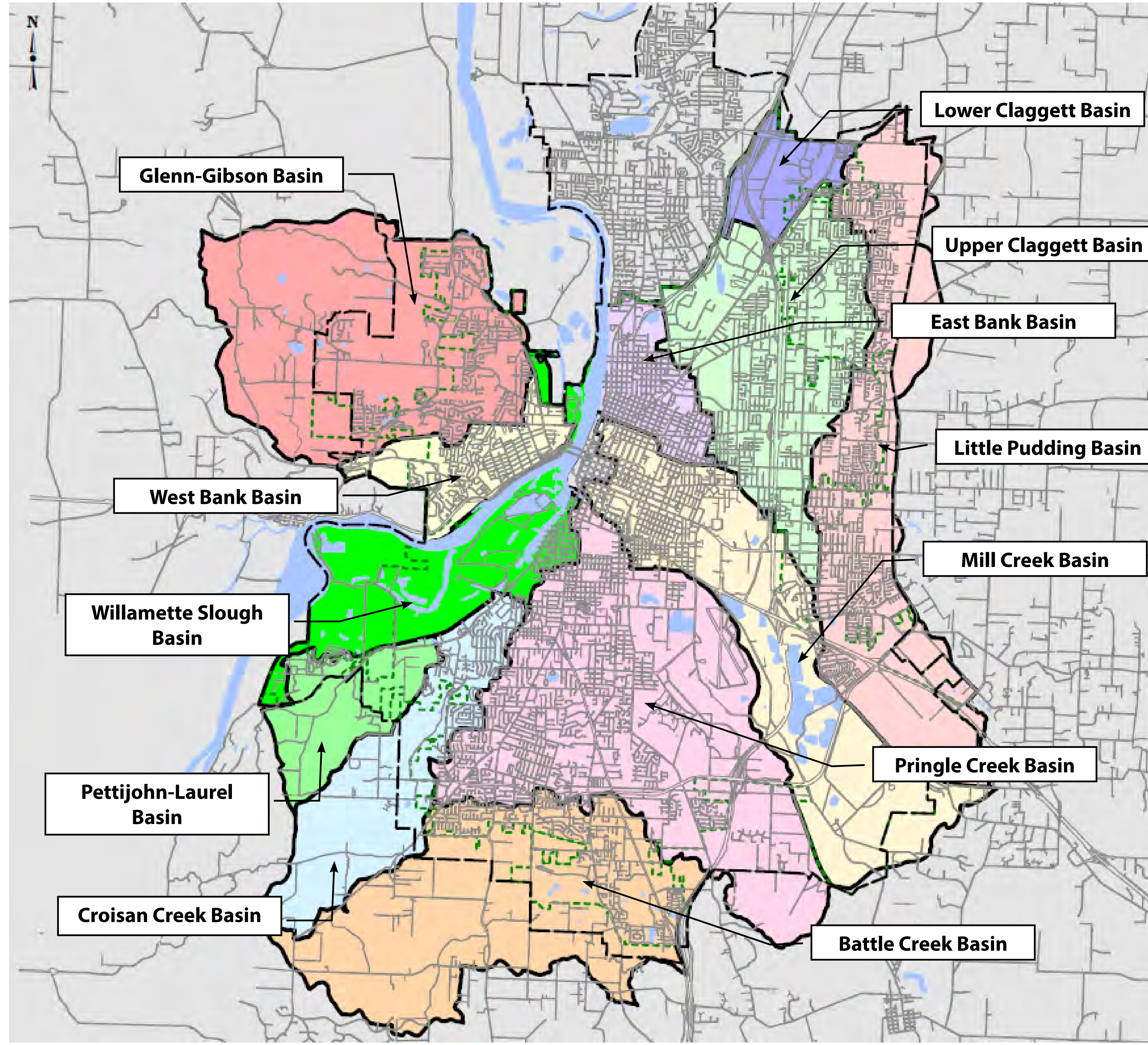
In practice, the intent is for amendments to the *Stormwater Master Plan* to occur as basin plans are revised. Basin plans will be updated following a rotating planning cycle as shown in Table 1.4 and amendments to the Stormwater Facilities Plan (see Chapter 3) and the respective basin chapters will accompany each basin plan revision. Updates to goals, policies, and supporting material in the *Stormwater Master Plan* will also occur as priorities change, new regulations are enacted, and background information becomes outdated.

Table 1.4

Planning Cycle for Salem's Stormwater Basins

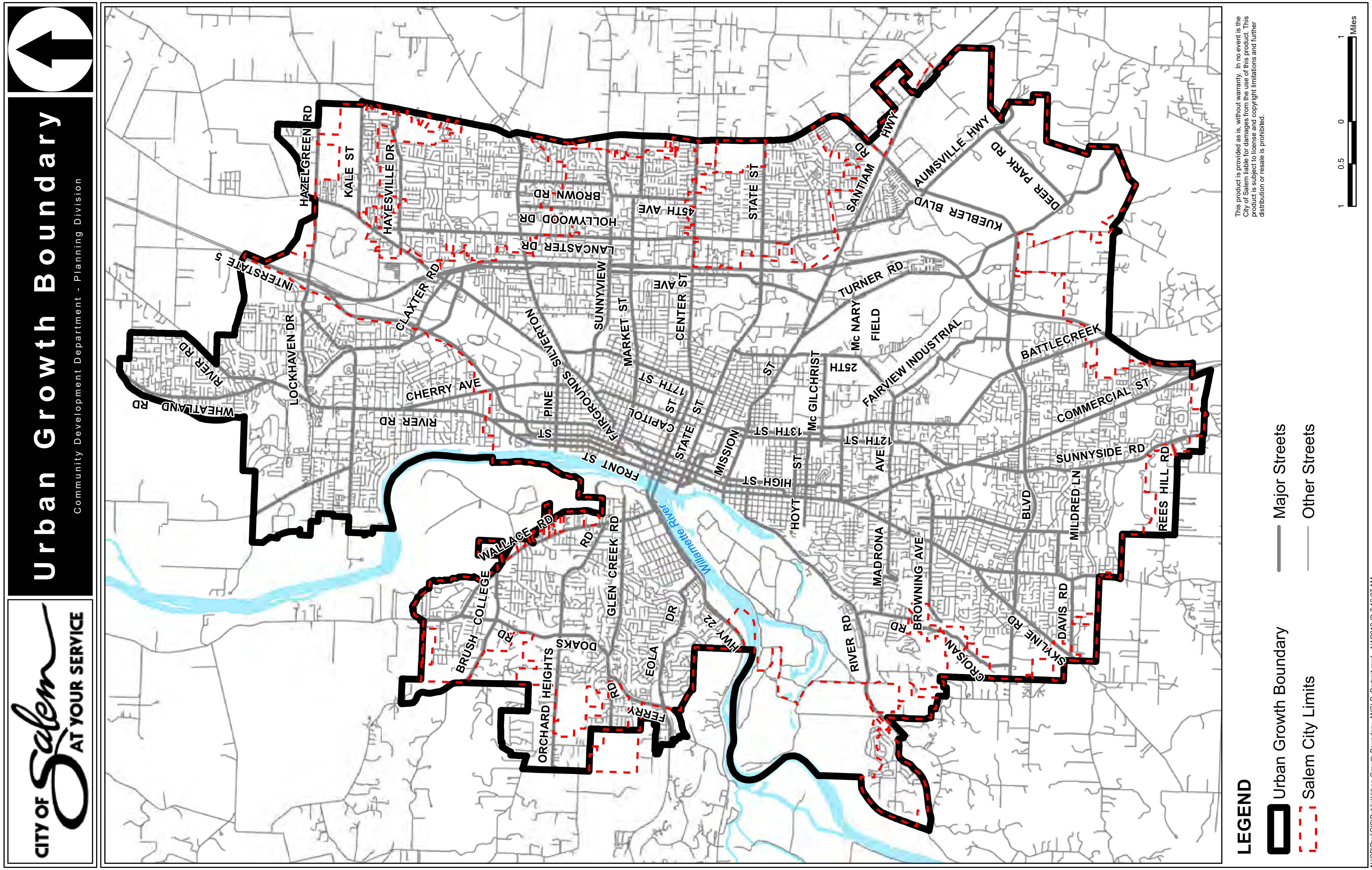
Table 1.4 Planning Cycle for Salem's Stormwater Basins	
Order of Planning	**Storm Basin**
1	Battle Creek Basin
2	Pringle Creek Basin
3	Mill Creek Basin
4	Glenn-Gibson Basin
8	West Bank Basin
6	Upper Clagget Basin
7	Croisan Creek Basin
5	Little Pudding Basin
9	East Bank Basin
-	Lower Clagget Basin
-	Pettijohn-Laurel Basin
-	Willamette Slough Basin

Note: Lower Claggett Basin, Pettijohn-Laurel Basin, and Willamette Slough Basin are listed for completeness. However, basin-wide planning is not required for these basins and they are not included in the planning cycle



Map 1.1

Salem Stormwater Basins



Map 1.2

Urban Growth Boundary for Salem-Keizer

Source: City of Salem 2014a

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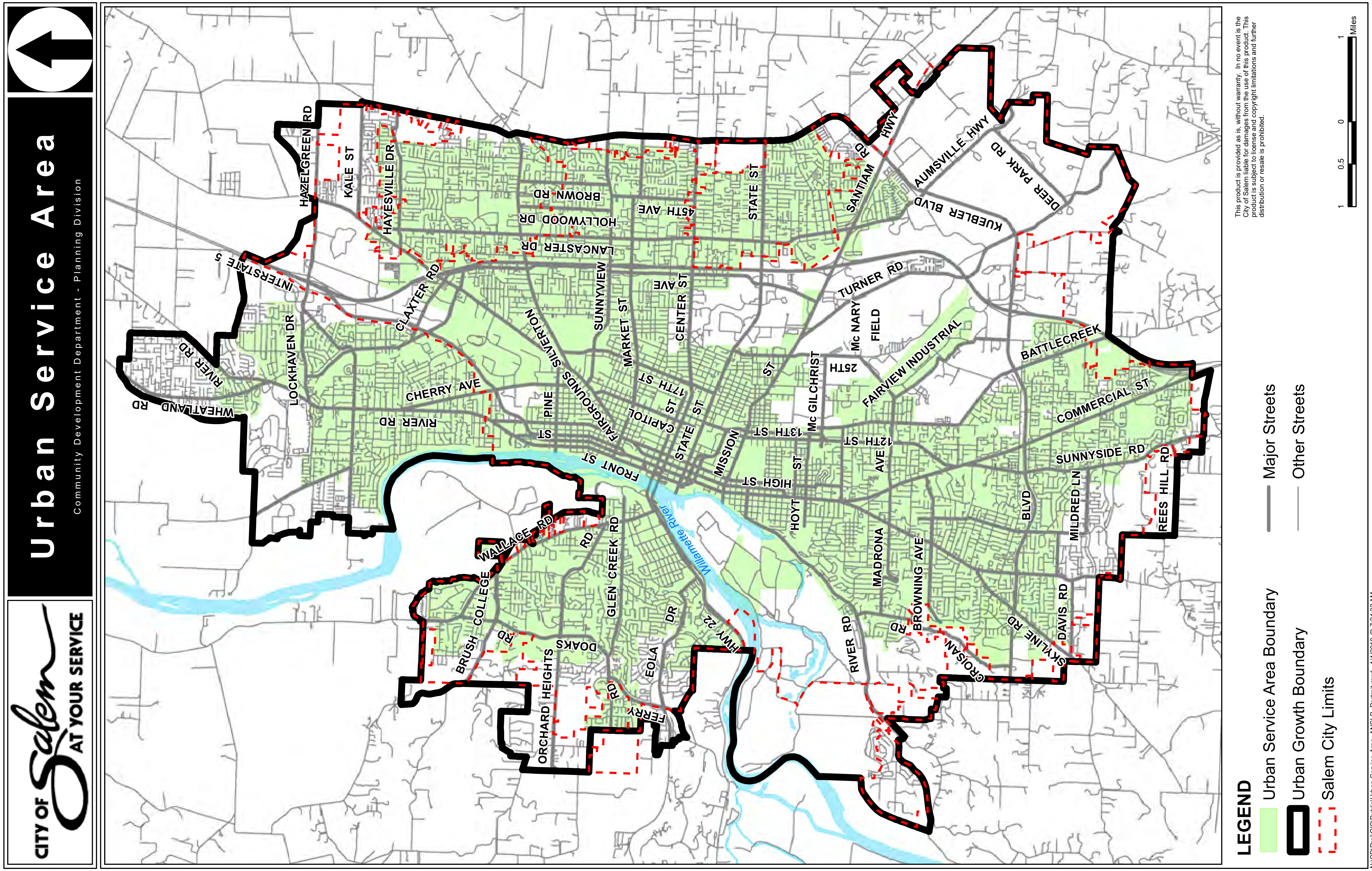

Map 1.3

Urban Service Area for Salem-Keizer

Source: City of Salem 2013a

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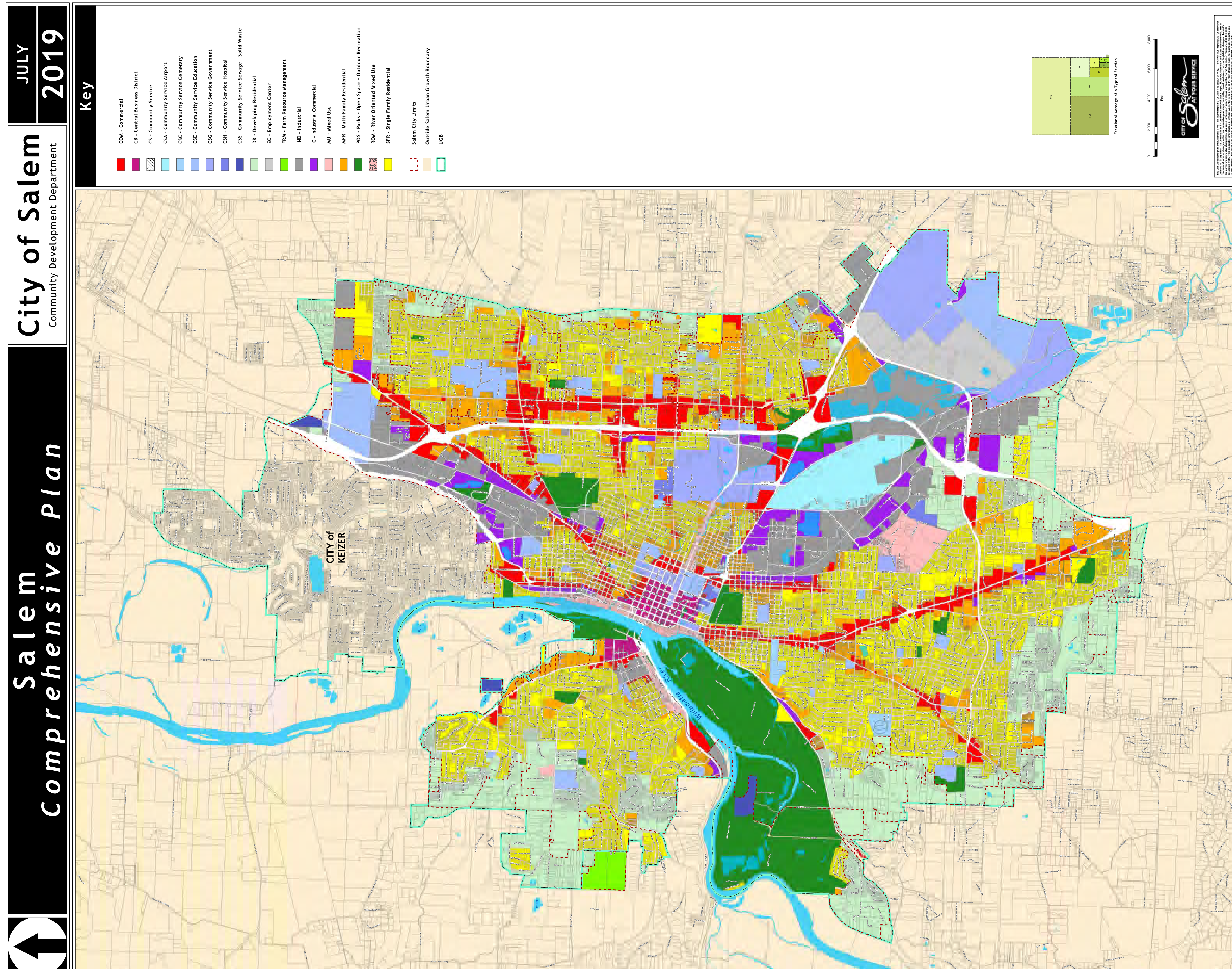

Map 1.4

Salem Comprehensive Plan Map

Source: City of Salem 2013b

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Comprehensive Goals & Policies

INTRODUCTION

The goals and policies presented in this chapter will guide how Salem should address challenges associated with urban stormwater runoff and constitute the foundational principles for determining how investments in stormwater projects and programs are to be made. These goals and policies are citywide and transcend watershed boundaries.

COMPREHENSIVE GOALS AND POLICIES

The goals and policies are organized below in eight categories: (1) Planning; (2) Capital Improvement Projects; (3) Flood Risk Reduction; (4) Operations and Maintenance; (5) Quantity and Quality; (6) Regulations and Standards; (7) Intergovernmental Coordination; and (8) Financing.

Policy 1: Planning

Goal of Stormwater Planning

The goal of stormwater planning is to support capital project and programmatic decision-making by providing information, establishing policies, and identifying and prioritizing action items.

Policy 1.1 Updating Stormwater Master Plan

The *Stormwater Master Plan* shall be reviewed and amended as required and at least every five years. Individual basin plans will be updated on a recurring basis and the results of new basin plans will be incorporated into the Stormwater Facilities Plan (see Chapter 3).

Policy 1.2 Watershed Management Plans

Watershed Management Plans shall be developed to meet the following objectives:

(1) Accomplishes a City Council goal or is completed in response to City Council directive;

(2) Fulfills a request by a Watershed Council;

(3) Augments information contained in the *Stormwater Master Plan* regarding watershed condition assessment, issues identification, and needs analysis; and

(4) Identifies programmatic and project action items that complement those contained in the *Stormwater Master Plan*.

Policy 1.3 Willamette Greenway

All programs and projects conducted within the Willamette Greenway Overlay Zone (See *Salem Revised Code* Chapter 600) will serve to protect and enhance the natural, scenic, recreational, historical, and economic resources of the Willamette River corridor.

Policy 2: Capital Improvement Planning

Goal of Stormwater Capital Improvement Planning

The goal of the stormwater capital improvement plan (CIP) is to efficiently deliver public stormwater conveyance, flow control, and treatment facilities.

Policy 2.1 CIP Project Criteria

Construction of stormwater facilities shall be prioritized based on the degree to which each project meets the following criteria:

(1) Reduces risks to life caused by flooding;

(2) Reduces risks to property caused by flooding;

(3) Protects and enhances the functions of creeks, lakes, ponds, waterways, wetlands, and their associated riparian zones;

(4) Supports existing land use within the Urban Growth Boundary (UGB);

(5) Supports new development or redevelopment within the UGB;

(6) Provides multiple benefits from a single facility, such as managing stormwater flows, reducing stormwater pollutants,

enhancing environmental conditions, providing aesthetic qualities, and incorporating park and recreation activities;

(7) Reduces pollutant loadings to assist with meeting applicable Total Maximum Daily Load waste load allocations;

(8) Meets state or federal regulatory requirements;

(9) Fulfills a City Council goal or City Council directive;

(10) Provides an opportunity for leveraging other resources or capital project funding;

(11) Involves an opportunity for grant funding; and

(12) Receives public support.

Policy 2.2 Project Cost Analysis

When comparing costs among stormwater capital projects, cost estimates for stormwater facilities shall be based on total life-cycle costs, which include planning, permitting, designing, constructing, operating, maintaining, monitoring, and decommissioning, as applicable, for each facility.

Policy 3: Flood Risk Reduction

Goal of Flood Risk Reduction

The goal of flood risk reduction is to identify flood-related hazards, establish actions to mitigate those hazards, and provide information related to flood risks to residents and businesses in Salem.

Policy 3.1 Floodplain Regulations

The City shall regulate activities in the floodplain according to the floodplain management standards of the Federal Emergency Management Agency.

Policy 3.2 Flood Insurance Rate Maps

The City shall adopt Flood Insurance Rate Maps published by the Federal Emergency Management Agency.

Policy 3.3 City Floodplain Regulations

The City shall implement all Floodplain Overlay Zone requirements per *Salem Revised Code* Chapter 601 that are applicable to the floodway, floodway fringe, and Interim Flood Hazard Area.

Policy 3.4 Floodplain Management Plan

The City shall implement, commensurate with existing priorities and funding levels, the proposed action items in the City of Salem Floodplain Management Plan (City of Salem 2014b).

Policy 3.5 Interim Flood Hazard Areas

The Director of Public Works shall designate Interim Flood Hazard Areas whenever one of the following indicates a property should be located within the Floodplain Overlay Zone:

(1) A draft Flood Insurance Study;

(2) An engineering report, approved by the Director, that includes hydrologic and hydraulic modeling that establishes a floodway and base flood elevations; or

(3) Flood levels documented during a major flood event with sufficient detail to establish a floodway and base flood elevations.

Policy 3.6 Flood Risk Mapping

The City shall make readily available to the general public information related to flooding including, but not limited to, the following:

(1) Flood Insurance Rate Maps on which the Federal Insurance Administration of the Federal Emergency Management Agency has delineated both the areas of special flood hazards and the risk premium zones applicable to the property owners;

(2) Interim Flood Hazard Area Maps on which the Director of Public Works has delineated areas of special flood hazards;

(3) Flood inundation maps, which represent estimates of partial or complete inundation, but which are of insufficient detail or lack the necessary technical rigor or level of confidence necessary for the Director to delineate areas of special flood hazards; and

(4) Known areas subject to past flooding on which the City has indicated the extent of flood inundation during major flooding events including, but not limited to, flooding that occurred in February 1996 and January 2012.

Policy 3.7 Flood Risks Outside of Floodplain Overlay Zone

The City shall make flood risk maps (see Policy 3.6), readily accessible to the general public, but will not mandate compliance with City floodplain regulations for properties identified as at risk of flooding (as indicated by flood inundation maps) or shown as areas subject to flooding (based on past flooding events) unless those properties are also within the floodplain as shown on a Floodplain Insurance Rate Map or are within a designated Interim Flood Hazard Area.

Policy 3.8 Modeling Standard of Practice

The City shall enhance its standard hydrologic and hydraulic modeling capabilities by shifting away from theoretical design storms and toward a continuous simulation approach that uses a wide range of observed antecedent conditions and precipitation patterns.

Policy 3.9 Promoting Flood Insurance

The City shall promote flood insurance for property owners identified on Flood Insurance Rate Maps or located within an Interim Flood Hazard Area. Furthermore, the City shall promote flood insurance for property owners whose properties may be at risk of flooding, even if not specifically identified on Flood Insurance Rate Maps or located within an Interim Flood Hazard Area.

Policy 3.10 Hazard Disclosure

The City shall make information pertaining to flooding-related hazards readily accessible to the general public.

Policy 3.11 Flood Warning System

The City shall establish, maintain, and enhance a network designed to provide early warning of flood events.

Policy 3.12 Flood Risks and Capital Project Criteria

When considering capital projects to reduce risks of flooding, the following shall be considered in addition to increasing conveyance capacity and constructing detention facilities:

(1) Opportunity to retrofit structures, including elevating or relocating buildings, and applying of floodproofing techniques such as shields, membranes, waterproofing, venting, and other practices;

(2) Evaluation of cost impacts based on damage assessment data contained in the Natural Hazard Mitigation Plan (City of Salem 2017);

(3) Ability to implement green stormwater infrastructure to reduce runoff volumes and peak flows;

(4) Ability to conduct floodplain and stream enhancement projects to increase flow attenuation and stream capacity; and

(5) Suitability of purchasing flood-prone properties.

Policy 3.13 Purchasing Property or Easement

When property cannot be reasonably protected from damage during a one percent annual chance flood event, the City shall consider the following criteria when determining whether to purchase the property or obtain an easement:

(1) The land can be used to enhance a creek system or riparian habitat;

(2) The land can be used to reduce risks of downstream flooding; and

(3) The land can be used for other public benefits, such as access to parks or recreation activities.

Policy 3.14 Changes in Historic Weather Patterns

The City shall continue to use historical data when conducting hydrologic and hydraulic analysis, but will also collect data and conduct analysis to detect variations in trends and changes in historic weather patterns.

Policy 3.15 Updating Floodplain Maps

The data and modeling methods developed for the *Stormwater Master Plan* will be used to update the floodplain maps in Salem. Specifically:

(1) The Federal Emergency Management Agency (FEMA) will be notified of the Interim Flood Hazard Areas that will be locally promulgated by the City. Further, the data/modeling used to determine the areas will be made available to the agency. However, because the City will not be using the FEMA-approved methodology for delineating floodplains, the City will not be able to submit the new floodplain maps for official adoption by FEMA.

(2) The floodplains should be delineated using a methodology that applies best professional judgement regarding whether non-accredited levee systems should be credited for reducing risks of flooding.

(3) The new floodplain maps will be promulgated locally as Interim Flood Hazard Areas and will be regulated as such by the City.

(4) The City will evaluate how the Interim Flood Hazard Areas would change if no credit was given for embankments not specifically designed or constructed as flood control structures. The resulting information will be used to apprise the public of potential flood risks.

Policy 4: Operations and Maintenance

Goal of Stormwater Operations and Maintenance

The goal of stormwater operations and maintenance is to properly care for Salem's stormwater systems at the level of service needed to support the City's programmatic, regulatory, and project requirements.

Policy 4.1 Asset Inventory

All major public and select private stormwater assets shall be inventoried and documented in the City's GIS database and Infor Public Sector computerized information management system.

Policy 4.2 Evaluating Inspection Results

Inspection results shall be analyzed for trends and will be used as a basis for prioritizing routine and corrective maintenance of stormwater facilities. Inspection results shall also be used to identify and prioritize stormwater projects to be placed in the Capital Improvement Plan.

Policy 4.3 Public Facility Maintenance

The frequency and nature of maintenance activities on public stormwater facilities will be established for each facility type and reflected in the maintenance management plan. This plan will be evaluated and updated at least biennially and will address the following public stormwater facilities:

(1) Piped system;

(2) Catch basins;

(3) Detention basins;

(4) Regional detention basins;

(5) Vegetative water quality facilities;

(6) Mechanical water quality facilities;

(7) Open channel system;

(8) Wetlands; and

(9) Surface waters.

Policy 4.4 Private Facility Maintenance

Private stormwater facilities, including conveyance (piped or open channel), catch basins, surface waters, detention facilities, and water quality facilities shall be maintained by the property owner. Where necessary for regulatory compliance, the City shall inspect such facilities for proper operation and maintenance.

(1) The City shall conduct an education and outreach program targeting private facility owners regarding the proper inspection, operation, and maintenance of such facilities.

(2) The City shall conduct a compliance assurance and assistance program that includes enforcement procedures designed to ensure owners of private stormwater systems perform proper operations and maintenance.

Policy 4.5 Access to Public Facilities on Private Property

The City shall inventory land ownership where public stormwater facilities are located. Access agreements or easement acquisitions will be obtained from private property owners where necessary.

Policy 4.6 Instream Water Quality and Stream Gauging Stations

The City will operate and maintain an array of instream water quality and flow monitoring stations to:

(1) Meet all regulatory data collection requirements;

(2) Provide reliable data to inform the Mid-Willamette Valley High Water Watch Program;

(3) Support hydrologic and hydraulic modeling; and

(4) Implement the Mill Creek Flood Warning System.

Policy 5: Quality and Quantity Facilities

Goal of Stormwater Quality and Quantity Facilities

The goal of stormwater quality and quantity facilities is to reduce the adverse impacts of high stormwater flow rates and volumes, remove pollutants from stormwater runoff, and safely convey stormwater flows to receiving water bodies.

Policy 5.1 Green Stormwater Infrastructure

Constructing stormwater facilities that mimic predevelopment hydrology by infiltration, interception, or evapotranspiration shall be preferred over other types of stormwater facilities.

Policy 5.2 Combined Stormwater Quantity and Quality Facilities

At a site where both stormwater flow control and treatment are required, constructing a combined stormwater facility that incorporates green stormwater infrastructure shall be preferred over constructing a separate stormwater flow control and treatment facility.

Policy 5.3 Daylighting Creeks

The following criteria shall be taken into account when daylighting a segment of a creek is being considered as an alternative to increasing the capacity of an underground pipe system:

(1) Downstream capacity requirements can be met;

(2) Instream water quality can be improved;

(3) Aquatic habitat or other environmental characteristics can be enhanced; and

(4) Flood risks can be reduced.

Policy 5.4 Level of Service for Conveyance Facilities

Conveyance systems shall be sized to carry the design storm flowing full as described in the *Public Works Design Standards*.

The design storm selected shall be based on either the size of the drainage area or the street classification, whichever results in the larger sized system.

Policy 5.5 Open Channels

Open channels, defined as a system of culverts and vegetated ditches designed to capture and convey stormwater, shall be the preferred means for conveying stormwater flows when the following criteria can be met:

(1) Using an open channel is consistent with sound engineering principles;

(2) The open channel is located in the public right-of-way;

(3) The open channel is located adjacent to a residential street or along the margins of a parking lot; and

(4) The open channel provides stormwater treatment, serves as pre-treatment for a stormwater facility, or can be constructed so it can be integrated with other green stormwater infrastructure.

Policy 6: Regulations and Standards

Goal of Stormwater Regulations and Standards

The goal of stormwater regulations and standards is to develop, implement, enforce, and comply with regulatory requirements that protect life, property, receiving waters, and the environment from loss, injury, degradation, or damage by stormwater.

Policy 6.1 Municipal Stormwater Discharge Permit

The City shall comply with its National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System discharge permit issued by the Oregon Department of Environmental Quality under the authority of the federal Clean Water Act.

Policy 6.2 New or Revised Stormwater Regulations

The City shall evaluate the need for and, if determined necessary, shall revise or create new regulations in the *Salem Revised Code* that address:

(1) Access and easements for stormwater facilities; or

(2) Buffers and setbacks for critical areas such as creeks, riparian corridors, wetlands, and waterways.

Policy 6.3 New or Revised Stormwater Standards

The City shall evaluate the need for and, if determined necessary, shall revise or create new standards that:

(1) Incorporate the results of the City of Salem Hydromodification Assessment (City of Salem 2013c);

(2) Advance the state-of-the-practice for stormwater hydrologic and hydraulic modeling; and

(3) Provide for basin- or subbasin-specific stormwater flow control requirements for new development and redevelopment

Policy 6.4 Balancing Urban Development and Stormwater Risks

(1) Stormwater regulations and standards will be adopted and administered in a manner that reasonably balances the need to encourage efficient use and development of buildable lands within the Salem-Keizer Urban Growth Boundary with the need to avoid significantly increasing risks to existing properties and the environment from damage caused by runoff.

Policy 7: Intergovernmental Coordination

Goal of Intergovernmental Coordination

The goal of intergovernmental coordination is to work in close collaboration with other agencies when addressing stormwater issues of mutual interest such as programs in shared creek basins, municipal regulations, joint planning, and other activities that span jurisdictional boundaries.

Policy 7.1 Salem/Keizer Area Plan Advisory Committee

The City shall coordinate stormwater-related issues, as appropriate, with the Salem/Keizer Area Plan Advisory Committee.

Policy 7.2 Oregon Association of Clean Water Agencies

The City shall coordinate stormwater-related issues, as appropriate, with the Oregon Association of Clean Water Agencies.

Policy 7.3 Consistent Development Requirements

The City shall coordinate with local jurisdictions to develop, to the maximum extent practicable, a set of common regional thresholds, performance standards, and design criteria for stormwater facilities for new development and redevelopment projects.

Policy 7.4 Consistent Operations and Maintenance Practices

The City shall coordinate with local jurisdictions to develop, to the maximum extent practicable, a set of common regional standards and practices for operating and maintaining stormwater facilities.

Policy 7.5 Stormwater Services Outside City Boundaries

The City may provide stormwater services to local jurisdictions by intergovernmental agreement when it has been determined that doing so is in the best interest of all the affected jurisdictions.

Policy 8: Financing

Goal of Stormwater Financing

The goal of stormwater financing is to implement a sustainable financial strategy that provides for the timely construction of stormwater facilities and effective implementation of a comprehensive suite of stormwater programs.

Policy 8.1 Stormwater System Development Charges

The City shall implement a stormwater system development charge (SDC) methodology on new development to help pay for eligible stormwater infrastructure. To the maximum extent feasible, the SDC methodology shall:

(1) Incorporate growth costs related to stormwater conveyance, flow control, and treatment;

(2) Allow for adjustment of growth units based on the types and locations of stormwater facilities used;

(3) Minimize complexity of administering and calculating costs per unit of growth;

(4) Calculate costs per unit of growth commensurate with historic expenditures per unit of non-growth; and

(5) Provide for flexibility in expenditures, which will not be limited by watershed or basin, or the need for matching non-SDC funds.

Policy 8.2 Funding Stormwater System Operations and Maintenance

Funding for stormwater system operations and maintenance activities shall be provided as necessary to meet the level of service required by the City's municipal stormwater discharge permit.

Stormwater Facility Plan

INTRODUCTION

This chapter lists the stormwater capital projects identified in the basin plans and recommended to support the land uses designated in the Salem Comprehensive Plan. Each project is given a unique alphanumeric identifier and rough cost estimates are provided. Also included with each project is one of three timeframes for when the project should be completed:

- Short term (within five years)
- Intermediate term (between five and ten years)
- Long term (over ten years)

All projects listed in this chapter are based on the individual basin plans. Cost estimates are derived from unit prices for components such as pipes, culverts, easements, outlet structures, etcetera, after applying the unit prices to the quantities required for each project. For projects carried forward from the 2000 *Stormwater Master Plan*, the estimated cost is based on values contained in that plan, with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. This multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs for projects in the 2000 *Stormwater Master Plan* also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five percent is also applied to each project.

SUMMARY OF STORMWATER FACILITIES PLANS

Table 3.1 summarizes the recommended stormwater projects by basin, total number of projects, total estimated costs, and timeframes. Cost estimates in **Table 3.1** are rounded to the nearest $10,000.

STORMWATER FACILITIES PLAN BY BASIN

Table 3.2 through **Table 3.10** contain the stormwater project listings for each basin. Some of the projects carried forward from the 2000 *Stormwater Master Plan* are described using the terms “Channelization” or “Bioengineering/Habitat” or “Special Stream Habitat” to summarize the recommended actions.

“Channelization” refers to capacity-increasing and erosion-preventing types of projects in waterways and ditches. These projects generally involve widening channels and reducing the slope of the bank away from the waterway. Projects in this category also involve removing trash, debris, non-native brush, diseased or unstable trees, and other obstructions that can impede the free flow of water. While channelization is generally done in combination with bioengineering or stream habitat work, the work can also be done as a stand-alone project.

“Bioengineering/Habitat” refers to restoration efforts intended to stabilize waterway banks through the use of mostly natural materials such as ground covers, burlap or coconut fiber blankets, closely planted and densely rooted trees, and low-growing hardy native species. Projects in this category may also involve placing tree trunks, larger rocks, or small constructed flow-diverting structures at critical erosion-prone locations and installing sinuosity or meanders in the waterway bed.

“Habitat” refers to more extensive waterway restoration efforts where the objective is to improve and enhance both the stream channel and the riparian zones along the waterway, including both in-stream restoration of waterway channels by improving or constructing spawning gravels, riffles, backwaters, and woody debris cover areas, and to increase stream shading by planting trees and native brush cover.

Each basin plan contains details regarding analysis, methodologies, and selection of projects. For projects carried forward from the 2000 *Stormwater Master Plan*, additional information is available in that plan (see City of Salem 2000a) and the two technical supplements, the Stormwater Management Program Plan (City of Salem 2000b) and the Drainage System Improvement Plan (City of Salem 2000c).

Table 3.1

Summary Listing of Stormwater Facilities

Basin	Total Number of Projects	Total Estimated Cost (2019)	Number of Short Term Projects	Total Cost of Short Term Projects	Number of Intermediate Term Projects	Total Costs of Intermediate Term Projects	Number of Long Term Projects	Total Costs of Long Term Projects	Date of Basin Plan
Battle Creek Basin	15	$18,820,000	3	$4,110,000	1	$520,000	11	$14,190,000	2019
Croisan Creek Basin	12	$9,440,000	0	$-	1	$520,000	11	$8,920,000	2000
East Bank Basin	15	$12,390,000	9	$7,360,000	2	$670,000	4	$4,210,000	2000
Glenn-Gibson Basin	11	$8,930,000	0	$-	3	$1,160,000	8	$7,770,000	2000
Little Pudding Basin	42	$49,660,000	3	$2,990,000	8	$4,340,000	31	$40,060,000	2000
Mill Creek Basin	36	$66,560,000	11	$9,320,000	7	$14,780,000	18	$43,180,000	2019
Pringle Creek Basin	55	$109,300,000	5	$2,000,000	3	$11,460,000	47	$95,840,000	2019
Upper Claggett Basin	52	$53,310,000	1	$130,000	2	$590,000	49	$52,590,000	2000
West Bank Basin	5	$4,070,000	0	$-	2	$1,940,000	3	$2,130,000	2000
Total	243	$332,480,000	32	$25,910,000	29	$35,980,000	187	$268,890,00	

Table 3.2

Battle Creek Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
BA-BC1	In vicinity of Battle Creek Elementary School	Install box culvert under Battle Creek Elementary School Driveway. Note: This project will not be required if BA-BC2, BA-BC 3, BA-BC4, and BA-BC5 are accomplished.	$245,740	Short term (within 5 years)
BA-BC2	Battle Creek-Waln Creek confluence within City-owned property	Create additional floodplain storage at Battle Creek-Waln Creek confluence within City-owned property.	$3,501,795	Short term (within 5 years)
BA-BC3	Battle Creek south of the elementary school	Create floodplain benches along the portion of Battle Creek channel located south of the elementary school.	$361,908	Short term (within 5 years)
BA-BC4(1)	Battle Creek between City-owned property and Sunnyside Road	Vegetation clearing/Channel reconstruction along Battle Creek between City-owned property and Sunnyside Road.	$1,112,532	Long term (over 10 years)
BA-BC4(2)	Battle Creek between City-owned property and Sunnyside Road	Vegetation clearing/Channel reconstruction along Battle Creek between City-owned property and Sunnyside Road. Acquire three residential properties & approximately 3.1 acres..	$2,440,000	Long term (over 10 years)
BA-BC5(1)	Battle Creek upstream of Commercial Street SE to I-5	Create floodplain benches along the portion of Battle Creek channel from just upstream of Commercial Street SE to Interstate 5.	$313,877	Long term (over 10 years)
BA-BC5(2)	Battle Creek upstream of Commercial Street SE to I-5	Create floodplain benches along the portion of Battle Creek channel from just upstream of Commercial Street SE to Interstate 5. Acquire approximately 2.5 acres.	$1,000,000	Long term (over 10 years)
BA-WC1(1)	Waln Creek between the northern extent of City-owned property and Mildred Lane SE	Vegetation clearing/minor channel improvements along Waln Creek between the northern extent of City-owned property and Mildred Lane SE.	$505,075	Long term (over 10 years)
BA-WC1(2)	Waln Creek between the northern extent of City-owned property and Mildred Lane SE	Vegetation clearing/minor channel improvements along Waln Creek between the northern extent of City-owned property and Mildred Lane SE, Acquire approximately 2.9 acres.	$1,160,000	Long term (over 10 years)
BCB5	Cinnamon Creek from Rees Hill Rd. to confluence w/ Battle Creek	Channelization/ Bioengineering/ Habitat; Replace undersized culvert.	$849,000	Long term (over 10 years)
BCB15	Drainage system crossing Fabry, tributary to Waln Creek	Replace undersized culvert.	$25,903	Long term (over 10 years)
BCB16	Waln Creek from Shannon to Woodside Dr.	Channelization/ Bioengineering/ Habitat	$2,287,521	Long term (over 10 years)
BCB20	Intersection of Holder Lane and Lone Oak Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat.	$518,898	Intermediate term (5 - 10 years)
BCB21	Jory Creek at Liberty Rd.	Detention Facility: Jory Creek at Liberty	$1,740,279	Long term (over 10 years)
BCB22	Battle Creek at Liberty/Bates Road	Detention Facility: Liberty/Bates	$2,760,031	Long term (over 10 years)
		Total	$18,822,559	

Table 3.3

Croisan Creek Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CCB12	Croisan Creek at Roberta Ave. South	Bridge	$521,042	Intermediate term (5 - 10 years)
CCB10	Croisan Creek at 3281 Croisan Creek Rd.	Bridge	$818,780	Long term (over 10 years)
CCB11	Croisan Creek, Spring St. to Madrona Ave.	Channelization/ Bioengineering/ Habitat	$2,011,161	Long term (over 10 years)
CCB13	Croisan Creek at 4451 Croisan Creek Road to Spring St.	Channelization/ Bioengineering/ Habitat	$3,024,274	Long term (over 10 years)
CCB15	Croisan Creek at Ballyntine Rd. S.	Install additional culvert	$86,642	Long term (over 10 years)
CCB2	Croisan Creek at 2611 South River Rd.	Replace culvert w/ Bridge	$521,042	Long term (over 10 years)
CCB3	2600 Block South River Rd.	Replace undersized pipe	$79,436	Long term (over 10 years)
CCB4	Croisan Creek at 2900 Block South River Rd.	Replace Culvert w/ Bridge	$521,042	Long term (over 10 years)
CCB6	Croisan Creek between Croisan Creek Rd. and Golf Course Rd.	Channelization/ Bioengineering/ Habitat	$1,136,019	Long term (over 10 years)
CCB7	Croisan Creek Rd. at South River Rd.	Replace undersized culvert	$53,749	Long term (over 10 years)
CCB8	Croisan Creek Rd. at South River Rd.	Replace undersized box culvert	$521,042	Long term (over 10 years)
CCB9	Croisan Creek, South of River Rd. West of Croisan Creek Rd.	Remove weir	$148,869	Long term (over 10 years)
		Total	$9,443,096	

Table 3.4

East Bank Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
EBB1	Columbia Ave between Front St and Liberty St	Replace undersized pipe	$319,473	Short term (within 5 years)
EBB2	Hickory St between the Willamette River and 4th St	Replace undersized pipe	$454,170	Short term (within 5 years)
EBB3	Parallel to Riviera Dr between the Willamette River and Maple Ave	Replace undersized pipe	$1,258,196	Short term (within 5 years)
EBB4	Liberty St. between Riviera Dr and Tryon Ave	Replace undersized pipe	$443,719	Short term (within 5 years)
EBB5	Intersection of Hickory St and Commerical St to intersection of Johnson St and Church St	Replace undersized pipe	$814,105	Short term (within 5 years)
EBB6	On Locust St and Maple St between Johnson and Laurel St	Replace undersized pipe	$351,643	Short term (within 5 years)
EBB7	Norway St between Commercial St and Fairgrounds Rd	Replace undersized pipe	$1,366,349	Short term (within 5 years)
EBB8	Fairgrounds Rd between Winter St and Capital St	Replace undersized pipe	$531,968	Intermediate term (5 - 10 years)
EBB9	From Fairgrounds Rd and Norway St to Baker St, along Baker to Market St and east to 16th St	Replace undersized pipe	$2,002,541	Short term (within 5 years)
EBB10	Hickory St between the Willamette River and Commercial St	Replace undersized pipe	$354,308	Short term (within 5 years)
EBB11	On Salem Pkwy between Commercial and Broadway	Replace undersized pipe	$612,447	Long term (over 10 years)
EBB12	Donna St between Highland Av and Fairgrounds Rd	Replace undersized pipe	$441,218	Long term (over 10 years)
EBB13	Sunnyview Ave between Warner St and 16th St	Replace undersized pipe	$135,128	Intermediate term (5 - 10 years)
EBB16	Gaines St between the Willamette River and Front St	Replace undersized pipe	$56,555	Long term (over 10 years)
EBB17	From Front St and Gaines east to 15th and Nebraska	Replace undersized pipe	$3,253,081	Long term (over 10 years)
		Total	$12,394,903	

Table 3.5

Glenn-Gibson Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
GGB2	Rogers Lane	Replace undersized pipe; Replace undersized flow-equalizing culvert	$663,256	Intermediate term (5 - 10 years)
GGB3	Gibson Creek at Doaks Ferry Rd.	Bridge	$521,042	Long term (over 10 years)
GGB4	Gibson Creek at Brush College Rd.	Bridge; Replace undersized culverts	$629,359	Long term (over 10 years)
GGB6	Drainage system along Wilark Dr.	Replace undersized culvert	$457,445	Intermediate term (5 - 10 years)
GGB7	Culvert across Doaks Ferry Road north of Brush College Rd.	Replace undersized culvert	$36,696	Intermediate term (5 - 10 years)
GGB8	Culvert across Orchard Heights, east of Grice Hill Rd. Draining to Gibson Creek.	Replace undersized culvert	$125,854	Long term (over 10 years)
GGB16	System draining to Glenn Creek from the intersection of Ptarmigan and Doaks Ferry Rd.	Replace undersized pipe	$225,790	Long term (over 10 years)
GGB17	Culvert under Doaks Ferry Rd. 600 ft east of Mogul St.	Replace undersized culvert	$71,219	Long term (over 10 years)
GGB20	Orchard Heights Park	Add detention facility	$1,890,636	Long term (over 10 years)
GGB21	Grice Hill Road crossing-South	Add detention facility	$1,728,369	Long term (over 10 years)
GGB22	Grice Hill Road crossing-North	Add detention facility	$2,581,388	Long term (over 10 years)
		Total	$8,931,053	

Table 3.6

Little Pudding Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
LPB1	Lake Labish Rd NE, North of Hazel Green Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,666,886	Long term (over 10 years)
LPB2	Crossing Hazel Green Rd. NE	Bridge	$818,780	Long term (over 10 years)
LPB3	Crossing Manning Dr.NE and Kale Rd. NE	Bridges	$1,042,083	Intermediate term (5 - 10 years)
LPB5	South of Settlers Dr. NE, Flintlock to Siesta	Replace undersized pipe	$1,258,211	Intermediate term (5 - 10 years)
LPB6	Crossings of Hayesville, Jan Ree and Rebecca NE	Replace undersized culverts	$417,697	Intermediate term (5 - 10 years)
LPB7	South of Hayesville Dr. NE	Replace undersized culvert	$783,021	Long term (over 10 years)
LPB8	Along Cordon Rd. NE, south of Hayesville Dr.	Replace undersized pipe	$525,388	Long term (over 10 years)
LPB9	Along Cordon Rd. NE, between Hayesville Rd. and Silverton Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$5,144,576	Long term (over 10 years)
LPB10	Herrin Rd. NE, west of Cordon Rd.	Replace undersized pipe	$498,562	Long term (over 10 years)
LPB11	Cordon Rd. NE, south of Silverton Rd.	Bridge	$1,786,428	Long term (over 10 years)
LPB12	From Indiana/Muncie to Mooreland/Mendocino NE	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,882,449	Long term (over 10 years)
LPB13	Oak Park Dr./ Cordon Rd.	Channelization/ Bioengineering/ Habitat	$1,951,970	Long term (over 10 years)
LPB14	Carolina NE south, east of San Diego	Channelization/ Bioengineering/ Habitat; Bridge	$1,598,615	Long term (over 10 years)
LPB15	Culverts at Sunnyview/ Brown, 47th Ave/Cedro Loop	Replace undersized culverts	$440,474	Short term (within 5 years)
LPB16	East side of Salem Academy	Replace undersized culvert	$122,073	Intermediate term (5 - 10 years)
LPB17	Center St. at Citation NE	Replace undersized culvert	$339,124	Intermediate term (5 - 10 years)
LPB18	Culverts at Hudson NE, Eldin NE, State St., , Channel improvements East of Evelyn, north of Hudson	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$843,283	Long term (over 10 years)
LPB19	East of Elma, Macleay to Durbin and along Durbin SE to Beck	Replace undersized pipe	$936,386	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
LPB22	Regal Dr NE, Camelot Dr NE, Kingdom Way NE, Squire Ct. NE	Replace undersized pipe	$1,886,289	Short term (within 5 years)
LPB23	South of Auburn Rd. and Cordon Rd. to Cordon Rd. north of Center St.	Replace undersized culvert; Replace undersized pipe; Channelization/ Bioengineering/ Habitat	$1,564,301	Long term (over 10 years)
LPB24	From 46th and Mahrt to East of Clearwater and Avens	Replace undersized culvert; Replace undersized pipe	$1,380,447	Long term (over 10 years)
LPB25	Cordon Rd at Powderhorn and north of Arrowood Ct. SE	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$896,846	Long term (over 10 years)
LPB26	Wagon SE to Pennsylvania at Cordon Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,128,576	Long term (over 10 years)
LPB27	West of Seattle Slew Dr SE and across Clydesdale Dr SE	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$539,382	Long term (over 10 years)
LPB28	Highway 22, west of Kuebler/Cordon	Replace undersized culvert	$679,498	Long term (over 10 years)
LPB29	Crossing Arabian Ave SE and the East end of Red Cherry Ct. SE	Replace undersized pipe	$352,284	Long term (over 10 years)
LPB30	West end of Red Cherry, Black Cherry Ct.	Replace undersized pipe	$213,091	Intermediate term (5 - 10 years)
LPB31	Highway 22 and Campbell St. SE	Replace undersized culvert	$664,313	Short term (within 5 years)
LPB32	Across Kuebler/Cordon at HWY 22 and at the SW corner of HWY 22 and Kuebler/Cordon	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$743,675	Long term (over 10 years)
LPB33	Buckhorn/Burntwood and 49th Ave. / Burntwood	Replace undersized pipe	$882,213	Long term (over 10 years)
LPB34	Shenandoah Dr. SE, 49th/Adobe, 48th Ct. SE	Replace undersized culvert; Replace undersized pipe	$1,566,429	Long term (over 10 years)
LPB35	Rickey to Macleay SE, Pennsylvania Ave SE, 46th to 47th Ave SE	Replace undersized pipe	$1,600,744	Long term (over 10 years)
LPB36	Cordon at Caplinger Rd. SE	Bridge	$818,780	Intermediate term (5 - 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
LPB37	East of Macleay Rd. between Cordon and Caplinger	Channelization/ Bioengineering/ Habitat	$1,906,491	Long term (over 10 years)
LPB38	Macleay Rd. SE	Bridge	$521,042	Long term (over 10 years)
LPB39	Macleay and Cordon Rd.	Channelization/ Bioengineering/ Habitat	$568,531	Long term (over 10 years)
LPB40	Cordon at Macleay	Replace undersized culvert	$133,089	Intermediate term (5 - 10 years)
LPB41	Cordon Rd. at Gaffin and south of Gaffin	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,352,475	Long term (over 10 years)
LPB42	South of Highway 22 and east of Cordon Rd.	Channelization/ Bioengineering/ Habitat	$2,435,571	Long term (over 10 years)
LPB43	Near Arabian Ave. and crossing Macleay Rd. west of 49th	Replace undersized culverts	$1,420,061	Long term (over 10 years)
LPB44	Indiana Ave NE, west of 49th, Glendale Ave NE, Oak Park Dr NE, and Greenbrook Dr. NE	Bridges	$2,084,166	Long term (over 10 years)
		Total	$47,394,298	

Table 3.7

Mill Creek Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
MC-01C(1)	Mill Creek downstream of North High School	Vegetation management along Mill Creek downstream of North High School - Remove invasive plant species and trim wood vegetation	$10,280	Short term (within 5 years)
MC-01C(2)	Mill Creek downstream of North High School	Vegetation management along Mill Creek downstream of North High School - Acquire approximately 0.38 acres of stormwater easements	$152,000	Long term (over 10 years)
MC-01F(1)	Sheldon Ditch	Vegetation Management along Shelton Ditch between 17th Street and Airport Road - Remove invasive plant species and trim wood vegetation	$33,924	Short term (within 5 years)
MC-01F(2)	Sheldon Ditch	Vegetation Management along Shelton Ditch between 17th Street and Airport Road - Acquire approximately 3.79 acres of stormwater easements	$1,516,000	Long term (over 10 years)
MC-01B	Winter Street Bridge	Replace Winter Street Bridge over Mill Creek	$3,292,684	Intermediate term (5 - 10 years)
MC-01D	17th Street Bridge	Replace 17th Street Bridge over Mill Creek	$4,023,592	Intermediate term (5 - 10 years)
MC-01E	Waller Dam	Replace Waller Dam with Adjustable Crest Weir	$606,520	Short term (within 5 years)
MC-01G	Turner Road east of Airport	Replace ditch culverts along Turner Road east of Airport	$914,920	Short term (within 5 years)
MC-01A	B Street west of State Hospital	Replace stormwater pipes along B Street and west of State Hospital storage ponds	$6,215,288	Long term (over 10 years)
MC-02 (1)	Quarry ponds adjacent to Mill Creek	Convert quarry ponds into three large flood storage areas, construct control structure for each pond, add levees, raise 37th avenue, and add a berm along Lakeside village and Paradise Park. (Note: Cost estimate assumes no general excavation costs for quarry ponds.)	$19,363,408	Long term (over 10 years)
MC-02 (2)	Quarry ponds adjacent to Mill Creek	Acquire property and easements for Project MC-02 (01)	$5,240,000	Long term (over 10 years)
MCB1	Turner Rd. north of I-5	Channelization/ Replace undersized culverts	$4,819,205	Intermediate term (5 - 10 years)
MCB3	Mission St. SE from Airport to 20th St.	Replace undersized culverts	$4,796,232	Long term (over 10 years)
MCB6	Along Lancaster St. SE from Glenwood Dr. to Munkers St.	Replace undersized culverts	$910,918	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
MCB7	East of I-5, south of Santiam Hwy	Replace undersized pipe; Replace undersized culverts	$194,244	Long term (over 10 years)
MCB8	Along Lancaster St SE from State St. to Mahrt St.	Replace undersized pipe; Replace undersized culverts	$353,209	Long term (over 10 years)
MCB14	Near 24th St. NE from Walker to Breyman	Replace undersized culvert	$1,229,044	Short term (within 5 years)
MCB15	Near 23rd St. NE between State St. and Breyman	Replace undersized pipe	$681,726	Intermediate term (5 - 10 years)
MCB16	West of 14th St. north from Lee St. to Shelton Ditch	Replace undersized pipe	$300,693	Intermediate term (5 - 10 years)
MCB18	East of Liberty St. between Trade St. and Ferry St. and along Ferry St. to High St.	Replace undersized pipe	$269,134	Long term (over 10 years)
MCB19	Along Cottage St. from Ferry St. to Court St. and along Court St. east to Winter St.	Replace undersized pipe	$563,942	Long term (over 10 years)
MCB20	Along State St. from Cottage St. to Capitol St.	Replace undersized pipe	$532,679	Long term (over 10 years)
MCB22	Along Church St. from Union St. north to Mill Creek	Replace undersized pipe	$480	Intermediate term (5 - 10 years)
MCB23	Summer St. from Marion St. north to Mill Ck, Union St. and 12th St. north to Mill Ck	Replace undersized pipe	$830,938	Intermediate term (5 - 10 years)
MCB24	Along D St. NE from 12th St. to Mill Ck and along Winter St. from Market St. to D St.	Replace undersized pipe	$2,086,506	Short term (within 5 years)
MCB25	From the intersection of 12th St. and Nebraska St. to Stewart St. and Lamberson St.	Replace undersized pipe	$769,160	Short term (within 5 years)
MCB26	West along B St. from 19th St. to Stewart St. and Lamberson St.	Replace undersized pipe	$1,009,385	Short term (within 5 years)
MCB27	Along B St. from 19th St. to Thompson St.	Replace undersized pipe	$804,850	Short term (within 5 years)
MCB28	From 23rd and B St. to B St. and Thompson St.	Replace undersized pipe	$648,017	Short term (within 5 years)
MCB29	From 24th St. and Greenway Dr. to B St. and Thompson St.	Replace undersized pipe	$839,589	Short term (within 5 years)
MCB30	Crossings of Deer Park and Aumsville Hwy	Replace undersized pipe; Replace undersized culvert	$303,808	Long term (over 10 years)
MCB31	Along Mill St. near 12th St.	Replace undersized pipe	$180,160	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
MCB32	From Stand Ave. and Mill St. to Trade St. and 17 St.	Replace undersized pipe	$393,764	Long term (over 10 years)
MCB33	Along Trade St. from 17th St. to Richmond Ave.	Replace undersized pipe	$1,047,792	Long term (over 10 years)
MCB34	Along Mill St. from 17th St. to 21st St.	Replace undersized pipe	$697,975	Long term (over 10 years)
MCB35	Crossing Turner Rd. south of Gath Rd. SE	Replace undersized pipe	$28,642	Long term (over 10 years)
MCB39	Crossing Kuebler south of Aumsville Hwy	Replace undersized culvert	$423,135	Long term (over 10 years)
		Total	$66,563,343	

Table 3.8

Pringle Creek Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
PC-01B(1)	Pringle Creek and Tributaries	Vegetation management along Pringle Creek and tributaries - Remove invasive plant species and trim woody vegetation.	$102,800	Short term (within 5 years)
PC-01B(2)	Pringle Creek and Tributaries	Vegetation management along Pringle Creek and tributaries - Acquire approximately 38 acres of stormwater easements	$15,200,000	Long term (over 10 years)
PC-01A	East Fork Pringle Creek	Raise a portion of Airway Drive, upsize railroad access culvert on East Fork Pringle Creek, add flood storage area next to Waste Treatment Facility	$8,778,048	Intermediate term (5 - 10 years)
PC-01C	West Fork Pringle Creek	Replace railroad and McGilcrist culverts on West Fork Pringle Creek	$2,401,408	Intermediate term (5 - 10 years)
PC-01D	West Fork Pringle Creek	Add levee along West Fork Pringle Creek downstream of railroad crossing	$239,624	Short term (within 5 years)
PC-01E	Clark Creek	Replace Clark Creek culverts at three locations on Ratcliff Drive	$1,142,108	Long term (over 10 years)
PCB2	Piped system along Oxford St.	Replace Undersized Pipe	$1,287,538	Long term (over 10 years)
PCB3	Clark Creek crossing Rural Ave. SE	Replace Undersized Culvert	$285,680	Long term (over 10 years)
PCB4	Clark Creek North of McGilchrist	Channelization/ Bioengineering/ Habitat	$87,088	Long term (over 10 years)
PCB5	Clark Creek at Fairview, 12th St and Bluff Rd	Replace Undersized Culverts	$699,684	Long term (over 10 years)
PCB7	Clark Creek at Ratcliff Dr	Bridge	$521,042	Short term (within 5 years)
PCB8	Clark Creek upstream of Ratcliff Dr and at intersections with Ratcliff Dr and Salem Hts Ave South	Replace Undersized Culverts; Channelization/ Bioengineering/ Habitat	$797,193	Short term (within 5 years)
PCB9	Clark Creek upstream of Commercial near Hillview; Triangle Dr SE	Replace Undersized Pipe/Culvert	$409,420	Long term (over 10 years)
PCB10	Clark Creek from Ewald to Halifax	Channelization/ Bioengineering/ Habitat	$818,780	Long term (over 10 years)
PCB11	Drainage system to Clark Creek upstream of Ewald Ave	Replace Undersized Pipe	$263,200	Long term (over 10 years)
PCB12	Clark Creek from Ewald Ave to Vine St.	Replace Undersized Pipe/Culvert; Channelization/ Bioengineering/ Habitat	$526,252	Long term (over 10 years)
PCB13	Clark Creek at Browning Ave	Replace Undersized Pipe/Culvert	$74,732	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
PCB14	East Fork Pringle Creek from Pringle Creek to McGilchrist	Channelization/ Bioengineering/ Habitat	$3,111,958	Long term (over 10 years)
PCB16	East Pringle crossing 16th St.	Bridge	$521,042	Long term (over 10 years)
PCB17	East Pringle crossing McGilchrist; 22nd Ave SE	Bridges	$1,042,083	Long term (over 10 years)
PCB18	East Pringle from McGilchrist to 25th	Channelization/ Bioengineering/ Habitat	$5,422,702	Long term (over 10 years)
PCB20	East Pringle from Airway Dr to Madrona	Channelization/ Bioengineering/ Habitat	$5,225,302	Long term (over 10 years)
PCB21	Culvert across Airway Drive Draining Airport; near Airway Drive	Replace Undersized Culvert	$281,958	Intermediate term (5 - 10 years)
PCB22	East Fork Airway Dr to I-5	Channelization/ Bioengineering/ Habitat	$4,993,066	Long term (over 10 years)
PCB24	East/Middle Fork upstream I-5 to Kuebler	Channelization/ Bioengineering/ Habitat	$2,902,946	Long term (over 10 years)
PCB25	East/Middle Fork at Treistad and Kuebler	Channelization/ Bioengineering/ Habitat; Bridge; Add Culvert	$800,528	Long term (over 10 years)
PCB26	East Middle Fork upstream of Kuebler	Channelization/ Bioengineering/ Habitat	$2,861,262	Long term (over 10 years)
PCB27	Middle Fork along SPRR from Pringle Creek to Boise Cascade	Channelization/ Stream Bank Stabilizaton; Bridge	$1,829,689	Long term (over 10 years)
PCB28	Middle Fork crossing Madrona	Bridge	$818,780	Long term (over 10 years)
PCB29	Middle Fork from Madrona to Ewald; from Fairview Ind Dr to SPRR	Channelization/ Bioengineering/ Habitat	$2,402,746	Long term (over 10 years)
PCB30	Culvert across Marietta	Replace Undersized Culvert	$78,275	Long term (over 10 years)
PCB31	Middle Fork upstream of 27th crossing Reed Ln	Replace Undersized Culvert	$297,976	Long term (over 10 years)
PCB32	Middle Fork at Battle Creek Rd and Reed Ln.	Replace Undersized Culvert	$189,957	Long term (over 10 years)
PCB33	Culvert across Baxter Rd SE	Replace Undersized Culvert	$84,855	Long term (over 10 years)
PCB34	Pringle Creek from Commercial to High St	Channelization/ Bioengineering/ Special Stream Habitat	$2,003,896	Long term (over 10 years)
PCB36	Pringle Creek at Church St	Bridge	$1,961,851	Long-term (over 10 years)
PCB37	Pringle Creek at Winter St	Bridge	$850,000	Long-term (over 10 years)
PCB38	Pringle Creek at Mission St	Bridge	$214,209	Long-term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
PCB39	Pringle Creek at Cross St	Bridge	$4,466,070	Long term (over 10 years)
PCB40	Pringle Creek at 13th St	Bridge	$4,466,070	Long term (over 10 years)
PCB41	West Pringle Creek from Oxford to McGilchrist	Channelization/ Bioengineering/ Habitat; Bridge	$3,435,985.84	Long term (over 10 years)
PCB42	West Pringle Creek at McGilchrist	Bridge	$1,488,690	Long term (over 10 years)
PCB43	Drainage system on Pringle Rd near Vista	Replace Undersized Pipe	$340,627	Short term (within 5 years)
PCB44	Drainage system crossing Commerical near Browning	Replace Undersized Culvert	$375,165	Long term (over 10 years)
PCB45	West Pringle Creek at Commercial near Welcome Way SE	Replace Undersized Culvert	$308,605	Long term (over 10 years)
PCB46	Drainage system upstream of Idylwood as well as Sunnyside Rd	Replace Undersized Pipe	$215,622	Long term (over 10 years)
PCB47	Drainage system upstream of Marietta Way and Coloma Dr	Replace Undersized Pipe	$672,888	Long term (over 10 years)
PCB48	West Pringle Creek at Woodmansee Park	Channelization/ Bioengineering/ Habitat	$1,265,387	Long term (over 10 years)
PCB49	West Pringle, Culvert across Jones Rd., upstream of Woodmansee Park	Bridge	$521,042	Long term (over 10 years)
PCB50	West Pringle Creek from Jones Rd to Bristol Dr and at Firdell and Lone Oak	Replace Undersized Culvert; Channelization/ Bioengineering/ Habitat	$732,644	Long term (over 10 years)
PCB51	West Pringle from Gardner Rd to Jones Rd SE	Channelization/ Bioengineering/ Habitat	$208,417	Long term (over 10 years)
PCB52	Closed system along Lone Oak and Gardner	Replace Undersized Pipe	$356,169	Long term (over 10 years)
PCB53	Closed system near Kuebler and Liberty	Replace Undersized Pipe	$632,991	Long term (over 10 years)
PCB57	Leslie Middle School, East Pringle Rd.	Detention Facility, West Pringle	$2,554,592	Long term (over 10 years)
PCB58	Webb Lake , 25th and McGilchrist	Detention Facility, East Pringle	$3,870,594	Long term (over 10 years)
		Total	$109,302,075	

Table 3.9

Upper Claggett Creek Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB1	Hyacinth St. near Salem Industrial Dr.	Replace undersized pipe	$1,713,557	Long term (over 10 years)
CLB2	Claxter Rd. to Hyacinth St.	Replace undersized pipe	$1,032,555	Long term (over 10 years)
CLB3	Claggett Creek at Burlington Northern Railroad	Remove culvert. Restore open channel.	$854,508	Long term (over 10 years)
CLB4	Claggett Creek at SPRR	Add parallel culvert. Requires boring	$531,760	Long term (over 10 years)
CLB7	Claggett Creek at Deerhaven	Bridge	$521,041	Long term (over 10 years)
CLB8	Claggett Creek near I-5 and Hyacinth	Channelization/ Bioengineering/ Habitat	$480,728	Long term (over 10 years)
CLB10	Claggett Creek crossing I-5	Replace undersized culvert	$1,294,565	Long term (over 10 years)
CLB11	Claggett Creek upstream of I-5 to NE Fisher Rd.	Channelization/ Bioengineering/ Habitat, Replace undersized culvert	$921,350	Long term (over 10 years)
CLB12	Crossing Cooley Rd. NE	Replace undersized culvert	$171,050	Long term (over 10 years)
CLB13	Along Lancaster from Cooley to Stortz	Channelization/ Bioengineering/ Habitat	$1,346,520	Long term (over 10 years)
CLB14	Along Lancaster from Devonshire Ct. to Wolverine	Replace undersized pipe	$477,482	Long term (over 10 years)
CLB15	Along Lancaster from Stortz to Devonshire	Replace undersized pipe	$899,005	Long term (over 10 years)
CLB16	Along Fisher Rd. from Ward Dr. NE to Covington	Replace undersized pipe	$128,816	Short term (within 5 years)
CLB17	From crossing of Fisher Rd. northeast along Lancaster to Hayesville	Replace undersized pipe/culvert	$2,349,034	Long term (over 10 years)
CLB18	39th Ave NE Ward Dr. to Ivy Way	Replace undersized pipe	$496,478	Long term (over 10 years)
CLB19	East from Fisher Rd. to Lancaster	Channelization/ Bioengineering/ Habitat	$690,008	Long term (over 10 years)
CLB20	Crossing of Lancaster Dr., south of Ibex St. NE	Replace undersized culvert	$523,796	Long term (over 10 years)
CLB21	Along Ibex St. NE and Ward Dr. from Lancaster to 45th Ave. NE	Channelization/ Bioengineering/ Habitat	$1,093,123	Long term (over 10 years)
CLB22	Along 42nd Ave. NE from Ward Dr. to Jade St.	Replace undersized pipe	$546,126	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB23	Crossings of 45th Ave. NE and Harlan	Replace undersized culverts	$246,229	Long term (over 10 years)
CLB24	Crossings of Satter Dr. and Selby Ct. NE	Replace undersized culverts	$300,418	Long term (over 10 years)
CLB25	Crossings of Sesame St. and 47th Ave. NE	Replace undersized culvert	$567,489	Long term (over 10 years)
CLB26	East of Brown Rd. NE from Idaho Ave. to Glendale Ave.	Channelization/ Bioengineering/ Habitat	$1,118,899	Long term (over 10 years)
CLB27	Culvert crossing Surfwood Dr. NE	Replace undersized culvert	$102,898	Long term (over 10 years)
CLB28	Shellyanne Way south to Roselawn Dr.	Replace undersized pipe	$725,885	Long term (over 10 years)
CLB29	From Lancaster and Stortz southeast to Tierra Dr.	Replace undersized culverts	$892,097	Long term (over 10 years)
CLB30	Along Phipps Ln. NE south from Carolina Ave NE to Phipps Circle	Replace undersized culvert/ pipe	$1,419,466	Long term (over 10 years)
CLB31	Crossings of Scotsman Ln. and Sunnyview Rd.	Replace undersized culverts	$329,656	Long term (over 10 years)
CLB32	Along Lancaster Dr. south from Market St to D St. NE	Replace undersized pipe	$1,631,342	Long term (over 10 years)
CLB34	South from Wooddale Ave NE to Silverton Rd. near Hawthorne NE	Replace undersized culvert/pipe	$2,697,357	Long term (over 10 years)
CLB35	Along Silverton Rd. near Beacon St. NE	Replace undersized pipe	$44,511.83	Long term (over 10 years)
CLB36	Drainage system east of Hawthorne from Devonshire Ave. to Beverly Ave. NE	Replace undersized pipe	$1,190,296.98	Long term (over 10 years)
CLB37	Along Hawthorne from Monarch Dr. to Sunnyview Rd.NE	Replace undersized pipe	$1,370,339.15	Long term (over 10 years)
CLB39	Northeast of Hawthorne Ave. and Rawlins NE	Replace undersized pipe/culvert	$15,185	Long term (over 10 years)
CLB41	From Hummingbird St. and Portland Rd. south to Silverton Rd. near Abrams Ave.	Replace undersized pipe	$3,470,136	Long term (over 10 years)
CLB42	From Sunnyview Rd. near Evergreen Ave. south to Evergreen Ave. near Market St.	Replace undersized pipe	$4,138,856	Long term (over 10 years)
CLB43	From Sunnyview Rd. near Evergreen Ave. south to Evergreen Ave. near Market St.	Replace undersized pipe	$870,586	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB44	From Evergreen Ave. and Market St. south to D St. and Park Ave.	Replace undersized pipe	$1,310,940	Long term (over 10 years)
CLB45	Along Lansing Ave. south from Silverton Rd. to Sorenson Ct.	Replace undersized pipe	$271,984	Long term (over 10 years)
CLB46	Along Park Ave. south from Silverton Rd. to Dawn St.	Replace undersized pipe	$2,483,730	Long term (over 10 years)
CLB47	Along Lansing Ave. south from Sorensen Ct. to Rawlins Ave.	Replace undersized pipe	$1,408,598	Long term (over 10 years)
CLB48	Along Lansing Ave. south from Sunnyview Rd to Market St. NE	Replace undersized pipe	$213,270	Long term (over 10 years)
CLB49	West of I-5, east of Ellis Ave.	Replace undersized pipe	$151,846	Long term (over 10 years)
CLB50	East of I-5, Center St. to Manor Dr.	Replace undersized pipe	$1,997,227	Long term (over 10 years)
CLB51	East side, I-5 at Manor Dr.	Replace undersized pipe	$2,428,053	Long term (over 10 years)
CLB52	Center St. to Monroe - east of 36th	Replace undersized pipe	$2,055,285	Long term (over 10 years)
CLB53	Along Center St. between 36th Ave and Lancaster Dr. NE	Replace undersized pipe	$518,064	Long term (over 10 years)
CLB54	Along Lancaster Dr. from Amber St. south to State St.	Replace undersized pipe	$829,200	Long term (over 10 years)
CLB55	Along Center St. from Vinyard east to Oregon Ave. NE	Replace undersized pipe	$277,164	Intermediate term (5 - 10 years)
CLB57	Near Brooks Ave. and McDonald Way	Replace undersized pipe	$316,347	Intermediate term (5 - 10 years)
CLB58	Along Portland Rd. near Beach Ave. NE	Replace undersized pipe	$283,208	Long term (over 10 years)
CLB59	Along 17th St. south from Silverton Rd. to Sunnyview Rd. NE	Replace undersized pipe	$1,560,719	Long term (over 10 years)
		Total	$53,308,788	

Table 3.10

West Bank Basin Plan Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
WBB3	From Cascade Drive to 9th and Gerth	Replace undersized pipe	$402,283	Long term (over 10 years)
WBB4	8th Ave between Gerth Ave and Rosemont Ave	Replace undersized pipe	$668,124	Intermediate term (5 - 10 years)
WBB5	Senate St between 6th Ave and the Willamette River	Replace undersized pipe	$1,269,912	Intermediate term (5 - 10 years)
WBB6	Culvert across the Salem-Dallas Hwy, near Moores Wy	Replace undersized pipe	$416,833	Long term (over 10 years)
WBB11	Eola Drive near intersection with Sunwood Dr	Add detention capacity at Woodhaven Detention Facility	$177,005	Long term (over 10 years)
		Total	$2,934,157	

Financial Plan

INTRODUCTION

The two main sources of funding for Salem's stormwater services are revenue from: (1) stormwater utility fees; and (2) stormwater system development charges, both of which are described in further detail below.

STORMWATER UTILITY FEE

Historically, Salem's stormwater services have been funded by the City's wastewater ratepayers. However, wastewater rates—which are largely determined by drinking water consumed during the rainy season—have no relationship to the impacts a property has on the stormwater system. On December 6, 2010, Salem's City Council approved creation of a stormwater utility and implementation of a stormwater rate. The stormwater rate consists of both a base fee and a fee that is calculated based on the impervious surface area associated with each ratepayer's property. By using impervious surface as a surrogate measure of stormwater runoff, the stormwater fee is more closely aligned with the stormwater impacts of a property than a wastewater fee. Initial implementation of the stormwater utility began on January 1, 2013, and the fee was phased in over a period of four rate periods. The complete separation of stormwater and wastewater rates occurred in January 2016.

The base fee is derived from the cost to provide stormwater services that are independent, or largely independent, of the stormwater quality or stormwater quantity impacts of the ratepayer's property. It includes such cost centers as: customer billing, account maintenance, 24/7 dispatch services, casualty insurance, debt repayment, and street sweeping. Every stormwater customer pays the same base fee regardless of the property's impervious surface area.

For the impervious surface component of the stormwater fee, the City of Salem has a three-tiered fee structure for single-family residential customers. For all other classifications, the fee is based on the total impervious surface area and is calculated on a per-equivalent dwelling unit (EDU) basis, where 1 EDU equals 3,000 square feet of impervious surface area.

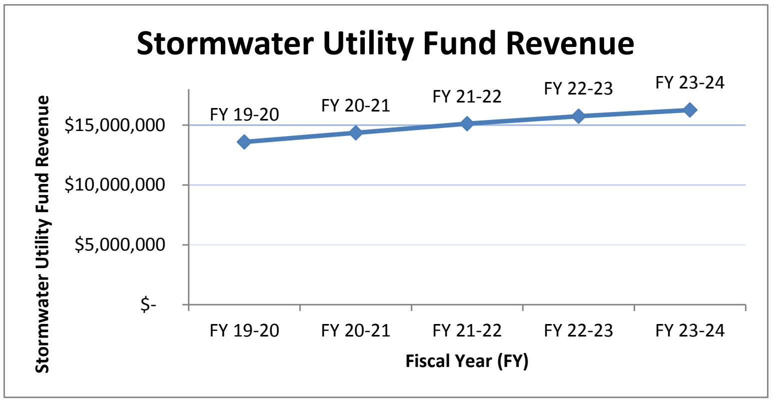
Commercial and industrial stormwater customers may be eligible to receive a reduction in their stormwater rate if there is a stormwater facility on their property that the customer operates and maintains. There are two types of stormwater facilities: (1) stormwater flow control facilities are designed to reduce the volume and/or rate of runoff leaving the property; and (2) stormwater treatment facilities that remove pollutants from stormwater through mechanical, biological, or other means. Some facilities provide both stormwater flow control and treatment. A ratepayer who can document a stormwater flow control or stormwater treatment facility is located on their property may be eligible for a stormwater rate credit, which will be based on the type of facility, the amount of stormwater that flows through the facility, and how the facility supports stormwater quality or stormwater quantity programs. Credit amounts vary from approximately five to 50 percent. Single-family residential ratepayers are currently not eligible for a rate credit.

The stormwater utility fees in effect as of January 1, 2018, are shown below. Utility fees are updated annually by resolution of City Council on their stormwater fee. Stormwater utility fees are established biennially every even year by resolution of City Council. New rates become effective on January 1 of each year.

Anticipated rate revenue from the Utility Fund through over the next five years is provided in **Figure 4.1** below.

Figure 4.1

Stormwater Utility Fund Revenue



New utility rates are adopted by City Council every two years.

SYSTEM DEVELOPMENT CHARGES

A system development charge (SDC) is a one-time fee imposed on new and increased development. There are two categories of SDCs:

- An improvement fee (SDCi) reflects the cost of capacity-increasing capital projects. The value of the improvement fee is calculated on a per-unit-of-growth. Revenues generated through an SDCi must be used for constructing capital improvements that increase capacity or for repaying the debt on completed capacity-increasing capital improvements.

- A reimbursement fee (SDCr) is based on the City's incurred costs related to capital improvements already constructed or under construction. The value of the reimbursement fee is typically determined from system fixed asset records and an analysis of available capacity. Owing to data limitations, particularly with respect to determining the value of fixed stormwater assets, the City has not implemented a stormwater reimbursement fee.

SDCs for single-family residential development are assessed based on the average impervious area for comparable dwelling units. Fees for multifamily and nonresidential developments are assessed based on actual measured impervious areas. The methodology for determining the stormwater system development charge is based on a study conducted in 2002 (CH2M Hill, 2002). Stormwater system development charges are established annually by resolution of the City Council.

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Battle Creek Basin Plan

BATTLE CREEK BASIN DESCRIPTION

Battle Creek Basin is the primary drainage area in Salem south of Kuebler Boulevard. For the purposes of the Battle Creek Basin Plan, the downstream limit of the basin is the Interstate 5 (I-5) crossing of Battle Creek, which coincides with the City of Salem Urban Growth Boundary (UGB). The UGB encompasses approximately half of the total Battle Creek drainage area. Downstream of I-5, Battle Creek continues for another 3.5 miles before its confluence with McKinney Creek, which then enters Mill Creek approximately 0.8 miles further downstream. The portion of Battle Creek Basin located upstream of I-5 has a drainage area of 10.1 square miles. **Map 5.1** shows the Battle Creek Basin, its relationship with city limits and the UGB, and the network of associated creeks.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR BATTLE CREEK BASIN

The minimum and maximum basin elevations are 383 feet and 1,070 feet, respectively. The mean elevation for the basin is 616 feet. Note that unless otherwise stated, all elevations are in the National Geodetic Vertical Datum of 1929 (NGVD 29).

The largest tributary to Battle Creek is Waln Creek, which has a drainage area of 4.4 square miles, most of which is developed single family residential. Smaller tributaries include Scotch Creek, Powell Creek, Jory Creek, and Champion Swale. Generally, the Battle Creek Basin is narrow with steep side slopes. However, at the confluence of Waln Creek and Battle Creek, located in Battle Creek Park, the basin and channel slopes become milder and the active floodplain becomes significantly larger.

In general, land use for most of the developed areas within the city limits is medium to low density residential. Land uses in the higher elevation portions of the basin located outside of the city limits are primarily cropland and forest.

FINDINGS OF THE 2000 STORMWATER MASTER PLAN

In the 2000 *Stormwater Master Plan*, the Battle Creek Basin was modeled using a planning-level XP-SWMM model, which provided coupled hydrologic and hydraulic modeling of the watershed and stormwater system. In that effort, the Battle Creek Basin was divided into 88 subbasins. The primary purpose of the model was to detect areas within the storm drainage network that were at-risk of surcharge during the 10-year 24-hour SCS Type-1A rainfall event. Models were developed for existing and full build-out conditions. The findings included 22 recommended Capital Improvement Projects (CIPs) within the Battle Creek Basin. The recommendations included bridge/culvert replacements, channelization, vegetation modifications, and detention facility construction. Also recommended were two detention facilities: one for Jory Creek at Liberty Road S and another for Battle Creek near the intersection of Liberty Road S and Bates Road S. The total cost for the recommended CIPs was $15,798,000 in 2000 dollars.

SUMMARY OF THE 2019 BATTLE CREEK BASIN PLAN

For modeling purposes, the 2019 Battle Creek Basin Plan (City of Salem 2019a) divided the basin into 88 subbasins within the Salem UGB as shown in **Map 5.2**.

An additional ten subbasins were defined between I-5 and the confluence of McKinney Creek and Mill Creek. These additional 10 subbasins were used to develop the outfall conditions of the Battle Creek model and to help evaluate potential impacts to the city of Turner as a result of development in the basin within the Salem's UGB. **Map 5.3** shows the extents of the Battle Creek Basin model, with the 88 subbasins inside the UGB and the additional 10 subbasins outside.

Modeling was performed using the XP-STORM model, which is a coupled hydrologic and hydraulic modeling package. The model integrated open channel and closed-conduit systems and produced both 1-D (riverine) and 2-D (overland) flow analyses. The results were then utilized to evaluate stormwater system capacities and flood risks. Depending on the purpose of the analysis, two different storm events were used:

(1) To evaluate flood risks within the Battle Creek Basin, the 100-year, 48-hour design storm was used;

(2) To evaluate the performance of existing drainage systems under existing and full build-out conditions, both the 100-year, 48-hour and the 100-year, 72-hour design storms were used;

(3) To evaluate the influence of new stormwater facilities, retrofitted stormwater facilities, or other best management practices not involving significant changes in flood storage, the 48-hour, 100-year storm design storm was used; and

(4) To evaluate the performance of new/retrofitted stormwater facilities involving flood storage, both the 100-year, 48-hour and the 100-year, 72-hour design storms were used.

Details regarding model development and analyses are provided in the 2019 *Battle Creek Basin Plan*.

RECOMMENDED STORMWATER CAPITAL IMPROVEMENT PROJECTS

Of the 22 projects in the 2000 *Stormwater Master Plan*, four have been completed and four have been determined to no longer be needed. Eight other projects have been incorporated into one of the five new projects recommended in the 2019 *Battle Creek Basin Plan*. **Table 5.1** lists the projects that have been completed, superseded, or are considered no longer required.

The remaining six projects from the 2000 *Stormwater Master Plan* are carried forward into this master plan. The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project.

The 2019 Battle Creek Basin Plan recommended six new stormwater capital projects in addition to carrying forward six projects from the 2000 *Stormwater Master Plan*. The new projects are summarized below with the locations shown on **Map 5.4**. Additional details for these projects are provided in the 2019 *Battle Creek Basin Plan*.

All projects recommended in this master plan for the Battle Creek Basin are shown on **Map 5.5**.

Project No. BA-BC1 (Short-term) - Install Box Culvert under Battle Creek Elementary School Driveway

Description: Install 8 ft wide by 3.5 ft tall by 80-ft long reinforced concrete box culvert beneath the school driveway. This project will not be required if BA-BC2, BA-BC 3, BA-BC4, and BA-BC5 are accomplished.

Project No. BA-BC2 (Short-term) - Create Additional Floodplain Storage at Battle Creek-Waln Creek Confluence within City-Owned Property

Description: Includes creating two large floodplain storage areas at the confluence of Waln Creek and Battle Creek. The project encompasses a 12-acre parcel located north of Battle Creek and east of Waln Creek and a 7.5 acre parcel located south of Battle Creek. Excavation depths average four to six feet and the total removal volume is approximately 150,600 cubic yards.

Project No. BA-BC3 (Short-term) - Create Floodplain Benches along the Portion of the Battle Creek Channel Located South of the Elementary School

Description: Includes creating floodplain benches along approximately 1,000 linear feet of Battle Creek to increase the conveyance capacity of the channel while maintaining the existing low flow channel characteristics. The project extends from the western extent of the City of Salem-owned property to the confluence with Scotch and Powell Creeks. The channel modifications would be similar to the modifications to that implemented along the reach of Waln Creek located immediately upstream of Battle Creek.

Project No. BA-BC4 (Long-term) - Vegetation Clearing/ Channel Reconstruction along Battle Creek between City Owned Property and Sunnyside Road

Description: Clear woody vegetation and reconstruct/restore channel along Battle Creek between western extent of City-owned property and Sunnyside Road. Project will require the acquisition of an approximate 75-foot-wide stormwater maintenance easement along Battle Creek, or about 3.1 acres, and the acquisition of at least three private properties adjacent to Battle Creek between the western extent of City of Salem property and 13th Avenue SE. Although not specifically modeled, the project was extended upstream to Sunnyside Road to help eliminate continued channel degradation and bank failures that have occurred along this reach due to hydromodifications.

Battle Creek Basin Data

Table 5.1

Battle Creek Basin Projects from 2000 Stormwater Master Plan Completed, Removed, or Superseded

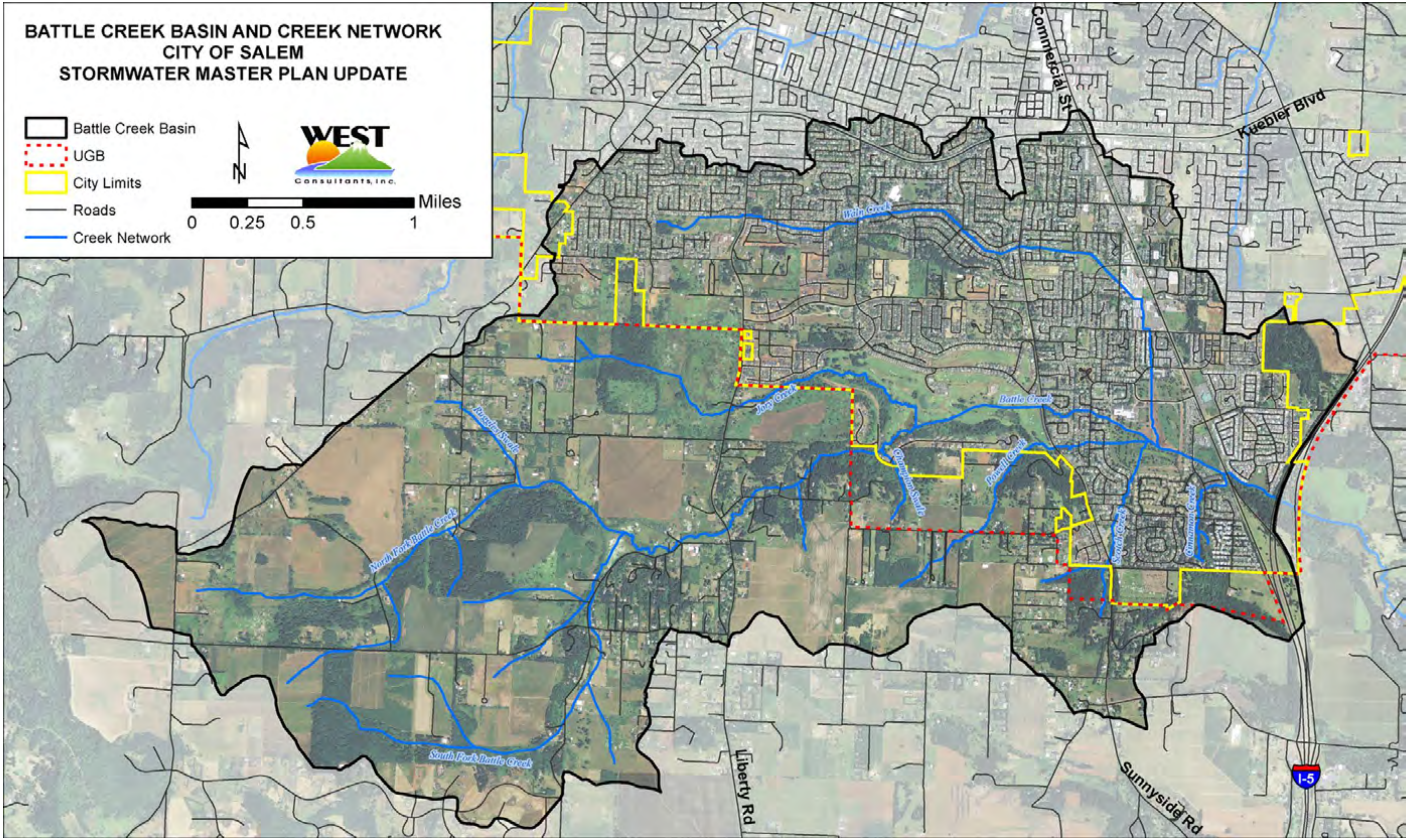
Proj. ID	Location	Recommended Improvement	Remarks
BCB3	Battle Creek crossing Fairway Ave.	Bridge	Completed
BCB9	Scotch Creek crossing of Rees Hill Rd.	Channelization/ Bioengineering/ Habitat	Completed
BCB10	Scotch Creek crossing Sunnyside Rd.	Replace undersized culvert	Completed
BCB11	Waln Creek from Madras St. to Battle Creek	Channelization/ Bioengineering, Replace 2 small culverts	Completed
BCB8	Powell Creek crossing Elkins Way	Replace undersized culvert	Removed - No longer needed
BCB17	Waln Creek crossing Fabry Rd.	Bridge	Removed - No longer needed
BCB18	Waln Creek between 7th Ave. and Sunnyside Rd.	Channelization/ Bioengineering/ Habitat	Removed - No longer needed
BCB19	Waln Creek crossing pedestrian path north of Springwood Ave.	Replace undersized culvert	Removed - No longer needed
BCB1	Battle Creek from Commercial St. to I-5	Channelization/ Bioengineering/ Habitat	Superseded - See 2019 Battle Creek Basin Plan
BCB2	Battle Creek east from Battle Creek Golf Course to Commercial St.	Channelization/ Bioengineering/ Habitat; Remove/upsize small culverts on Battle, Scotch, and Powell Creeks	Superseded - See 2019 Battle Creek Basin Plan
BCB4	Battle Creek from Sunnyside Rd. to Battle Creek Golf Course	Channelization/ Bioengineering/ Habitat; Place berm along Sunnyside to prevent over-topping of road near Pawnee Circle	Superseded - See 2019 Battle Creek Basin Plan
BCB6	Powell Creek from Meriweather Ct. to 220 ft east of Doral Dr.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat; Bridge	Superseded - See 2019 Battle Creek Basin Plan
BCB7	Powell Creek from Sunnyside Rd. to 13th Ave.	Bridge; Channelization/ Bioengineering/ Habitat; Add parallel culvert	Superseded - See 2019 Battle Creek Basin Plan
BCB12	Waln Creek crossing Madras St.	Bridge	Superseded - See 2019 Battle Creek Basin Plan
BCB13	Waln Creek from Wiltsey Rd. to Madras St.	Bridge; Channelization/ Bioengineering/ Habitat	Superseded - See 2019 Battle Creek Basin Plan
BCB14	Waln Creek from Woodside Dr. to Wiltsey Rd.	Channelization/ Bioengineering/ Habitat	Superseded - See 2019 Battle Creek Basin Plan

Table 5.2

Battle Creek Basin Project List

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
BA-BC1	In vicinity of Battle Creek Elementary School	Install box culvert under Battle Creek Elementary School Driveway. Note: This project will not be required if BA-BC2, BA-BC 3, BA-BC4, and BA-BC5 are accomplished.	$245,740	Short term (within 5 years)
BA-BC2	Battle Creek-Waln Creek confluence within City-owned property	Create additional floodplain storage at Battle Creek-Waln Creek confluence within City-owned property	$3,501,795	Short term (within 5 years)
BA-BC3	Battle Creek south of the elementary school	Create floodplain benches along the portion of Battle Creek channel located south of the elementary school	$361,908	Short term (within 5 years)
BA-BC4(1)	Battle Creek between City-owned property and Sunnyside Road	Vegetation clearing/Channel reconstruction along Battle Creek between City-owned property and Sunnyside Road	$1,112,532	Long term (over 10 years)
BA-BC4(2)	Battle Creek between City-owned property and Sunnyside Road	Vegetation clearing/Channel reconstruction along Battle Creek between City-owned property and Sunnyside Road. Acquire three residential properties & approximately 3.1 acres	$2,440,000	Long term (over 10 years)
BA-BC5(1)	Battle Creek upstream of Commercial Street SE to I-5	Create floodplain benches along the portion of Battle Creek channel from just upstream of Commercial Street SE to Interstate 5	$313,877	Long term (over 10 years)
BA-BC5(2)	Battle Creek upstream of Commercial Street SE to I-5	Create floodplain benches along the portion of Battle Creek channel from just upstream of Commercial Street SE to Interstate 5. Acquire approximately 2.5 acres.	$1,000,000	Long term (over 10 years)
BA-WC1(1)	Waln Creek between the northern extent of City-owned property and Mildred Lane SE	Vegetation clearing/minor channel improvements along Waln Creek between the northern extent of City-owned property and Mildred Lane SE.	$505,075	Long term (over 10 years)

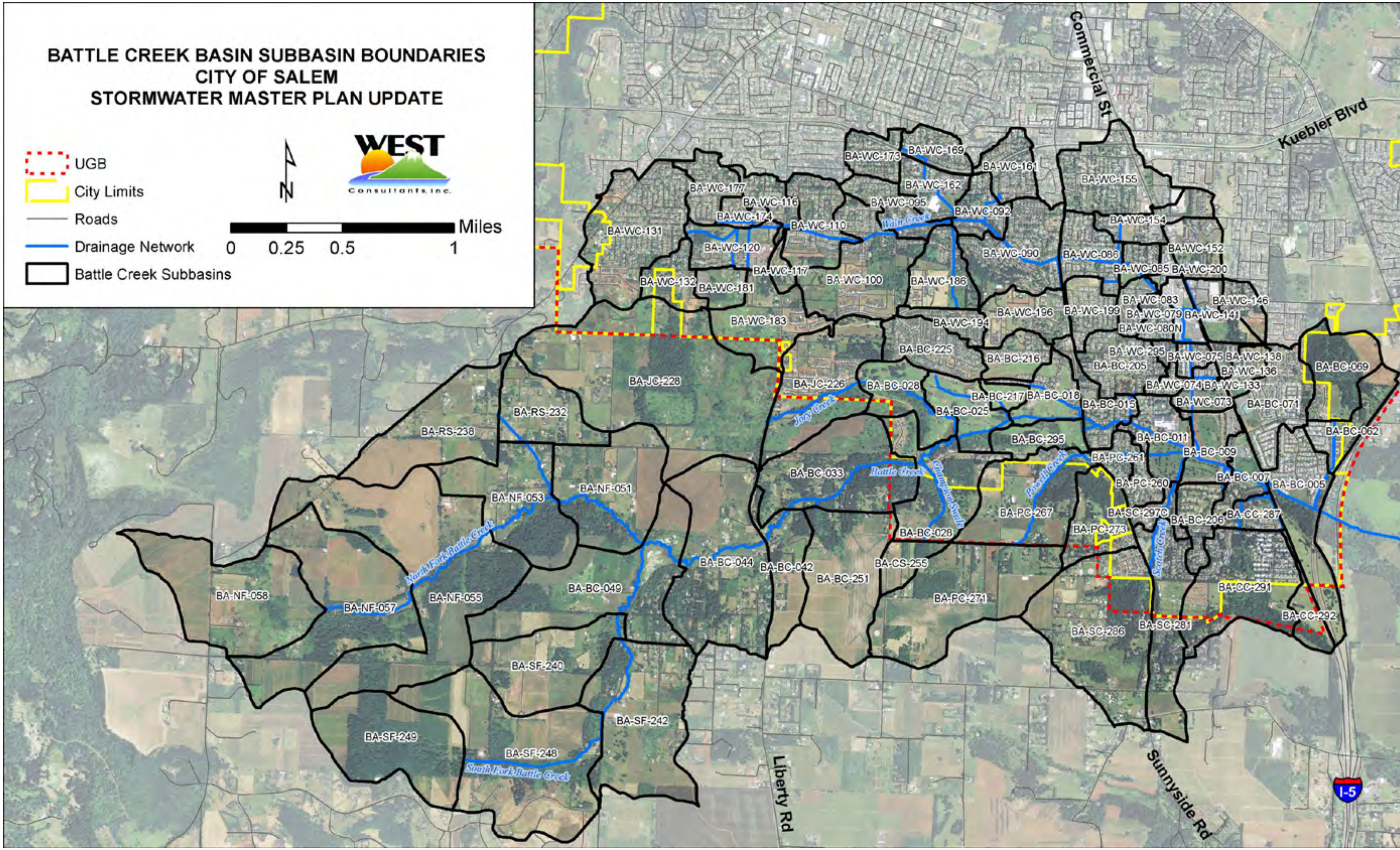
Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
BA-WC1(2)	Waln Creek between the northern extent of City-owned property and Mildred Lane SE	Vegetation clearing/minor channel improvements along Waln Creek between the northern extent of City-owned property and Mildred Lane SE, Acquire approximately 2.9 acres.	$1,160,000	Long term (over 10 years)
BCB5	Cinnamon Creek from Rees Hill Rd. to confluence w/ Battle Creek	Channelization/ Bioengineering/ Habitat; Replace undersized culvert	$849,000	Long term (over 10 years)
BCB15	Drainage system crossing Fabry, tributary to Waln Creek	Replace undersized culvert	$25,903	Long term (over 10 years)
BCB16	Waln Creek from Shannon to Woodside Dr.	Channelization/ Bioengineering/ Habitat	$2,287,521	Long term (over 10 years)
BCB20	Intersection of Holder Lane and Lone Oak Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$518,898	Intermediate term (5 - 10 years)
BCB21	Jory Creek at Liberty Rd.	Detention Facility: Jory Creek at Liberty	$1,740,279	Long term (over 10 years)
BCB22	Battle Creek at Liberty/Bates Road	Detention Facility: Liberty/ Bates	$2,760,031	Long term (over 10 years)
		Total	$18,822,559	



Map 5.1

Battle Creek Basin and Creek Network

From the City of Salem 2019 Battle Creek Basin Plan, Figure 1



Map 5.2

Battle Creek Subbasin Boundaries

From the City of Salem 2019 Battle Creek Basin Plan, Figure 3

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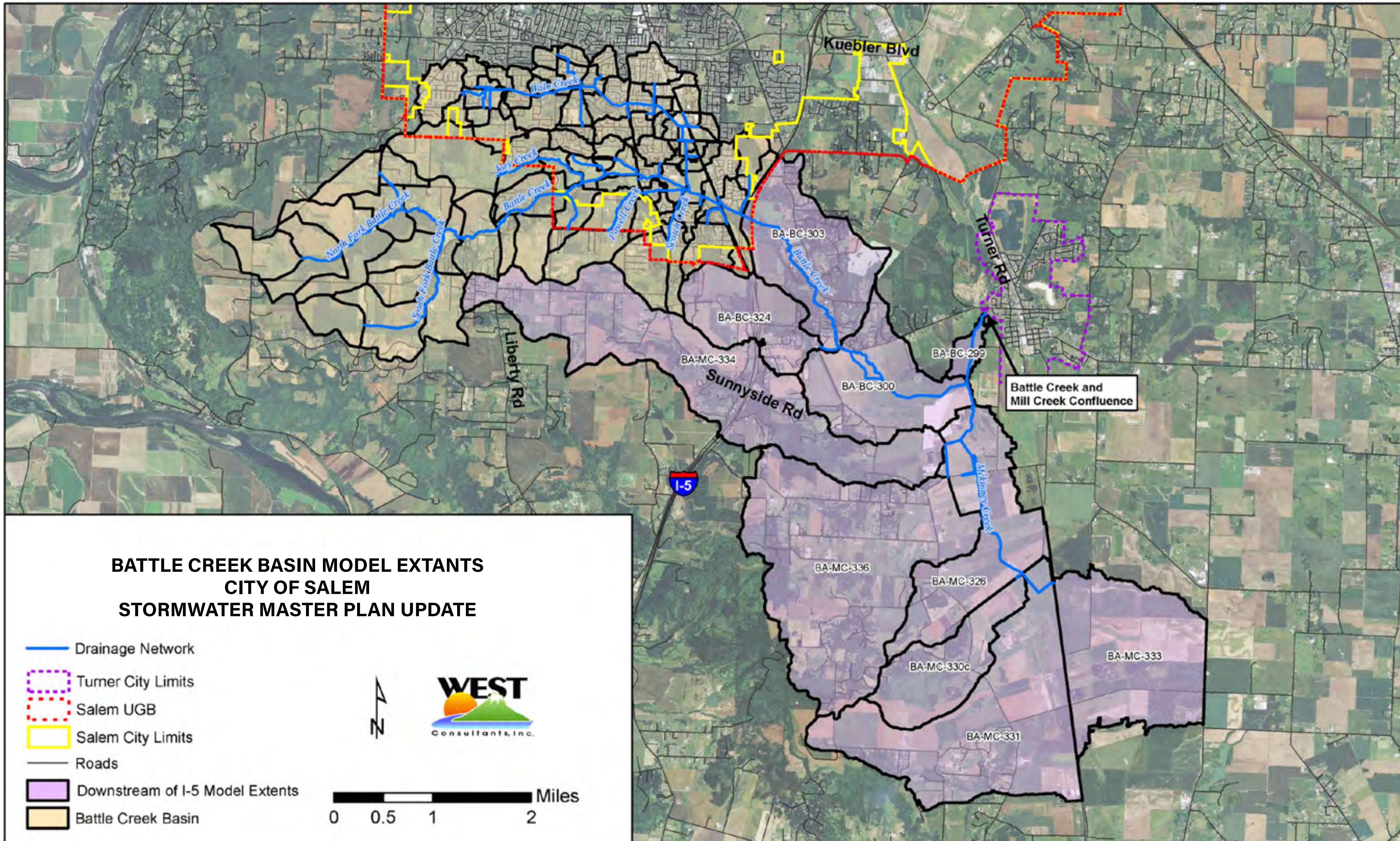

Map 5.3

Battle Creek Basin Model Extents

From the City of Salem 2019 Battle Creek Basin Plan, Figure 4

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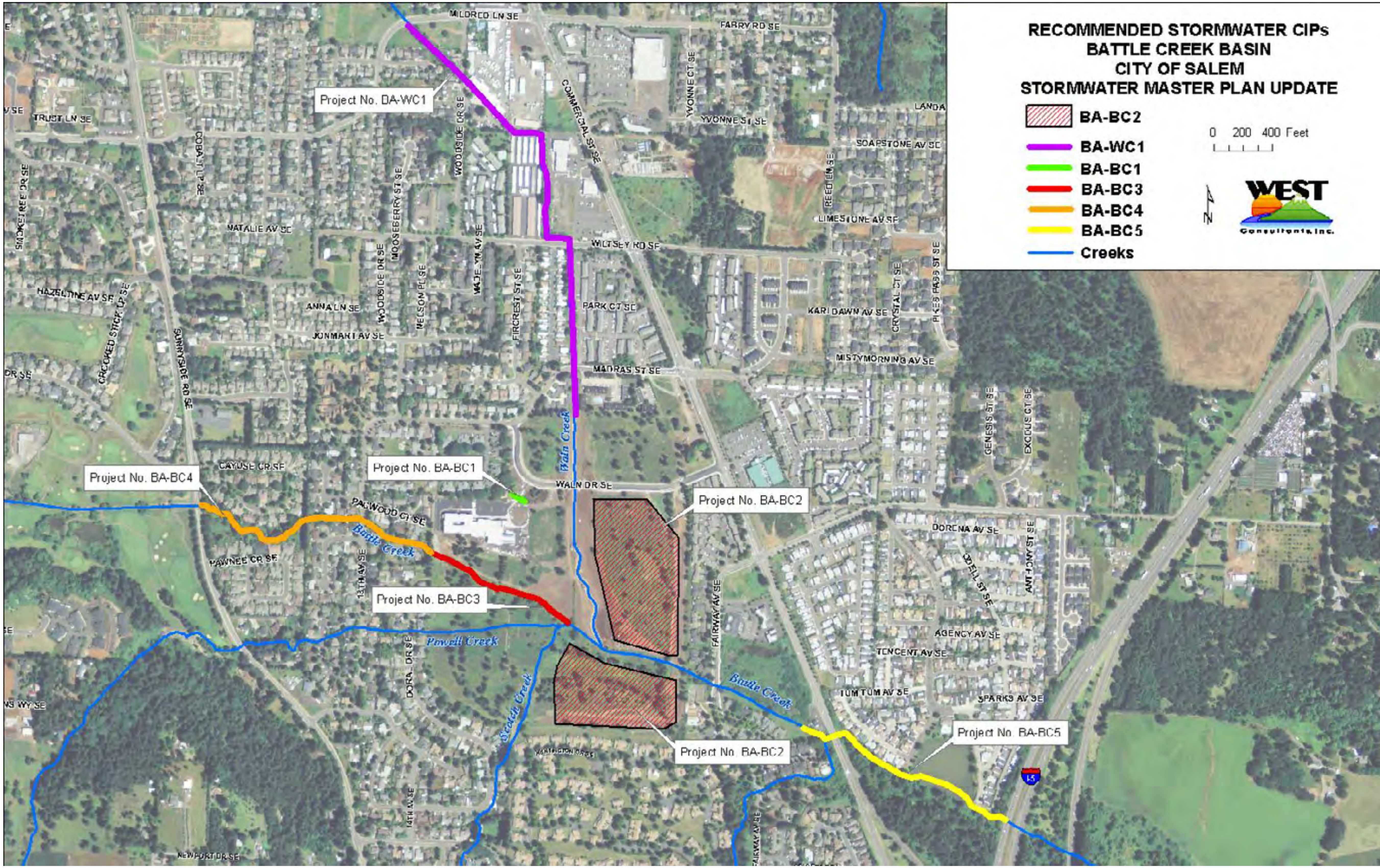

Map 5.4 2019

Battle Creek BasinPlan Project Locations

From the City of Salem 2019 Battle Creek Basin Plan, Figure 10

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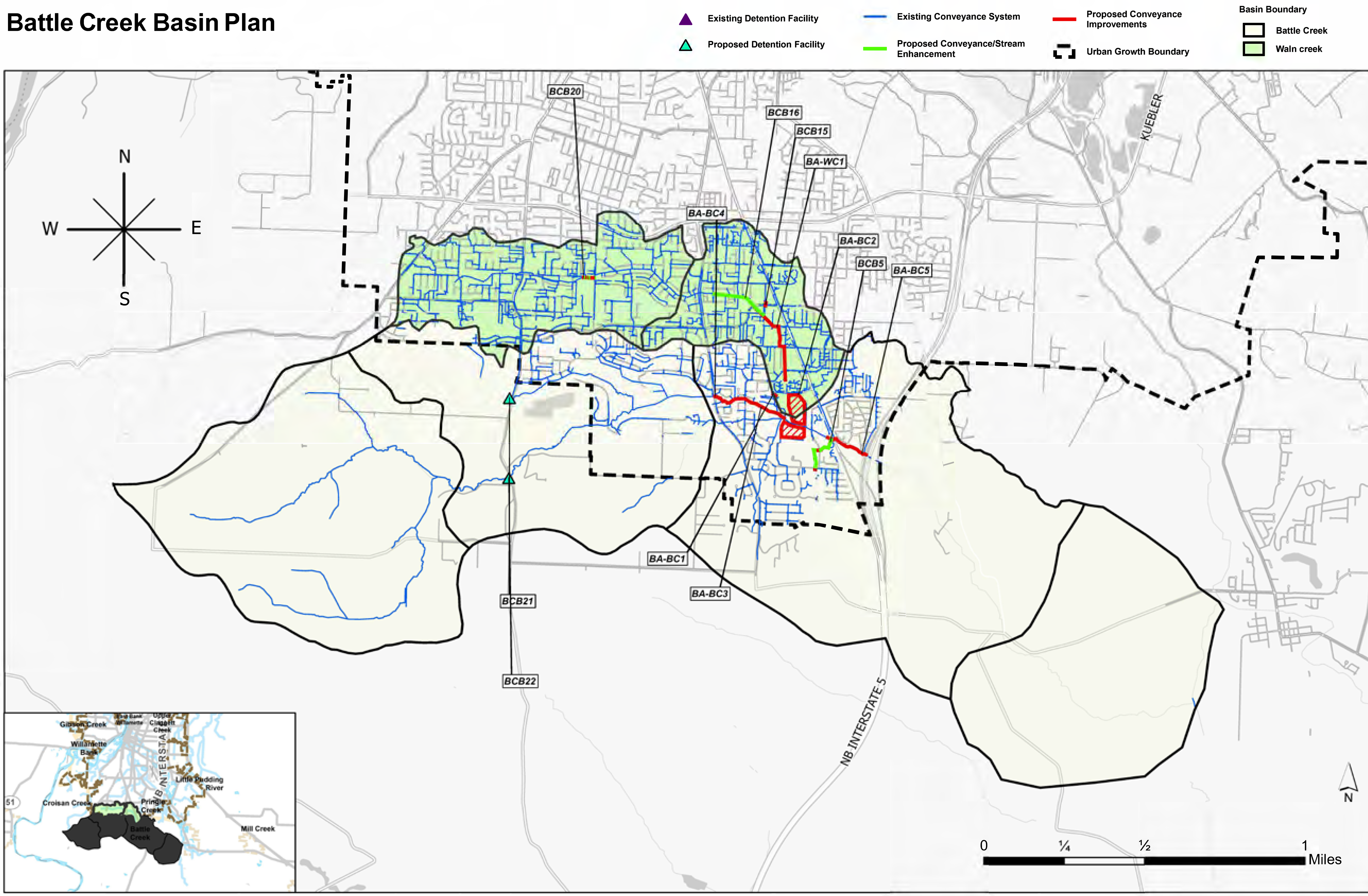

Map 5.5 2020

Stormwater Master Plan Battle Creek Basin Recommended Project Locations

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Croisan Creek Basin Plan

CROISAN CREEK BASIN DESCRIPTION

The Croisan Creek basin encompasses 4.9 square miles of southwest Salem, approximately half of which are within the Urban Growth Boundary (UGB). The basin is narrow with steeply sloped sides. The drainage system is primarily open, with Croisan Creek as the dominant drainage feature. Croisan Creek originates outside the UGB near Skyline Road S and flows north through Salem, across River Road S, and into the East Willamette Slough. Land use in the lower portions of the basin is primarily residential. The upper reaches within the UGB are currently rural. Outside the UGB, land use is primarily agricultural.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR CROISAN CREEK BASIN

The 2000 *Stormwater Master Plan* divided the Croisan Creek Basin into 41 catchments (Map 6.1) and estimated existing and future impervious surface areas (Table 6.1).

Using a planning-level XP-SWMM model and assuming the existing conveyance system, no new detention facilities, and a 10-year design storm, the 2000 *Stormwater Master Plan* modeling results identified several segments that could be subject to surcharging (Map 6.2).

Peak discharges reported by the XP-SWMM model that correspond to the flow locations identified in Map 6.2 are provided in Table 6.2.

There were 15 capital project improvements listed in the 2000 *Stormwater Master Plan* to address the needs of Croisan Creek Basin. Projects included replacing undersized pipes and culverts, installing new bridges, and constructing habitat improvements. A potential site for a detention facility was identified in the vicinity of Kuebler Road S. Map 6.3 shows the locations for the recommended projects. The total estimated cost for all 15 projects (in 2000 dollars) was $8,764,212.

CROISAN CREEK BASIN PLAN

Detailed analysis of the Croisan Creek Basin was not performed as part of the latest update to the *Stormwater Master Plan*. Until analysis is conducted and a new basin plan adopted, the results of the 2000 *Stormwater Master Plan*—updated using staff input to reflect completed projections and current requirements—will serve in the interim for the Croisan Creek Basin Plan.

Of the 15 recommended improvement projects identified in the 2000 *Stormwater Master Plan*, one has been completed under a railroad crossing (CCB 1), and one has been completed at Golf Course Road S (CCB5). The detention facility at Kuebler Road S (CCB 14) has been removed as a recommended project pending the results of additional detailed analysis. See Table 6.3.

Table 6.4 identifies the remaining 12 projects that are being carried forward as the interim basin plan for the Croisan Creek Basin. The proposed timeframes for completing these projects are indicated as short-term (within five years), intermediate-term (between five and ten years), and long-term (over ten years). There are no short-term projects identified in the Croisan Creek Basin Plan. One project, replacing a bridge at Roberta Avenue S (CCB12), is recommended as an intermediate-term project.

All projects recommended in this master plan for the Croisan Creek Basin are shown on **Map 6.4**.

The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project. The total estimated cost in 2017 dollars for all 13 projects currently identified for the Croisan Creek Basin, rounded to the nearest $10,000, is $9,440,00.

Croisan Creek Basin Data

Table 6.1

Croisan Creek Basin Hydrologic Parameters

From the City of Salem 2000 *Stormwater Master Plan*, Table A-2

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
CB005	15.5	20	62	70	129
CB030	91.9	25	48	72	33
CB045	21.7	10	84	70	40
CB050A	10.0	25	51	70	16
CB050B	27.8	30	50	68	30
CB050C	16.0	15	15	68	26
CB075	17.4	20	63	68	76
CB085	71.9	35	50	68	30
CB090	20.7	10	51	68	108
CB095	8.5	30	50	72	26
CB100	15.0	25	50	70	24
CB105	18.0	20	50	70	26
CB115	84.9	35	50	72	36
CB125	44.5	30	50	72	23
CB130	82.3	20	40	72	35
CB135	38.8	20	41	72	25
CB140	24.6	30	30	72	18
CB165	161.9	30	45	70	47
CB170	117.5	15	50	69	37
CB175	100.0	5	5	70	35
CB185A	67.1	15	43	70	35
CB185B	55.8	10	16	70	32
CB190	94.3	8	28	70	36
CB195	126.5	3	3	70	51
CB200	82.3	8	12	72	35
CB210A	93.2	10	44	71	45

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
CB210B	178.3	5	10	69	44
CB220A	240.9	5	10	69	50
CB220B	89.9	8	40	71	36
CB225	63.7	5	15	71	35
CB230	160.9	5	5	72	49
CB240	83.5	5	5	70	35
CB245	43.1	5	5	70	28
CB250A	105.6	5	5	70	42
CB250B	80.4	5	5	70	32
CB255	38.8	5	5	72	35
CB260	31.7	5	5	70	22
CB265A	123.4	5	5	68	42
CB265B	126.1	3	3	68	44
CB270A	108.0	3	3	69	41
CB270B	146.0	3	3	69	45

Table 6.2

Croisan Creek Basin Model Results for Selected Flow Locations

From the City of Salem 2000 *Stormwater Master Plan*, Table B-1

Storm Recurrence Flow Location Identifier	10-Year Storm Existing Peak Flow (cfs)	10-Year Storm Future Peak Flow (cfs)	10-Year Storm Future w/ Detention Peak Flow (cfs)	25-Year Storm Existing Peak Flow (cfs)	25-Year Storm Future Peak Flow (cfs)	25-Year Storm Future w/ Detention Peak Flow (cfs)	100-Year Storm Existing Peak Flow (cfs)	100-Year Storm Future Peak Flow (cfs)	100-Year Storm Future w/ Detention Peak Flow (cfs)
CCF1	278.00	425.00	424.00	446.00	609.00	588.00	719.00	895.00	807
CCF2	243.00	362.00	361.00	401.00	533.00	513.00	642.00	797.00	687
CCF3	190.00	281.00	279.00	332.00	434.00	407.00	547.00	673.00	538
CCF4	134.00	189.00	188.00	249.00	314.00	282.00	430.00	512.00	369
CCF5	7.02	7.02	7.02	12.50	12.50	12.50	23.10	23.10	23.1
CCF6	102.00	137.00	136.00	192.00	237.00	214.00	340.00	391.00	276
CCF7	60.90	60.90	60.90	116.00	116.00	116.00	206.00	206.00	206

Table 6.3

Croisan Creek Basin Projects from 2000 Stormwater Master Plan Completed or Removed

DSIP Project ID	Location	Recommended Improvement	Status
CCB1	Croisan Creek railroad crossing, 2600 block, South River Rd.	Bck 3 n cuerts under railroad; Remove weir near railroad	
CCB5	Golf Course Rd. at South River Rd.	Replace undersized pipe and ditch system	Completed
CCB14	Croisan Creek at Kuebler Rd.	Kuebler Road Detention Facility	Removed pending further analysis

Table 6.4

Croisan Creek Basin Plan Project List

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CCB12	Croisan Creek at Roberta Ave. South	Bridge	$521,042	Intermediate term (5 - 10 years)
CCB10	Croisan Creek at 3281 Croisan Creek Rd.	Bridge	$818,780	Long term (over 10 years)
CCB11	Croisan Creek, Spring St. to Madrona Ave.	Channelization/ Bioengineering/ Habitat	$2,011,161	Long term (over 10 years)
CCB13	Croisan Creek at 4451 Croisan Creek Road to Spring St.	Channelization/ Bioengineering/ Habitat	$3,024,274	Long term (over 10 years)
CCB15	Croisan Creek at Ballyntine Rd. S.	Install additional culvert	$86,642	Long term (over 10 years)
CCB2	Croisan Creek at 2611 South River Rd.	Replace culvert w/ Bridge	$521,042	Long term (over 10 years)
CCB3	2600 Block South River Rd.	Replace undersized pipe	$79,436	Long term (over 10 years)
CCB4	Croisan Creek at 2900 Block South River Rd.	Replace Culvert w/ Bridge	$521,042	Long term (over 10 years)
CCB6	Croisan Creek between Croisan Creek Rd. and Golf Course Rd.	Channelization/ Bioengineering/ Habitat	$1,136,019	Long term (over 10 years)
CCB7	Croisan Creek Rd. at South River Rd.	Replace undersized culvert	$53,749	Long term (over 10 years)
CCB8	Croisan Creek Rd. at South River Rd.	Replace undersized box culvert	$521,042	Long term (over 10 years)
CCB9	Croisan Creek, South of River Rd. West of Croisan Creek Rd.	Remove weir	$148,869	Long term (over 10 years)
		Total	$9,443,096	

The Croisan Creek Basin Project List is based on results of 2000 *Stormwater Master Plan*, updated using staff input to reflect completed projects and current requirements.

Estimated costs include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%).

Each project has a small conveyance improvement allowance based on 5% of the subtotal.

The 2000 to 2019 dollar conversion is 1.668, which is based on the Engineering News Record Construction Cost Indices for Seattle, San Francisco, and Los Angeles

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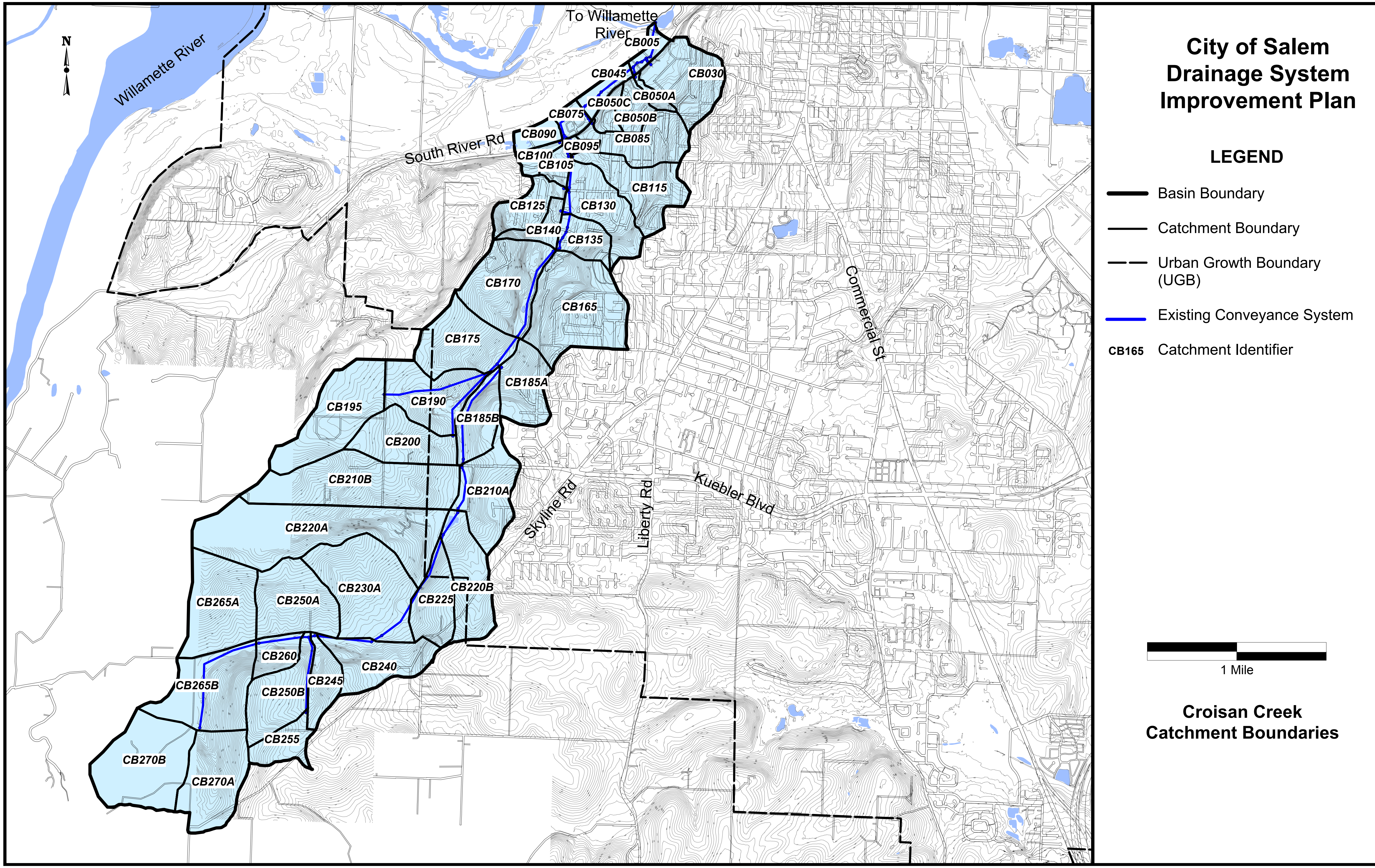

Map 6.1

Croisan Creek Basin Boundaries

From the City of Salem 2000 Stormwater Master Plan, Figure A-2

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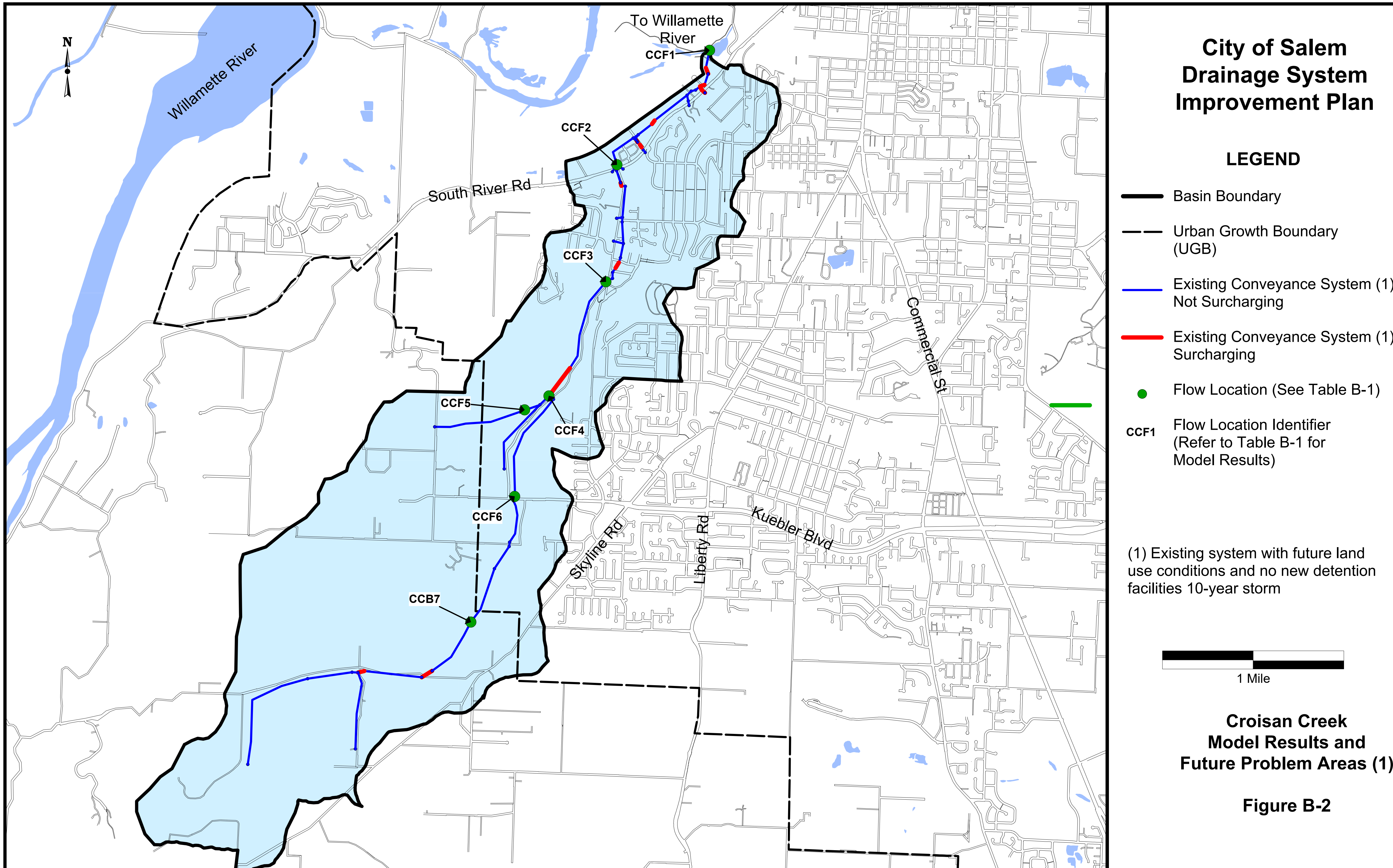

Map 6.2

Croisan Creek Basin Model Results and Future Problem Areas

From the City of Salem 2000 Stormwater Master Plan, Figure B-2

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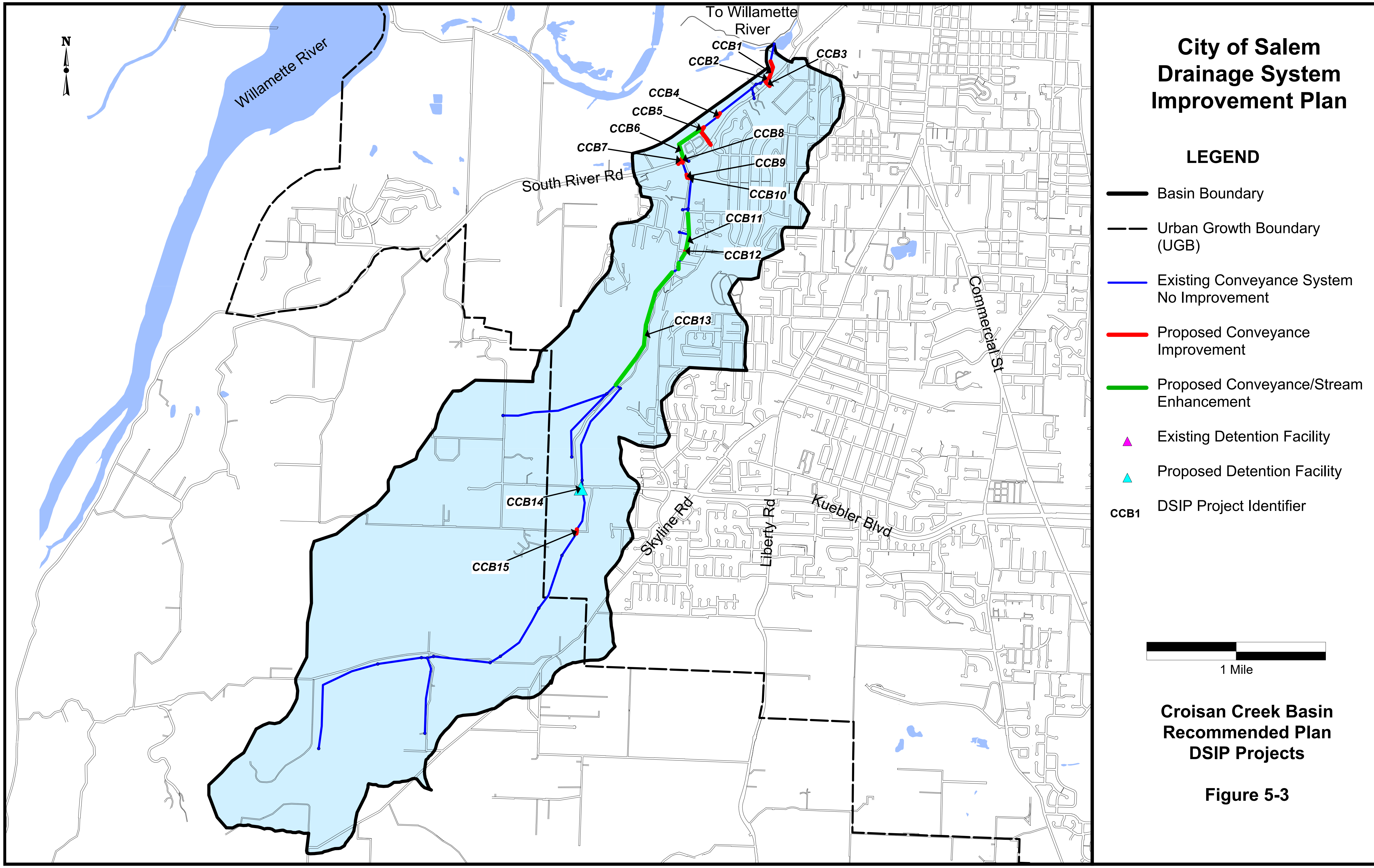

Map 6.3

Croisan Creek Basin Recommended Project Locations

From the City of Salem 2000 Stormwater Master Plan, Figure 5-3

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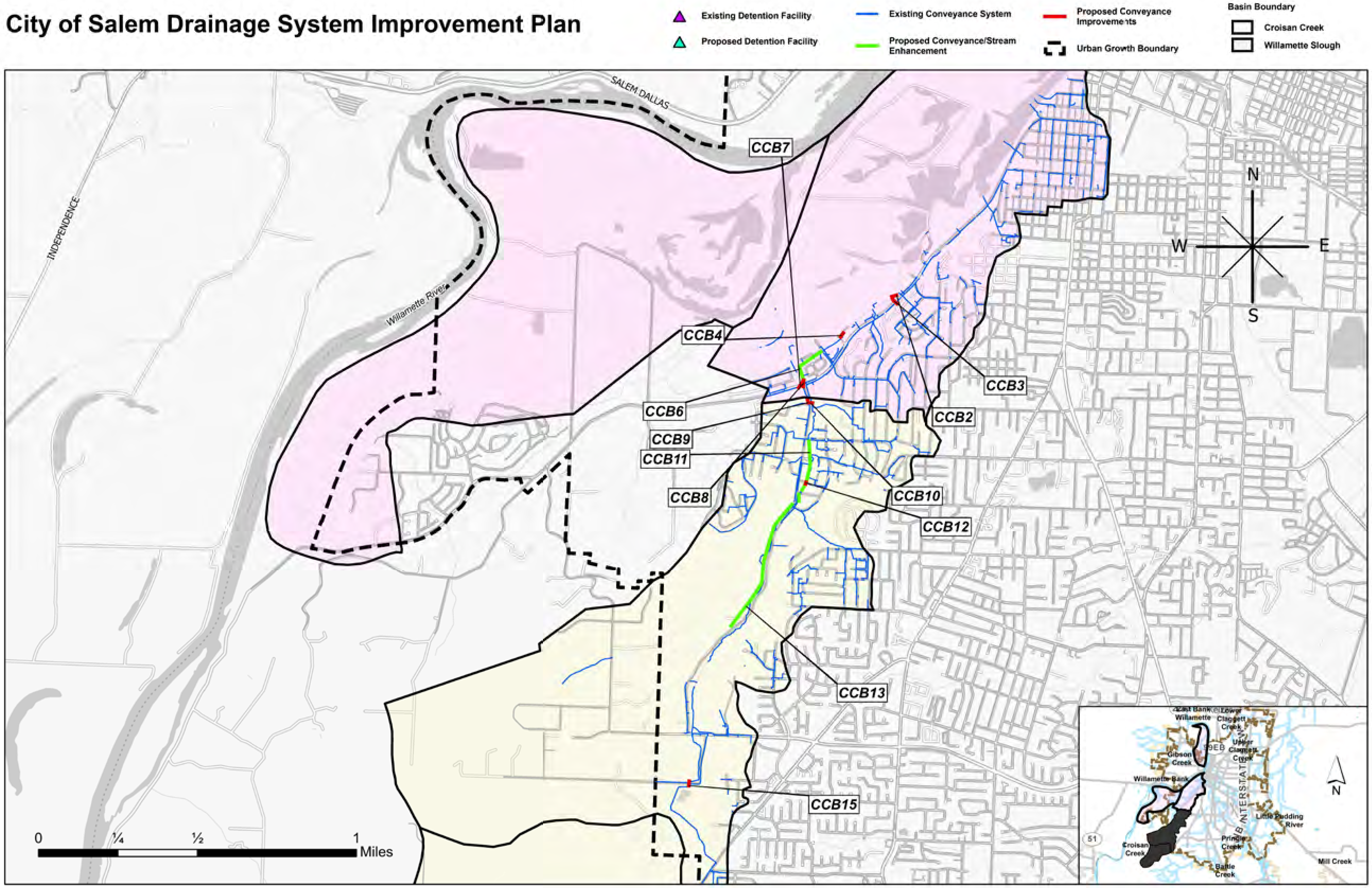


Map 6.3

2020 Stormwater Master Plan Croisan Creek Basin Recommended Project Locations

East Bank Basin Plan

EAST BANK BASIN DESCRIPTION

The East Bank Basin consists of 2.0 square miles. Located entirely within the Urban Growth Boundary, the basin has outfalls located along the east bank of the Willamette River north of downtown Salem. The basin is urban and flat, with residential, commercial, and industrial land uses.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR EAST BANK BASIN

The 2000 *Stormwater Master Plan* divided the East Bank Basin into 53 catchments (**Map 7.1**) and estimated existing and future impervious surface areas (**Table 7.1**).

Using a planning-level XP-SWMM model and assuming the existing conveyance system, no new detention facilities, and a 10-year design storm, the 2000 *Stormwater Master Plan* modeling results identified several segments that could be subject to surcharging (**Map 7.2**).

Peak discharges reported by the XP-SWMM model that correspond to the flow locations identified in **Map 7.2** are provided in **Table 7.2**.

There were 17 capital project improvements listed in the 2000 *Stormwater Master Plan* to address the needs of East Bank Basin, all of which involved replacing undersized pipes. **Map 7.3** shows the locations for the recommended projects. The total estimated cost for all 17 projects (in 2000 dollars) was $7,793,988.

EAST BANK BASIN PLAN

Detailed analysis of the East Bank Basin was not performed as part of the latest update to the *Stormwater Master Plan*. Until analysis is conducted and a new basin plan adopted, the results of the 2000

Stormwater Master Plan—updated using staff input to reflect completed projections and current requirements—will serve in the interim for the East Bank Basin Plan.

Of the 17 recommended improvement projects identified in the 2000 *Stormwater Master Plan*, two have been completed, as shown in **Table 7.3**.

Table 7.4 identifies the remaining 15 projects that are being carried forward as the interim basin plan for the East Bank Basin. The proposed timeframes for completing these projects are indicated as short-term (within five years), intermediate-term (between five and ten years), and long-term (over ten years). Nine of the pipe replacement projects in the East Bank Basin are recommended for short-term action, two pipe replacements are recommended as intermediate-term projects, and the remaining four as long-term projects.

The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project. The total estimated cost in 2019 dollars for all 15 projects currently identified for the East Bank Basin, rounded to the nearest $10,000, is $12,390,000.

All projects recommended in this master plan for the East Bank Basin Plan are shown on **Map 7.4.**

East Bank Basin Data

Table 7.1

East Bank Basin Hydrologic Parameters

From the City of Salem 2000 *Stormwater Master Plan*, Table A-3

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
CO1	13.1	40.0	53.0	72.0	56.0
CO2	22.0	40.0	60.0	72.0	58.0
CO3	25.1	40.0	89.0	72.0	70.0
GA1	97.8	45.0	46.0	72.0	108.0
GA2	22.5	45.0	52.0	72.0	112.0
GA3	38.8	45.0	60.0	72.0	128.0
GA4	25.8	45.0	72.0	72.0	143.0
GA5	13.6	70.0	86.0	72.0	156.0
HI1	15.1	45.0	50.0	72.0	74.0
HI2	23.5	45.0	71.0	72.0	90.0
HI3	7.7	40.0	89.0	72.0	56.0
IV1	48.6	10.0	79.0	72.0	119.0
IV2	4.9	30.0	59.0	72.0	56.0
IV3	17.8	50.0	82.0	72.0	127.0
IV4	29.5	35.0	52.0	72.0	55.0
LO1	13.9	35.0	66.0	72.0	63.0
LO2	23.3	35.0	61.0	72.0	63.0
LO3	13.0	35.0	53.0	72.0	120.0
LO4	13.8	25.0	67.0	72.0	104.0
LO5	7.5	35.0	90.0	72.0	92.0
MA1	35.2	45.0	50.0	72.0	67.0
MA2	25.6	45.0	70.0	72.0	85.0
MA4	26.2	45.0	60.0	72.0	130.0
MA5	19.3	42.0	59.0	72.0	69.0
MA6	11.4	40.0	89.0	72.0	71.0
NO1	14.5	42.0	78.0	72.0	76.0

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
N02	29.8	45.0	56.0	72.0	99.0
N03	25.5	45.0	52.0	72.0	65.0
N04	20.3	45.0	50.0	72.0	79.0
N04A	13.7	45.0	56.0	72.0	88.0
N05	53.3	45.0	67.0	72.0	104.0
N06	29.5	40.0	65.0	72.0	120.0
N07	22.7	45.0	82.0	72.0	81.0
NR1	35.9	35.0	66.0	72.0	47.0
PI1	4.1	35.0	90.0	72.0	45.0
SA1	20.7	45.0	81.0	72.0	65.0
SA2	40.2	25.0	79.0	72.0	56.0
SA3	5.4	20.0	84.0	72.0	168.0
SA4	7.4	35.0	68.0	72.0	54.0
SP1	8.9	30.0	89.0	72.0	65.0
SP10	17.9	40.0	76.0	72.0	107.0
SP1A	18.4	55.0	90.0	72.0	115.0
SP2	7.0	45.0	85.0	72.0	62.0
SP3	29.1	45.0	81.0	72.0	76.0
SP4	26.3	45.0	85.0	72.0	63.0
SP5	27.7	45.0	57.0	72.0	96.0
SP6	24.2	45.0	55.0	72.0	86.0
SP7	37.7	45.0	56.0	72.0	384.0
SP8	25.0	45.0	50.0	72.0	114.0
SP9	28.9	45.0	50.0	72.0	134.0
ST1	17.1	25.0	56.0	72.0	81.0
ST2	21.4	35.0	56.0	72.0	124.0
ST3	13.7	35.0	54.0	72.0	94.0

Table 7.2

East Bank Basin Model Results for Selected Flow Locations

From the City of Salem 2000 *Stormwater Master Plan*, Table B-1

Storm Recurrence Flow Location Identifier	10-Year Storm Existing Peak Flow (cfs)	10-Year Storm Future Peak Flow (cfs)	10-Year Storm Future w/ Detention Peak Flow (cfs)	25-Year Storm Existing Peak Flow (cfs)	25-Year Storm Future Peak Flow (cfs)	25-Year Storm Future w/ Detention Peak Flow (cfs)	100-Year Storm Existing Peak Flow (cfs)	100-Year Storm Future Peak Flow (cfs)	100-Year Storm Future w/ Detention Peak Flow (cfs)
EBF1	12.2	15.8	15.8	15.3	19.3	19.3	19.5	24.0	24.0
EBF2	22.2	33.3	33.3	28.0	38.5	38.5	33.9	48.7	48.7
EBF3	19.9	26.1	26.1	24.5	31.5	31.5	30.7	38.0	38.0
EBF4	20.3	30.8	30.8	25.2	36.4	36.4	31.7	43.4	43.4
EBF5	14.7	18.0	18.0	17.9	21.3	21.3	22.2	25.7	25.7
EBF6	56.3	71.6	71.6	68.9	85.3	85.3	85.3	104.0	104.0
EBF7	20.9	27.2	27.2	25.5	32.6	32.6	32.1	39.2	39.2
EBF8	30.1	41.3	41.3	36.4	49.3	49.3	46.2	60.6	60.6
EBF9	62.8	72.9	72.9	75.5	85.7	85.7	92.2	113.0	113.0
EBF10	47.7	57.7	57.7	60.5	71.3	71.3	77.7	89.3	89.3
EBF11	29.3	42.3	42.3	35.9	49.7	49.7	44.5	60.1	60.1

Table 7.3

East Bank Basin Projects from 2000 Stormwater Master Plan Completed

DSIP Project ID	Location	Recommended Improvement	Status
EBB14	Stark St between Willamette Dr and North River Rd.	Replace undersized pipe	Completed
EBB15	Stark St crossing River Rd and Broadway	Replace undersized pipe	Completed

Table 7.4

East Bank Basin Plan Project List

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
EBB1	Columbia Ave between Front St and Liberty St	Replace undersized pipe	$319,473	Short-term (within 5 years)
EBB2	Hickory St between the Willamette River and 4th St	Replace undersized pipe	$454,170	Short-term (within 5 years)
EBB3	Parallel to Riviera Dr between the Willamette River and Maple Ave	Replace undersized pipe	$1,258,196	Short-term (within 5 years)
EBB4	Liberty St. between Riviera Dr and Tryon Ave	Replace undersized pipe	$443,719	Short-term (within 5 years)
EBB5	Intersection of Hickory St and Commerical St to intersection of Johnson St and Church St	Replace undersized pipe	$814,105	Short-term (within 5 years)
EBB6	On Locust St and Maple St between Johnson and Laurel St	Replace undersized pipe	$351,643	Short-term (within 5 years)
EBB7	Norway St between Commercial St and Fairgrounds Rd	Replace undersized pipe	$1,366,349	Short-term (within 5 years)
EBB8	Fairgrounds Rd between Winter St and Capital St	Replace undersized pipe	$531,968	Short-term (within 5 years)
EBB9	From Fairgrounds Rd and Norway St to Baker St, along Baker to Market St and east to 16th St	Replace undersized pipe	$2,002,541	Short-term (within 5 years)
EBB10	Hickory St between the Willamette River and Commercial St	Replace undersized pipe	$354,308	Intermediate-term (5 - 10 years)
EBB11	On Salem Pkwy between Commercial and Broadway	Replace undersized pipe	$612,447	Intermediate-term (5 - 10 years)
EBB12	Donna St between Highland Av and Fairgrounds Rd	Replace undersized pipe	$441,218	Long-term (over 10 years)
EBB13	Sunnyview Ave between Warner St and 16th St	Replace undersized pipe	$135,128	Long-term (over 10 years)
EBB16	Gaines St between the Willamette River and Front St	Replace undersized pipe	$56,555	

East Bank Basin Plan

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
EBB17	From Front St and Gaines east to 15th and Nebraska	Replace undersized pipe	$3,253,081	
		Total	$12,394,903	

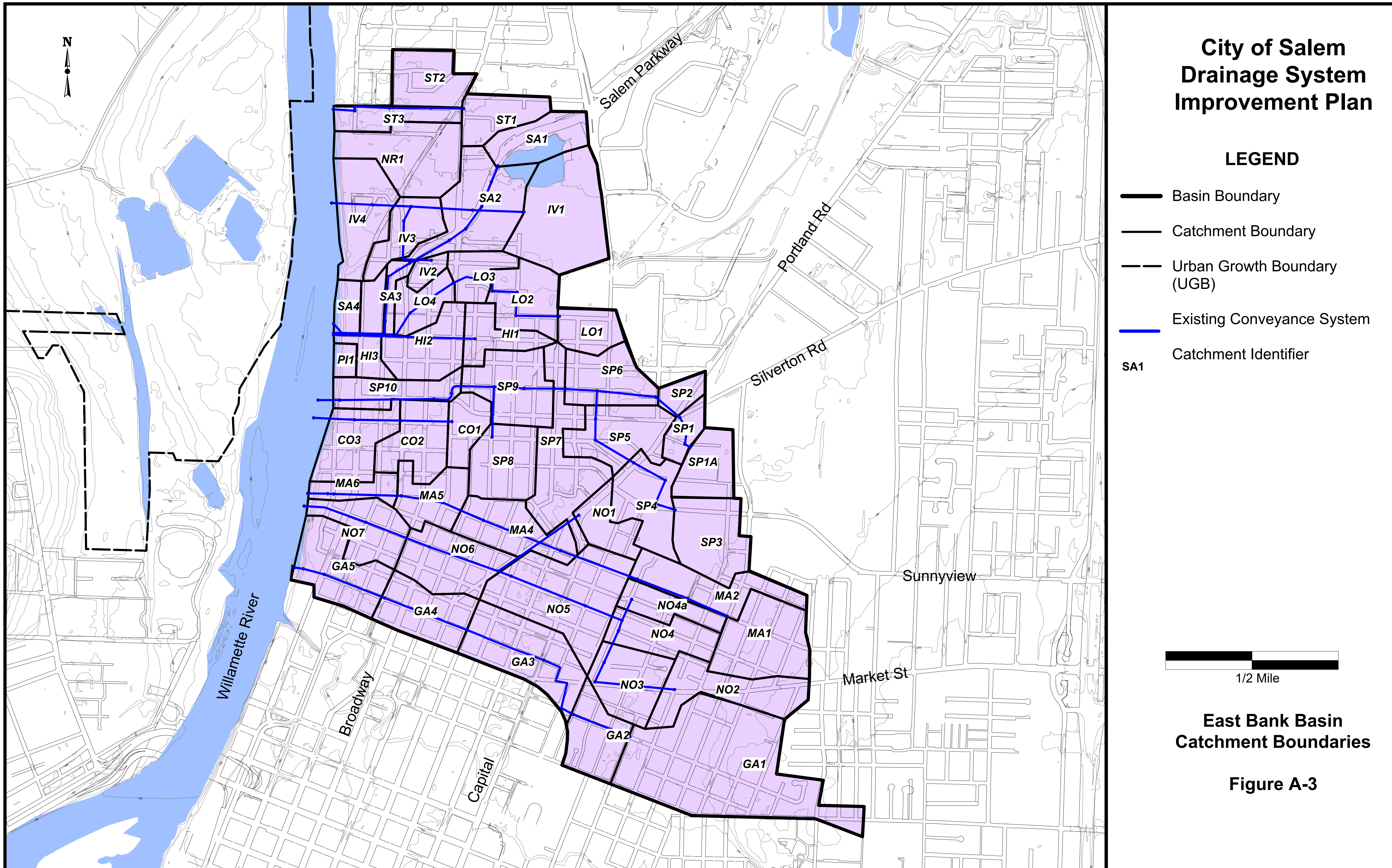
Notes:

The East Bank Basin Project List is based on results of 2000 *Stormwater Master Plan*, updated using staff input to reflect completed projects and current requirements.

Estimated costs include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%).

Each project has a small conveyance improvement allowance based on 5% of the subtotal.

The 2000 to 2019 dollar conversion is 1.668, which is based on the Engineering News Record Construction Cost Indices for Seattle, San Francisco, and Los Angeles.



Map 7.1

East Bank Basin Boundaries

From the City of Salem 2000 *Stormwater Master Plan*, Figure A-3

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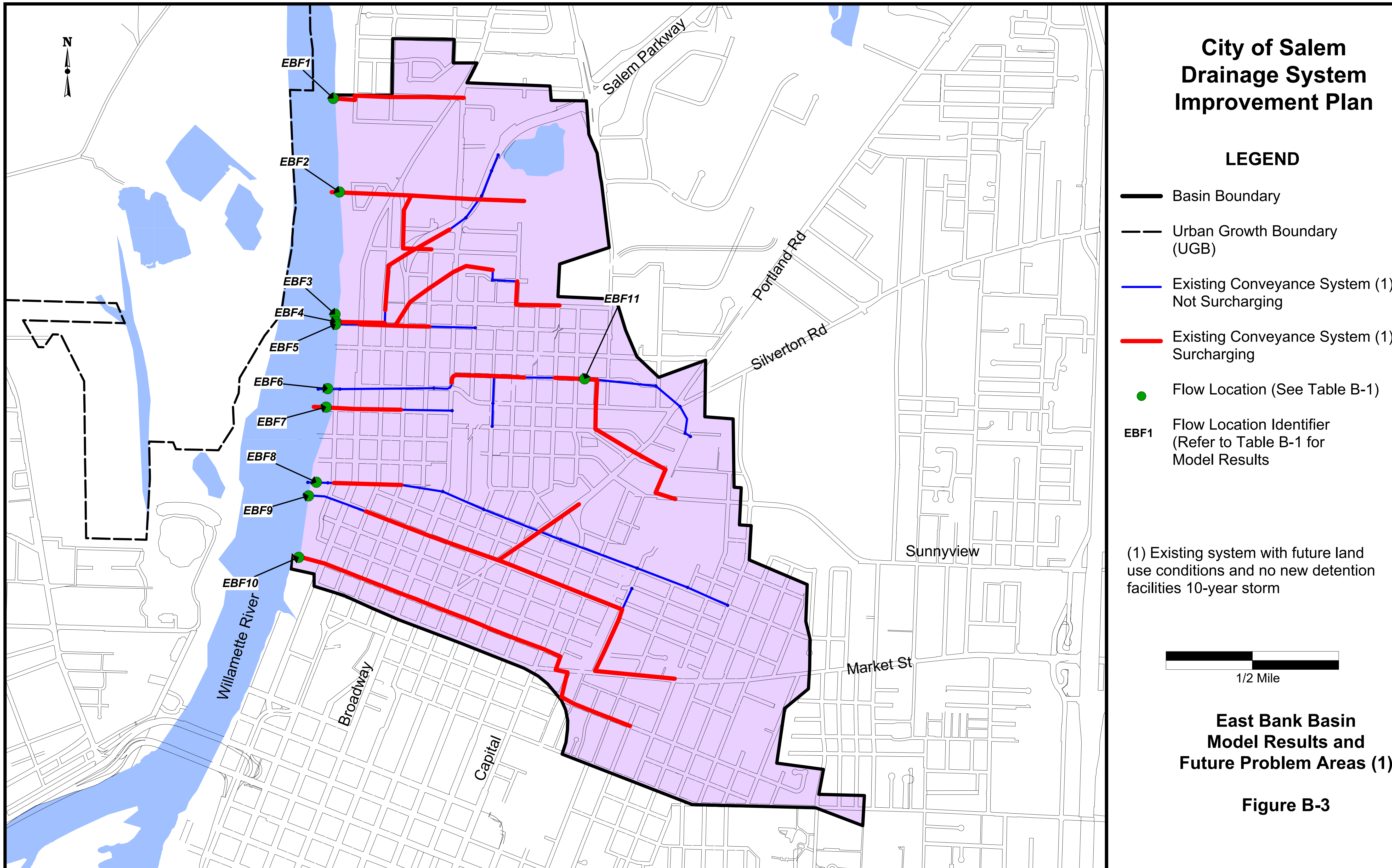

Map 7.2

East Bank Basin Model Results and Future Problem Areas

From the City of Salem 2000 *Stormwater Master Plan*, Figure B-3

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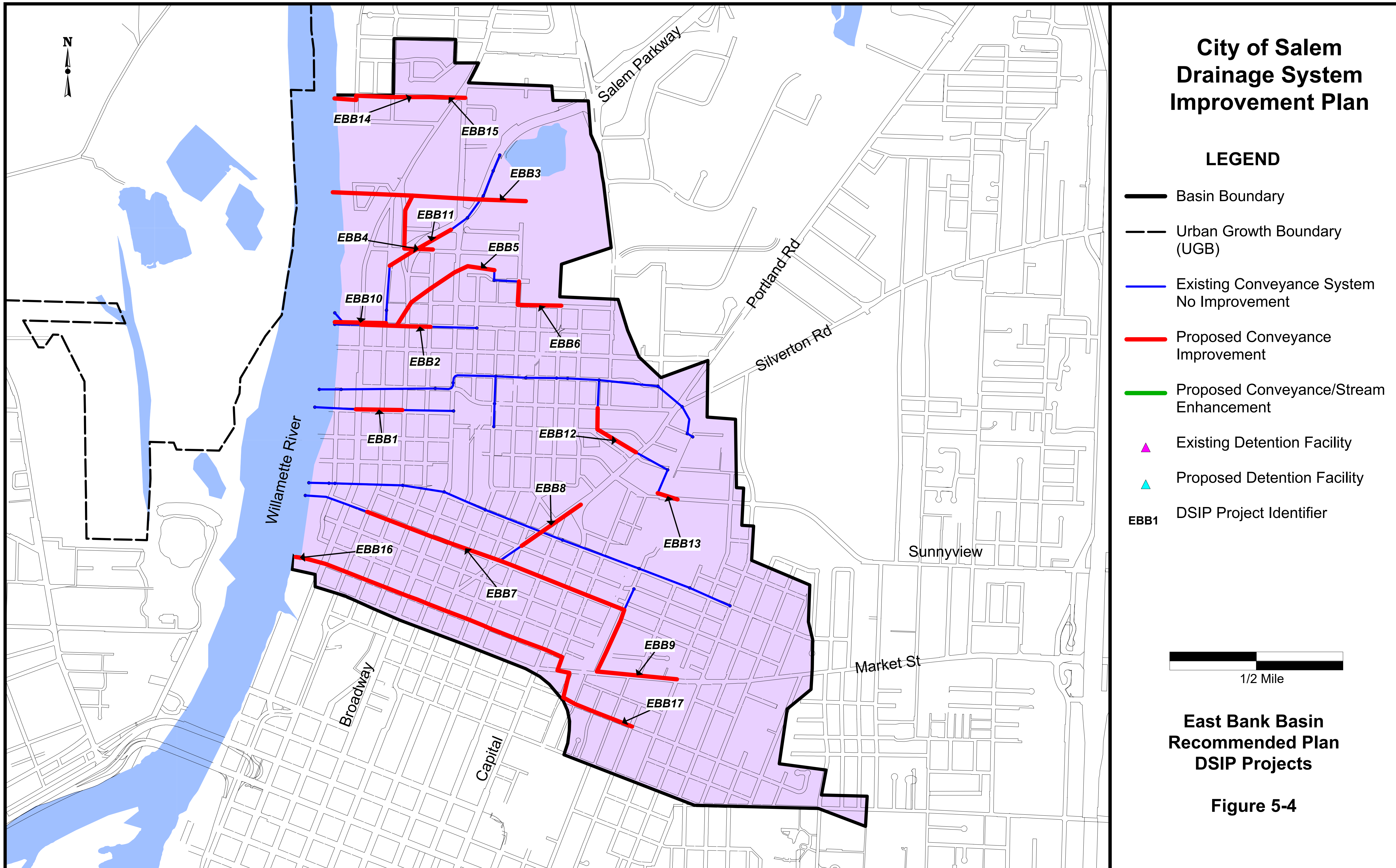

Map 7.3

East Bank Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure 5-4

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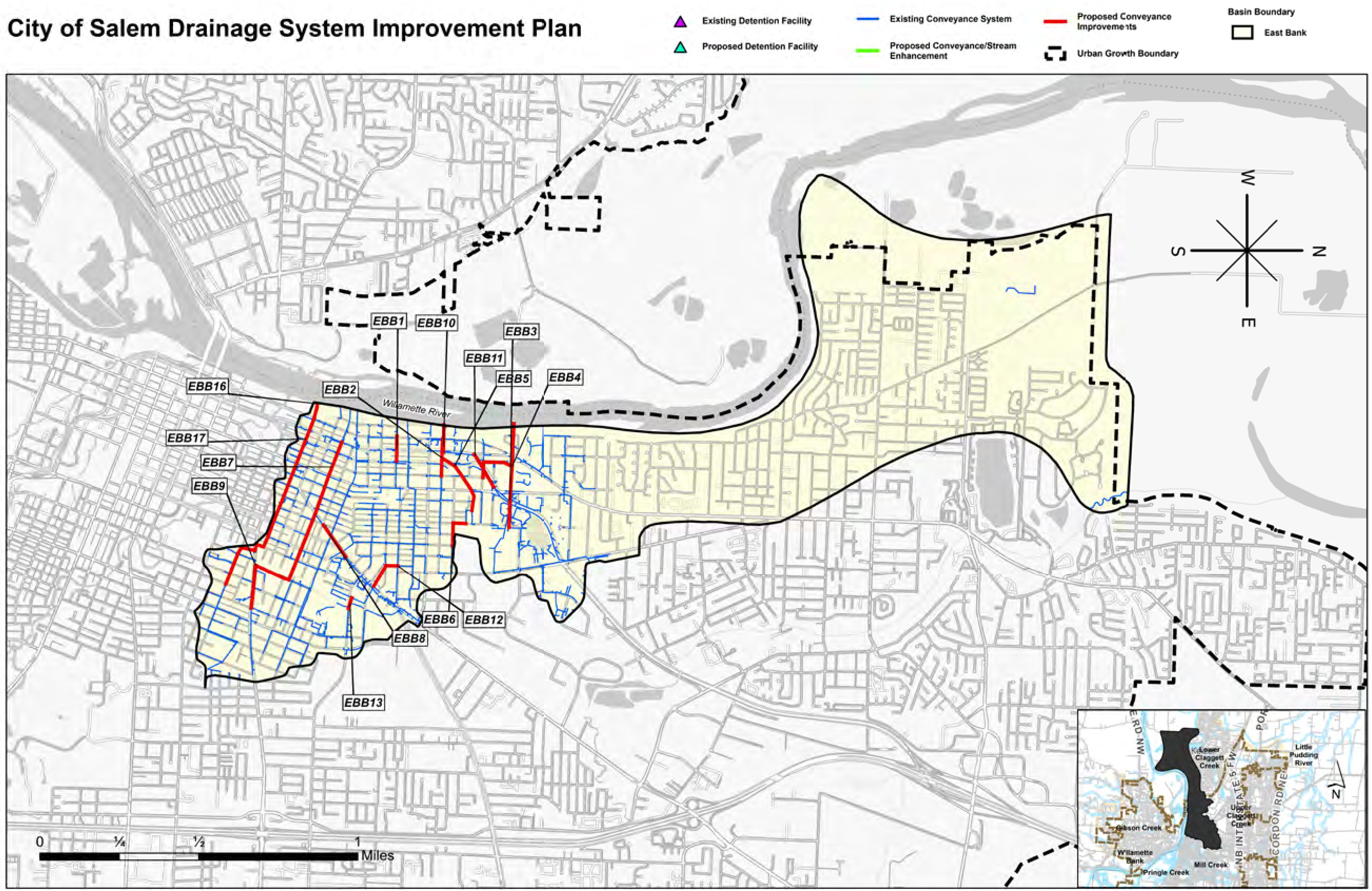

Map 7.4

2020 Stormwater Master Plan East Bank Basin Recommended Project Locations

Glenn-Gibson Creek Basin Plan

GLENN-GIBSON CREEK BASIN DESCRIPTION

The Glenn-Gibson basin is located in Polk County and drains 10.4 square miles of west Salem. Approximately half of the basin is within the Urban Growth Boundary (UGB). The basin terrain is steep, particularly in the upper reaches, with flatter slopes near the basin outlet. There are over 20 small tributaries in the basin. The two main drainage channels are Glenn Creek and Gibson Creek. The Glenn-Gibson basin is experiencing rapid growth in the upper-western reaches inside the UGB. Some development is also occurring outside the UGB in Polk County. Glenn Creek originates outside the UGB, on the west fringe of Best Road NW north of Dahlia Way NW, and flows east through agricultural areas and residential developments. It eventually flows into the West Willamette Slough.

Gibson Creek is a tributary of Glenn Creek. It originates outside the UGB near Eagle Crest Road NW and flows east through primarily agricultural and rural residential areas to a confluence with Glenn Creek near Wallace Road NW.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR GLENN-GIBSON CREEK BASIN

The 2000 *Stormwater Master Plan* divided the Glenn-Gibson Creek Basin into 133 catchments (**Map 8.1**) and estimated existing and future impervious surface areas (**Table 8.1**).

Using a planning-level XP-SWMM model and assuming the existing conveyance system, no new detention facilities, and a 10-year design storm, the 2000 *Stormwater Master Plan* modeling results identified several segments that could be subject to surcharging (**Map 8.2**).

Peak discharges reported by the XP-SWMM model that correspond to the flow locations identified in **Map 8.2** are provided in **Table 8.2**.

There were 23 capital project improvements listed in the 2000 *Stormwater Master Plan* to address the needs of Glenn-Gibson Creek Basin. Of these projects, 12 involved replacing undersized pipes or culverts, five involved bridges, and two projects included habitat improvements. Six potential sites for new detention facilities were identified, three of which were located outside the UGB. Five projects were identified as Early Action Items to be completed within five years. **Map 8.3** shows the locations for the recommended projects. The total estimated cost for all 15 projects (in 2000 dollars) was $8,764,212.

GLENN-GIBSON CREEK BASIN PLAN

Detailed analysis of the Glenn-Gibson Creek Basin was not performed as part of the latest update to the *Stormwater Master Plan*. Until analysis is conducted and a new basin plan adopted, the results of the 2000 *Stormwater Master Plan*—updated using staff input to reflect completed projections and current requirements—will serve in the interim for the Glenn-Gibson Creek Basin Plan.

Of the 23 recommended improvement projects identified in the 2000 *Stormwater Master Plan*, eight have been completed. Additionally, one project, a proposed detention facility upstream of Glenn Eden Court NW (GGB 18), has been removed from the list pending further detailed analysis. Two other projects involving new detention facilities (GGB 19 and GGB 23) have been removed owing to their location being outside the UGB as well as a need to conduct further detailed analysis. One project (GGB 13) has been determined to no longer be required. See **Table 8.3** for a complete listing.

Table 8.4 identifies the remaining 11 projects that are being carried forward as the interim basin plan for the Glenn-Gibson Creek Basin. The proposed timeframes for completing these projects are indicated as short-term (within five years), intermediate-term (between five and ten years), and long-term (over ten years). There are no short-term projects identified in the Glenn-Gibson Creek Basin Plan. Three projects involving undersized pipes and culverts (GGB 2 and GGB 7) are recommended as intermediate-term projects.

The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project. The total estimated cost in 2019 dollars for all the projects currently identified for the Glenn-Gibson Creek Basin, rounded to the nearest $10,000, is $8,930,000.

All projects recommended in this master plan for the Glenn-Gibson Creek Basin are shown on **Map 8.4**.

Glenn-Gibson Creek Basin Data

Table 8.1

Glenn-Gibson Creek Basin Hydrologic Parameters

From the City of Salem 2000 *Stormwater Master Plan*, Table A-4

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
GD0000	26.5	35	47	73	43
GD0005	124.3	35	50	73	69
GD010A	30.2	0	5	73	104
GD0010B	38.8	35	56	73	95
GD0015	18.8	0	32	73	59
GD0020	52.2	0	50	73	44
GD0045	31.4	10	50	73	38
GD0057	17.5	15	50	73	47
GD0065	13.7	35	50	73	26
GD0075	17.8	30	50	73	25
GD0080	6.3	30	50	73	22
GD0085	13.3	30	50	73	28
GI0005	33.9	15	50	73	46
GI0020A	62.0	15	44	73	51
GI0020B	23.5	15	72	73	128
GI0025	18.3	35	45	73	47
GI0035	5.8	15	37	73	28
GI0045A	3.5	15	50	73	30
GI0045B	30.4	15	50	73	29
GI0050A	43.6	0	50	73	35
GI0050B	8.3	0	50	73	39
GI0055A	57.1	0	50	73	32
GI0055B	62.5	0	50	73	39
GI0060A	70.3	0	50	73	45
GI0060B	72.3	0	10	73	41
GI0065	220.1	0	18	73	73

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
GI0070A	61.3	0	2	70	38
GI0070B	92.5	0	2	70	38
GI0075A	83.5	0	2	70	39
GI0075B	134.5	0	0	70	47
GI0087	31.1	0	2	70	39
GI0090A	51.5	0	2	70	39
GI0090B	55.5	0	2	70	42
GI0095	81.7	0	2	70	47
GI0125	4.1	30	50	73	17
GI0130	16.1	35	55	73	56
GI0135	14.4	35	54	73	65
GI0140	17.7	35	50	73	68
GI0145A	30.6	35	50	73	48
GI0145B	29.7	35	50	73	40
GI0150A	36.7	35	50	73	40
GI0150B	43.9	15	49	73	40
GI0160	62.4	0	50	73	39
GI0170A	79.6	15	50	73	36
GI0170B	23.6	15	50	73	28
GI0180	30.8	0	50	73	38
GI0190	28.6	15	39	73	32
GI0195	42.9	0	48	73	32
GI0200	130.7	0	20	73	50
GI0210A	68.1	0	25	73	39
GI0210B	26.9	0	50	73	29
GI0215	52.3	5	50	73	44
GI0220	114.9	0	50	73	55
GI0223	101.6	15	50	73	44
GI0235A	36.8	0	0	73	39
GI0235B	59.7	0	0	73	45
GI0245A	159.0	0	2	70	54

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
GI0245B	55.8	0	2	70	34
GI0245C	65.8	0	0	70	39
GI0245D	37.6	0	2	70	34
GI0245E	52.1	28	2	70	39
GI0250	149.9	0	20	73	50
GI0255A	36.2	0	17	70	31
GI0255B	107.0	0	20	73	38
GI0260A	85.5	0	2	70	51
GI0260B	78.7	0	2	70	39
GI0265	112.0	0	2	70	63
GI0280	117.5	0	2	73	53
GI0285A	142.6	0	2	70	50
GI0285B	100.4	0	2	70	43
GI0285C	49.6	0	2	70	35
GI0285D	44.6	0	2	70	35
GI0285E	32.6	0	2	70	30
GL0005A	39.0	15	50	73	51
GL0005B	3.0	5	50	73	41
GL0015	32.2	35	51	73	51
GL0020	17.0	15	50	73	34
GL0025	26.3	15	50	73	50
GL0030A	25.2	5	5	73	35
GL0030B	70.3	35	50	73	44
GL0040	49.7	15	50	73	45
GL0045A	38.4	35	35	73	38
GL0045B	34.6	15	35	73	47
GL0050	19.1	15	50	73	27
GL0055	36.2	35	47	73	53
GL0060	26.6	5	50	73	35
GL0065A	44.0	35	48	73	45
GL0065B	25.3	35	50	73	35

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
GL0070A	32.2	15	50	73	32
GL0070B	21.3	5	50	73	31
GL0075A	16.7	35	50	73	26
GL0075B	20.7	35	50	73	26
GL0075C	65.7	15	15	73	46
GL0080	9.0	35	50	73	28
GL0090	5.1	35	35	73	53
GL0095	31.7	35	50	73	39
GL0100	27.4	35	50	73	34
GL0105	12.3	5	50	73	24
GL0115A	13.8	35	50	73	25
GL0115B	9.1	35	50	73	24
GL0015C	39.0	15	50	73	34
GL0120A	13.1	35	50	73	33
GL0120B	19.5	35	48	73	31
GL0130	10.1	5	50	73	20
GL0135	15.9	5	50	73	26
GL0140	30.2	5	50	73	33
GL0141	51.3	35	50	73	46
GL0145A	16.4	5	50	73	23
GL0145B	11.1	35	50	73	48
GL0155	19.8	0	50	73	39
GL0160A	62.5	0	49	73	46
GL0160B	55.6	0	50	73	40
GL0160C	77.6	5	5	73	47
GL0170	33.1	0	50	73	62
GL0175A	32.0	0	50	73	31
GL0175B	45.5	5	50	73	35
GL0180	60.3	35	50	73	43
GL0185	30.2	15	20	73	27
GL0190	12.1	5	5	73	21

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
GL0200	16.7	5	50	73	27
GL0205A	69.7	35	50	73	43
GL0205B	47.5	15	50	73	35
GL0214	43.4	5	30	73	31
GL0215A	96.4	0	20	73	37
GL0215B	60.7	0	20	73	34
GL0220A	106.6	0	15	73	43
GL0220B	125.0	0	8	70	47
GL0225A	55.1	0	2	78	27
GL0225B	43.1	0	2	78	26
GL0225C	35.7	0	2	70	27
GL0225D	112.0	0	2	70	51
GL0230	155.1	0	9	78	55
GL0235	135.5	0	4	74	57

Table 8.2

Glenn-Gibson Creek Basin Model Results for Selected Flow Locations

From the City of Salem 2000 *Stormwater Master Plan*, Table B-1

Storm Recurrence Flow Location Identifier	10-Year Storm Existing Peak Flow (cfs)	10-Year Storm Future Peak Flow (cfs)	10-Year Storm Future w/ Detention Peak Flow (cfs)	25-Year Storm Existing Peak Flow (cfs)	25-Year Storm Future Peak Flow (cfs)	25-Year Storm Future w/ Detention Peak Flow (cfs)	100-Year Storm Existing Peak Flow (cfs)	100-Year Storm Future Peak Flow (cfs)	100-Year Storm Future w/ Detention Peak Flow (cfs)
GGF1	27.8	42.1	42.1	36.8	53.0	53.0	49.1	67.4	67.4
GGF2	535.0	744.0	573.0	758.0	997.0	757.0	1090.0	1340.0	1010.0
GGF3	435.0	564.0	385.0	633.0	780.0	525.0	912.0	1090.0	716.0
GGF4	99.7	115.0	115.0	150.0	166.0	166.0	220.0	238.0	238.0
GGF5	141.0	163.0	106.0	209.0	236.0	154.0	302.0	337.0	220.0
GGF6	131.0	167.0	47.4	192.0	229.0	52.5	271.0	304.0	59.1
GGF7	50.1	52.7	13.9	75.4	77.5	17.7	110.0	112.0	21.9
GGF8	460.0	677.0	533.0	638.0	876.0	612.0	876.0	1170.0	707.0
GGF9	413.0	593.0	461.0	576.0	781.0	524.0	788.0	1020.0	593.0
GGF10	311.0	440.0	348.0	432.0	579.0	431.0	594.0	767.0	540.0
GGF11	148.0	178.0	96.7	210.0	245.0	111.0	296.0	337.0	126.0

Table 8.3

Glenn-Gibson Creek Basin Projects from 2000 Stormwater Master Plan Completed or Removed

DSIP Project ID	Location	Recommended Improvement	Status
GGB1	Wallace Road north of Rogers Lane	Replace undersized pipe	Completed
GGB5	Drainage system from Wintergreen and Brush College to Gibson Creek	Replace undersized pipe	Completed
GGB9	Glenn Creek crossing of Harritt Dr. 200 ft west of Wallace Rd.	Bridge	Completed
GGB10	Culvert crossing Harritt Dr.	Replace undersized culvert	Completed
GGB11	Culvert across Linwood St.	Replace undersized culvert	Completed
GGB12	Glenn Creek crossing of Orchard Heights Rd..	Bridge; Channelization/Bioengineering/Habitat	Completed
GGB13	Glenn Creek upstream of Orchard Heights Rd.	Channelization/Bioengineering/Habitat	No longer required
GGB14	Pipe along Glenn Creek road east of Windemere Dr.	Replace undersized pipe	Completed
GGB15	Glenn Creek crossing of Glenn Creek Rd.	Bridge	Completed
GGB18	Hidden Valley Detention Facility: Glen Creek just upstream of Glen Eden Ct	Add detention facility	Removed pending further analysis
GGB19	Gladow Pond: Gibson Creek upstream of Orchard Hts. Rd.	Add detention facility at Gladow Pond, or at pond approx. 1000 ft downstream	Removed - Outside of UGB, require further analysis
GGB23	Holiday Tree Farm Pond	Add detention facility	Removed - Outside of UGB, require further analysis

Table 8.4

Glenn-Gibson Creek Basin Plan Project List

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
GGB2	Rogers Lane	Replace undersized pipe; Replace undersized flow-equalizing culvert	$663,256	Intermediate term (5 - 10 years)
GGB3	Gibson Creek at Doaks Ferry Rd.	Bridge	$521,042	Long term (over 10 years)
GGB4	Gibson Creek at Brush College Rd.	Bridge; Replace undersized culverts	$629,359	Long term (over 10 years)
GGB6	Drainage system along Wilark Dr.	Replace undersized culvert	$457,445	Intermediate term (5 - 10 years)
GGB7	Culvert across Doaks Ferry Road north of Brush College Rd.	Replace undersized culvert	$36,696	Intermediate term (5 - 10 years)
GGB8	Culvert across Orchard Heights, east of Grice Hill Rd. Draining to Gibson Creek.	Replace undersized culvert	$125,854	Long term (over 10 years)
GGB16	System draining to Glenn Creek from the intersection of Ptarmigan and Doaks Ferry Rd.	Replace undersized pipe	$225,790	Long term (over 10 years)
GGB17	Culvert under Doaks Ferry Rd. 600 ft east of Mogul St.	Replace undersized culvert	$71,219	Long term (over 10 years)
GGB20	Orchard Heights Park	Add detention facility	$1,890,636	Long term (over 10 years)
GGB21	Grice Hill Road crossing-South	Add detention facility	$1,728,369	Long term (over 10 years)
GGB22	Grice Hill Road crossing-North	Add detention facility	$2,581,388	Long term (over 10 years)
		Subtotal	$8,931,053	

Notes:

The Glenn-Gibson Creek Basin Project List is based on results of 2000 *Stormwater Master Plan*, updated using staff input to reflect completed projects and current requirements.

Estimated costs include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%).

Each project has a small conveyance improvement allowance based on 5% of the subtotal.

The 2000 to 2019 dollar conversion is 1.668, which is based on the Engineering News Record Construction Cost Indices for Seattle, San Francisco, and Los Angeles.

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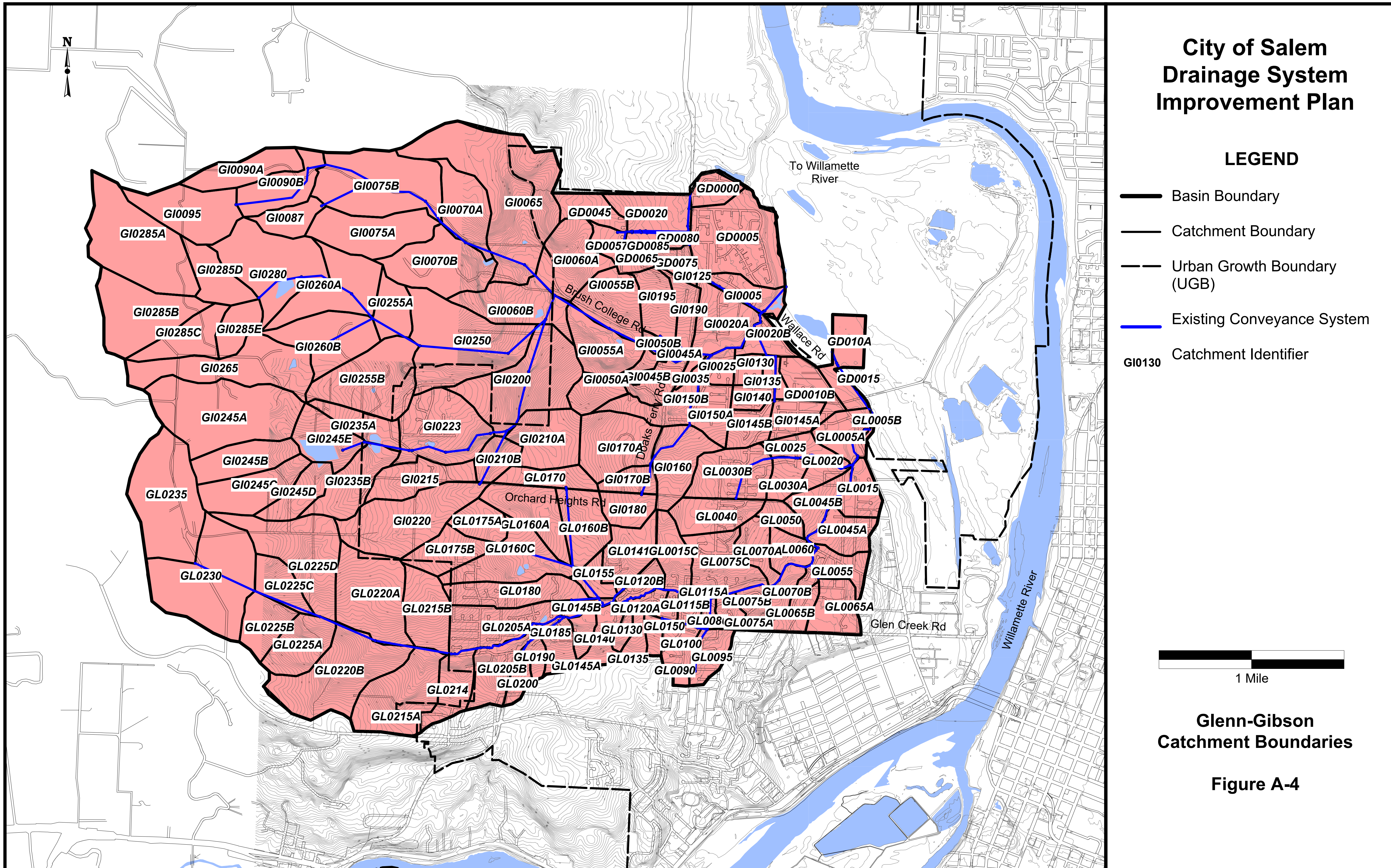

Map 8.1

Glenn-Gibson Creek Basin Boundaries

From the City of Salem 2000 *Stormwater Master Plan*, Figure A-4

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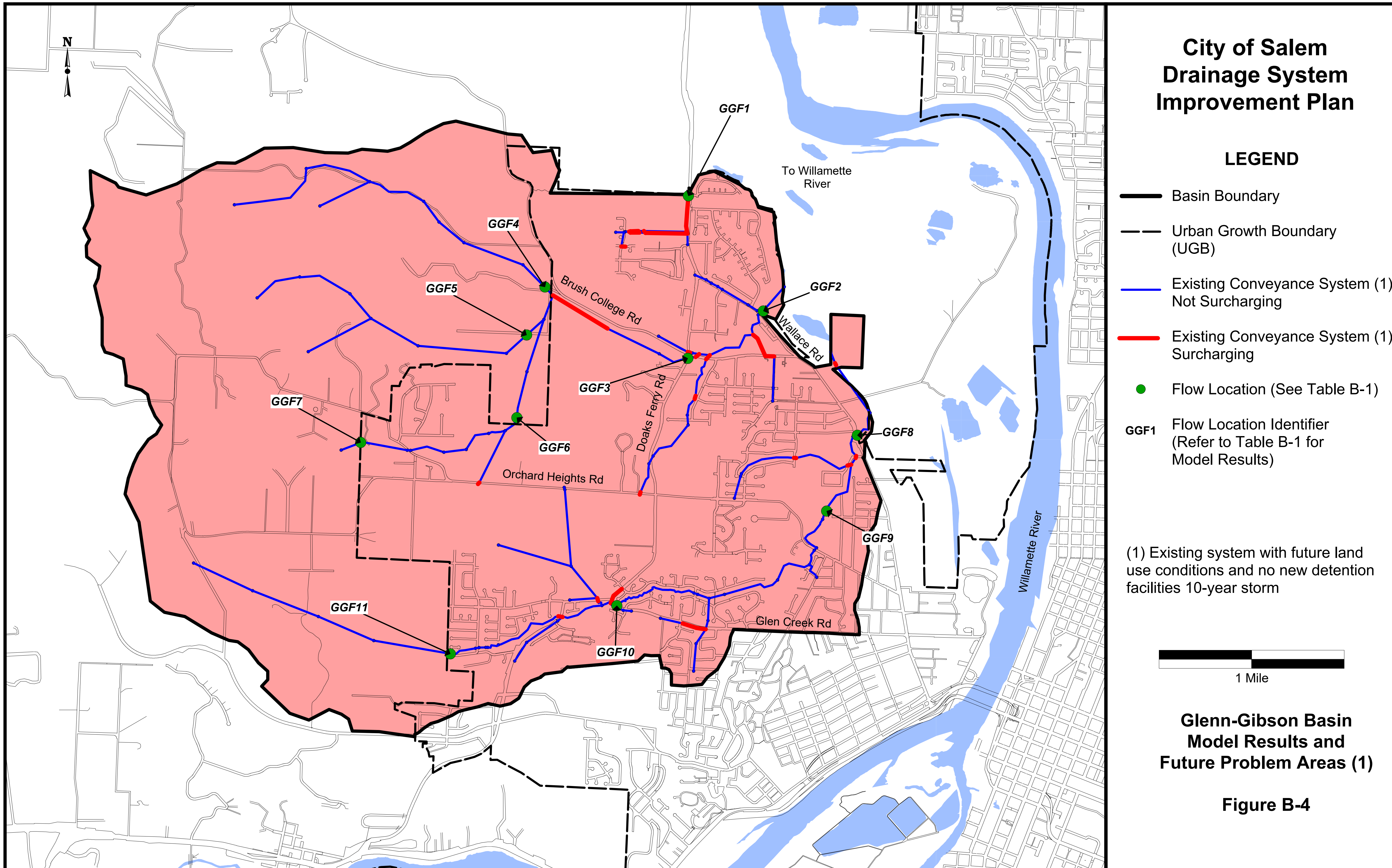

Map 8.2

Glenn-Gibson Creek Basin Model Results and Future Problem Areas

From the City of Salem 2000 *Stormwater Master Plan*, Figure B-4

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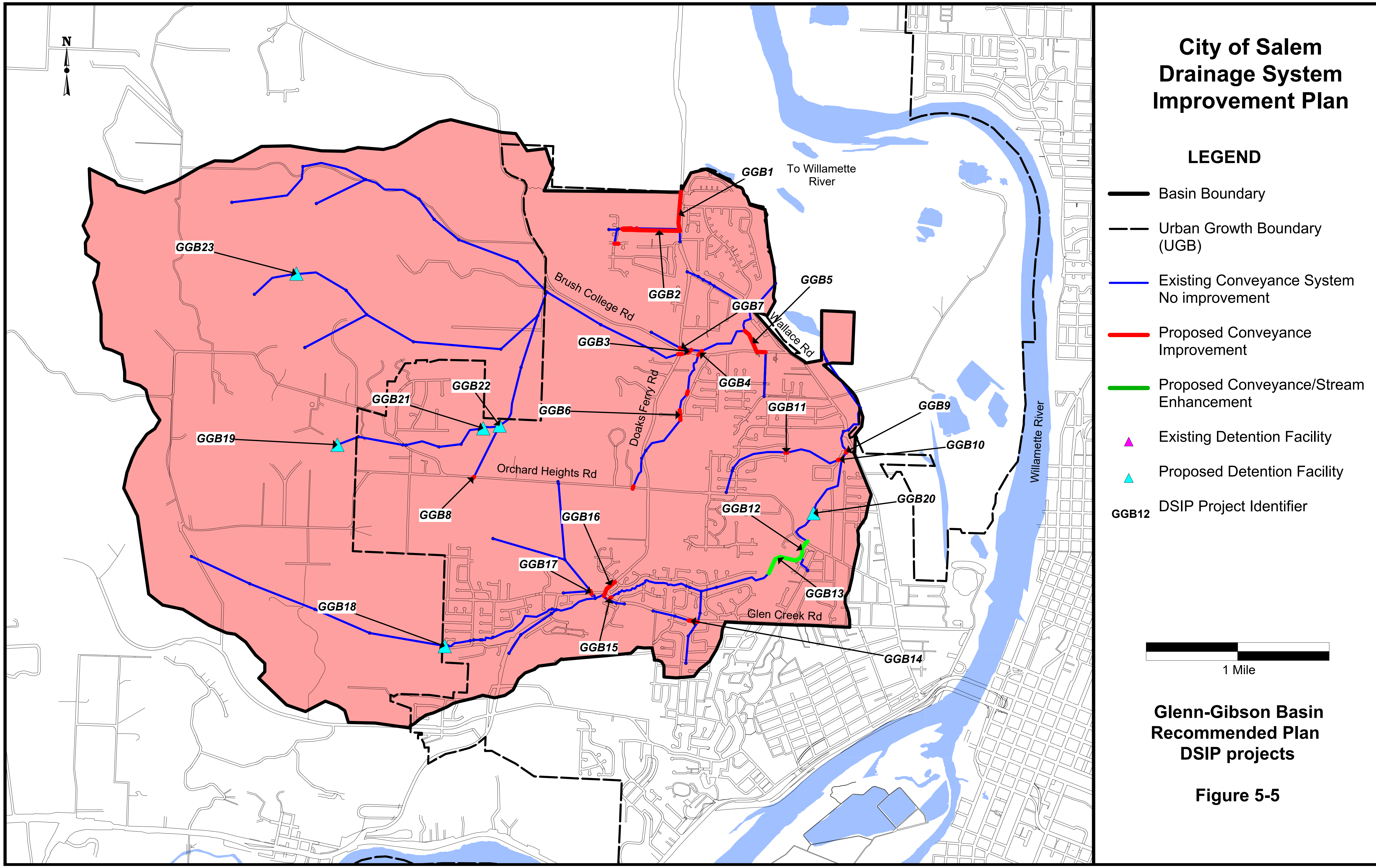
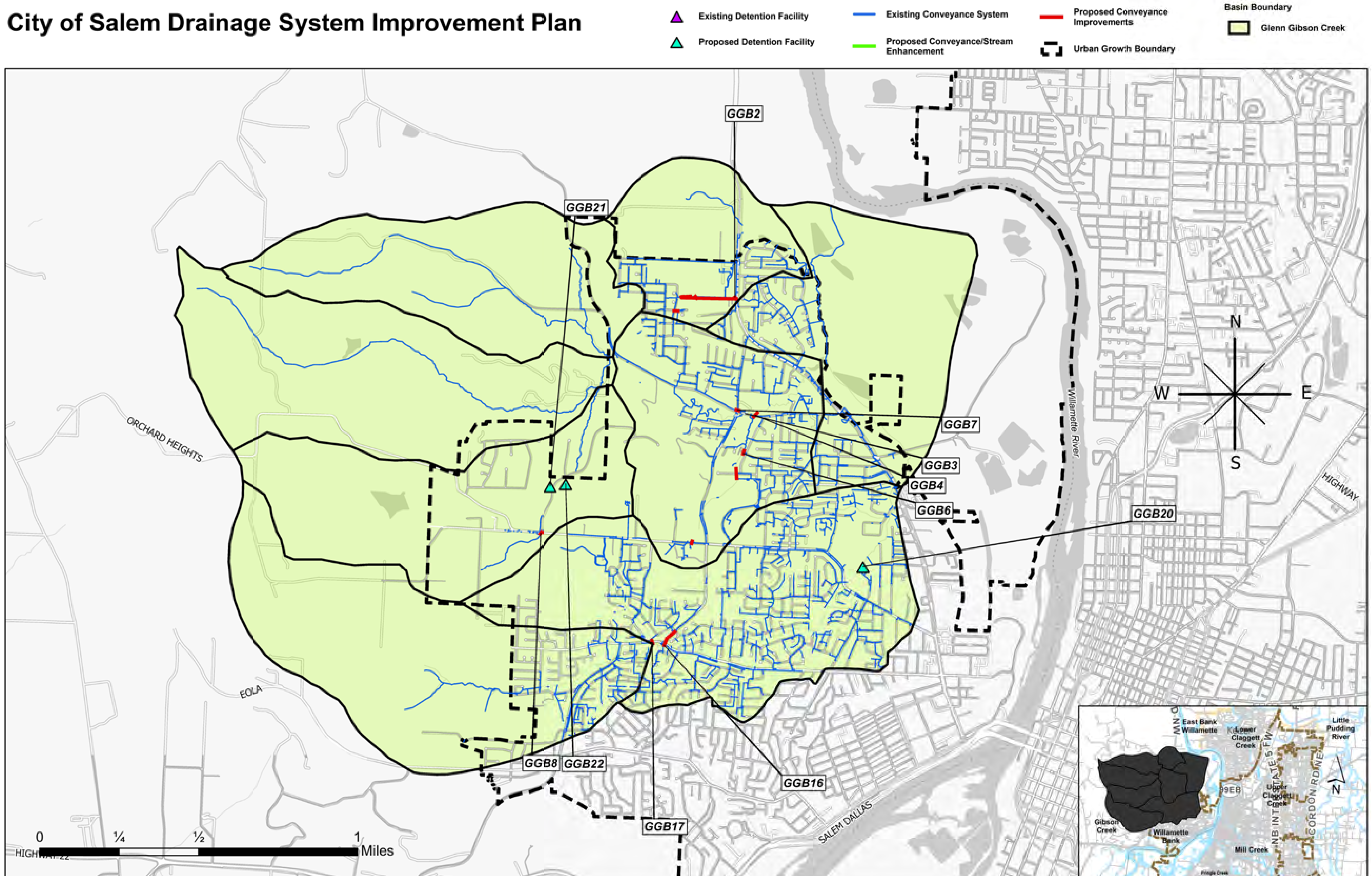


Map 8.3

Glenn-Gibson Creek Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure 5-5



Map 8.4

2020 Stormwater Master Plan Glenn-Gibson Bank Basin Recommended Project Locations

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Little Pudding Basin Plan

LITTLE PUDDING BASIN DESCRIPTION

The Little Pudding River basin is a long, narrow basin. It consists of 9.1 square miles and drains much of east Salem. Stormwater from the basin flows into the Little Pudding River, which eventually reaches the Willamette River near Canby (via the Pudding River). The basin has a flat slope. There are no major creeks in this basin. The drainage system consists of both open and closed conduits. Land use in the basin ranges from rural and agricultural in the outlying areas to residential and commercial closer to the center of Salem. High groundwater levels and saturated soils are a common complaint in the Little Pudding basin during the winter months.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR LITTLE PUDDING BASIN

The 2000 *Stormwater Master Plan* divided the Little Pudding Basin into 75 catchments (**Map 9.1**) and estimated existing and future impervious surface areas (**Table 9.1**).

Using a planning-level XP-SWMM model and assuming the existing conveyance system, no new detention facilities, and a 10-year design storm, the 2000 *Stormwater Master Plan* modeling results identified several segments that could be subject to surcharging (**Map 9.2**).

Peak discharges reported by the XP-SWMM model that correspond to the flow locations identified in **Map 9.2** are provided in **Table 9.2**.

There were 44 capital project improvements listed in the 2000 *Stormwater Master Plan* to address the needs of Little Pudding Basin. Of these projects, 33 involved replacing undersized pipes or culverts and seven involved bridge work. There were 17 projects that included habitat improvements, 12 of which were in conjunction with projects involving undersized pipes or culverts and one as part of a bridge project. **Map 9.3** shows the locations for the recommended projects. The total estimated cost for all 44 projects (in 2000 dollars) was $30,604,293.

LITTLE PUDDING BASIN PLAN

Detailed analysis of the Little Pudding Basin was not performed as part of the latest update to the *Stormwater Master Plan*. Until analysis is conducted and a new basin plan adopted, the results of the 2000 *Stormwater Master Plan*—updated using staff input to reflect completed projections and current requirements—will serve in the interim for the Little Pudding Basin Plan.

Of the 44 recommended improvement projects identified in the 2000 *Stormwater Master Plan*, three have been completed. See **Table 9.3**.

Table 9.4 identifies the remaining 41 projects that are being carried forward as the interim basin plan for the Little Pudding Basin. The proposed timeframes for completing these projects are indicated as short-term (within five years), intermediate-term (between five and ten years), and long-term (over ten years). Three projects involving replacing undersized culverts or pipes, are recommended as short-term projects. Eight projects—two involving bridges and six replacing undersized pipes/culverts, are recommended as intermediate-term projects.

The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project. The total estimated cost in 2019 dollars for all the projects currently identified for the Little Pudding Basin, rounded to the nearest $10,000, is $47,390,000.

All projects recommended in this master plan for the Little Pudding Basin are shown on **Map 9.4**.

Little Pudding Basin Data

Table 9.1

Little Pudding Basin Hydrologic Parameters

From the City of Salem 2000 *Stormwater Master Plan*, Table A-5

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
EF-1	68.2	30	53	92	202
EF-2A	91.8	40	50	92	230
EF-2B	81.8	40	50	92	240
EF-3	100.3	30	50	92	244
EF-4	63.2	10	40	87	154
EF-5	59.6	20	45	90	121
NF-1A	54.9	40	50	92	175
NF-1B	51.1	40	50	92	166
NF-1C	121.3	40	50	92	315
NF-2	171.2	30	50	92	514
NF-3	163.9	20	50	90	383
NF-4	50.6	5	50	87	253
NF-5A	110.3	5	40	87	200
NF-5B	75.0	5	40	87	142
NF-6	238.9	8	53	90	282
OB-1	109.2	25	50	87	315
SF-1	59.6	0	90	87	210
SF-10	82.7	40	50	92	166
SF-11	66.3	10	50	90	129
SF-12	90.5	40	71	92	307
SF-13	46.4	0	86	87	135
SF-14	47.2	5	51	90	89
SF-15	27.3	5	50	90	81
SF-2	132.7	30	56	92	264
SF-3	32.1	10	56	90	145
SF-4A	33.7	20	90	90	143

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
SF-4B	35.1	20	51	90	152
SF-4C	58.8	50	55	87	224
SF-5	81.5	30	57	92	207
SF-6A	31.4	30	50	92	109
SF-6B	42.0	30	50	92	113
SF-7	18.4	20	50	90	110
SF-8A	35.7	40	50	92	118
SF-8B	74.1	40	70	92	228
SF-9A	43.3	40	50	92	141
SF-9B	93.3	40	50	92	208
WF-10	170.6	0	5	87	243
EF-1	68.2	30	53	92	202
EF-2A	91.8	40	50	92	230
EF-2B	81.8	40	50	92	240
EF-3	100.3	30	50	92	244
WF-11	203.9	5	5	87	201
WF-12	77.4	5	40	87	120
WF-1A	83.0	40	50	92	178
WF-1B	95.8	40	50	92	180
WF-1C	49.7	40	64	92	156
WF-2	238.3	40	53	92	391
WF-3	142.6	30	50	92	234
WF-4	170.5	40	51	92	296
WF-5	63.0	40	50	92	152
WF-6	132.7	30	50	91	160
WF-7	40.4	10	45	90	96
WF-8	79.4	20	50	90	152
WF-9A	70.6	40	50	92	257
WMF-1	72.3	0	0	87	41
WMF-10	16.7	0	0	89	36
WMF-11	36.3	10	20	90	52

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
WMF-12	28.2	0	0	87	94
WMF-13A	90.6	0	0	87	97
WMF-13B	162.7	0	0	87	333
WMF-14	26.4	0	0	87	110
WMF-15	59.7	0	0	90	40
WMF-16	73.5	0	0	87	133
WMF-17	85.2	0	90	87	210
WMF-18	58.9	0	50	90	121
WMF-19	45.4	0	79	90	153
WMF-2	64.5	0	0	87	51
WMF-20	44.9	5	90	90	104
WMF-21	159.9	5	20	90	196
WMF-22	20.6	0	74	90	91
WMF-23	18.9	0	0	89	28
WMF-24	31.9	0	71	90	118
WMF-3	37.7	5	5	89	32
WMF-4	12.7	30	40	90	81
WMF-5	7.1	30	50	90	60
WMF-6	58.4	0	68	87	115
WMF-7	40.4	10	35	87	130
WF-11	203.9	5	5	87	201
WF-12	77.4	5	40	87	120
WF-1A	83.0	40	50	92	178
WF-1B	95.8	40	50	92	180
WF-1C	49.7	40	64	92	156
WMF-8	92.2	0	0	89	43
WMF-9	27.5	0	0	89	26

Table 9.2

Little Pudding Basin Model Results for Selected Flow Locations

From the City of Salem 2000 *Stormwater Master Plan*, Table B-1

Storm Recurrence Flow Location Identifier	10-Year Storm Existing Peak Flow (cfs)	10-Year Storm Future Peak Flow (cfs)	10-Year Storm Future w/ Detention Peak Flow (cfs)	25-Year Storm Existing Peak Flow (cfs)	25-Year Storm Future Peak Flow (cfs)	25-Year Storm Future w/ Detention Peak Flow (cfs)	100-Year Storm Existing Peak Flow (cfs)	100-Year Storm Future Peak Flow (cfs)	100-Year Storm Future w/ Detention Peak Flow (cfs)
LPF1	179.0	199.0	199.0	215.0	244.0	244.0	262.0	286.0	286.0
LPF2	103.0	109.0	109.0	122.0	129.0	135.0	147.0	154.0	161.0
LPF3	435.0	461.0	461.0	532.0	545.0	545.0	633.0	650.0	650.0
LPF4	323.0	337.0	337.0	393.0	396.0	396.0	464.0	479.0	479.0
LPF5	182.0	187.0	187.0	213.0	216.0	216.0	258.0	264.0	264.0
LPF6	131.0	132.0	132.0	150.0	154.0	154.0	181.0	186.0	186.0
LPF7	50.0	53.7	53.7	60.0	61.0	61.0	73.8	74.8	74.8
LPF8	103.0	109.0	109.0	124.0	128.0	128.0	149.0	154.0	154.0
LPF9	129.0	132.0	132.0	150.0	154.0	154.0	179.0	186.0	186.0
LPF10	84.7	99.2	99.2	103.0	114.0	114.0	126.0	136.0	136.0
LPF11	59.9	63.9	63.9	70.8	75.1	75.1	84.8	89.2	89.2
LPF12	136.0	165.0	165.0	158.0	196.0	196.0	193.0	229.0	229.0
LPF13	123.0	149.0	149.0	149.0	174.0	174.0	182.0	209.0	209.0
LPF14	306.0	338.0	338.0	371.0	407.0	407.0	456.0	493.0	493.0
LPF15	176.0	181.0	181.0	218.0	220.0	220.0	272.0	274.0	274.0

Table 9.3

Little Pudding Basin Projects from 2000 Stormwater Master Plan Completed or Removed

From the City of Salem 2000 Stormwater Master Plan, Table B-1

DSIP Project ID	Location	Recommended Improvement	Status
LPB4	Between Kate Rd. NE and Hazelgreen Rd. NE	Replace undersized culvert; Channelization/ Bioengineering/Habitat	
LPB21	Swegle west of Royalty Dr. and west end of Future Dr. NE	Replace undersized culverts	Completed
LPB20	Carolina NE at Cordon Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	Completed

Table 9.4

Little Pudding Basin Plan Project List

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
LPB1	Lake Labish Rd NE, North of Hazel Green Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,666,886	Long term (over 10 years)
LPB2	Crossing Hazel Green Rd. NE	Bridge	$818,780	Long term (over 10 years)
LPB3	Crossing Manning Dr.NE and Kale Rd. NE	Bridges	$1,042,083	Intermediate term (5 - 10 years)
LPB5	South of Settlers Dr. NE, Flintlock to Siesta	Replace undersized pipe	$1,258,211	Intermediate term (5 - 10 years)
LPB6	Crossings of Hayesville, Jan Ree and Rebecca NE	Replace undersized culverts	$417,697	Intermediate term (5 - 10 years)
LPB7	South of Hayesville Dr. NE	Replace undersized culvert	$783,021	Long term (over 10 years)
LPB8	Along Cordon Rd. NE, south of Hayesville Dr.	Replace undersized pipe	$525,388	Long term (over 10 years)
LPB9	Along Cordon Rd. NE, between Hayesville Rd. and Silverton Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$5,144,576	Long term (over 10 years)
LPB10	Herrin Rd. NE, west of Cordon Rd.	Replace undersized pipe	$498,562	Long term (over 10 years)
LPB11	Cordon Rd. NE, south of Silverton Rd.	Bridge	$1,786,428	Long term (over 10 years)
LPB12	From Indiana/Muncie to Mooreland/Mendocino NE	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,882,449	Long term (over 10 years)
LPB13	Oak Park Dr./ Cordon Rd.	Channelization/ Bioengineering/ Habitat	$1,951,970	Long term (over 10 years)
LPB14	Carolina NE south, east of San Diego	Channelization/ Bioengineering/ Habitat; Bridge	$1,598,615	Long term (over 10 years)
LPB15	Culverts at Sunnyview/ Brown, 47th Ave/Cedro Loop	Replace undersized culverts	$440,474	Short term (within 5 years)
LPB16	East side of Salem Academy	Replace undersized culvert	$122,073	Intermediate term (5 - 10 years)
LPB17	Center St. at Citation NE	Replace undersized culvert	$339,124	Intermediate term (5 - 10 years)
LPB18	Culverts at Hudson NE, Eldin NE, State St., , Channel improvements East of Evelyn, north of Hudson	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$843,283	Long term (over 10 years)

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
LPB19	East of Elma, Macleay to Durbin and along Durbin SE to Beck	Replace undersized pipe	$936,386	Long term (over 10 years)
LPB22	Regal Dr NE, Camelot Dr NE, Kingdom Way NE, Squire Ct. NE	Replace undersized pipe	$1,886,289	Short term (within 5 years)
LPB23	South of Auburn Rd. and Cordon Rd. to Cordon Rd. north of Center St.	Replace undersized culvert; Replace undersized pipe; Channelization/ Bioengineering/ Habitat	$1,564,301	Long term (over 10 years)
LPB24	From 46th and Mahrt to East of Clearwater and Avens	Replace undersized culvert; Replace undersized pipe	$1,380,447	Long term (over 10 years)
LPB25	Cordon Rd at Powderhorn and north of Arrowood Ct. SE	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$896,846	Long term (over 10 years)
LPB26	Wagon SE to Pennsylvania at Cordon Rd.	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,128,576	Long term (over 10 years)
LPB27	West of Seattle Slew Dr SE and across Clydesdale Dr SE	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$539,382	Long term (over 10 years)
LPB28	Highway 22, west of Kuebler/Cordon	Replace undersized culvert	$679,498	Long term (over 10 years)
LPB29	Crossing Arabian Ave SE and the East end of Red Cherry Ct. SE	Replace undersized pipe	$352,284	Long term (over 10 years)
LPB30	West end of Red Cherry, Black Cherry Ct.	Replace undersized pipe	$213,091	Intermediate term (5 - 10 years)
LPB31	Highway 22 and Campbell St. SE	Replace undersized culvert	$664,313	Short term (within 5 years)
LPB32	Across Kuebler/Cordon at HWY 22 and at the SW corner of HWY 22 and Kuebler/Cordon	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$743,675	Long term (over 10 years)
LPB33	Buckhorn/Burntwood and 49th Ave. /Burntwood	Replace undersized pipe	$882,213	Long term (over 10 years)
LPB34	Shenandoah Dr. SE, 49th/ Adobe, 48th Ct. SE	Replace undersized culvert; Replace undersized pipe	$1,566,429	Long term (over 10 years)
LPB35	Rickey to Macleay SE, Pennsylvania Ave SE, 46th to 47th Ave SE	Replace undersized pipe	$1,600,744	Long term (over 10 years)

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
LPB36	Cordon at Caplinger Rd. SE	Bridge	$818,780	Intermediate term (5 - 10 years)
LPB37	East of Macleay Rd. between Cordon and Caplinger	Channelization/ Bioengineering/ Habitat	$1,906,491	Long term (over 10 years)
LPB38	Macleay Rd. SE	Bridge	$521,042	Long term (over 10 years)
LPB39	Macleay and Cordon Rd.	Channelization/ Bioengineering/ Habitat	$568,531	Long term (over 10 years)
LPB40	Cordon at Macleay	Replace undersized culvert	$133,089	Intermediate term (5 - 10 years)
LPB41	Cordon Rd. at Gaffin and south of Gaffin	Replace undersized culvert; Channelization/ Bioengineering/ Habitat	$1,352,475	Long term (over 10 years)
LPB42	South of Highway 22 and east of Cordon Rd.	Channelization/ Bioengineering/ Habitat	$2,435,571	Long term (over 10 years)
LPB43	Near Arabian Ave. and crossing Macleay Rd. west of 49th	Replace undersized culverts	$1,420,061	Long term (over 10 years)
LPB44	Indiana Ave NE, west of 49th, Glendale Ave NE, Oak Park Dr NE, and Greenbrook Dr. NE	Bridges	$2,084,166	Long term (over 10 years)
		Total	$47,394,298	

Notes:

The Little Pudding Creek Basin Project List is based on results of 2000 *Stormwater Master Plan*, updated using staff input to reflect completed projects and current requirements.

Estimated costs include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%).

Each project has a small conveyance improvement allowance based on 5% of the subtotal.

The 2000 to 2019 dollar conversion is 1.668, which is based on the ENR Construction Cost Indices for Seattle, San Francisco, and Los Angeles

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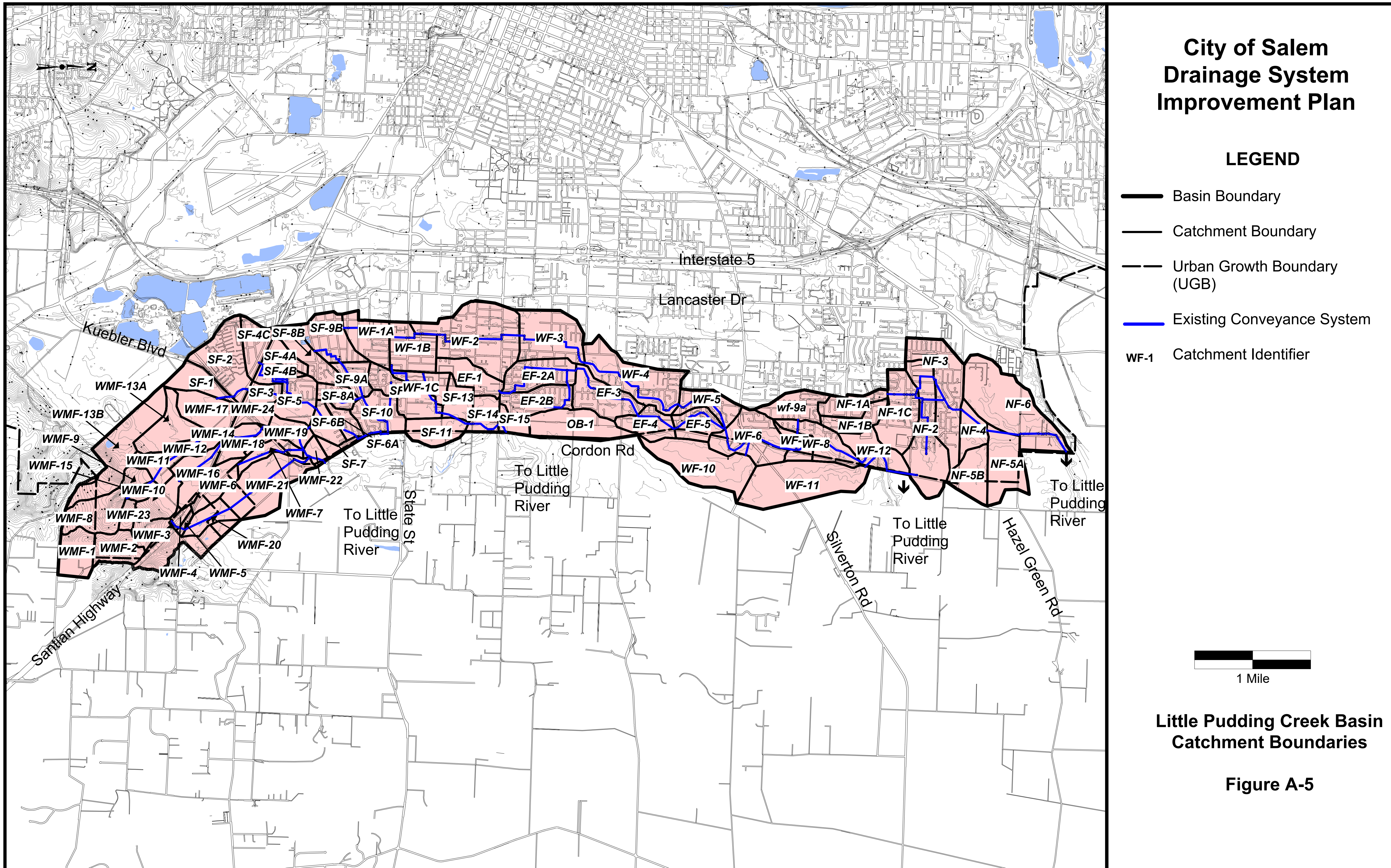
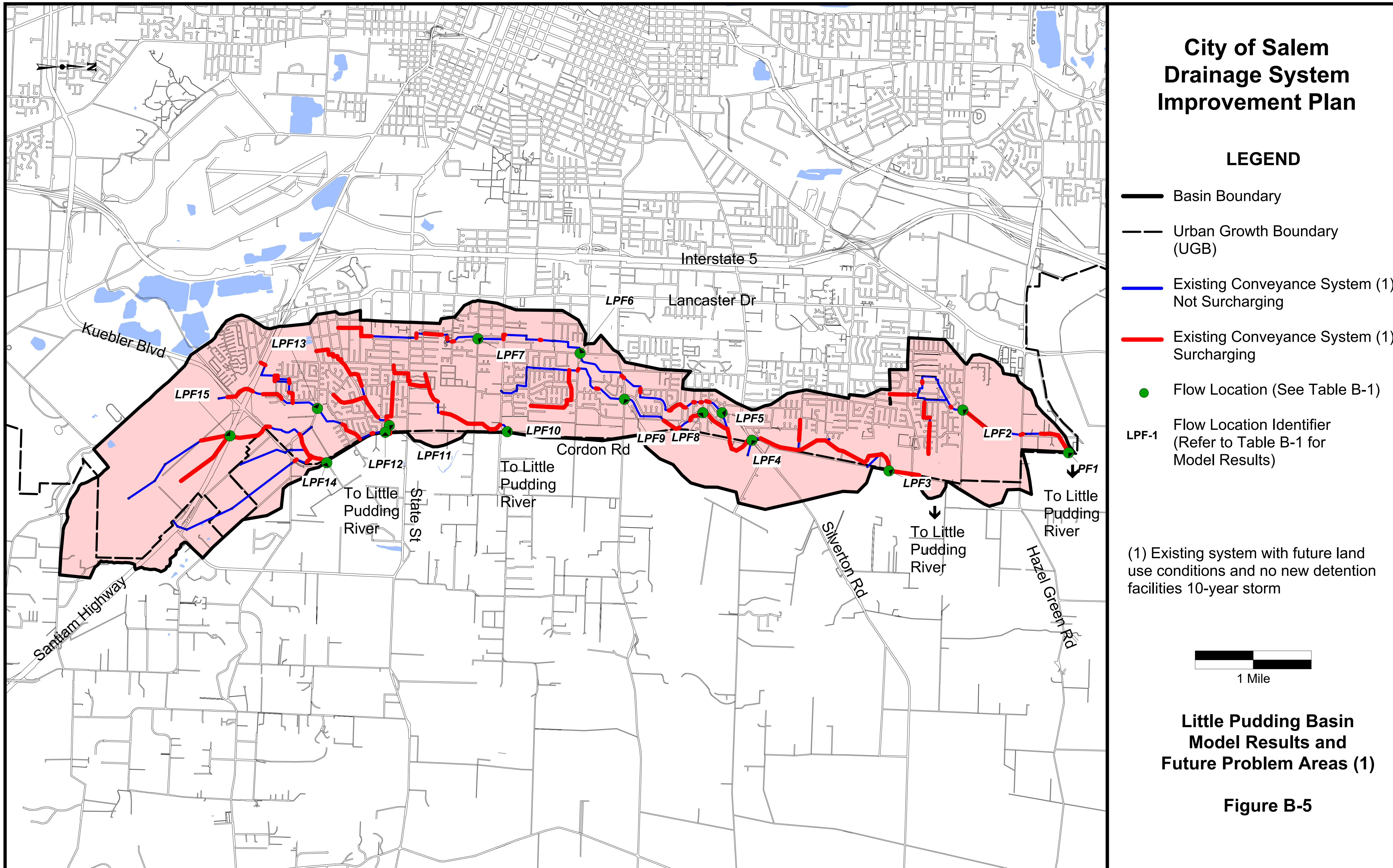


Map 9.1

Little Pudding Basin Boundaries

From the City of Salem 2000 *Stormwater Master Plan*, Figure A-5



Map 9.2

Little Pudding Basin Model Results and Future Problem Areas

From the City of Salem 2000 *Stormwater Master Plan*, Figure B-5

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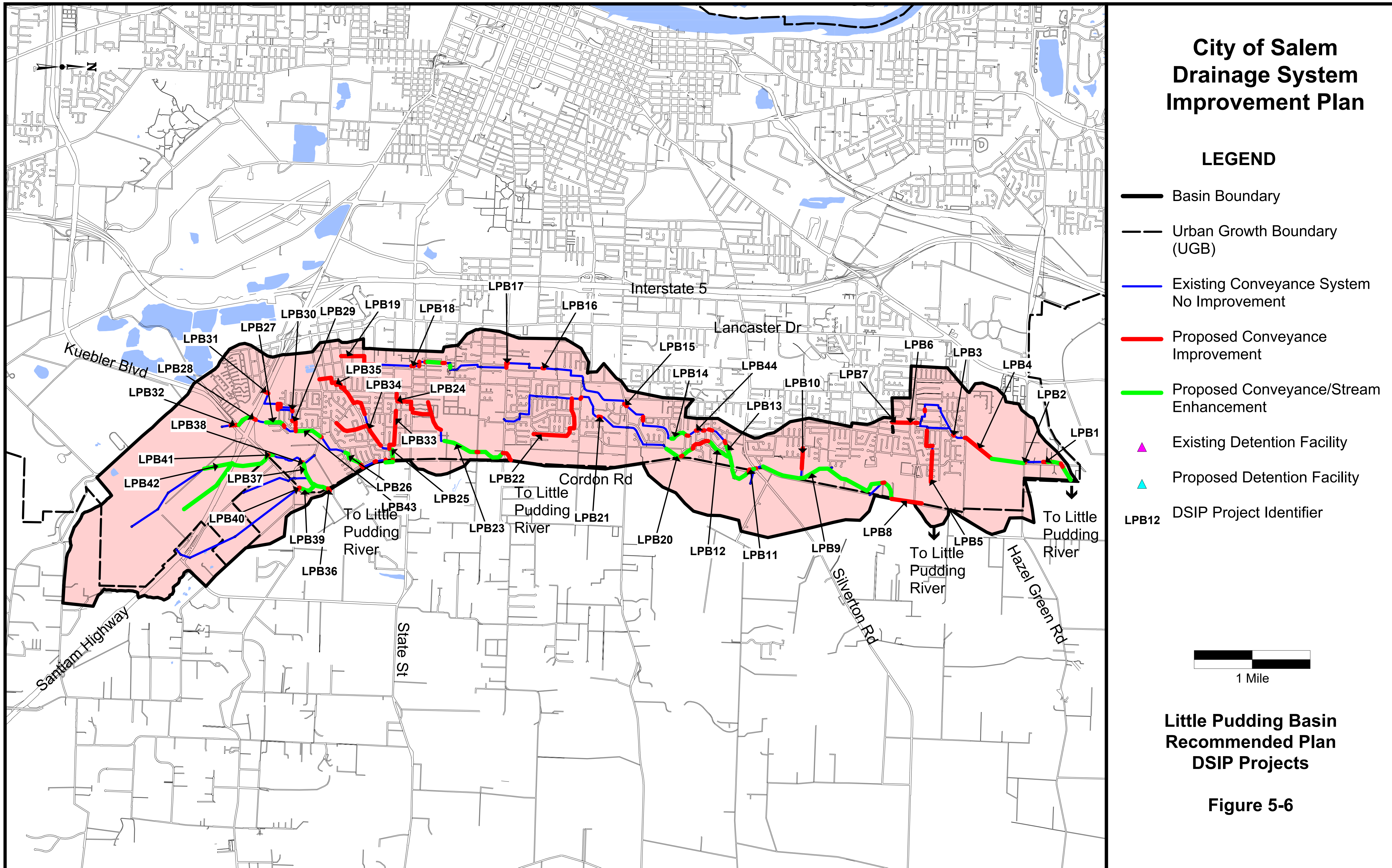

Map 9.3

Little Pudding Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure 5-6

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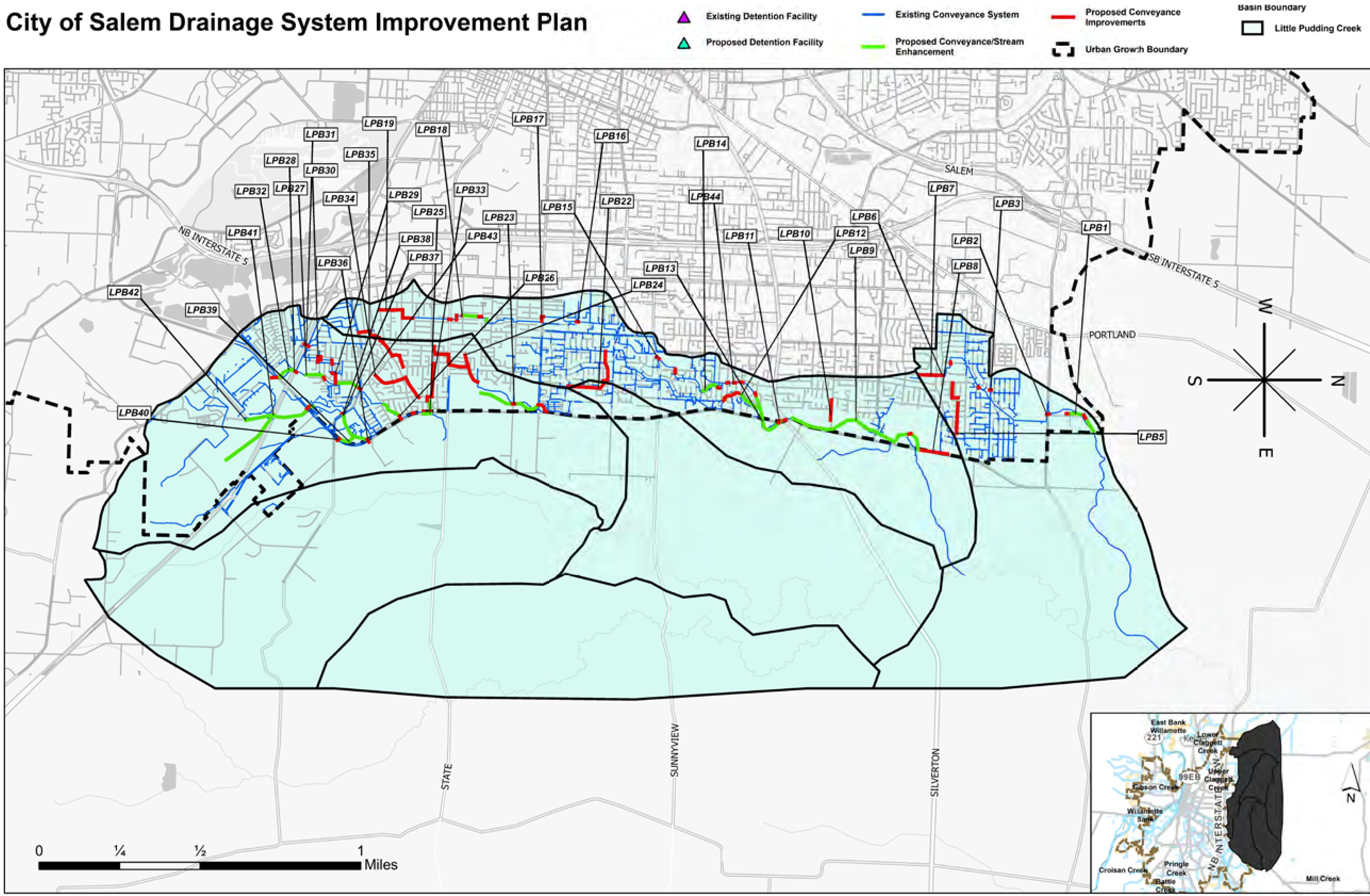

Map 9.4

2020 Stormwater Master Plan Little Pudding Basin Recommended Project Locations

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Lower Claggett Creek Basin Plan

LOWER CLAGGETT CREEK BASIN DESCRIPTION

The Lower Claggett Creek basin is 1.5 square miles and located in north Salem near the city of Keizer. It is mildly sloped with one primary drainage path, Labish Ditch, which drains to Claggett Creek downstream of Keizer. **Map 9.1** shows the basin boundaries. The basin is currently zoned for industrial, commercial, public, and residential agricultural uses.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR LOWER CLAGGETT CREEK BASIN

In the 2000 *Stormwater Master Plan* it was determined that "the Lower Claggett Creek basin presents very few development opportunities that cannot be handled with a detailed analysis of the particular site, if needed." For this reason, the Lower Claggett Creek basin was not modeled in 2000 and no projects were identified for the basin in the 2000 *Stormwater Master Plan*.

LOWER CLAGGETT CREEK BASIN PLAN

This *Stormwater Master Plan* carries forward the conclusion of the 2000 *Stormwater Master Plan* that basin-wide analysis is not necessary and that development-specific stormwater facilities will be sufficient to address stormwater-related issues into the foreseeable future. Accordingly, until a detailed hydrologic and hydraulic analysis is conducted, the Lower Claggett Creek Basin Plan consists of **Map 9.1** delineating the basin boundaries.

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Lower Claggett Creek Basin Data

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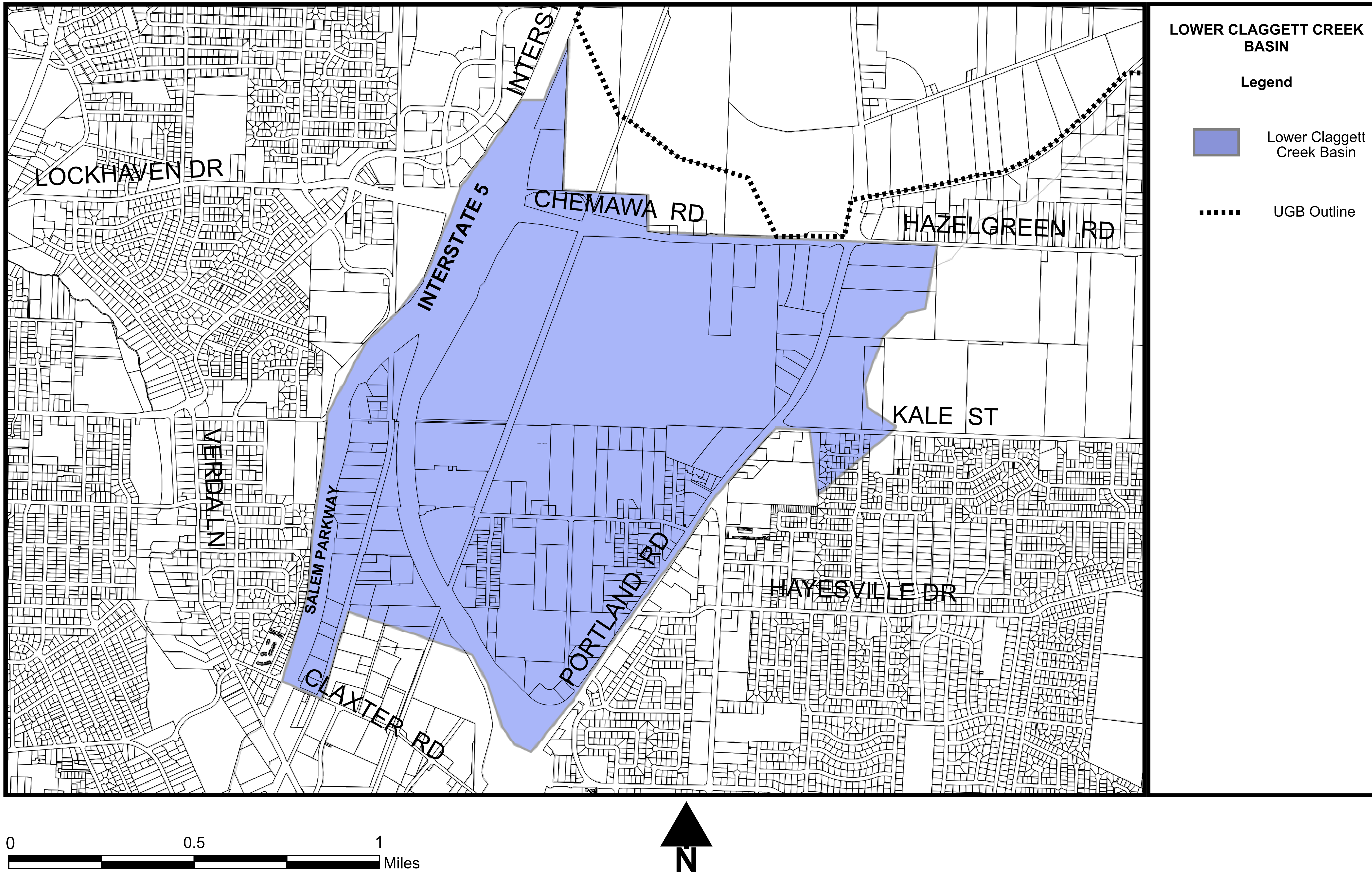

Map 10.1

Lower Claggett Creek Basin Boundaries

Mill Creek Basin Plan

MILL CREEK BASIN DESCRIPTION

Mill Creek is the largest creek basin within the City of Salem. Originating in the foothills of the Cascade Mountain Range, the watershed varies in elevation from approximately 116 feet at its confluence with the Willamette River to approximately 2,200 feet along its eastern boundary. It has a mean watershed elevation of 530 feet and a drainage area of approximately 111 square miles. [Unless otherwise stated, all elevations mentioned in this document are in the National Geodetic Vertical Datum of 1929 (NGVD 29).]. Incorporated communities in the Mill Creek basin include: City of Stayton, City of Aumsville, City of Turner, and City of Salem. From its headwaters in the lower foothills of the Cascade Mountains, Mill Creek flows west through the Cities of Stayton and Aumsville to the City of Turner and then flows northwest through the City of Salem. Major tributaries to Mill Creek include Beaver Creek, McKinney Creek, and Battle Creek. Salem Ditch (also known as Stayton Ditch) diverts water from the Santiam River to Mill Creek. The diversion provides water for irrigation and augments low flow conditions in Mill Creek during the summer months.

Only the portions of Mill Creek Basin within the Salem city limits were studied in detail for this analysis. The upstream extent of the detailed study is located approximately 0.75 miles upstream of the Mill Creek Correctional Facility. The downstream extent of the detailed study area is the confluence with the Willamette River. The drainage area for the detailed study area is 8.3 square miles. It is located north of the Pringle Creek Basin and south of the East Bank, Upper Claggett Creek, and Little Pudding River basins. Most of the detailed study area is developed residential, commercial, gravel mining, and industrial land use. A small portion of the southeast corner is undeveloped agriculture, forest, grassland, and pasture. Several large quarry ponds are in the upstream portion of the detailed study area.

The City of Salem urban growth boundary (UGB) encompasses approximately 93% of the detailed study area. The minimum and maximum elevation within the study area are 120 feet and 650 feet, respectively. There are two major water diversions from Mill Creek within the City of Salem. The Shelton Ditch diversion, which is located approximately 1,500 feet downstream of Hawthorne Avenue, is a constructed channel that is used to reduce flood risk along Mill Creek. Shelton Ditch outfalls into Pringle Creek in Pringle Park. The Mill Race diversion, located approximately 300 feet downstream of 21st Street, is a constructed channel that is primarily used to divert water to the historic Thomas Kay Woolen Mill. The Mill Race outfalls into Pringle Creek downstream of Liberty Street SE. **Map 11.1** shows the limits of the Mill Creek Basin detailed study area, the entire extent of the Mill Creek Basin, and the Mill Creek drainage network.

The Mill Creek Basin detailed study area is relatively flat with a few hills along the southeastern boundary. The northeast portion is largely composed of McNary Field, developed industrial land use, and a few pockets of residential area. Downtown Salem, Willamette University, and the Oregon State Capital complex are located in the northwest portion of the study area. The central portion of the detailed study area is composed of commercial and government development, with significant amounts of impervious area. This includes the Oregon State Hospital, the Oregon State Penitentiary, and the ODOT Motor Pool. The southeast portion of the detailed study area includes several large quarry pond lakes, Corban University, industrial land use, and a few agricultural areas.

The low lying and relatively flat terrain adjacent to the streams makes much of the Mill Creek detailed study area flood prone. The relatively flat terrain that forms the eastern portion of Pringle Creek Basin and its close proximity to Mill Creek allows high flows in Mill Creek to overflow into the Pringle Creek Basin. Several privately-owned large quarry ponds located southeast of the Interstate 5 and Highway 22 interchange with a total area of approximately 200 acres are used to route and store high flows in Mill Creek. Additional detention facilities and wetlands with a total area of approximately 60 acres were constructed east of the quarry ponds as part of the Mill Creek Corporate Center development.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR MILL CREEK BASIN

In the *Stormwater Master Plan* (SWMP) developed for the City of Salem by Montgomery Watson (2000), portions of the Mill Creek Basin were modeled using a planning-level XP-SWMM model, which provided coupled hydrologic and hydraulic modeling of the watershed and stormwater system. In that effort, the Mill Creek Basin was divided into 91 subbasins. The primary purpose of the model was to detect areas within the storm sewer network that were at-risk of surcharge during the 10-year 24-hour SCS Type-1A rainfall event. Models were developed for existing and full build-out conditions. The Mill Creek, Shelton Ditch, and Mill Race channels were not evaluated as part of the 2000 SWMP.

The findings of the 2000 SWMP included 39 recommended Capital Improvement Projects (CIPs) within the Mill Creek Basin. The recommendations included bridge/culvert replacements, channelization, vegetation modifications, and detention facility construction. The total cost for the recommended CIPs was $20,986,930 in 2000 dollars.

SUMMARY OF THE 2019 MILL CREEK BASIN PLAN

For modeling purposes, the 2019 Mill Creek Basin Plan (City of Salem 2019b) divided the basin into 108 subbasins as shown in **Map 11.2**.

Of the 108 subbasins, seven are partially located outside of the Salem City Limits and two subbasins are located partially outside of the UGB. During high flows in the Mill Creek Basin, overflows from Mill Creek enter the Pringle Creek basin. Consequently, models developed for the Mill Creek Basin and Pringle Creek Basin were merged into a single XP-STORM model. The combined model extent is shown in **Map 11.3**.

RECOMMENDED STORMWATER CAPITAL IMPROVEMENT PROJECTS

There were 39 capital improvement projects listed in the 2000 *Stormwater Master Plan* to address the needs of Mill Creek Basin. Projects included replacing undersized pipes and culverts, installing new bridges, and constructing habitat improvements. Of the 39 projects in the 2000 *Stormwater Master Plan*, 11 have been completed and two have been determined to no longer be needed. **Table 11.1** lists the projects that have been completed, superseded, or are considered no longer required.

The remaining 26 projects from the 2000 *Stormwater Master Plan* are carried forward into this master plan. The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project.

The 2019 *Mill Creek Basin Plan* recommended eight new stormwater capital projects. The new projects are summarized below with the locations shown on **Map 11.4**. Additional details for these projects are provided in the 2019 *Mill Creek Basin Plan*.

The recommended stormwater capital improvement projects were divided into three categories, short, intermediate, and long-term. Short-term projects are recommended for implementation within the next five years. Intermediate-term projects are recommended to be implemented in the next 5 to 10 years. Long-term projects are recommended to be implemented after 10 years. All cost estimates are in 2019 Dollars.

The project with the highest cost estimate also has the highest potential benefit. Project MC-02 involves converting the three quarry ponds adjacent to Mill Creek and upstream of I-5 into three flood control areas. If completed, model results indicate that peak flows downstream at the Mission Street Bridge would decrease by 24% for a 10-year storm event and 12% for a 100-year storm event. The project includes property and easement acquisition and involves construction of berms and outlet structures.

The project also requires excavation of material from the quarries. Excavation and hauling can be accomplished either as part of the existing private gravel mining operation and completed prior to project construction or incorporated into the project construction budget. If the project budget includes excavation, the cost is prohibitively expensive at approximately $200M. If the project does not include general excavation and haul costs, the estimate drops to approximately $25M. Both cost estimates are provided in the 2019 *Mill Creek Basin Plan*, but only the project with the lower cost estimate is recommended for consideration in the *Stormwater Master Plan*.

Short-Term CIPs

The following are the recommended short-term stormwater CIPs in recommended order of implementation. Detailed cost estimates are provided in the 2019 Mill Creek Basin Plan.

Project No. MC-01C - Vegetation management along Mill Creek downstream of North High School

Description: Remove invasive plant species and trim woody vegetation to acceptable limits along 550 feet of Mill Creek downstream of North High School. This project will require the acquisition of a 30-ft wide stormwater maintenance easement along both banks of Mill Creek.

Results: The vegetation management decreases flood risk near North High School for the 10-year food event. For the 100-year event the flood extent decreases near North High but there is also a slight inundation extent increase along Mill Creek, downstream of North High School.

Project No. MC-01F - Vegetation management along Shelton Ditch between 17th Street and Airport Road

Description: Remove invasive plant species and trim woody vegetation to acceptable limits along 5,500 feet of Shelton Ditch between 12th Street and Airport Road. This project will require the acquisition of a 30-ft wide stormwater maintenance easement along both banks of Shelton Ditch.

Results: Model results indicated a significant decrease of flood risk for the 25-, 50-, and 100-year flood events in the areas adjacent to Shelton Ditch downstream of the Shelton Ditch weir. This included residential areas adjacent to Shelton Ditch, east of 25th Street. The flood risk slightly increased downstream of the project near the Shelton Ditch Winter Street bridge.

Project No. MC-01E - Replace Waller Dam with Adjustable Crest Weir

Description: Replace Waller Dam with a 46-ft long adjustable crest dam.

Results: This alternative was effective at flood risk reduction along State Street and Ferry Street in the vicinity of Waller Dam for flood events with a return period of 25-years or less. For these smaller events, there was a small increase in flood risk for areas located downstream of Court Street.

Project No. MC-01G - Replace Ditch Culverts Along Turner Road East of Airport

Description: Replace nine culverts with 3-ft circular RCPs and 9 culverts with 4-ft circular RCPs along Turner Road east of McNary Field. The average culvert length is 45-ft.

Results: This alternative helped reduce flooding along Turner Road and some parts of the airport for both the 50- and 100-year flood events.

Intermediate-Term CIPs

Project No. MC-01B - Replace Winter Street Bridge over Mill Creek

Description: Includes the replacement of the Winter Street Bridge over Mill Creek to increase the bridge's hydraulic capacity. Assumed 55-ft span, 75-ft roadway width, and a 4-ft thick bridge deck with no piers.

Results: The bridge replacement significantly lowered flooding extent upstream of Winter Street to North High for the 50- and 100-year flood events. The bridge replacement resulted in a minor reduction in flood risk for the 25-year flood event.

Project No. MC-01D - Replace 17th Street Bridge over Mill Creek

Description: Includes the replacement of the 17th Street Bridge over Mill Creek to increase the bridge's hydraulic capacity. Assumed 80-ft total span, 65-ft roadway width, a 3-ft thick bridge deck, and 3 rows of 1-ft wide piers.

Results: This alternative significantly reduced upstream flooding for the 25-,50-, and 100-year flood events. The bridge replacement also reduced the flood risk in the vicinity of Mill Race by decreasing the floodwaters spilling out of Mill Creek and entering Mill Race at 17th Street. This alternative slightly increased the flood risk along Mill Creek downstream of 17th Street. The Winter Street bridge replacement (Project No. MC-01B) and the vegetation management downstream of North High School (Project No. MC-01C) help offset the additional flood risks downstream of the 17th Street bridge.

Long-Term CIPs

The following are the recommended long-term stormwater CIPs in recommended order of implementation. Detailed cost estimates are provided in the 2019 Mill Creek Basin Plan.

Project No. MC-01A - Replace stormwater pipes along B Street and west of State Hospital storage ponds

Description: Includes the replacement of 2,950 linear feet of stormwater pipe along B Street with 5-ft circular RCP and 2,850 linear feet of stormwater pipe downstream of the State Hospital storage pond with 3.5-ft circular RCP.

Results: In the existing conditions model, local flooding started to occur along B Street during the 50-year storm event, and local flooding started to occur near the State Hospital ponds during the 100-year storm event. Model output indicates a significant reduction in flood risk near B Street between 18th Street and Breys Avenue for both the 50- and 100-year flood events. There was also a significant reduction in flood risk for the residential area located west of Walker Park. However, some areas near the storage pond along 25th will still flood during the 100-year event.

Project No. MC-02 - Convert quarry ponds into 3 large flood storage areas, construct control structure for each pond, add levees, raise 37th Ave, and add berm along Lakeside Village and Paradise Park

Description: This project includes the conversion of multiple quarry ponds located adjacent to Mill Creek upstream of I-5 into three flood storage areas. The northern storage area is approximately 110 acres and will require the excavation of material down to elevation 195-ft. The middle storage area is approximately 335-acres and will require the excavation of material down to elevation 195-ft. The southern storage area is approximately 62-acres and will require excavation of material down to elevation 215-ft. It is unknown if the material would be removed as part of the existing gravel mining operation prior to project construction or if the excavation will occur as part of the project construction. Since the excavation costs are a significant part of the total project costs, two cost estimates are provided for this project. One estimate excludes the general excavation and haul costs and one includes these costs.

The northern pond will require the construction of a 1,600-ft long berm along its northern boundary and a 2,500-ft long berm along its western boundary. The middle pond will require the construction of a 700-ft long berm along its western boundary and the blockage of two 8-ft x 4-ft box culverts that connect the existing quarry pond to Mill Creek. The southern pond will require the construction of a 1,700-ft long berm along its north eastern boundary and raising approximately 1,800-ft of 37th Avenue SE between 0 - 3 ft along its western boundary. Each pond will require the construction of outlet structures. Also included in this project is the construction of a 4,000-ft long berm along Mill Creek adjacent to Lakeside Village and Paradise Park.

Results: Model results indicate that this project significantly reduced the risk of overflows into Pringle Creek for the 100-year flood event. For the 10-year storm event, peak flows downstream at the Mission Street Bridge decreased by 24% and the 100-year peak flows decreased by 12%. This project significantly reduced the flood risk for areas adjacent to Mill Creek and Shelton Ditch for the 10-year through the 100-year events.

Table 11.2 provides a summary listing of the recommended stormwater projects. Of these projects, 11 are short-term and recommended for implementation within the next five years; seven are intermediate-term with an implementation timeframe of five to ten years; and the remaining 20 are long-term projects with an anticipated implementation of more than ten years in the future. All project cost estimates are based on 2019 dollars. The estimates for MC-01C and MC-01F (both involving vegetation management) are divided into two cost components: project costs and land/easement acquisition costs. The vegetation management is recommended to occur in the short-term with access provided through agreements with property owners. Acquisition of easements is expected to occur over long-term period. The total cost for all the listed capital improvement projects, rounded to the nearest $10,000, is $73,560,000.

All projects recommended in this master plan for the Mill Creek Basin are shown on **Map 11.5**.

Mill Creek Basin Data

Table 11.1

Mill Creek Basin Projects from 2000 Stormwater Master Plan Completed or Removed

From the City of Salem 2019 Mill Creek Basin Plan, Figure 1

Proj. ID	Location	Recommended Improvement	Remarks
MCB2	Turner Rd. North of I-5	Channelization/Replace undersized culverts	Completed
MCB 4	Along Airport Rd. and Ryan Dr. from Mission St. to Shelton Ditch	Replace undersized culverts	Completed
MCB5	NE quadrant of I-5/Highway 22 interchange	Channelization/Replace undersized culverts	Completed
MCB10	Along Hawthorne Ave. near State St.	Replace undersized culvert	Completed
MCB 9	East of I-5 near Bayonne Ct. SE	Replace undersized pipe	Completed
MCB11	Along Hawthorne Ave. NE south of Monroe Ave.	Channelization/ Bioengineering	Completed
MCB12	Along Monroe Ave. from Illinois Ave. NE to Hawthorne Ave. NE	Replace undersized culvert	Completed
MCB13	Between 25th St. NE and Blacksmith Dr.	Replace undersized pipe	No longer required
MCB17	Across Mission St. near 13th St.	Replace undersized pipe	Completed
MCB21	Along 15th St. from Court St. to Chemeketa St.	Replace undersized pipe	Completed
MCB36	Along Hawthorne north of Ryan Dr.	Replace undersized pipe	Completed
MCB37	Along 15th St. from Hines St. to Oak St.	Replace undersized pipe	Completed
MCB38	Crossing Kuebler east of Turner Rd.	Replace undersized culvert	No longer required

Table 11.2

Mill Creek Basin Project List

Note:

Estimated costs include allowances for permiting, acquistion, pre-design, and final design; administration; construction management; contingency, and a conveyance improvement allowance.

For projects carried forward from the 2000 *Stormwater Master Plan*, the conversion from 2000 to 2019 values is 1.668. This factor is based on the Engineering News Record Construction Cost Indices for Seattle, San Fransisco, and Los Andeles.

The estimates for property/easement acquisition assume a constant $400,000 per acre or $400,000 per residential property.

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
MC-01C(1)	Mill Creek downstream of North High School	Vegetation management along Mill Creek downstream of North High School - Remove invasive plant species and trim wood vegetation	$10,280	Short term (within 5 years)
MC-01C(2)	Mill Creek downstream of North High School	Vegetation management along Mill Creek downstream of North High School - Acquire approximately 0.38 acres of stormwater easements	$152,000	Long term (over 10 years)
MC-01F(1)	Sheldon Ditch	Vegetation Management along Shelton Ditch between 17th Street and Airport Road - Remove invasive plant species and trim wood vegetation	$33,924	Short term (within 5 years)
MC-01F(2)	Sheldon Ditch	Vegetation Management along Shelton Ditch between 17th Street and Airport Road - Acquire approximately 3.79 acres of stormwater easements	$1,516,000	Long term (over 10 years)
MC-01B	Winter Street Bridge	Replace Winter Street Bridge over Mill Creek	$3,292,684	Intermediate term (5 - 10 years)
MC-01D	17th Street Bridge	Replace 17th Street Bridge over Mill Creek	$4,023,592	Intermediate term (5 - 10 years)
MC-01E	Waller Dam	Replace Waller Dam with Adjustable Crest Weir	$606,520	Short term (within 5 years)
MC-01G	Turner Road east of Airport	Replace ditch culverts along Turner Road east of Airport	$914,920	Short term (within 5 years)
MC-01A	B Street west of State Hospital	Replace stormwater pipes along B Street and west of State Hospital storage ponds	$6,215,288	Long term (over 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
MC-02 (1)	Quarry ponds adjacent to Mill Creek	Convert quarry ponds into three large flood storage areas, construct control structure for each pond, add levees, raise 37th avenue, and add a berm along Lakeside village and Paradise Park. (Note: Cost estimate assumes no general excavation costs for quarry ponds.)	$19,363,408	Long term (over 10 years)
MC-02 (2)	Quarry ponds adjacent to Mill Creek	Acquire property and easements for Project MC-02 (1)	$5,240,000	Long Term (over 10 years)
MCB1	Turner Rd. north of I-5	Channelization/ Replace undersized culverts	$4,819,205	Intermediate term (5 - 10 years)
MCB3	Mission St. SE from Airport to 20th St.	Replace undersized culverts	$4,796,232	Long term (over 10 years)
MCB6	Along Lancaster St. SE from Glenwood Dr. to Munkers St.	Replace undersized pipe; Replace undersized culverts	$910,918	Long term (over 10 years)
MCB7	East of I-5, south of Santiam Hwy	Replace undersized culvert	$194,244	Long term (over 10 years)
MCB8	Along Lancaster St SE from State St. to Mahrt St.	Replace undersized culvert	$353,209	Long term (over 10 years)
MCB14	Near 24th St. NE from Walker to Breyman	Replace undersized pipe	$1,229,044	Short term (within 5 years)
MCB15	Near 23rd St. NE between State St. and Breyman	Replace undersized pipe	$681,726	Intermediate term (5 - 10 years)
MCB16	West of 14th St. north from Lee St. to Shelton Ditch	Replace undersized pipe	$300,693	Intermediate term (5 - 10 years)
MCB18	East of Liberty St. between Trade St. and Ferry St. and along Ferry St. to High St.	Replace undersized pipe	$269,134	Long term (over 10 years)
MCB19	Along Cottage St. from Ferry St. to Court St. and along Court St. east to Winter St.	Replace undersized pipe	$563,942	Long term (over 10 years)
MCB20	Along State St. from Cottage St. to Capitol St.	Replace undersized pipe	$532,679	Long term (over 10 years)
MCB22	Along Church St. from Union St. north to Mill Creek	Replace undersized pipe	$480,474	Intermediate term (5 - 10 years)

Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
MCB23	Summer St. from Marion St. north to Mill Ck, Union St. and 12th St. north to Mill Ck	Replace undersized pipe	$830,938	Intermediate term (5 - 10 years)
MCB24	Along D St. NE from 12th St. to Mill Ck and along Winter St. from Market St. to D St.	Replace undersized pipe	$2,086,506	Short term (within 5 years)
MCB25	From the intersection of 12th St. and Nebraska St. to Stewart St. and Lamberson St.	Replace undersized pipe	$769,160	Short term (within 5 years)
MCB26	West along B St. from 19th St. to Stewart St. and Lamberson St.	Replace undersized pipe	$1,009,385	Short term (within 5 years)
MCB27	Along B St. from 19th St. to Thompson St.	Replace undersized pipe	$804,850	Short term (within 5 years)
MCB28	From 23rd and B St. to B St. and Thompson St.	Replace undersized pipe	$648,017	Short term (within 5 years)
MCB29	From 24th St. and Greenway Dr. to B St. and Thompson St.	Replace undersized pipe	$839,590	Short term (within 5 years)
MCB30	Crossings of Deer Park and Aumsville Hwy	Replace undersized pipe; Replace undersized culvert	$303,808	Long term (over 10 years)
MCB31	Along Mill St. near 12th St.	Replace undersized pipe	$180,161	Long term (over 10 years)
MCB32	From Stand Ave. and Mill St. to Trade St. and 17 St.	Replace undersized pipe	$393,764	Long term (over 10 years)
MCB33	Along Trade St. from 17th St. to Richmond Ave.	Replace undersized pipe	$1,047,792	Long term (over 10 years)
MCB34	Along Mill St. from 17th St. to 21st St.	Replace undersized pipe	$697,975	Long term (over 10 years)
MCB35	Crossing Turner Rd. south of Gath Rd. SE	Replace undersized pipe	$28,642	Long term (over 10 years)
MCB39	Crossing Kuebler south of Aumsville Hwy	Replace undersized culvert	$423,135	Long term (over 10 years)
		Total	$66,563,843	

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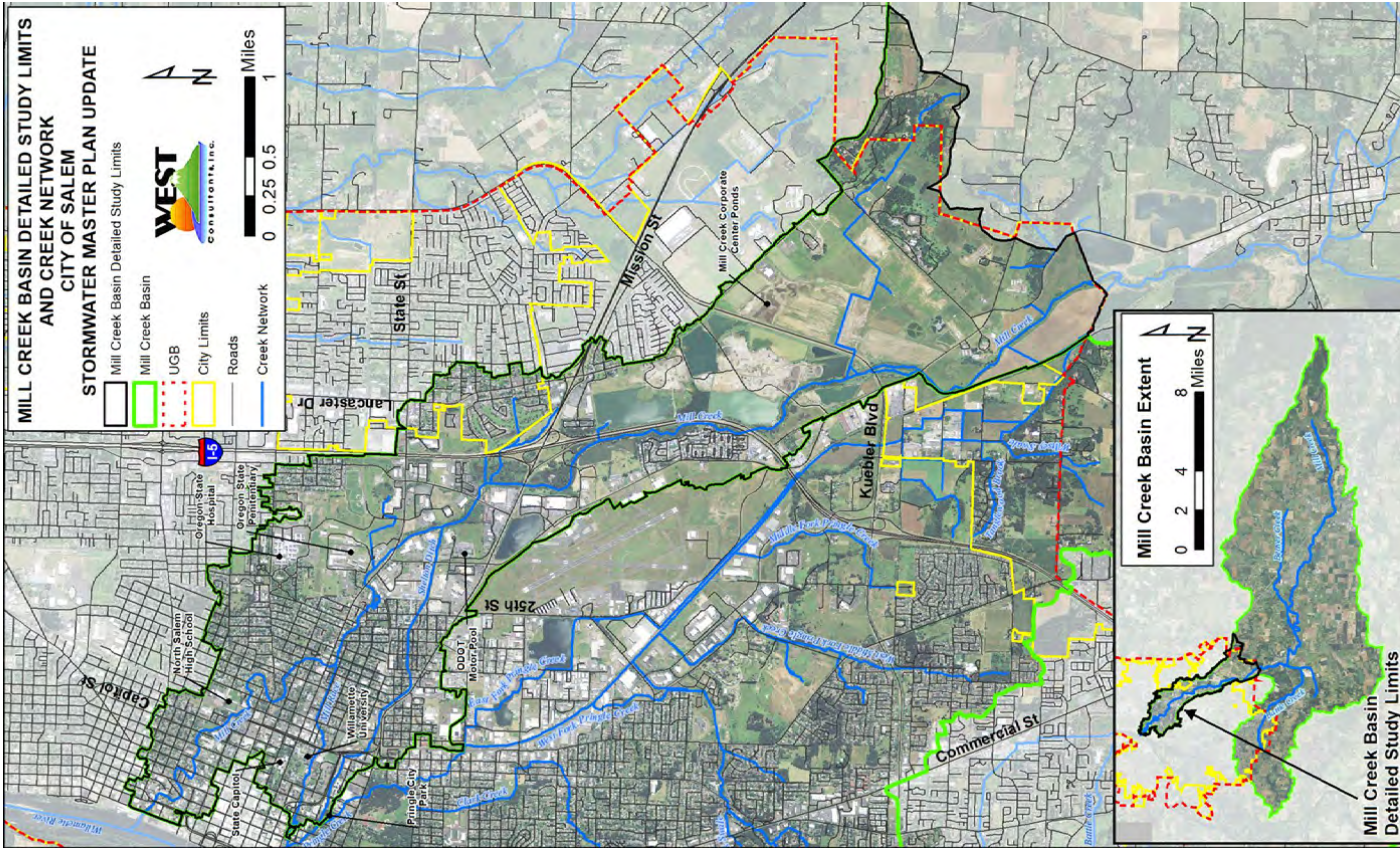
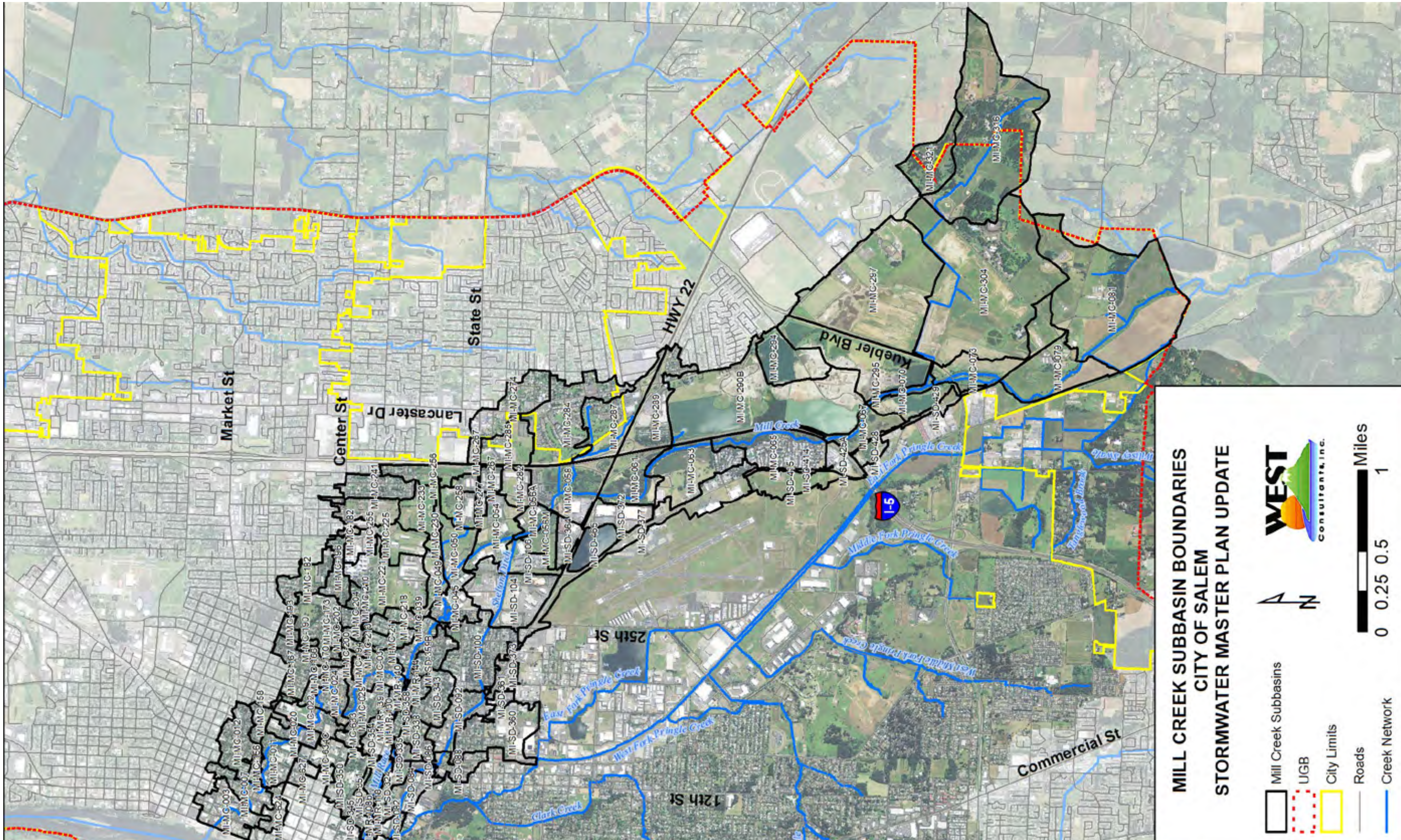


Map 11.1

Mill Creek Basin and Creek Network

From the City of Salem 2019 Mill Creek Basin Plan, Figure 1



Map 11.2

Mill Creek Subbasin Bounderies

From the City of Salem 2019 Mill Creek Basin Plan, Figure 3

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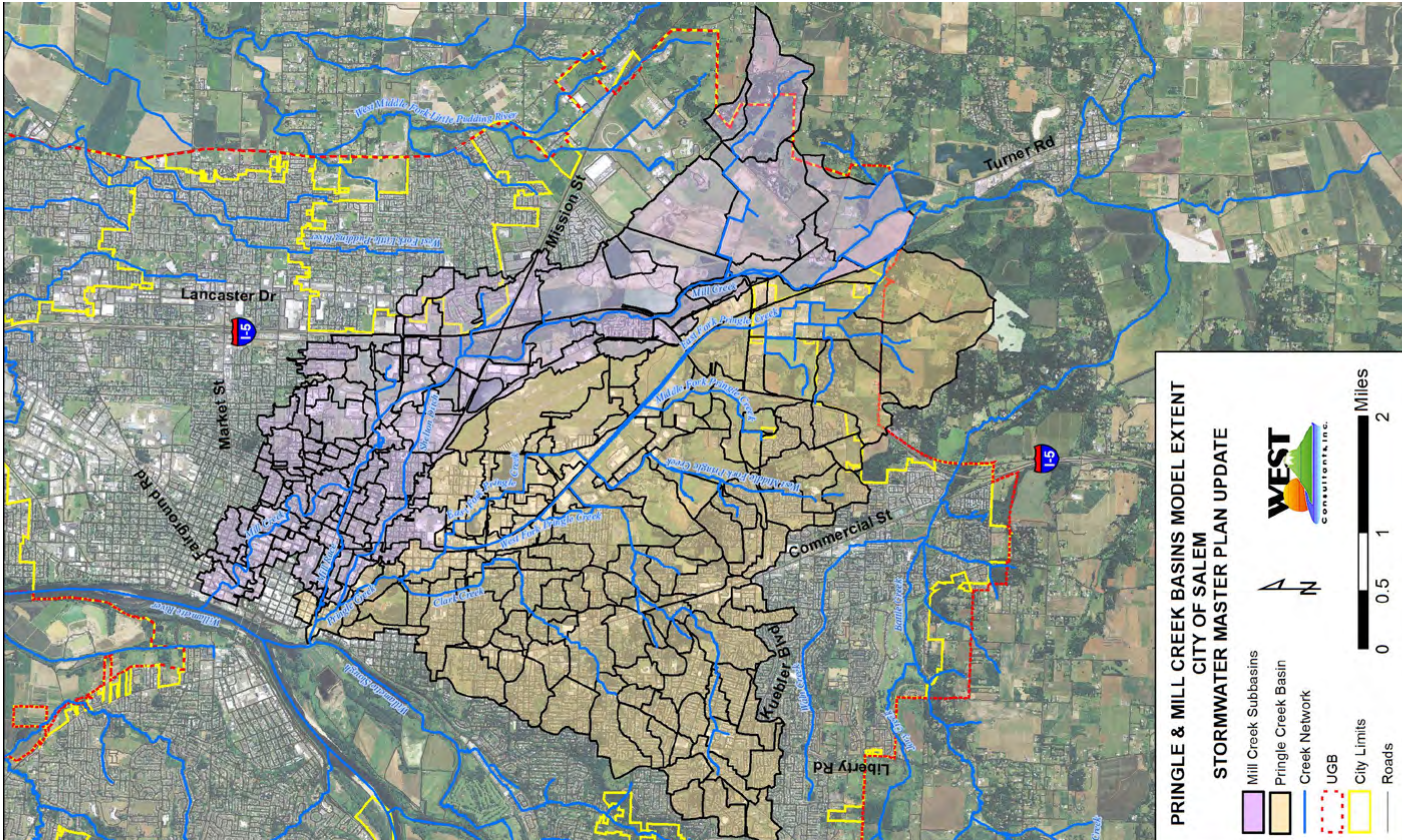

Map 11.3

Pringle and Mill Creek Basins Model Extents

From the City of Salem 2019 Mill Creek Basin Plan, Figure 4

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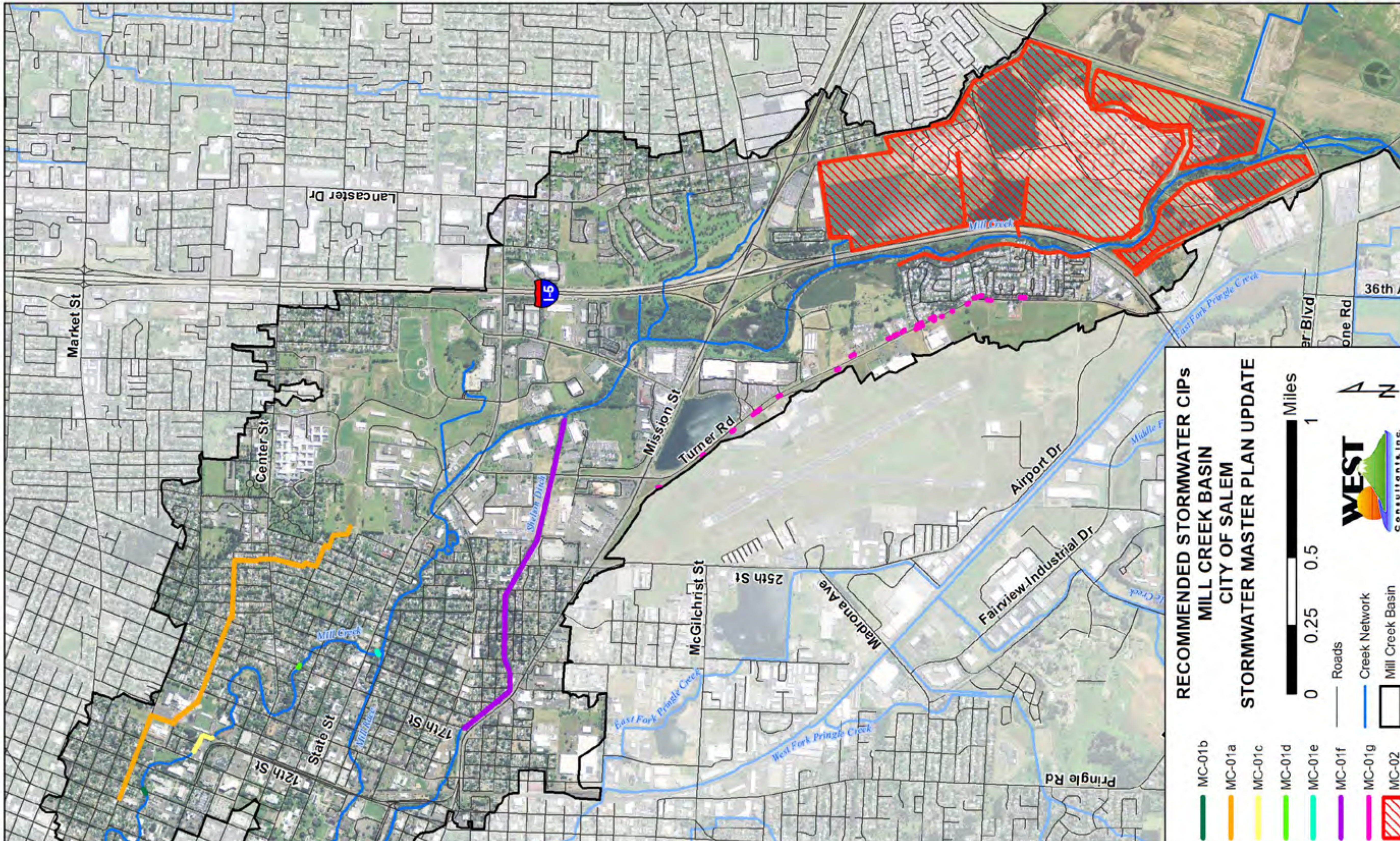

Map 11.4

2019 Mill Creek Basin Plan Project Locations

From the City of Salem 2019 Mill Creek Basin Plan, Figure 14

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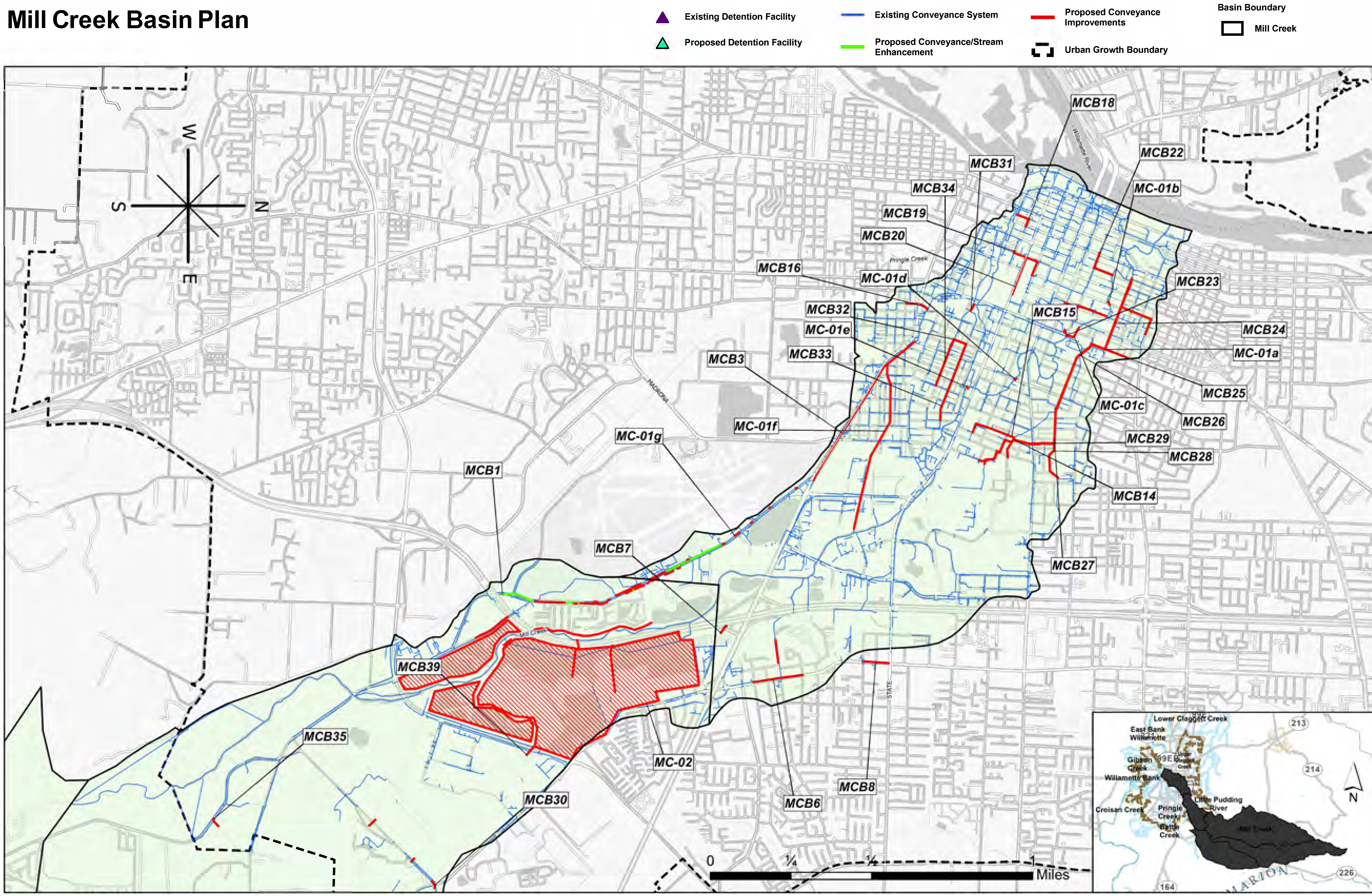

Map 11.5

2020 Stormwater Master Plan Mill Creek Basin Recommended Project Locations

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Pettijohn-Laurel Creek Basin Plan

PETTIJOHN-LAUREL CREEK BASIN DESCRIPTION

The Pettijohn-Laurel basin is 2.6 square miles and located in southwest Salem. Less than half of the basin is within the Urban Growth Boundary. It is moderately sloped with two primary drainage paths (Pettijohn Creek and Laurel Creek), both of which drain to the Willamette Slough. **Map 12.1** shows the basin boundaries. Land use in the basin is primarily residential and agricultural.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR PETTIJOHN-LAUREL CREEK BASIN

In the 2000 *Stormwater Master Plan* it was determined that "the Pettijohn-Laurel Creek basin presents very few development opportunities that cannot be handled with a detailed analysis of the particular site, if needed." For this reason, the Pettijohn-Laurel Creek basin was not modeled in 2000 and no projects were identified for the basin in the 2000 *Stormwater Master Plan*.

PETTIJOHN-LAUREL CREEK BASIN PLAN

This *Stormwater Master Plan* carries forward the conclusion of the 2000 *Stormwater Master Plan* that basin-wide analysis is not necessary and that development-specific stormwater facilities will be sufficient to address stormwater-related issues into the foreseeable future. Accordingly, until a detailed hydrologic and hydraulic analysis is conducted, the Pettijohn-Laurel Creek Basin Plan consists of **Map 12.1** delineating the basin boundaries.

Pettijohn-Laurel Creek Basin Data

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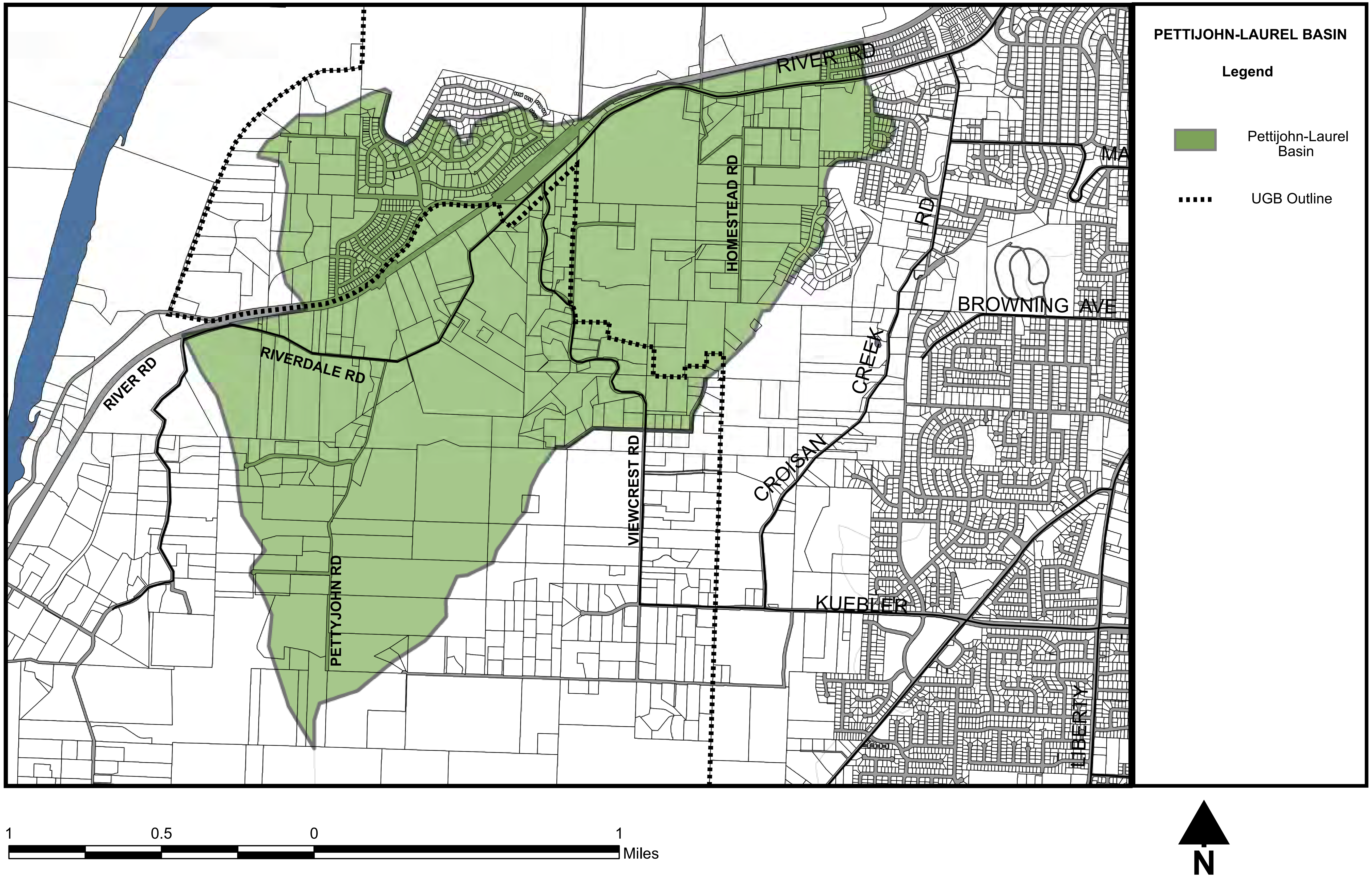

Map 12.1

Pettijohn-Laurel Creek Basin Boundaries

Pringle Creek Basin Plan

PRINGLE CREEK BASIN DESCRIPTION

Pringle Creek Basin is a drainage area located in the City of Salem between the Battle Creek Basin to the south and the Mill Creek Basin to the north. The majority of Pringle Creek Basin is developed residential, commercial, and industrial land use. The southwest portion of the basin contains undeveloped agricultural land, forest, and grassland.

The outlet for Pringle Creek Basin is the Willamette Slough, a backwater area of the Willamette River next to Minto Brown Island. Prior to its confluence with the Willamette Slough, two Mill Creek diversion channels, Shelton Ditch and Mill Race, discharge into Pringle Creek. Since the primary source of these diversion channels is Mill Creek, the channels and their contributing drainage areas are part of the Mill Creek Basin. **Map 13.1** shows the extents of the Pringle Creek Basin and its drainage network.

The Pringle Creek Basin has a drainage area of 13.4 square miles. The City of Salem Urban Growth Boundary (UGB) encompasses approximately 93% of the basin. The minimum and maximum basin elevations are 121 feet and 673 feet, respectively. The mean elevation for the basin is 329 feet [Unless otherwise stated, all elevations mentioned in this document are in the National Geodetic Vertical Datum of 1929 (NGVD 29).]

The western half of the Pringle Creek drainage system is hydraulically and hydrologically distinct from the eastern half. It is largely composed of developed residential and commercial land use. It has hilly topography, steep channel slopes, significant impervious areas, and an extensive storm drain pipe network. These conditions combine to produce a relatively fast runoff response during large storm events. The existing stormwater conveyance system quickly conveys floodwaters downstream, limiting the flood risk in the western half of the Pringle Creek Basin.

The main tributaries in the western half of the basin include Clark Creek, West Fork Pringle Creek, West Middle Fork Pringle Creek, and Middle Fork Pringle Creek. While Clark Creek and West Fork Pringle Creek are generally developed, large portions of West Middle Fork Pringle Creek and Middle Fork Pringle Creek are currently undeveloped, but are assigned as Developing Residential in the Salem Comprehensive Plan (City of Salem, 2015). Two major detention basins are in the western portion of the Pringle Creek basin, one at Gilmore Field with an area of 5.7 acres and the other at Clark Creek Park with an area of 1.9 acres, both located along Clark Creek.

The eastern portion of the Pringle Creek Basin is generally mildly sloped; however, some hilly terrain is located along the basin's southeastern boundary. The northeast portion includes McNary Field, developed industrial land use, and pockets of residential area. The southeast portion of the basin includes developed medium and low-density industrial land use, undeveloped open space, cropland, and a small amount of forest. The main tributaries in the eastern half of the basin include East Fork Pringle Creek, a branch of West Fork Pringle Creek, and a branch of West Middle Fork Pringle Creek. Because this area is composed of flat terrain, flooding is common, especially in the industrial area west of the airport and east of the railroad. Most drainage channels within the eastern portion of the basin are constructed ditches that are often heavily vegetated with blackberry and other non-native vegetation. In the southeast portion of the Pringle Creek Basin (south of Kuebler Blvd), outside of the City Limits but within the UGB, the East Fork Pringle channels are used as irrigation ditches and are managed by the Santiam Water Control District. Because the ground in the eastern portion of the Pringle Creek Basin is both of low elevation and near Mill Creek, high flows along Mill Creek can lead to an inter-basin exchange of floodwaters into Pringle Creek. The eastern half of the Pringle Creek Basin does not contain any large engineered detention facilities; however, a few large abandoned quarry ponds are located along East Fork Pringle Creek, including Waller Pond and Spinnaker Lake, that provide some amount of flood storage during storm events.

FINDINGS OF 2000 STORMWATER MASTER PLAN

In the 2000 *Stormwater Master Plan*, the Pringle Creek Basin was modeled using a planning-level XP-SWMM model, which provided coupled hydrologic and hydraulic modeling of the watershed and stormwater system. In that effort, the Pringle Creek Basin was divided into 99 subbasins. The primary purpose of the model was to detect areas within the storm drainage network that were at-risk of surcharge during the 10-year 24-hour SCS Type-1A rainfall event. Models were developed for existing and full build-out conditions. The findings included 58 recommended Capital Improvement Projects (CIPs) within the Pringle Creek Basin. The recommendations included bridge/culvert replacements, channelization, vegetation modifications, and detention facility construction. The total cost for the recommended CIPs was $61,413,000 in 2000 dollars.

SUMMARY OF THE 2019 PRINGLE CREEK BASIN PLAN

For modeling purposes, the 2019 Pringle Creek Basin Plan (City of Salem 2019c) divided the basin into 131 subbasins as shown in **Map 13.2**

Of the 131 subbasins, six subbasins are predominantly located outside of the Salem city limits and two subbasins are located predominantly outside of the UGB. During high flows in the Mill Creek Basin, Mill Creek floodwaters can overflow into the Pringle Creek basin. Consequently, models developed for the Mill Creek Basin and Pringle Creek Basin were merged into a single XP-STORM model. The combined model extents are shown in **Map 13.3**.

Modeling was performed using the XP-STORM model, which is a coupled hydrologic and hydraulic modeling package. The model integrated open channel and closed-conduit systems and produced both 1-D (riverine) and 2-D (overland) flow analyses. The results were then utilized to evaluate stormwater system capacities and flood risks.

While the City of Salem Design Standards recommends the 24-hour SCS Type-1A storm distribution (City of Salem, 2014), modeling conducted for development of the Battle Creek Basin plan suggested that this distribution was inadequate for a basin wide model. Therefore, an evaluation of available rainfall data within Battle Creek Basin was conducted to determine the most appropriate design storms for use in the City of Salem SWMP Update. Ultimately, a 100-year, 48-hour design storm using a normalized distribution based on a November 1996 event, was recommended for evaluation of the flood risk for the Battle Creek Basin.

The 24, 48, and 72-hour design storm distributions were also tested in the Mill-Pringle Creek Basin model and the results were evaluated to determine which normalized rainfall distributions produced the highest peak flows within the Pringle Creek Basin. In general, as with the Battle Creek Basin, the 48-hour distribution based on the normalized November 1996 48-hour storm event produced the largest discharges in the Pringle Creek Basin. Consequently, the normalized November 1996 48-hour distribution was selected as the design storm distribution for the Pringle Creek Basin.

Details regarding model development and analyses are provided in the 2019 *Pringle Creek Basin Plan*.

RECOMMENDED STORMWATER CAPITAL IMPROVEMENT PROJECTS

There were 57 capital improvement projects listed in the 2000 *Stormwater Master Plan* to address the needs of Pringle Creek Basin. Projects included replacing undersized pipes and culverts, installing new bridges, and constructing habitat improvements. Of the 57 projects in the 2000 *Stormwater Master Plan*, six have been completed and two have been determined to no longer be needed. **Table 13.1** lists the projects that have been completed, superseded, or are considered no longer required.

The remaining 49 projects from the 2000 *Stormwater Master Plan* are carried forward into this master plan. The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project.

The 2019 Pringle Creek Basin Plan recommended five new stormwater capital projects. The new projects are summarized below with the locations shown on **Map 13.4**. Additional details for these projects are provided in the 2019 Pringle Creek Basin Plan.

The recommended stormwater capital improvement projects were divided into three categories, short, intermediate, and long-term. Short-term projects are recommended for implementation within the next five years. Intermediate-term projects are recommended to be implemented in the next five to ten years. Long-term projects are recommended to be implemented after ten years. All cost estimates are in 2019 Dollars.

Short-Term CIPs

The following are the recommended list of short-term stormwater CIPs. Detailed cost estimates are provided in the 2019 Pringle Creek Basin Plan.

Project No. PC-01B - Vegetation Management along Pringle Creek and Tributaries

Description: Remove invasive plant species and trim woody vegetation to acceptable limits along the following reaches in the Pringle Creek drainage network:

- 2,800 feet along Pringle Creek from the Clark Creek confluence to the West Fork Pringle Creek confluence
- 15,600 feet along East Fork Pringle Creek between West Fork Pringle Creek confluence and I-5. Note that vegetation management along East Fork Pringle Creek upstream of the railroad access culvert on Airway Drive should only occur after the railroad access culvert has been replaced (see Project no. PC-01A).
- 6,500 feet along West Fork Pringle Creek between East Fork Pringle Creek confluence and Madrona Avenue
- 2,700 feet along West Middle Fork Pringle Creek between Fairview Industrial Drive and Reed Road.

Note that this project will require the acquisition of an approximate 60 ft-wide stormwater maintenance easement along each of the creeks.

Results: The vegetation management decreases flood risk along Pringle Creek at 13th Street, East Fork Pringle Creek near Pence Loop, and along West Fork Pringle Creek in the airport and north of McGilchrist Road. The construction of the berm along West Fork Pringle Creek (Project No. PC-01D) and the West Fork Pringle Creek culvert replacements (Project No. PC-01C) help mitigate the additional flood risk near McGilchrist Road caused by the vegetation management.

Intermediate-Term CIPs

Project No. PC-01A - Raise a Portion of Airway Drive, Upsize Railroad Access Culvert on East Fork Pringle Creek, Add Flood Storage Area Next to Waste Treatment Facility

Description: Includes the creation of a 26-acre floodplain storage area between Airway Drive and East Fork Pringle Creek surrounding the City's Waste Treatment Facility. Construct a 1,200-ft long berm to elevation 215.5 ft between the creek and the storage area. Raise 1,400-ft of Airway Drive to elevation 212.5 ft to prevent water in the storage area from spilling northward into the airport. Replace East Fork Pringle Creek culvert at railroad access along Airway Drive with a 10-ft wide by 6-ft tall by 90-ft long reinforced concrete box culvert.

Results: Model output indicates that the flood risk along Airway Drive, within the airport, and in the developed area north of McGilchrist Street will be significantly reduced. The raising of Airway Drive and the replacement of the railroad access culvert allows more flood waters to stay within East Fork Pringle Creek. This reduces the risk of flood waters routing through the airport to developed areas west of 25th Street and north of McGilchrist Street.

Project No. PC-01C - Replace Railroad and McGilchrist Culverts on West Fork Pringle Creek

Description: Includes the replacement of an existing railroad culvert in West Fork Pringle Creek with a 150-foot long 22-foot span x 10-foot rise concrete box culvert embedded 3-feet. The alternative also includes the replacement of the existing McGilchrist culvert over West Fork Pringle Creek with a 100-ft long 22-ft span x 10-ft rise concrete box culvert embedded 3-ft. This project should be completed before the implementation of upstream Project No. PC-01D.

Results: Model output indicates that the culvert replacements reduce flood risk along West Fork Pringle Creek both upstream and downstream of McGilchrist Street and partially offset the minor flood risk increase due to levee construction (Project No. PC-01D).

Long-Term CIPs

There was one recommended list of long-term stormwater CIPs in recommended order of implementation. Detailed cost estimates are provided in 2019 Pringle Creek Basin Plan.

Project No. PC-01E - Replace Clark Creek culverts at three locations on Ratcliff Dr

Description: Replace Clark Creek culverts at three locations on Ratcliff Drive with 60-foot long 6-foot span x 6-foot rise concrete box culverts embedded 2-feet.

Results: Model output indicates that the roadways would no longer have a significant risk of overtopping up to the 100-year event.

Table 13.2 provides a summary listing of the recommended stormwater projects. Of these projects, one is short-term and recommended for implementation within the next five years; two are intermediate-term with an implementation timeframe of five to ten years; and the remaining are long-term projects with an anticipated implementation of more than ten years in the future. All project cost estimates are based on 2019 dollars. The estimate for PC-01B (vegetation management) is divided into two cost components: project costs and land/easement acquisition costs. The vegetation management is recommended to occur in the short-term with access provided through agreements with property owners. Acquisition of easements is expected to occur over long-term period. The total cost for all the listed capital improvement projects, rounded to the nearest $10,000, is $109,300,000.

All projects recommended in this master plan for the Pringle Creek Basin are shown on **Map 13.5**.

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Pringle Creek Basin Data

Table 13.1

Pringle Creek Basin Projects from 2000 Stormwater Master Plan Completed or Removed

Project ID	Location	Recommended Improvement	Remarks
PCB1	Clark Creek from Lefelle to Howard	Add Additonal Pipe/Culvert	Completed
PCB6	Clark Creek between Winter St and Summer St; Summer St.	Replace Undersized Culvert; Channelization/ Bioengineering/ Habitat	Completed
PCB19	East Pringle at Madrona	Bridge	No longer required
PCB23	East Fork: Culvert Under I-5; Middle Fork near I-5	Channelization/ Bioengineering/ Habitat; New box culvert/ bridge	No longer required
PCB35	Pringle Creek at Liberty St.	Bridge	Completed
PCB54	West Pringle Creek near Skyline and Liberty	Channelization/ Bioengineering/ Habitat	Completed
PCB55	Pipe/Ditch system along Skyline downstream of Kuebler	Replace Undersized Pipe	Completed
PCB56	Clark Creek Park at Ratcliff Dr.	Detention Facility, Clark Creek	Completed

Table 13.2

Pringle Creek Basin Project List

Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
PCB17	East Pringle crossing McGilchrist; 22nd Ave SE	Bridges	$1,042,083	Long term (over 10 years)
PCB18	East Pringle from McGilchrist to 25th	Channelization/ Bioengineering/ Habitat	$5,422,702	Long term (over 10 years)
PCB20	East Pringle from Airway Dr to Madrona	Channelization/ Bioengineering/ Habitat	$5,225,302	Long term (over 10 years)
PCB21	Culvert across Airway Drive Draining Airport; near Airway Drive	Replace Undersized Culvert	$281,958	Intermediate term (5 - 10 years)
PCB22	East Fork Airway Dr to I-5	Channelization/ Bioengineering/ Habitat	$4,993,066	Long term (over 10 years)
PCB24	East/Middle Fork upstream I-5 to Kuebler	Channelization/ Bioengineering/ Habitat	$2,902,946	Long term (over 10 years)
PCB25	East/Middle Fork at Treistad and Kuebler	Channelization/ Bioengineering/ Habitat; Bridge; Add Culvert	$800,528	Long term (over 10 years)
PCB26	East Middle Fork upstream of Kuebler	Channelization/ Bioengineering/ Habitat	$2,861,262	Long term (over 10 years)
PCB27	Middle Fork along SPRR from Pringle Creek to Boise Cascade	Channelization/ Stream Bank Stabilizaton; Bridge	$1,829,689	Long term (over 10 years)
PCB28	Middle Fork crossing Madrona	Bridge	$818,780	Long term (over 10 years)
PCB29	Middle Fork from Madrona to Ewald; from Fairview Ind Dr to SPRR	Channelization/ Bioengineering/ Habitat	$2,402,746	Long term (over 10 years)
PCB30	Culvert across Marietta	Replace Undersized Culvert	$78,275	Long term (over 10 years)
PCB31	Middle Fork upstream of 27th crossing Reed Ln	Replace Undersized Culvert	$297,976	Long term (over 10 years)
PCB32	Middle Fork at Battle Creek Rd and Reed Ln.	Replace Undersized Culvert	$189,957	Long term (over 10 years)
PCB33	Culvert across Baxter Rd SE	Replace Undersized Culvert	$84,855	Long term (over 10 years)
PCB34	Pringle Creek from Commercial to High St	Channelization/ Bioengineering/ Special Stream Habitat	$2,003,896	Long term (over 10 years)
PCB36	Pringle Creek at Church St	Bridge	$5,954,760	Long term (over 10 years)
PCB37	Pringle Creek at Winter St	Bridge	$4,466,070	Long term (over 10 years)
PCB38	Pringle Creek at Mission St	Bridge	$4,466,070	Long term (over 10 years)
PCB39	Pringle Creek at Cross St	Bridge	$4,466,070	Long term (over 10 years)

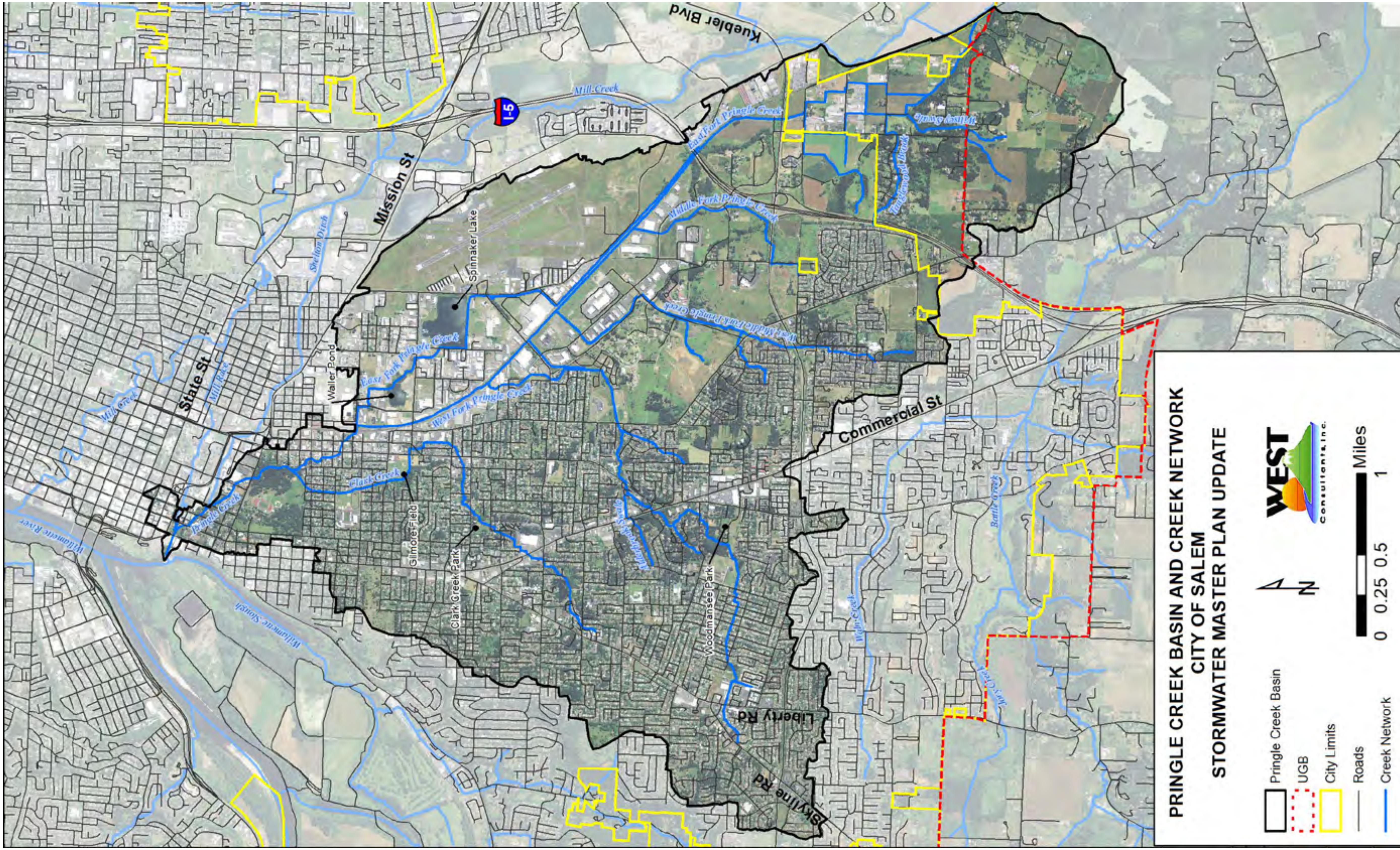
Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
PCB40	Pringle Creek at 13th St	Bridge	$4,466,070	Long term (over ten years)
PCB41	West Pringle Creek from Oxford to McGilchrist	Channelization/ Bioengineering/ Habitat; Bridge	$3,435,986	Long term (over ten years)
PCB42	West Pringle Creek at McGilchrist	Bridge	$1,488,690	Long term (over ten years)
PCB43	Drainage system on Pringle Rd near Vista	Replace Undersized Pipe	$340,627	Short term (within five years)
PCB44	Drainage system crossing Commerical near Browning	Replace Undersized Culvert	$375,165	Long term (over ten years)
PCB45	West Pringle Creek at Commercial near Welcome Way SE	Replace Undersized Culvert	$308,605	Long term (over ten years)
PCB46	Drainage system upstream of Idylwood as well as Sunnyside Rd	Replace Undersized Pipe	$215,622	Long term (over ten years)
PCB47	Drainage system upstream of Marietta Way and Coloma Dr	Replace Undersized Pipe	$672,888	Long term (over ten years)
PCB48	West Pringle Creek at Woodmansee Park	Channelization/ Bioengineering/ Habitat	$1,265,387	Long term (over ten years)
PCB49	West Pringle, Culvert across Jones Rd., upstream of Woodmansee Park	Bridge	$521,042	Long term (over ten years)
PCB50	West Pringle Creek from Jones Rd to Bristol Dr and at Firdell and Lone Oak	Replace Undersized Culvert; Channelization/ Bioengineering/ Habitat	$732,644	Long term (over ten years)
PCB51	West Pringle from Gardner Rd to Jones Rd SE	Channelization/ Bioengineering/ Habitat	$208,417	Long term (over ten years)
PCB52	Closed system along Lone Oak and Gardner	Replace Undersized Pipe	$356,169	Long term (over ten years)
PCB53	Closed system near Kuebler and Liberty	Replace Undersized Pipe	$632,991	Long term (over ten years)
PCB57	Leslie Middle School, East Pringle Rd	Detention Facility, West Pringle	$2,554,592	Long term (over ten years)
PCB58	Webb Lake , 25th and McGilchrist	Detention Facility, East Pringle	$3,870,594	Long term (over ten years)
		Total	$72,034,480	

Notes:

Estimated costs include allowances for permitting, acquistion, pre-design, and final design; administration; construction management; contingency, and a conveyance improvement allowance.

For projects carried forward from the 2000 Storwater Master Plan, the conversation from 2000 to 2019 values is 1.688. This factor is based on the Engineering News Record Construction Cost for Seattle, San Fransisco, and Los Angelas.

The estimates for property/easement acquistion assume a constant $400,000 per acre or $400,000 per residential property



Map 13.1

Pringle Creek Basin and Network

From the City of Salem 2019 Pringle Creek Basin Plan, Figure 1

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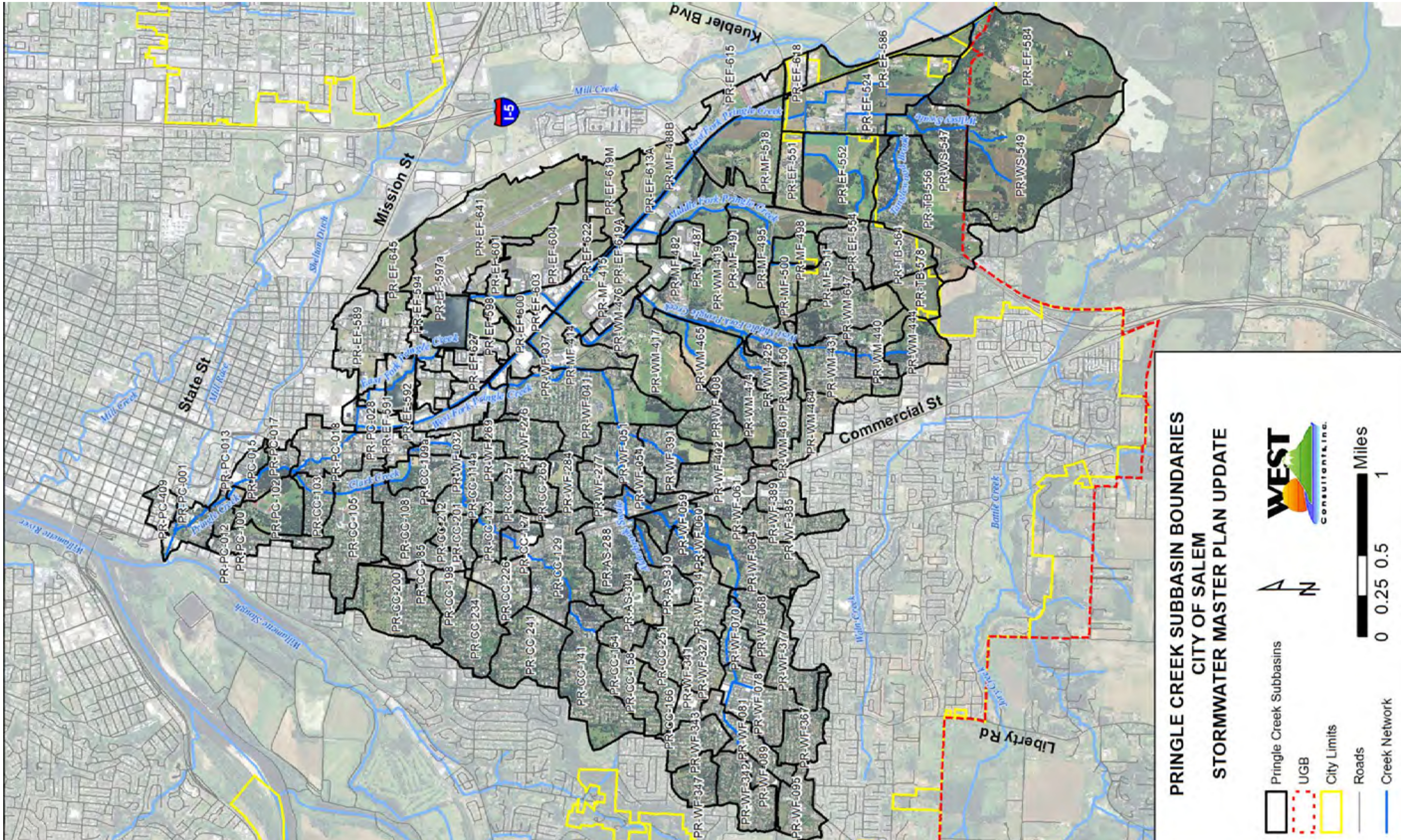
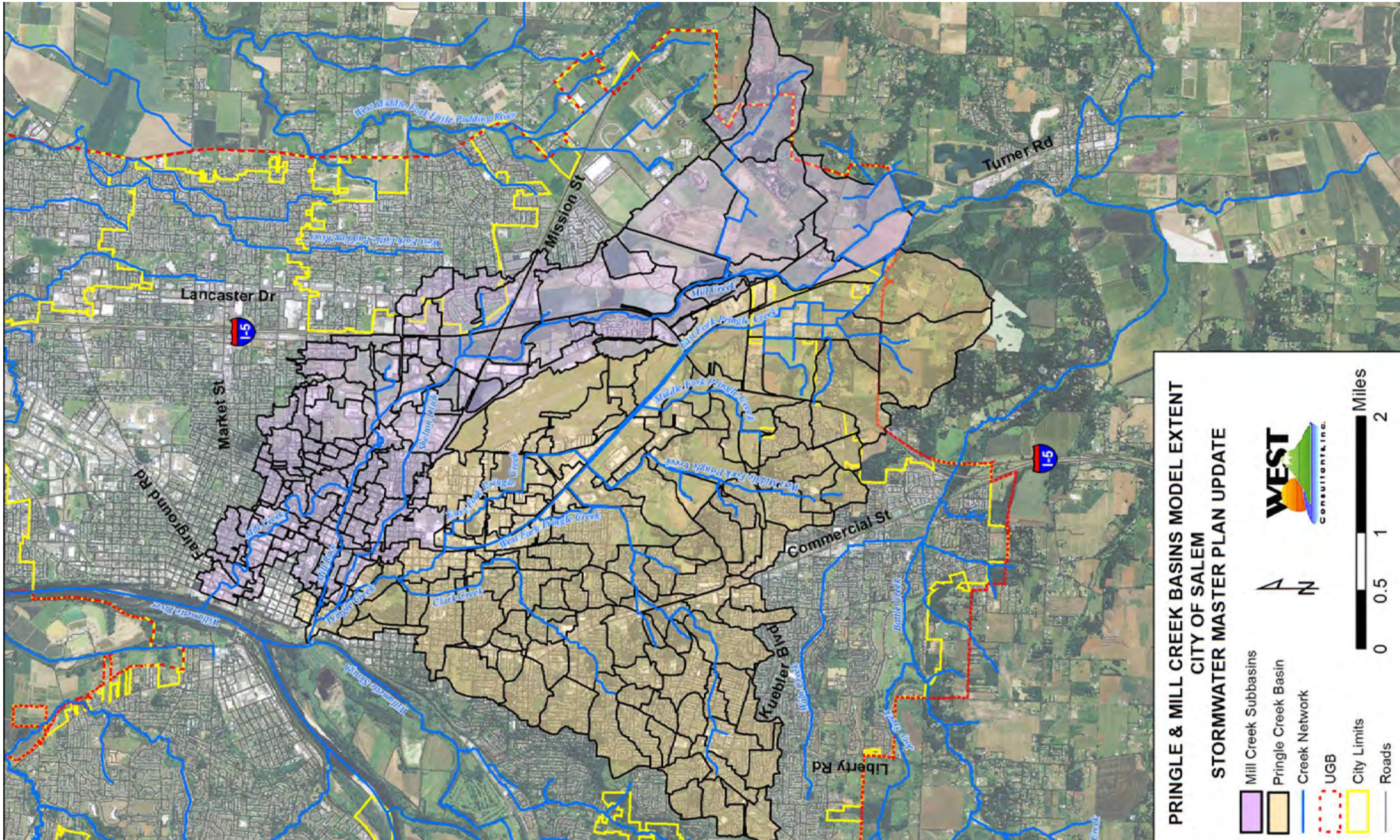


Map 13.2

Pringle Creek Subbasin Boundaries

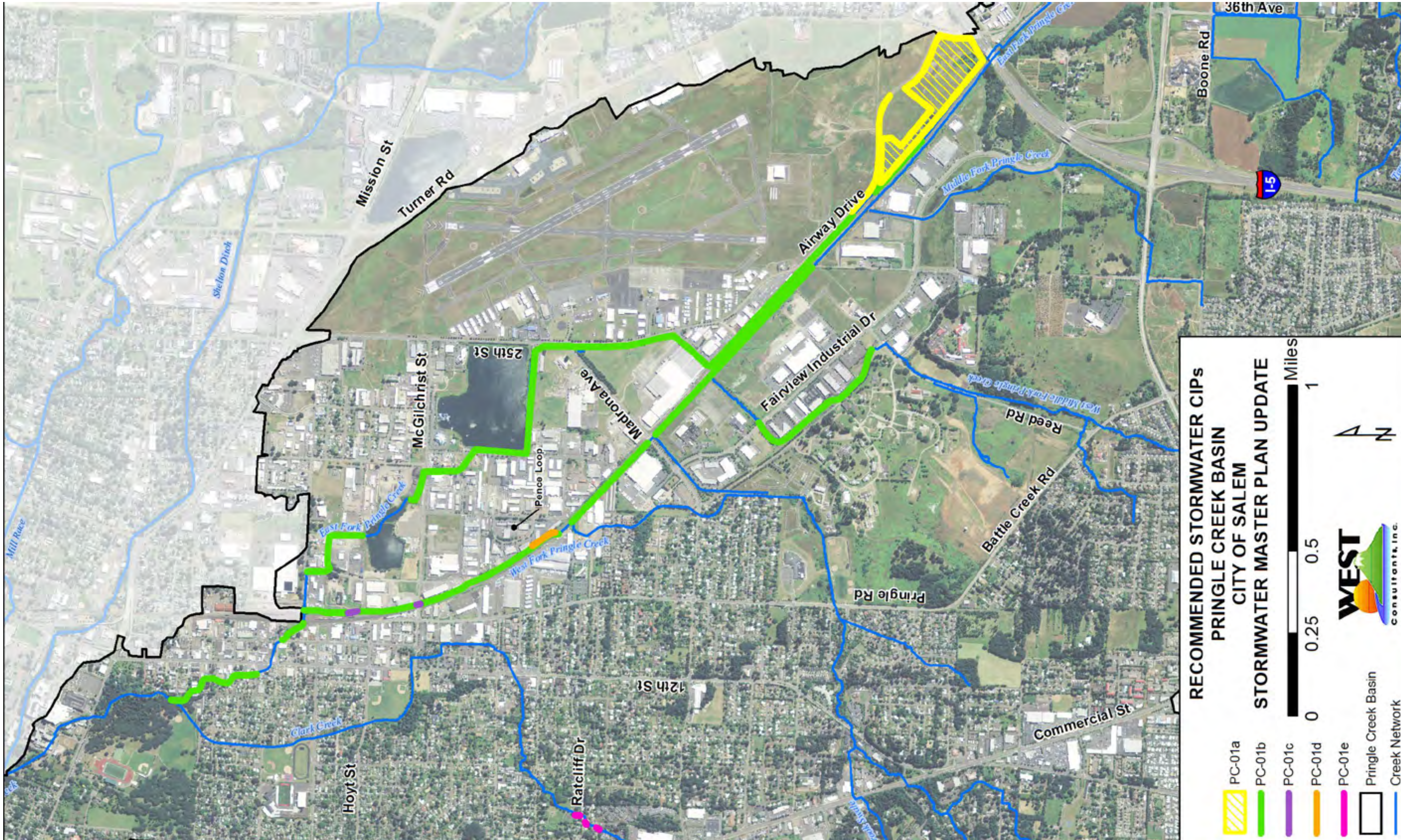
From the City of Salem 2019 Pringle Creek Basin Plan, Figure 3



Map 13.3

Pringle and Mill Creek Basins Model Extents

From the City of Salem 2019 Pringle Creek Basin Plan, Figure 4



Map 13.4

2019 Pringle Creek Basin Plan Project Locations

From the City of Salem 2019 Pringle Creek Basin Plan, Figure 15

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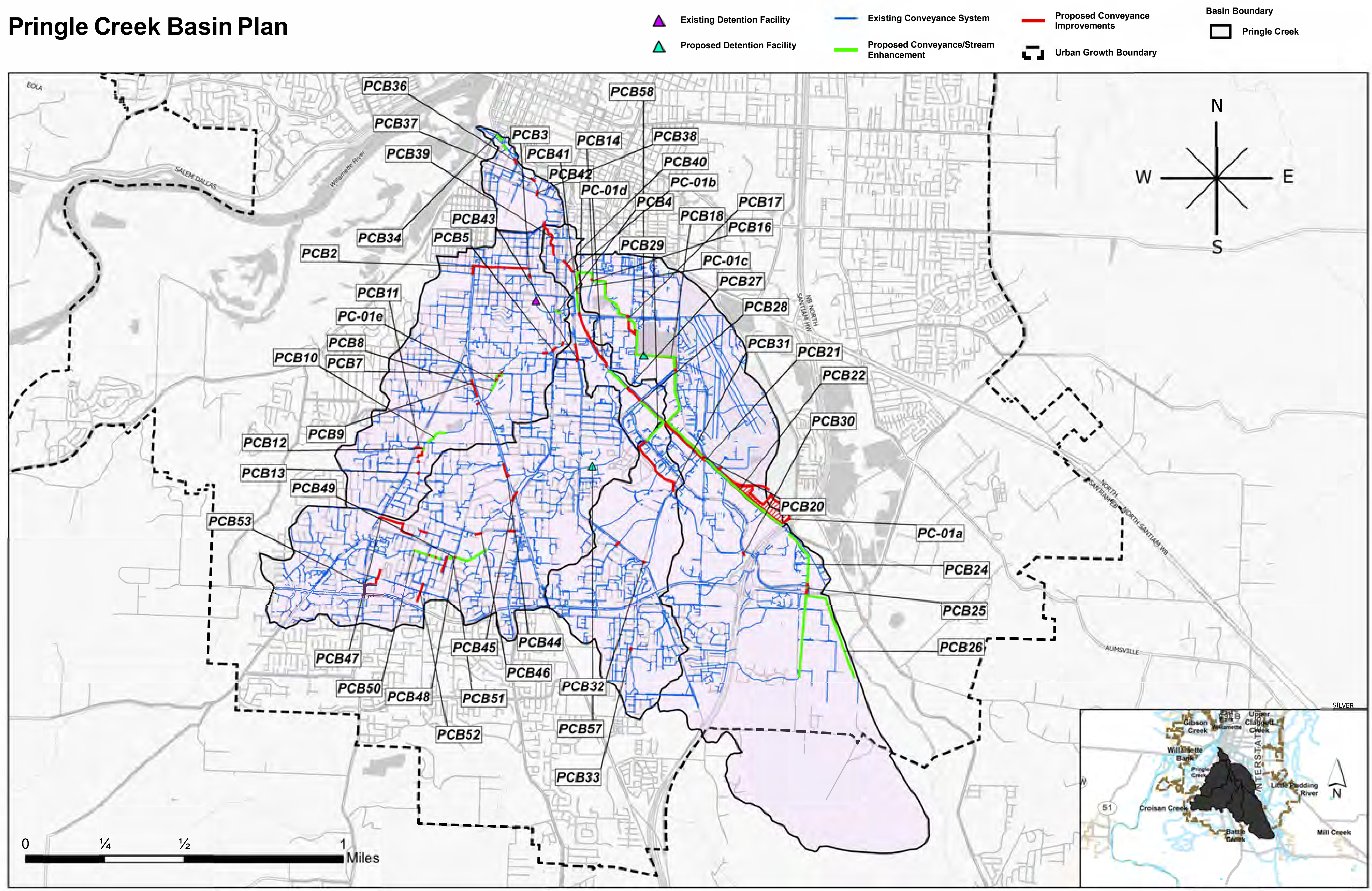

Map 13.5

2020 Stormwater Master Plan Pringle Creek Basin Recommended Project Locations

From the City of Salem 2019 Pringle Creek Basin Plan, Figure 15

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Upper Claggett Creek Basin Plan

UPPER CLAGGETT CREEK BASIN DESCRIPTION

The Upper Claggett Creek basin drains 7.4 square miles, all of which are within the Urban Growth Boundary. The Upper Claggett basin drains into Claggett Creek, which flows through the city of Keizer and is a tributary of the Willamette River. The basin slope is very flat. The Upper Claggett Creek basin is highly developed, with land use including single and multi-family residential, industrial, commercial, rural, and agricultural areas. Two existing city-owned regional detention facilities are located in the basin: (1) the 37th Place NE facility; and (2) the Eastgate Soccer Field.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR UPPER CLAGGETT CREEK BASIN

The 2000 *Stormwater Master Plan* divided the Upper Claggett Creek Basin into 89 catchments (**Map 14.1**) and estimated existing and future impervious surface areas (**Table 14.1**).

Using a planning-level XP-SWMM model and assuming the existing conveyance system, no new detention facilities, and a 10-year design storm, the 2000 *Stormwater Master Plan* modeling results identified several segments that could be subject to surcharging (**Map 14.2**).

Peak discharges reported by the XP-SWMM model that correspond to the flow locations identified in **Map 14.2** are provided in **Table 14.2**.

There were 60 capital project improvements listed in the 2000 *Stormwater Master Plan* to address the needs of Upper Claggett Creek Basin. Of these projects, 48 involved replacing undersized pipes or culverts; three involved bridge work; and eight were related to habitat improvements. A potential site for a new detention facility was identified at Claggett Creek upstream of the Salem Parkway. **Map 14.3** shows the locations for the recommended projects. The total estimated cost for all 60 projects (in 2000 dollars) was $40,045,487.

UPPER CLAGGETT CREEK BASIN PLAN

Detailed analysis of the Upper Claggett Creek Basin was not performed as part of the latest update to the *Stormwater Master Plan*. Until analysis is conducted and a new basin plan adopted, the results of the 2000 *Stormwater Master Plan*—updated using staff input to reflect completed projections and current requirements—will serve in the interim for the Upper Claggett Creek Basin Plan.

Of the 60 recommended improvement projects identified in the 2000 *Stormwater Master Plan*, six have been completed. two other projects have been determined as no longer required. See **Table 14.3**.

Table 14.4 identifies the remaining 52 projects that are being carried forward as the interim basin plan for the Upper Claggett Creek Basin. The proposed timeframes for completing these projects are indicated as short-term (within five years), intermediate-term (between five and ten years), and long-term (over ten years). One project, replacing an undersized pipe (CLB16) is recommended as a short-term project and two other pipe replacement projects are recommended for intermediate-term completion.

The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project. The total estimated cost in 2019 dollars for all the projects currently identified for the Upper Claggett Creek Basin, rounded to the nearest $10,000, is $53,310,000.

All projects recommended in this master plan for the Upper Claggett Creek Basin are shown on **Map 14.4**.

Upper Claggett Creek Basin Data

Table 14.1

Upper Claggett Creek Basin Hydrologic Parameters

From the City of Salem 2000 *Stormwater Master Plan*, Table A-8

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
CL01	14.5	38	50	92	92
CL02	31.7	85	85	97	218
CL03	37.6	65	65	95	238
CL04	27.5	85	85	97	112
CL05	25.8	72	80	96	122
CL06	48.5	38	50	92	230
CL07	48.2	38	50	92	92
CL08	31.9	38	52	92	124
CL09	19.1	65	65	96	98
CL10	50.1	38	55	92	106
CL11	42.9	15	50	90	117
CL12	83.1	65	65	95	141
CL13	26.8	50	88	92	236
CL14	79.3	72	88	96	207
CL15	89.9	72	81	96	203
CL16	189.8	72	89	94	275
CL17	51.5	50	89	84	147
CL17a	55.5	50	90	95	137
CL18	47.1	10	90	84	188
CL19	19.2	15	88	84	54
CL20a	21.3	25	25	90	120
CL20B	23.9	38	60	92	86
CL20C	32.1	25	25	90	111
CL20D	22.9	38	60	92	113
CL21	39.6	72	88	94	123
CL22	37.0	38	62	87	150

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
CL23	96.5	38	66	87	222
CL24a	19.4	38	60	92	99
CL25	95.0	15	61	83	185
CL26	90.4	65	65	95	266
CL27	89.1	20	55	90	238
CL28	85.4	38	54	87	153
CL30	99.4	38	38	92	261
CL31	77.8	38	50	92	153
CL32	75.9	38	57	92	146
CL33	93.6	38	55	92	220
CL34	61.9	20	60	90	277
CL35	37.2	38	65	92	272
CL36	12.7	10	55	90	110
CL37	64.0	65	70	95	165
CL37a	38.7	65	84	95	81
CL38	56.0	38	60	92	126
CL39	55.4	38	58	92	120
CL40	40.9	65	69	95	136
CL41	62.9	65	84	95	230
CL42	45.2	77	77	96	203
CL43	16.8	38	65	92	128
CL44	103.7	25	60	90	226
CL45	25.1	72	85	96	181
CL46	68.4	25	25	90	150
CL47	79.0	38	66	92	155
CL48	124.9	10	50	90	169
CL49	97.2	38	67	92	202
CL50	40.8	38	60	92	185
CL51	65.6	72	72	96	159
CL52	17.7	72	72	96	92
CL53	55.7	25	50	90	175
CL54	45.6	38	82	92	199

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
CL55	46.1	65	65	95	176
CL56	45.4	38	72	90	130
CL57	5.1	20	20	92	139
CL58	43.4	30	50	91	191
CL59	23.3	38	50	94	107
CL59a	24.2	20	38	92	103
CL60	38.0	38	50	92	100
CL61	34.6	38	50	92	174
CL62	46.5	38	50	92	116
CL62a	13.2	38	50	92	58
CL63	48.4	38	64	96	122
CL64	27.2	38	50	92	97
CL65	50.7	38	55	92	195
CL65a	30.4	38	55	92	119
CL66	179.0	40	67	96	268
CL67	69.9	38	67	92	212
CL68A	57.2	65	65	93	165
CL68B	34.4	25	50	96	100
CL69	52.5	38	55	87	156
CL70	79.8	30	75	92	225
CL71	53.9	72	84	96	181
CL72	44.3	25	72	90	161
CL73	46.0	38	50	92	306
CL74	34.4	20	50	90	123
CL75	65.9	38	60	92	230
CL76	6.3	38	62	92	130
CL77	33.2	25	65	90	177
CL78	45.6	38	53	87	193
CL80	53.6	20	79	94	115
CL81	65.2	15	86	94	116
CL82	81.7	5	90	90	131

Table 14.2

Upper Claggett Creek Basin Model Results for Selected Flow Locations

From the City of Salem 2000 Stormwater Master Plan, Table B-1

Storm Recurrence Flow Location Identifier	10-Year Storm Existing Peak Flow (cfs)	10-Year Storm Future Peak Flow (cfs)	10-Year Storm Future w/ Detention Peak Flow (cfs)	25-Year Storm Existing Peak Flow (cfs)	25-Year Storm Future Peak Flow (cfs)	25-Year Storm Future w/ Detention Peak Flow (cfs)	100-Year Storm Existing Peak Flow (cfs)	100-Year Storm Future Peak Flow (cfs)	100-Year Storm Future w/ Detention Peak Flow (cfs)
CLF1	1240.0	1340.0	1250.0	1480.0	1550.0	1280.0	1720.0	1790.0	1450.0
CLF2	1180.0	1230.0	1120.0	1390.0	1440.0	1170.0	1620.0	1680.0	1230.0
CLF3	168.0	174.0	174.0	196.0	202.0	202.0	234.0	238.0	238.0
CLF4	69.7	72.4	72.4	81.4	83.7	83.7	96.4	98.9	98.9
CLF5	218.0	227.0	227.0	259.0	269.0	269.0	313.0	320.0	320.0
CLF6	113.0	116.0	116.0	132.0	136.0	136.0	158.0	161.0	161.0
CLF7	103.0	106.0	106.0	124.0	124.0	124.0	145.0	147.0	147.0
CLF8	243.0	249.0	250.0	255.0	257.0	257.0	284.0	292.0	293.0
CLF9	212.0	220.0	221.0	226.0	224.0	224.0	247.0	251.0	252.0
CLF10	122.0	125.0	125.0	140.0	142.0	142.0	163.0	165.0	165.0
CLF11	205.0	219.0	219.0	244.0	258.0	258.0	292.0	307.0	307.0
CLF12	115.0	123.0	123.0	137.0	144.0	144.0	164.0	171.0	171.0
CLF13	37.8	38.2	38.2	44.0	44.3	44.3	52.0	52.4	52.4
CLF14	206.0	214.0	214.0	244.0	252.0	252.0	293.0	303.0	303.0
CLF15	73.0	78.3	78.3	86.9	91.8	91.8	104.0	111.0	111.0
CLF16	49.8	54.8	54.8	59.0	64.7	64.7	72.7	78.1	78.1

Table 14.3

Upper Claggett Creek Basin Projects from 2000 Stormwater Master Plan Completed or Removed

DSIP Project ID	Location	Recommended Improvement	Status
CLB5	Claggett Creek along Claggett Gravel Pit	Channelization/Bioengineering/Special Stream Habitat	Completed
CLB6	Claggett Creek at Portland Rd. NE	Bridge	Completed
CLB9	Claggett Creek crossing Hyacinth near I-5	Bridge	Completed
CLB33	Along Hawthorne from North of Felina Court to 32nd and Rockingham	Channelization/Bioengineering/Habitat; replace undersized culvert	Completed
CLB38	Sunnyview Rd. from Hawthorne Ave. to Fisher Rd. NE	Replace undersized pipe	Completed
CLB40	Near Market St. and Hawthorne Ave. NE	Replace undersized pipe	Completed
CLB56	Salem Industrial Drive from Anunsen St. north to the Claggett Gravel Pit	Replace undersized culvert; replace undersized culvert/pipe with new culvert/open channel	No longer required
CLB60	Claggett Gravel Pit: Claggett Creek upstream of Salem Parkway	New detention facility	No longer required

Table 14.4

Upper Claggett Creek Basin Plan Project List

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB1	Hyacinth St. near Salem Industrial Dr.	Replace undersized pipe	$1,713,557	Long term (over 10 years)
CLB2	Claxter Rd. to Hyacinth St.	Replace undersized pipe	$1,032,555	Long term (over 10 years)
CLB3	Claggett Creek at Burlington Northern Railroad	Remove culvert. Restore open channel.	$854,508	Long term (over 10 years)
CLB4	Claggett Creek at SPRR	Add parallel culvert. Requires boring	$531,760	Long term (over 10 years)
CLB7	Claggett Creek at Deerhaven	Bridge	$521,042	Long term (over 10 years)
CLB8	Claggett Creek near I-5 and Hyacinth	Channelization/ Bioengineering/ Habitat	$480,728	Long term (over 10 years)
CLB10	Claggett Creek crossing I-5	Replace undersized culvert	$1,294,565	Long term (over 10 years)
CLB11	Claggett Creek upstream of I-5 to NE Fisher Rd.	Channelization/ Bioengineering/ Habitat, Replace undersized culvert	$921,350	Long term (over 10 years)
CLB12	Crossing Cooley Rd. NE	Replace undersized culvert	$171,050	Long term (over 10 years)
CLB13	Along Lancaster from Cooley to Stortz	Channelization/ Bioengineering/ Habitat	$1,346,520	Long term (over 10 years)
CLB14	Along Lancaster from Devonshire Ct. to Wolverine	Replace undersized pipe	$477,482	Long term (over 10 years)
CLB15	Along Lancaster from Stortz to Devonshire	Replace undersized pipe	$899,005	Long term (over 10 years)
CLB16	Along Fisher Rd. from Ward Dr. NE to Covington	Replace undersized pipe	$128,816	Short term (within 5 years)
CLB17	From crossing of Fisher Rd. northeast along Lancaster to Hayesville	Replace undersized pipe/ culvert	$2,349,034	Long term (over 10 years)
CLB18	39th Ave NE Ward Dr. to Ivy Way	Replace undersized pipe	$496,478	Long term (over 10 years)
CLB19	East from Fisher Rd. to Lancaster	Channelization/ Bioengineering/ Habitat	$690,008	Long term (over 10 years)
CLB18	39th Ave NE Ward Dr. to Ivy Way	Replace undersized pipe	$283,475	Long-term (over 10 years)
CLB19	East from Fisher Rd. to Lancaster	Channelization/ Bioengineering/ Habitat	$393,975	Long-term (over 10 years)

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB20	Crossing of Lancaster Dr., south of Ibex St. NE	Replace undersized culvert	$523,796	Long term (over 10 years)
CLB21	Along Ibex St. NE and Ward Dr. from Lancaster to 45th Ave. NE	Channelization/ Bioengineering/ Habitat	$1,093,123	Long term (over 10 years)
CLB22	Along 42nd Ave. NE from Ward Dr. to Jade St.	Replace undersized pipe	$546,126	Long term (over 10 years)
CLB23	Crossings of 45th Ave. NE and Harlan	Replace undersized culverts	$246,229	Long term (over 10 years)
CLB24	Crossings of Satter Dr. and Selby Ct. NE	Replace undersized culverts	$300,418	Long term (over 10 years)
CLB25	Crossings of Sesame St. and 47th Ave. NE	Replace undersized culvert	$567,489	Long term (over 10 years)
CLB26	East of Brown Rd. NE from Idaho Ave. to Glendale Ave.	Channelization/ Bioengineering/ Habitat	$1,118,899	Long term (over 10 years)
CLB27	Culvert crossing Surfwood Dr. NE	Replace undersized culvert	$102,898	Long term (over 10 years)
CLB28	Shellyanne Way south to Roselawn Dr.	Replace undersized pipe	$725,885	Long term (over 10 years)
CLB29	From Lancaster and Stortz southeast to Tierra Dr.	Replace undersized culverts	$892,097	Long term (over 10 years)
CLB30	Along Phipps Ln. NE south from Carolina Ave NE to Phipps Circle	Replace undersized culvert/ pipe	$1,419,466	Long term (over 10 years)
CLB31	Crossings of Scotsman Ln. and Sunnyview Rd.	Replace undersized culverts	$329,656	Long term (over 10 years)
CLB32	Along Lancaster Dr. south from Market St to D St. NE	Replace undersized pipe	$1,631,342	Long term (over 10 years)
CLB34	South from Wooddale Ave NE to Silverton Rd. near Hawthorne NE	Replace undersized culvert/ pipe	$2,697,357	Long term (over 10 years)
CLB35	Along Silverton Rd. near Beacon St. NE	Replace undersized pipe	$44,512	Long term (over 10 years)
CLB36	Drainage system east of Hawthorne from Devonshire Ave. to Beverly Ave. NE	Replace undersized pipe	$1,190,297	Long term (over 10 years)
CLB37	Along Hawthorne from Monarch Dr. to Sunnyview Rd.NE	Replace undersized pipe	$1,370,339	Long term (over 10 years)
CLB39	Northeast of Hawthorne Ave. and Rawlins NE	Replace undersized pipe/ culvert	$15,185	Long term (over 10 years)
CLB41	From Hummingbird St. and Portland Rd. south to Silverton Rd. near Abrams Ave.	Replace undersized pipe	$3,470,136	Long term (over 10 years)

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB42	From Sunnyview Rd. near Evergreen Ave. south to Evergreen Ave. near Market St.	Replace undersized pipe	$4,138,856	Long term (over 10 years)
CLB43	From Sunnyview Rd. near Evergreen Ave. south to Evergreen Ave. near Market St.	Replace undersized pipe	$870,586	Long term (over 10 years)
CLB44	From Evergreen Ave. and Market St. south to D St. and Park Ave.	Replace undersized pipe	$1,310,940	Long term (over 10 years)
CLB45	Along Lansing Ave. south from Silverton Rd. to Sorenson Ct.	Replace undersized pipe	$271,984	Long term (over 10 years)
CLB46	Along Park Ave. south from Silverton Rd. to Dawn St.	Replace undersized pipe	$2,483,730	Long term (over 10 years)
CLB47	Along Lansing Ave. south from Sorensen Ct. to Rawlins Ave.	Replace undersized pipe	$1,408,598	Long term (over 10 years)
CLB48	Along Lansing Ave. south from Sunnyview Rd to Market St. NE	Replace undersized pipe	$213,270	Long term (over 10 years)
CLB49	West of I-5, east of Ellis Ave.	Replace undersized pipe	$151,846	Long term (over 10 years)
CLB50	East of I-5, Center St. to Manor Dr.	Replace undersized pipe	$1,997,227	Long term (over 10 years)
CLB51	East side, I-5 at Manor Dr.	Replace undersized pipe	$2,428,053	Long term (over 10 years)
CLB52	Center St. to Monroe - east of 36th	Replace undersized pipe	$2,055,285	Long term (over 10 years)
CLB53	Along Center St. between 36th Ave and Lancaster Dr. NE	Replace undersized pipe	$518,064	Long term (over 10 years)
CLB54	Along Lancaster Dr. from Amber St. south to State St.	Replace undersized pipe	$829,200	Long term (over 10 years)
CLB55	Along Center St. from Vinyard east to Oregon Ave. NE	Replace undersized pipe	$277,164	Intermediate term (5 - 10 years)
CLB57	Near Brooks Ave. and McDonald Way	Replace undersized pipe	$316,347	Intermediate term (5 - 10 years)
CLB58	Along Portland Rd. near Beach Ave. NE	Replace undersized pipe	$283,208	Long term (over 10 years)

DSIP Project ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
CLB59	Along 17th St. south from Silverton Rd. to Sunnyview Rd. NE	Replace undersized pipe	$1,560,719	Long term (over 10 years)
		Total	$53,308,788	

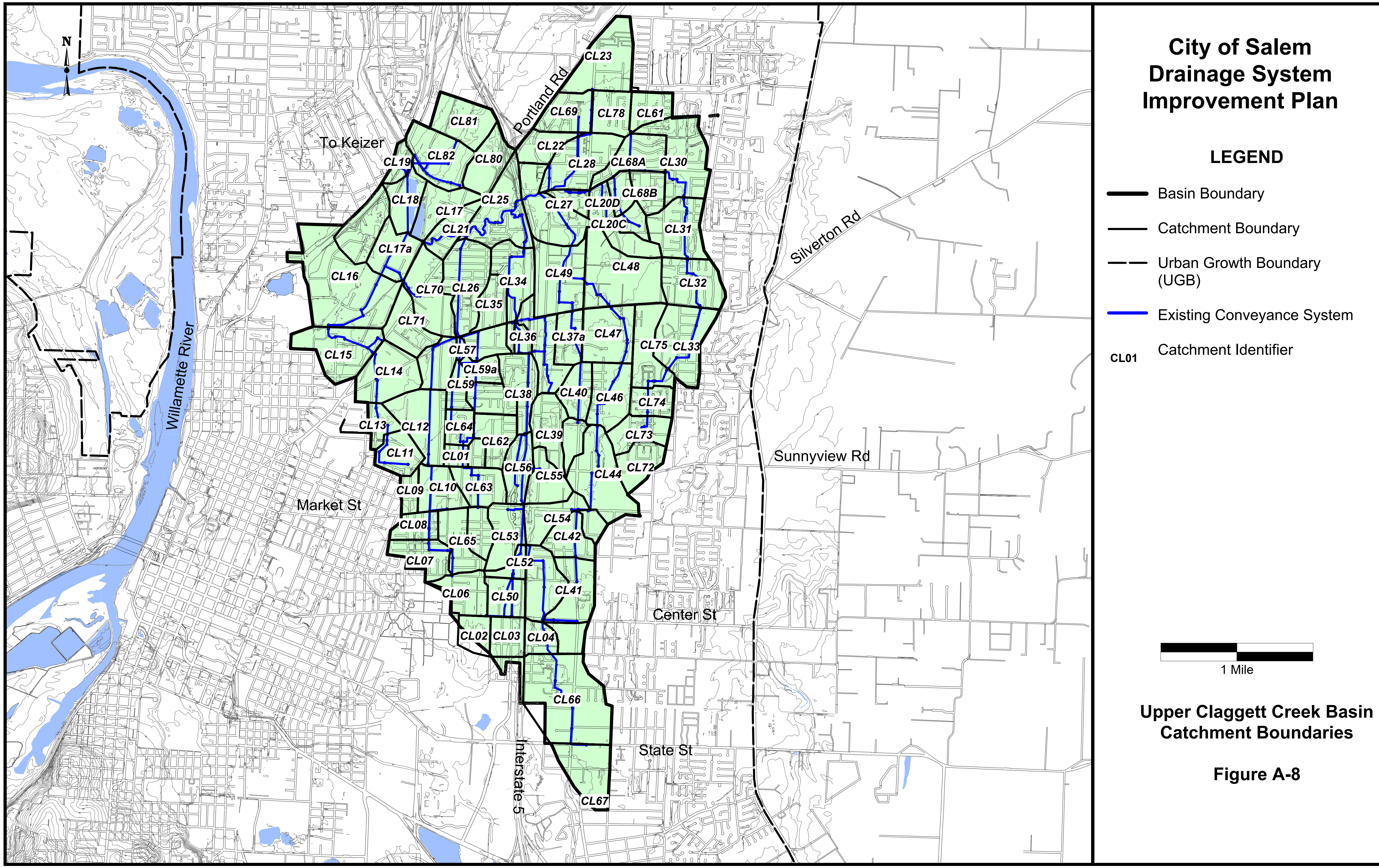
Notes:

The Upper Claggett Creek Basin Project List is based on results of 2000 *Stormwater Master Plan*, updated using staff input to reflect completed projects and current requirements.

Estimated costs include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%).

Each project has a small conveyance improvement allowance based on 5% of the subtotal.

The 2000 to 2019 dollar conversion is 1.668, which is based on the Engineering News Record Construction Cost Indices for Seattle, San Francisco, and Los Angeles.



Map 14.1

Upper Claggett Creek Basin Boundaries

From the City of Salem 2000 *Stormwater Master Plan*, Figure A-8

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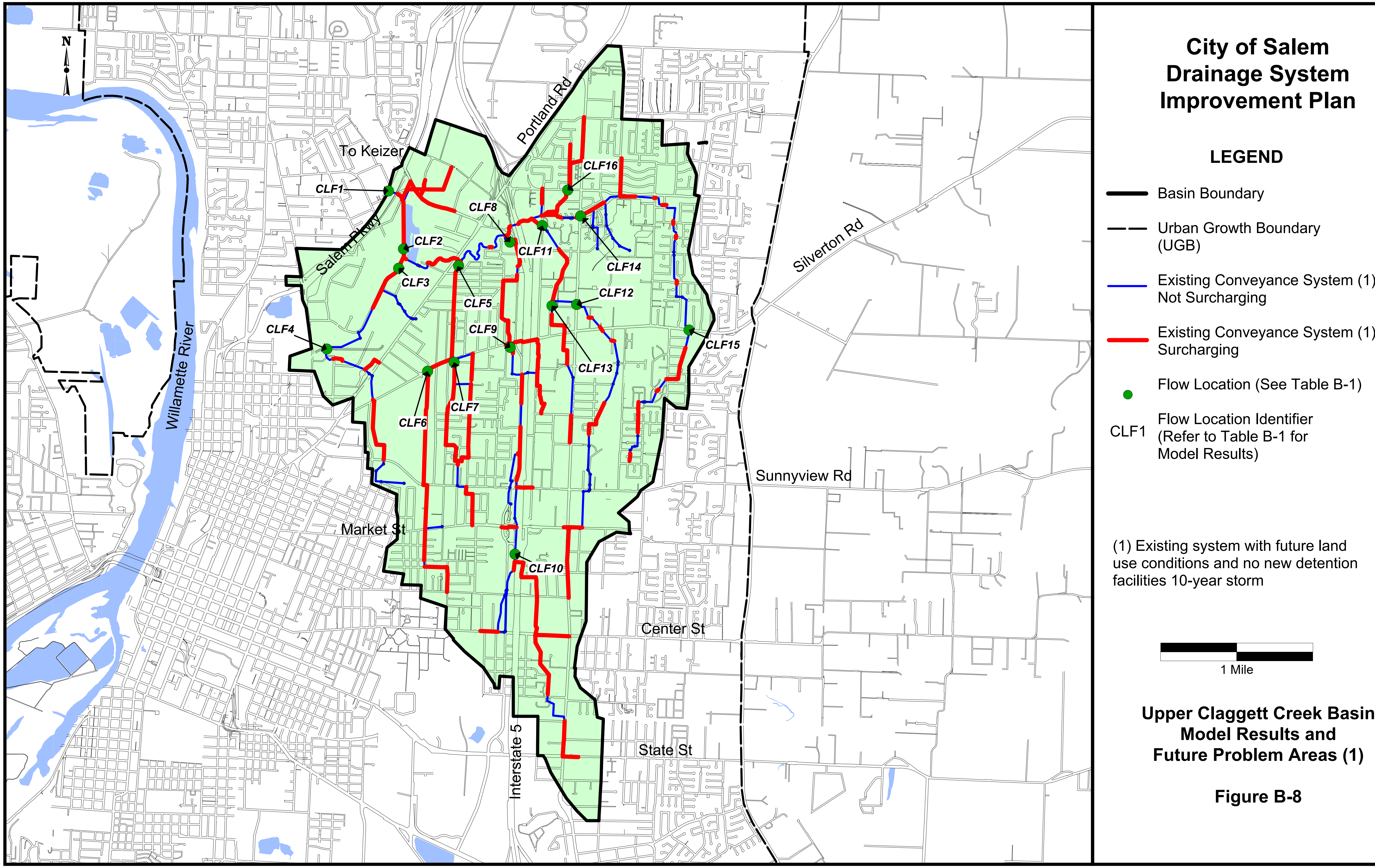

Map 14.2

Upper Claggett Creek Basin Model Results and Future Problem Areas

From the City of Salem 2000 *Stormwater Master Plan*, Figure B-8

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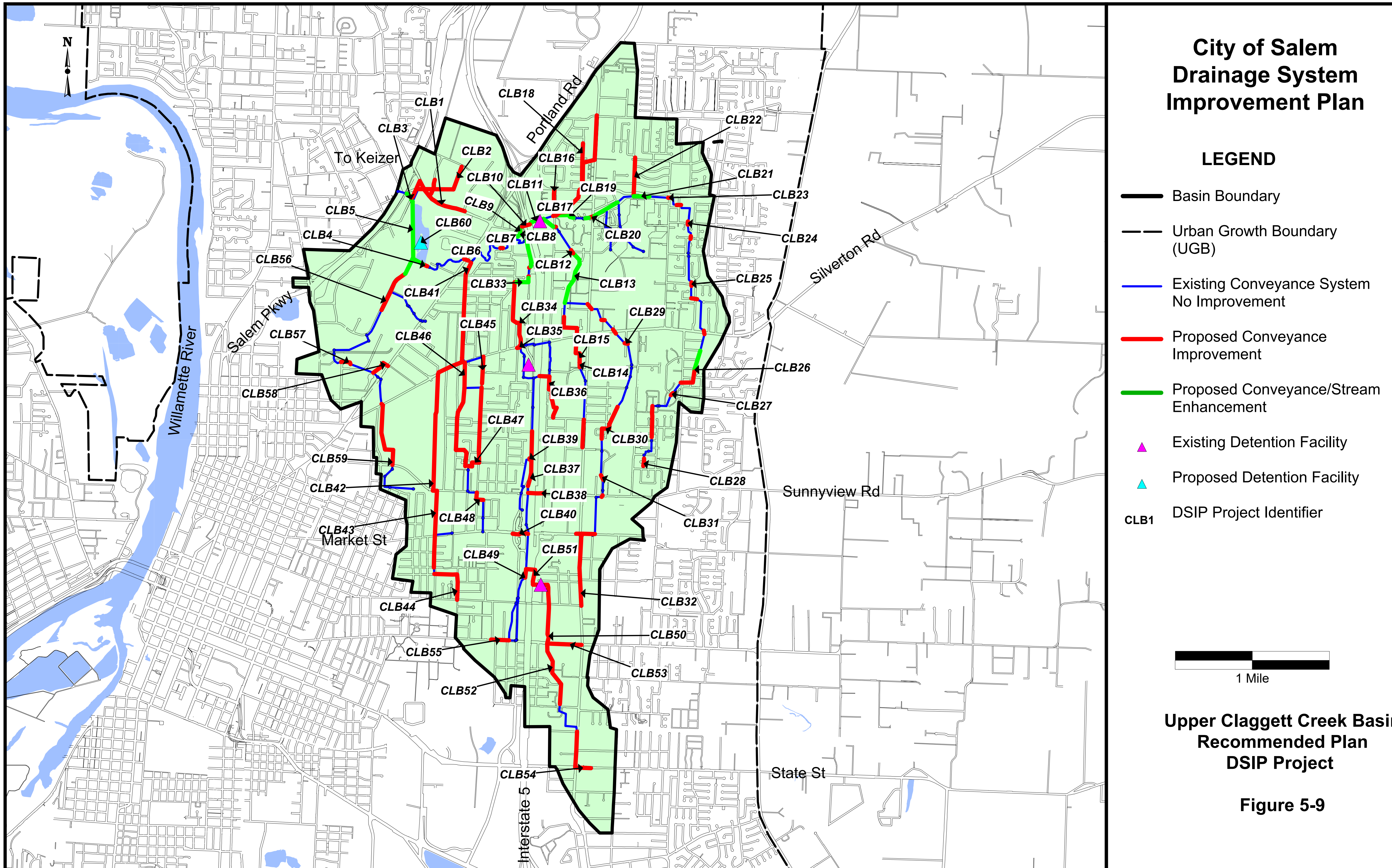

Map 14.3

Upper Claggett Creek Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure 5-9

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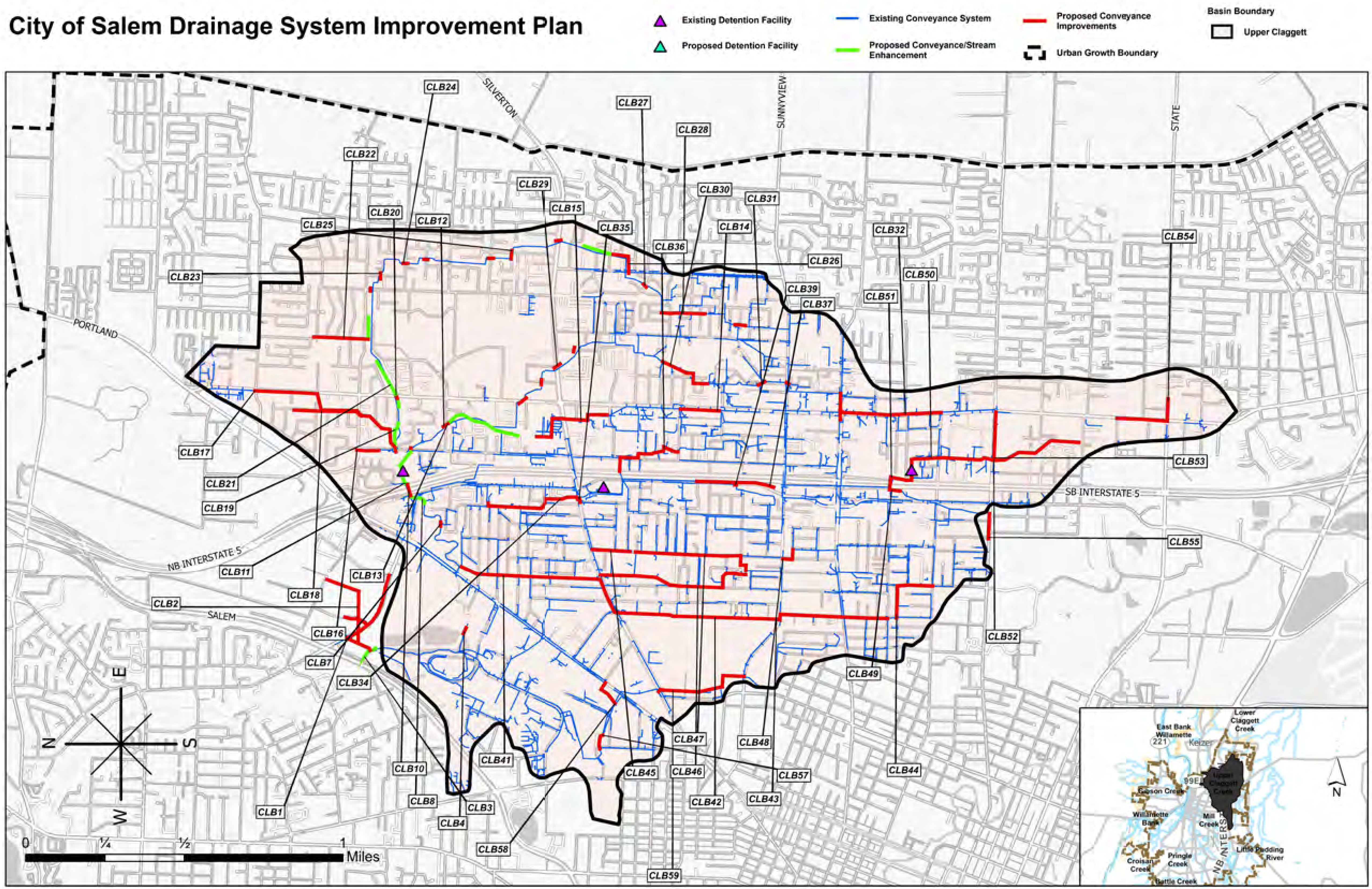

Map 14.4

2020 Stormwater Master Plan Upper Claggett Creek Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure B-8

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West Bank Basin Plan

WEST BANK BASIN DESCRIPTION

The West Bank Basin consists of those areas in west Salem draining directly to the Willamette River. The basin area is 2.3 square miles and is almost entirely within the Urban Growth Boundary. The terrain has two distinct regions: (1) high rolling hills toward the west end of the basin with land still available for development; and (2) a large flat area (near Edgewater Street NW) that is highly developed. The hills are zoned primarily single family residential. The flat area contains industrial, commercial, multi-family, and single family residential zones.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR WEST BANK BASIN

The 2000 *Stormwater Master Plan* divided the West Bank Basin into 32 catchments (**Map 15.1**) and estimated existing and future impervious surface areas (**Table 15.1**).

Using a planning-level XP-SWMM model and assuming the existing conveyance system, no new detention facilities, and a 10-year design storm, the 2000 *Stormwater Master Plan* modeling results identified several segments that could be subject to surcharging (**Map 15.2**).

Peak discharges reported by the XP-SWMM model that correspond to the flow locations identified in **Map 15.2** are provided in **Table 15.2**.

The 2000 *Stormwater Master Plan* evaluated three primary drainage paths. One of these paths was primarily an open system; the other two were a mixture of open and closed systems. Eleven capital projects were listed in the 2000 *Stormwater Master Plan* to address the needs of the West Bank Basin. Eight of the projects involved replacing undersized pipes, two involved replacing undersized culverts, and one was to increase detention volume at the Woodhaven detention facility. **Map 15.3** shows the locations for the recommended projects. The total estimated cost for all 11 projects (in 2000 dollars) was $4,211,652.

WEST BANK BASIN PLAN

Detailed analysis of the West Bank Basin was not performed as part of the latest update to the *Stormwater Master Plan*. Until analysis is conducted and a new basin plan adopted, the results of the 2000 *Stormwater Master Plan*—updated using staff input to reflect completed projections and current requirements—will serve in the interim for the West Bank Basin Plan.

Of the 11 recommended improvement projects identified in the 2000 *Stormwater Master Plan*, five have been completed and one other project has been identified as being no longer required. See **Table 15.3**.

Table 15.4 identifies the remaining five projects that are being carried forward as the interim basin plan for the West Bank Basin. The proposed timeframes for completing these projects are indicated as short-term (within five years), intermediate-term (between five and ten years), and long-term (over ten years). There are no short-term projects identified in the West Bank Basin Plan. Two projects, both involving replacement of undersized pipes, are recommended as intermediate-term projects.

The estimated cost for these projects is based on estimates contained in the 2000 *Stormwater Master Plan* with a multiplier of 1.668 applied to convert the 2000 values to 2019 dollars. The multiplier is based on the Engineering News Record Construction Costs Indices for Seattle, San Francisco, and Los Angeles. The costs also include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%). A small conveyance improvement allowance of five-percent is applied to the subtotal of each project. The total estimated cost in 2019 dollars for all the projects currently identified for the West Bank Basin, rounded to the nearest $10,000, is $4,070,000.

All projects recommended in this master plan for the West Bank Basin are shown on **Map 15.4**.

West Bank Basin Data

Table 15.1

West Bank Basin Hydrologic Parameters

From the City of Salem 2000 *Stormwater Master Plan*, Table A-9

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
WD0005	50.9	60	72	74	64
WD0015	20.5	40	58	74	29
WD0020	36.3	40	58	74	36
WD0025	19.2	40	50	74	34
WD0033	92.2	60	60	74	152
WD0040	47.9	40	40	74	64
WD0060	41.2	40	50	74	43
WD0070	32.6	40	51	74	29
WD0075	51.7	40	40	74	33
WD0090	28	40	51	74	32
WD0100	8.4	40	54	74	28
WD0105	7.8	30	54	74	25
WD0115	24.3	20	20	69	59
WD0116	13.7	40	54	74	36
WD0147A	38.8	20	65	74	46
WD0147B	26	40	56	74	38
WD0165	28.7	40	40	74	41
WD0170	22.4	40	50	74	52
WD0205	21.8	10	50	74	35
WD0245A	19.7	10	50	74	28
WD0245B	32.3	10	50	74	38
WD0255	21	40	42	74	67
WD0285	22.6	10	50	74	29
WD0301	60	10	50	74	42
WD0325	31.9	10	50	74	38
WD0340	63.9	20	47	74	39

Catchment Name	Area (acre)	Existing Percent Impervious	Future Percent Impervious	Pervious Area Curve Number	Time of Concentration (min.)
WD0375	29.6	10	50	74	38
WD0380	60.2	40	50	74	41
WD0382	46	10	50	74	49
WD0385	20.7	20	50	74	33
WD0390	25.6	20	38	74	33
WD0395	133.9	20	68	74	75

Table 15.2

West Bank Basin Model Results for Selected Flow Locations

From the City of Salem 2000 *Stormwater Master Plan*, Table B-1

Storm Recurrence Flow Location Identifier	10-Year Storm Existing Peak Flow (cfs)	10-Year Storm Future Peak Flow (cfs)	10-Year Storm Future w/ Detention Peak Flow (cfs)	25-Year Storm Existing Peak Flow (cfs)	25-Year Storm Future Peak Flow (cfs)	25-Year Storm Future w/ Detention Peak Flow (cfs)	100-Year Storm Existing Peak Flow (cfs)	100-Year Storm Future Peak Flow (cfs)	100-Year Storm Future w/ Detention Peak Flow (cfs)
WBF1	108	118	118	136	157	157	183	195	195
WBF2	68.8	74.4	74.4	93	94.2	94.2	113	125	125
WBF3	59.6	63.9	63.9	75.1	79.7	79.7	98.5	102	102
WBF4	17.7	21.2	21.2	22.4	26.4	26.4	29.5	32.8	32.8
WBF5	95.6	145	136	127	191	167	166	244	217
WBF6	79.7	116	103	106	154	131	134	207	173
WBF7	18.4	39.4	22.5	24.1	53.3	26.9	39.6	62.4	32.2

Notes:
(1) Data for these locations were taken from analyses performed by the Army Corps of Engineers (USACE 2002)

Table 15.3

West Bank Basin Projects from 2000 Stormwater Master Plan Completed or Removed

DSIP Proj. ID	Location	Recommended Improvement	Remarks
WBB1	Wallace Rd between Orchard Hts and Taybin Rd	Replace undersized pipe	Completed
WBB2	From Wallace Rd and Glen Creek Rd to Gerth Ave and 9th	Replace undersized pipe	Completed
WBB7	Culvert across Eola Dr near the intersection of Eola Dr and Turnage St	Replace undersized culvert	Completed
WBB8	Culvert across Jasper Wy near intersection with Eola Dr	Replace undersized culvert	No longer required
WBB9	Along Eola Dr between Gehlar Rd and Sunwood Dr	Replace undersized pipe	Completed
WBB10	Barberry St between 23rd Ct and Eola Dr	Replace undersized pipe	Completed

Table 15.4

West Bank Basin Plan Project List

TDSIP Proj. ID	Location	Recommended Improvement	Estimated Cost (2019)	Construction Time Frame
WBB3	From Cascade Drive to 9th and Gerth	Replace undersized pipe	$402,283	Long term (over 10 years)
WBB4	8th Ave between Gerth Ave and Rosemont Ave	Replace undersized pipe	$668,124	Intermediate term (5 - 10 years)
WBB5	Senate St between 6th Ave and the Willamette River	Replace undersized pipe	$1,269,912	Intermediate term (5 - 10 years)
WBB6	Culvert across the Salem-Dallas Hwy, near Moores Wy	Replace undersized pipe	$416,833	Long term (over 10 years)
WBB11	Eola Drive near intersection with Sunwood Dr	Add detention capacity at Woodhaven Detention Facility	$1,311,536	Long term (over 10 years)
		Total	$4,068,688	

Notes:

The West Bank Basin Project List is based on results of 2000 *Stormwater Master Plan*, updated using staff input to reflect completed projects and current requirements.

Estimated costs include allowances for permitting, acquisition, pre-design, and final design (15%); administration (6%); construction management (9%); and contingency (40%).

Each project has a small conveyance improvement allowance based on 5% of the subtotal.

The 2000 to 2019 dollar conversion is 1.668, which is based on the Engineering News Record Construction Cost Indices for Seattle, San Francisco, and Los Angeles.

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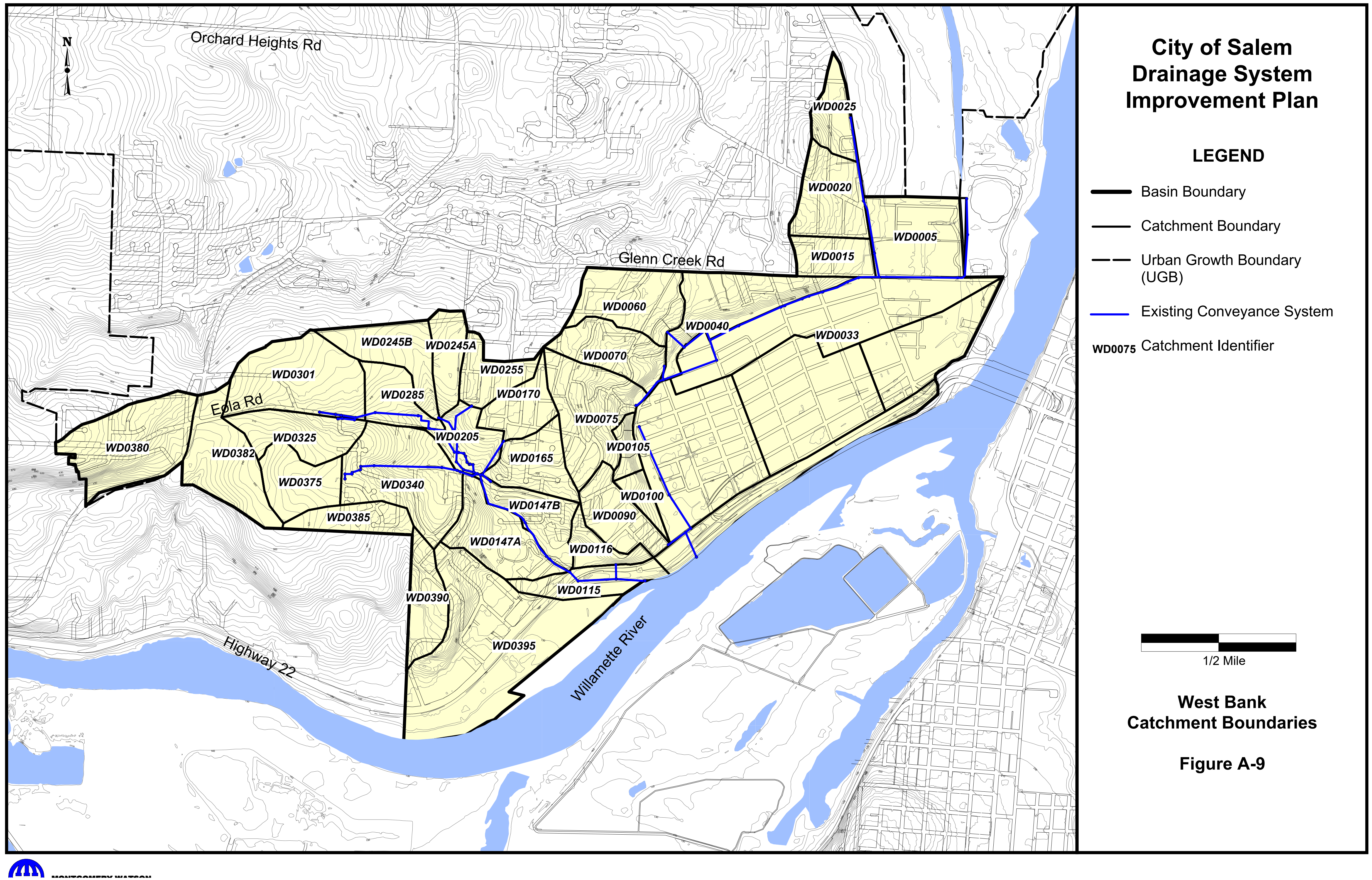
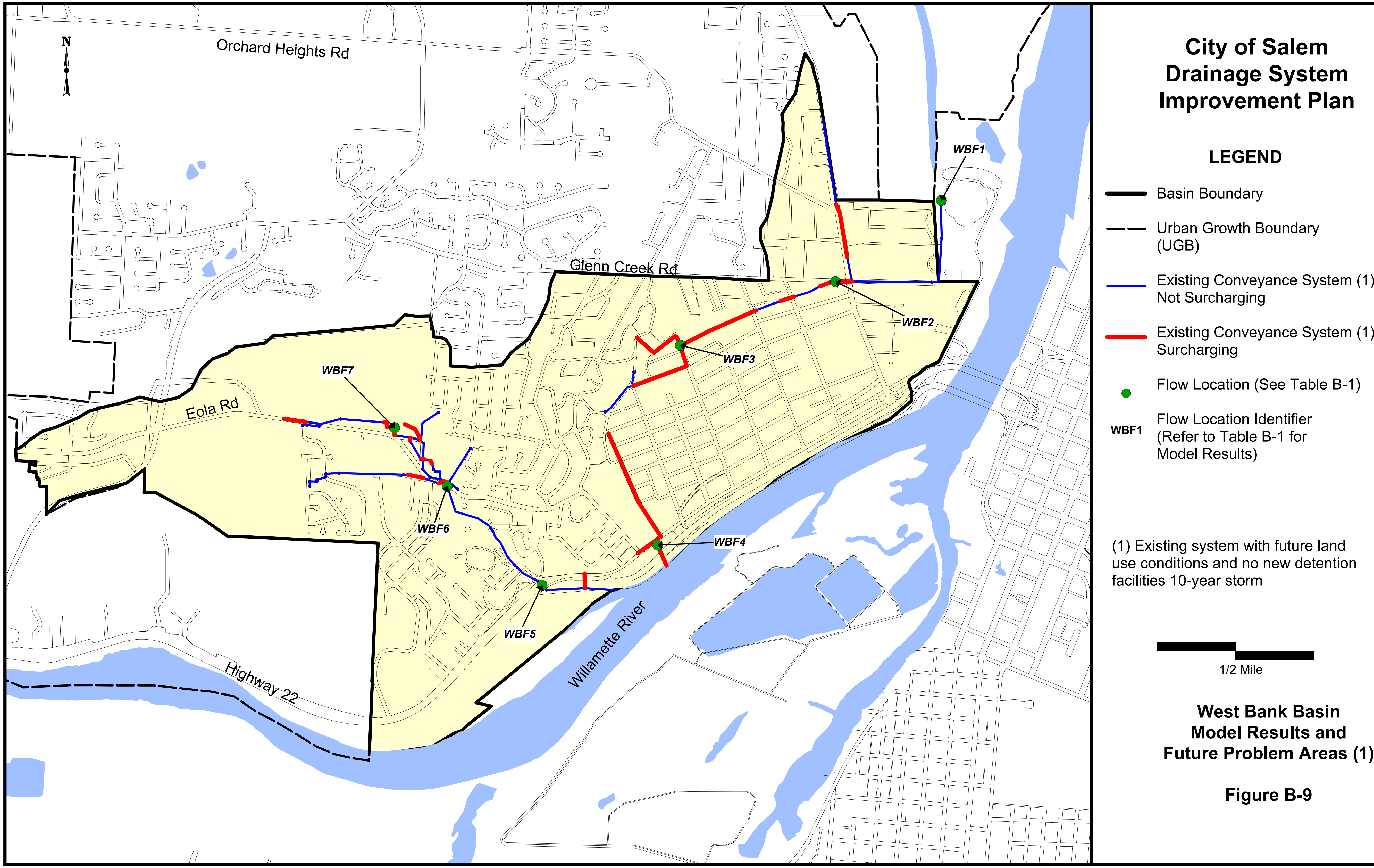


Map 15.1

West Bank Basin Boundaries

From the City of Salem 2000 *Stormwater Master Plan*, Figure A-8



Map 15.2

West Bank Basin Model Results and Future Problem Areas

From the City of Salem 2000 *Stormwater Master Plan*, Figure B-9

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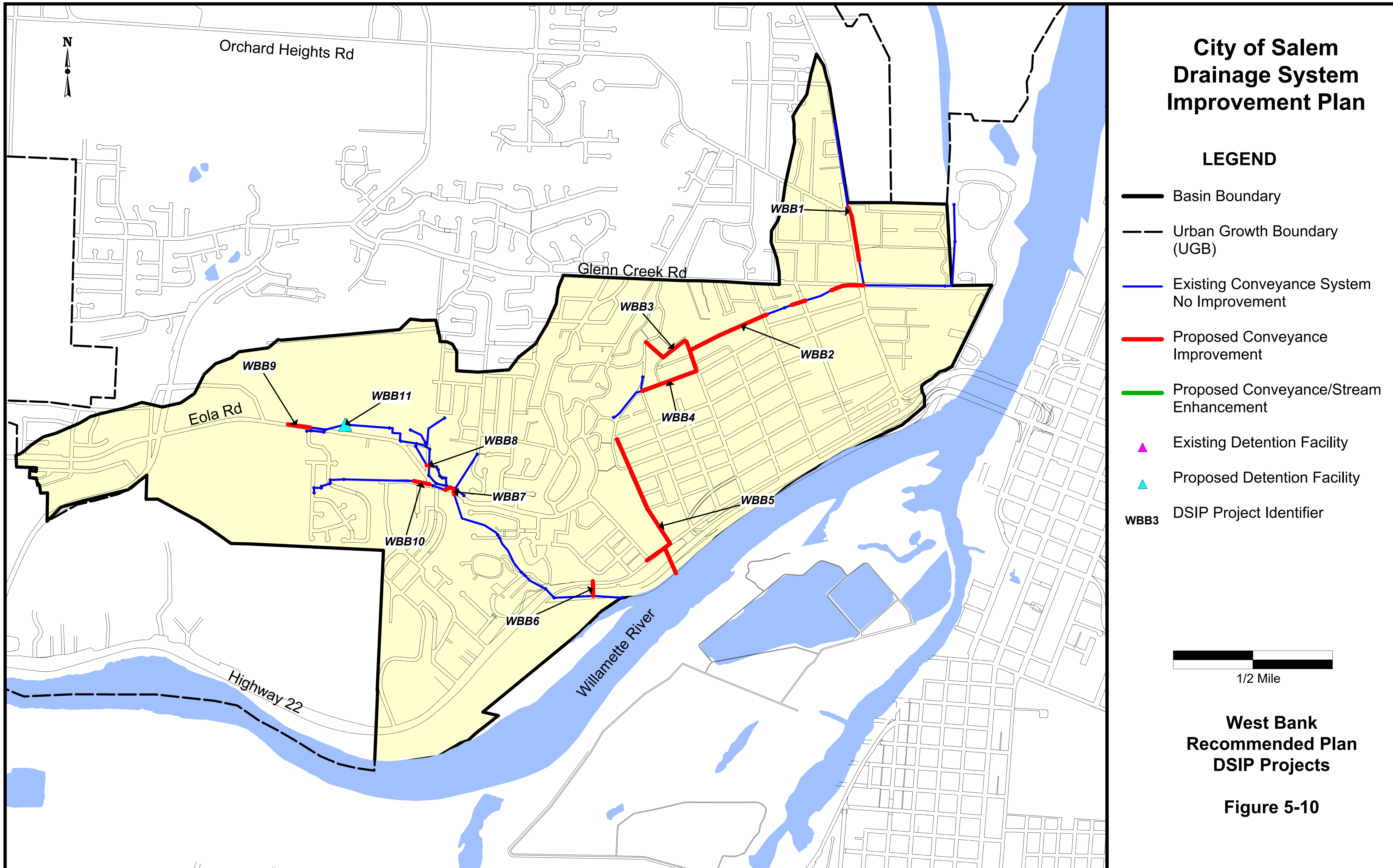

Map 15.3

West Bank Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure 5-10

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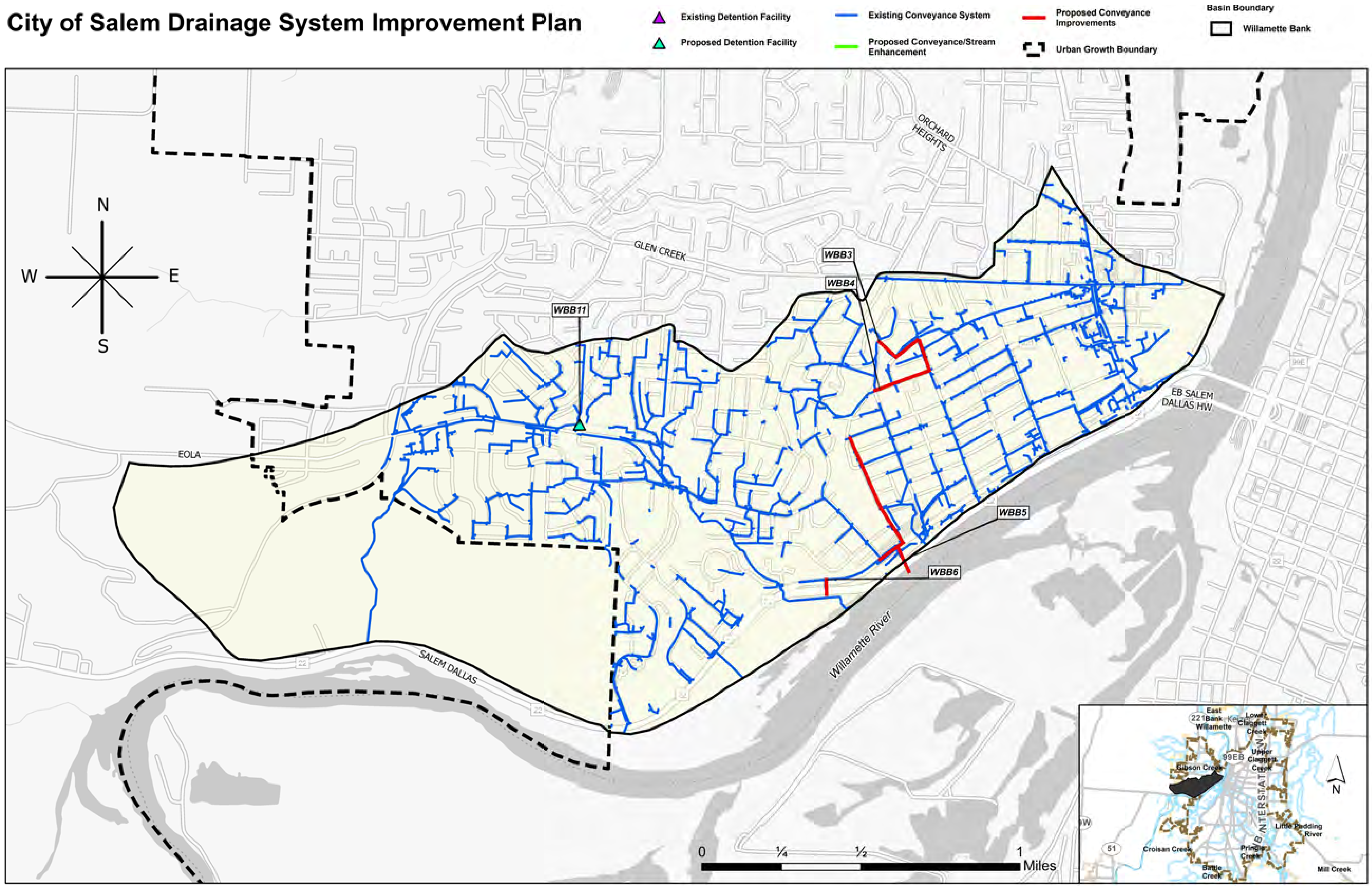

Map 15.4

2020 Stormwater Master Plan West Bank Basin Recommended Project Locations

From the City of Salem 2000 *Stormwater Master Plan*, Figure A-8

Willamette Slough Basin Plan

WILLAMETTE SLOUGH BASIN DESCRIPTION

The Willamette Slough basin is 4.8 square miles and consists mostly of low elevation areas along the Willamette River. This basin is flat and almost entirely within the Willamette River 100-year floodplain. **Map 16.1** shows the basin boundaries. Land use within the Willamette Slough basin is primarily related to parks, recreation, and agriculture, with some residential areas at higher elevations.

FINDINGS OF 2000 STORMWATER MASTER PLAN FOR WILLAMETTE SLOUGH BASIN

In the 2000 *Stormwater Master Plan* it was determined that "the Willamette Slough basin presents very few development opportunities that cannot be handled with a detailed analysis of the particular site, if needed." For this reason, the Willamette Slough basin was not modeled in 2000 and no projects were identified for the basin in the 2000 *Stormwater Master Plan*.

WILLAMETTE SLOUGH BASIN PLAN

This *Stormwater Master Plan* carries forward the conclusion of the 2000 *Stormwater Master Plan* that basin-wide analysis is not necessary and that development-specific stormwater facilities will be sufficient to address stormwater-related issues into the foreseeable future. Accordingly, until a detailed hydrologic and hydraulic analysis is conducted, the Willamette Slough Basin Plan consists of Map 16.1 delineating the basin boundaries.

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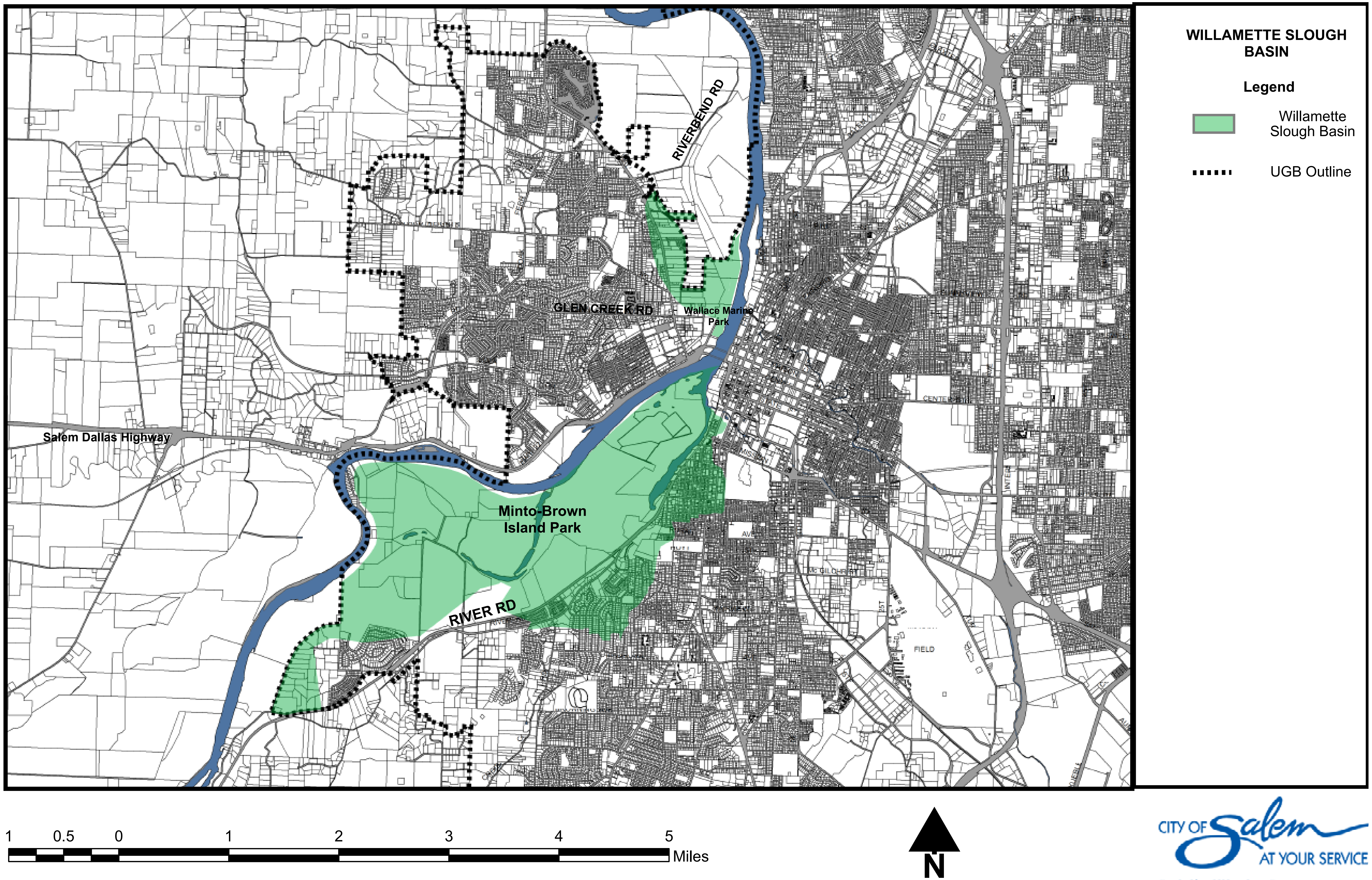
Willamette Slough Basin Data



CITY OF Salem AT YOUR SERVICE
Public Works Department

Map 16.1

Willamette Slough Basin Boundaries

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CIP	Capital Improvement Project
CCI	Construction Cost Index
CRS	Community Rating System
CWA	Federal Clean Water Act
DEQ	Oregon State Department of Environmental Quality
DLCD	Oregon Department of Land Conservation and Development
DSIP	City of Salem Drainage System Improvement Plan
EDU	Equivalent Dwelling Unit
ENR	Engineering News Record
EPA	US Environmental Protection Agency
ESA	Federal Endangered Species Act
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FWS	US Fish and Wildlife Service
GIS	Geographic Information System
GSI	Green Stormwater Infrastructure
IPS	Infor Public Sector
LCDC	Oregon Land Conservation and Development Commission
MS4	Municipal Separate Storm Sewer System
NFIP	National Flood Insurance Program
NGVD	National Geodetic Vertical Datum
NMFS	US National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWS	US National Weather Service
OAR	Oregon Administrative Rule
ODFW	Oregon Department of Fish and Wildlife
ORS	Oregon Revised Statute
SDC	System Development Charge
SRC	Salem Revised Code
SWMM	Stormwater Management Model
SWMP	Stormwater Master Plan
TMDL	Total Maximum Daily Load
UGB	Urban Growth Boundary
USA	Urban Service Area
USACE	United States Army Corps of Engineers

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Memo

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Name: Robert Chandler, Ph.D., P.E., Assistant Public Works Director

Company: City of Salem

Date: August 12, 2014

From: Hans Hadley, P.E., Sr. Project Manager /Hydraulic Engineer

Subject: Stormwater Master Plan Update – Modeling Software Recommendation

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Purpose and Need

The City of Salem desires to develop hydrologic and hydraulic stormwater modeling which will accurately reflect the behavior of its various natural and constructed stormwater drainage systems for the primary purpose of updating the Stormwater Master Plan and individual Basin Plans. The stormwater drainage systems include open channel conveyances (both natural channels and constructed ditches), closed conduit stormwater systems, bridges and culverts, diversion weirs, and local and regional detention basins. During high flow conditions, complex (2-dimensional) overland flooding results in transfers of flows between basins. The following is a discussion of various available hydrologic/hydraulic modeling software packages that were considered for use in updating the City's Stormwater Master Plan and Basin Plans. Also provided is our recommendation for the most appropriate hydrologic/hydraulic modeling software to meet the City's needs.

Selecting modeling software appropriate for the task requires consideration of the various factors, principle among them is the primary purpose of the modeling and the availability of required data. The primary purpose of the modeling will be to update the City's Stormwater Master Plan and associated Basin Plans. As such, the model(s) will need to be capable of depicting the existing flood risk, reflecting the inter-basin flow transfers (i.e. Mill Creek overflows to Pringle Creek), and evaluating alternative solutions to reduce flood risk. Additional desired capabilities include the ability to model impacts to flows from hydromodifications and their associated impacts to in-channel and riparian habitat. The available data are abundant and will generally allow for needed detailed hydrologic and hydraulic analysis, but may need to be supplemented with additional data collection. An inventory of available data is currently being developed. Recommendations for collection of additional data are pending.

Potential Modeling Solutions

The following are brief descriptions of the modeling software packages considered for use in updating the Stormwater Master Plan and associated Basin Plans.

HEC-HMS Hydrologic Model

HEC-HMS, developed by the U.S. Army Corps of Engineer Hydrologic Engineering Center (HEC), is hydrologic modeling software designed to simulate the complete hydrologic processes of dendritic watershed systems. The software includes many traditional hydrologic analysis procedures such as event infiltration, unit hydrographs, and hydrologic routing. HEC-HMS is also capable of continuous simulation and accounts for evapo-transpiration, snowmelt, and soil moisture accounting. HEC-HMS is commonly used in conjunction with HEC-RAS when hydrology and hydraulics are both required. However, the transfer of hydrologic data into the hydraulic model is typically done manually, which tends to be inefficient.

HEC-RAS Hydraulic Model

HEC-RAS, developed by HEC, is the predominant 1-dimensional (1-D) hydraulic modeling software used in the United States. It is capable of computing steady-state and unsteady-state hydraulics, compute bridge scour, perform sediment transport analysis, and water quality analysis. The software is GIS compatible and has an integrated mapping component capable of plotting water surface results. HEC-RAS is easy to use with a robust graphical user interface capable of displaying computation results in both graphical and tabular formats. The majority of 1-D hydraulic analyses performed for flood risk assessments are performed using HEC-RAS or its predecessor HEC-2.

HEC-RAS is capable and widely applied modeling software. It is likely the most commonly used modeling program for 1-D open channel hydraulics in the United States. That said, it is lacks several abilities necessary for the City of Salem Stormwater Master Plan Update. While HEC-RAS is currently developing a 2-D component, it is still undergoing beta testing and is not ready for commercial applications. Also, HEC-RAS is not capable of analyzing systems of closed conduits.

HSPF Hydrologic Model

HSPF is a hydrologic modeling software package developed by Scientific Software Group (SSG). It is a U.S. EPA program developed for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants. The HSPF model uses information such as the time history of rainfall, temperature and solar radiation; land surface characteristics such as land use patterns; and land management practices to simulate the hydrologic processes that occur in a watershed. This allows the simulation of a time history of the quantity and quality of runoff from an urban or agricultural watershed.

HSPF is a well-regarded hydrologic modeling platform and has wide acceptance in certain areas of the Pacific Northwest. However, it lacks hydraulic capabilities and would necessarily have to be employed in conjunction with additional hydraulic modeling software such as HEC-RAS. As with HEC-HMS and HEC-RAS, there would be the need to transfer hydrologic results from HSPF into a hydraulic model as inputs. This process, especially in models as large and complex as those necessary for this project, is inefficient.

EPA-SWMM Hydrologic and Hydraulic Model

EPA-SWMM is a dynamic rainfall-runoff and hydraulic simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. Developed by the U.S. Environmental Protection Agency in the early 70's, it has undergone multiple major upgrades and improvements over the years. The runoff component of SWMM operates on a collection of subcatchment areas on which rain falls and runoff is generated. The routing portion of SWMM transports this runoff through a conveyance system of pipes, channels, storage/treatment devices, pumps, and regulators.

EPA-SWMM is an appropriate modeling solution for the combination of closed conduit stormwater systems and open channel conveyances that make up most of the urban drainage basins within the

City of Salem. The coupling of the hydrologic and hydraulic analyses makes EPA-SWMM efficient and reduces the likelihood of error when transferring hydrologic results to hydraulic inputs. However, it is lacking 2-D or coupled 1-D/2-D capability. Further, it is limited in its ability to perform analyses on bridges and lacks a floodplain mapping component.

Surface-water Modeling System (SMS) with RMA-2 Hydraulic Model

SMS, developed by Aquaveo, and RMA-2, developed by the U.S. Army Corps of Engineers Coastal and Hydraulics Laboratory, when combined make a comprehensive environment for one-, and two-dimensional hydrodynamic modeling. A pre- and post-processor for surface water modeling and design, SMS includes multiple 2-D finite element modeling tools. The numeric models supported in SMS compute a variety of information applicable to surface water modeling. Primary applications of the models include calculation of water surface elevations and flow velocities for shallow water flow problems, for both steady-state or dynamic conditions. Additional applications include the modeling of contaminant migration, salinity intrusion, sediment transport (scour and deposition), wave energy dispersion, wave properties (directions, magnitudes and amplitudes) and others.

SMS/RMA-2 is well-regarded hydrodynamic modeling software capable of 1-D and 2-D hydraulic computations. However, it lacks both a hydrologic component and the ability to analyze close conduit systems. Further, it is quite limited in its ability to analyze bridge crossings or perform floodplain mapping.

Xpstorm Hydrologic and Hydraulic Model

Xpstorm, developed by XP Solutions, is a comprehensive hydrologic and hydraulic modeling environment for evaluation of stormwater systems and flood risk. It is applicable to a wide range of water resource management, design, and emergency action planning issues. Xpstorm is a versatile software package for dynamic modeling of urban stormwater systems, river systems and floodplains including ponds, rivers, lakes, floodplains, and interaction with groundwater. The software is capable of combined 1-D riverine and 2-D overland flow analyses and also integrates closed-conduit stormwater systems making it a robust and effective tool for modeling stormwater systems and conducted flood risk analysis.

xpstorm is capable of analyzing the full range of hydrologic and hydraulic processes necessary for the update of the City's Stormwater Master Plan. Its weakest capability is the modeling of hydraulics of bridges and other complex crossings. Where such instances are identified, additional computations external to xpstorm can be conducted with more appropriate software such as HEC-RAS and the results integrated into the greater xpstorm model. Xpstorm is a coupled hydrologic and hydraulic modeling package which will increase modeling efficiency and reduce the likelihood of errors being introduced as hydrologic results are transferred to inputs for hydraulic analysis.

InfoSWMM Hydrologic and Hydraulic Model

InfoSWMM, developed by Innovyze, is a fully ArcGIS-integrated, advanced and comprehensive hydrologic, hydraulic, and water quality simulation model for the evaluation of urban stormwater and wastewater collection systems. InfoSWMM is a fully dynamic, geospatial wastewater and stormwater modeling and management software application. The model can perform single event or long-term (continuous) rainfall-runoff simulations accounting for soil types, land use, and watershed topography. InfoSWMM can also predict runoff quality including buildup and wash off of pollutants from primarily urban watersheds. Once runoff quantity and quality are simulated, and wastewater loads at receiving junctions are determined, the software can route the flow through a conveyance system of pipes, channels, storage/treatment devices, pumps, and hydraulic regulators such as weirs and orifices.

InfoSWMM is capable of analyzing the majority of hydrologic and hydraulic processes necessary for the update of the City's Stormwater Master Plan. However, it lacks the capability of performing hydraulics at bridges and other complex hydraulic structures. This could be overcome in a similar manner as with xpstorm by performing bridge hydraulic analyses externally and incorporating the results. An additional drawback of InfoSWMM is that it operates entirely within the ESRI ArcGIS environment, which would require modelers to be well versed not only in hydrology and hydraulics, but also in GIS. The additional cost of purchasing and maintaining GIS software is also a factor to be considered.

FLO-2D Hydrologic and Hydraulic Model

FLO-2D is a flood routing model that simulates channel flow, unconfined overland flow, and street flow over complex topography. The software is capable of simulating rainfall, infiltration, sediment transport, buildings, levees, embankments, walls (wall collapse), dam breach, mudflows, storm drain, culverts, bridges, hydraulic structures and groundwater. Rainfall, infiltration, and most features can be spatially and temporally variable with historical rainfall events replicated with

NEXRAD data. FLO-2D can be integrated with EPA-SWMM for analyzing piped stormwater and has additional GIS and flood hazard mapping capabilities.

FLO-2D is very capable hydrodynamic modeling software which also simulates hydrologic processes. It is somewhat limited in its hydraulic computations and is really a quasi-2-D model, meaning it only solves part of the 2-D overland flow equations. Its ability to compute hydraulics at bridges and other hydraulic structures is limited. Closed conduit systems are analyzed externally using EPA-SWMM algorithms with limited functionality.

The matrix below illustrates a comparison of the different modeling software considered.

	Model Features																
	Hydrologic Capabilities							*Hydraulic Capabilities*									
Software	Single Event	Continuous Simulation	Multiple rainfall-runoff methods	Multiple routing methods	Detention / Retention Basins	Gage data	Antecedent Conditions	Open Channels	Closed Conduits	2D Analysis	1D/2D Coupled Analysis	Steady-State	Unsteady-State	Bridges/Culverts	GIS Capabilities	Floodplain Mapping	**Cost [2]**
Hydrology																	
HEC-HMS	✓	1	✓	✓	✓	✓	1										free
HSPF	✓	✓	✓	✓	✓	✓	✓										free
Hydraulics																	
HEC-RAS								✓		3	3	✓	✓	✓	✓	✓	free
SMS/RMA-2								✓		✓	✓	✓	✓		✓	✓	13.4[4]
Coupled H&H																	
EPA-SWMM	✓	✓	✓	n/a	✓	✓	1	✓	✓			✓	✓	1	1		free
xpstorm (w/2D)	✓	✓	✓	n/a	✓	✓	1	✓	✓	✓	✓	✓	✓	1	✓	✓	12.5[4]
InfoSWMM	✓	✓	✓	n/a	✓	✓	1	✓	✓	✓	1	✓	✓		✓	✓	12.0[4,5]
FLO-2D	✓		✓	n/a			1	✓	1	✓	1	✓	✓	1	✓	✓	1.0[4]

1 Indicates limited capabilities
2 Costs are approximate and provided in $1,000s
3 Currently in Beta testing phase
4 Additional subscription/maintenance fees may apply
5 Requires a fully-licensed ArcGIS platform at an additional estimated cost of $10,000

Additional software packages such as MIKE-URBAN and MIKE-FLOOD by DHI Software, HydroCAD, and PondPack are also available. DHI software is generally more expensive than other commercially available software and as such is not been extensively adopted in the United States. HydroCAD and PondPack are primarily used for design of stormwater facilities by development engineers and don't have the capabilities needed for basin scale modeling.

Recommended Solution

Considering the primary purpose of the modeling and characteristics of the drainages systems to be analyzed, it is recommended that the City use XP Solutions' xpstorm software with the 2-D module for updating the Stormwater Master Plan and associated Basin Plans. Xpstorm is capable of evaluating all three major components of the City's storm drainage system: open channel, closed conduit, and overland two-dimensional flow. Further, xpstorm is a fully-integrated modeling software package which combines hydrologic and hydraulic modeling into one program. It also has robust GIS and floodplain mapping capabilities which will assist the City in maintaining the data within the model as well as in producing output for use in products such as flood hazard analysis and hydromodification assessment. Xpstorm is also readily accepted by FEMA for developing Flood Insurance Studies and is commonly used by the consulting community. The only drawback of xpstorm is that it has less robust analysis techniques for bridges than does HEC-RAS. Where necessary, this can be overcome by developing models for specific bridge/culvert crossings within HEC-RAS and incorporating the resulting stage-discharge rating curves directly into xpstorm.

Please contact me at (503) 485-5490 if you have any questions regarding the contents of this memo.

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The following summarizes how the runoff parameters is XP-STORM were developed.

AVERAGE SLOPE

The high density LiDAR digital elevation model (DEM) developed by Watershed Sciences for the Oregon Department of Geology and Mineral Industries (DOGOMI) was processed with tools in ESRI's ArcGIS software package to calculate the average slope for each subbasin.

AREA

The area of each subbasin was calculated using ArcGIS tools.

WIDTH

The RUNOFF Method uses the width parameter for hydrologic routing of the runoff. The width parameters represents the width of the overland flow within the subbasin. As the width decreases, the runoff hydrograph attenuates. As per XP Solution's recommendation, the width parameter is best estimated by dividing the subbasin area by the length of the longest flow path. The longest flow paths were calculated using the ArcHydro extension in ArcGIS. This first required that the storm sewer data be "burned" into the DEM. Ultimately the width parameter was used as a calibration parameter.

PERCENT IMPERVIOUS

The RUNOFF Method assumes that the percent impervious is hydraulically connected to the drainage network. For the areas outside of the city limits without available detailed impervious GIS data, the impervious area was estimated using the 2011 National Land Cover Database (NLCD). The 2011 NLCD metadata include total imperious area assumptions for each of the land cover type. These values were converted to percent directly connect impervious using the Sutherland Equations (Sutherland, 2000).

The portions of the basin near the City of Salem used the city supplied impervious area GIS data to estimate the directly connected impervious area. While the city impervious area data provided the type of impervious area (i.e. rooftop, paved street), it did not provide percent directly connected impervious estimates. Table D.1 shows impervious area assumptions for both the 2011 NLCD data and the city's impervious data. The resulting distribution of both the total impervious and directly connected impervious was overlaid with each subbasin to develop an average subbasin total and directly connected percent impervious estimate.

Land Cover	GIS Data Source	Total Impervious	Total Impervious Area Estimate Source	Directly Connected Impervious	Source
Deciduous Forest	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Mixed Forest	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Woody Wetlands	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Emergent Herbaceous Wetlands	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Evergreen Forest	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Shrub/Scrub	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Grassland/ Herbaceous	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Pasture/Hay	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Cultivated Crops	2011 NLCD	0	2011 NLCD Metadata mean	0	n/a
Barren Land (Rock/Sand/ Clay)	2011 NLCD	10	2011 NLCD Metadata mean	0	n/a
Open Water	2011 NLCD	100	Assumed (typical)	100	Assumed
Developed, Commercial	2011 NLCD	85	Assumed no IDC impervious	85	TR-55
Developed, Industrial	2011 NLCD	72	Assumed no IDC impervious	72	TR-55
Developed, High Intensity	2011 NLCD	90	2011 NLCD Metadata mean	89	Sutherland Equations, Highly Connected Basin
Developed, Low Intensity	2011 NLCD	35	2011 NLCD Metadata mean	17	Sutherland Equations, Somewhat Connected

Land Cover	GIS Data Source	Total Impervious	Total Impervious Area Estimate Source	Directly Connected Impervious	Source
Developed, Medium High Intensity	2011 NLCD	70	Manual Estimate	60	
Developed, Medium Intensity	2011 NLCD	65	2011 NLCD Metadata mean	52	Sutherland Equations, Average Basin
Developed, Open Space	2011 NLCD	10	2011 NLCD Metadata mean	0	Assumed
Sidewalk, connected	Salem GIS Data	98	Assumed half runoff to road, and half flows to grass	50	Assumed
Sidewalk, disconnected	Salem GIS Data	98	Assumed most runoff to grass	15	Assumed
Under Construction	Salem GIS Data	10	Assumed open space for calibration	0	Assumed
Unpaved Parking Driveway	Salem GIS Data	80	Assumed	20	Assumed
Unpaved Road	Salem GIS Data	80	Assumed	40	Assumed
Unpaved Trail	Salem GIS Data	80	Assumed	0	Assumed
Paved Trail	Salem GIS Data	98	Assumed that all runoff goes to pervious	0	Assumed
Paved Parking Driveway	Salem GIS Data	98	Assumed pretty much all runoff enters storm sewer	98	Assumed
Paved Road	Salem GIS Data	98	Assumed pretty much all runoff enters storm sewer	98	Assumed
Concrete	Salem GIS Data	98	Assumed half runoff goes to pervious area	50	Assumed
Bridge	Salem GIS Data	98	Assumed pretty much all runoff enters storm sewer	98	Assumed
Private Gravel	Salem GIS Data	80	Assumed	10	Assumed
Private Patio	Salem GIS Data	98	Assumed all runoff drains to pervious areas	0	Assumed
Private Sidewalk	Salem GIS Data	98	Assumed most runoff to pervious	20	Assumed

Land Cover	GIS Data Source	Total Impervious	Total Impervious Area Estimate Source	Directly Connected Impervious	Source
Rooftop, Non-Residential	Salem GIS Data	98	Assumed pretty much all runoff enters storm sewer	98	Assumed
Rooftop, Residential	Salem GIS Data	98	Assumed front half drains to storm sewer	50	Assumed
Rooftop, Rural Residential	Salem GIS Data	98	Assumed most runoff to pervious	10	Assumed

SURFACE LOSS AND OVERLAND ROUGHNESS

The surface loss is the total volume that needs to be filled with rainfall before runoff occurs. These loses include the sum of the depression storage and interception. The overland roughness is a land cover dependent parameter that uses Manning's "n" value, in conjunction with the width parameter, to estimate the timing and attenuation of a subbasins runoff hydrograph. For both surface loss and overland roughness XP-STORM requires different values for pervious and impervious areas. Because XP-STORM uses percent directly connected impervious for the impervious data, the indirectly connected areas were weighted in the composite pervious value. For each subbasin, composite surface loss and overland roughness values were developed proportionately according to the land cover category. The land cover classifications, which were developed from city impervious data for the areas within the city limits and the 2011 NLCD in the areas outside the city limits, were divided into five distinct land cover categories to simplify the calibration process. The five land cover categories included developed impervious, developed pervious, forest, grassland, and agricultural/pasture.

For surface loss, the ranges of values for the developed pervious, forest, grassland and agricultural/pasture categories were developed from **Table 6-1** of EM 1110-2-1417 (Corps, 1994). As per XP-Solutions instructions, the developed impervious surface loss can be estimated using an empirical equation that estimates impervious surface storage using the average basin slope (Kidd, 1978). Further refinements to the surface loss were made during calibration to match runoff volumes.

For overland roughness, ranges of values for the five land cover categories were developed from **Table 7-1** of EM 1110-2-1417 (Corps, 1994). Further refinements to the roughness values were made during calibration to help match runoff volumes and peak flows.

Table D.2 shows the assumed surface loss and overland roughness values used in the pre-calibration model as wells as the range of values considered during calibration for each of the five land cover categories.

PERCENT ZERO DETENTION

The percent zero detention is the percent of the impervious area that has immediately runoff. Generally, open water is categorize as having zero detention since it does not provided surface storage. This was calculated for each subbasin using the rivers and lakes GIS data provided by the City.

INFILTRATION PARAMETERS

Soil infiltration was modeled using the Horton Infiltration method. Horton Infiltration uses an initial initiation rate (F_o) to model the higher infiltration rates that are associated with less saturated soils. As rain falls onto the soils, the infiltration rate decays at a non-linear rate (k) to the critical infiltration rate (F_c) which is generally much lower than Fo. Once the rainfall stops, the infiltration capacity regenerates back to the F_o at a default rate of 0.01 times the decay rate. Infiltration regeneration has minimal impacts on short term simulations and is generally used for long-term simulations.

While there is significant uncertainty in soil infiltration rates, initial estimates were developed using hydrologic soil group classifications in the Web Soil Survey Data (NRCS, 2014). According to the U.S. Environmental Protection Agency (EPA), initial infiltration rates for areas with dense vegetation are approximately double that of areas with sparse vegetation. Therefore, the land cover GIS dataset was overlaid onto the soils GIS data set to categorize areas by hydrologic soil type and vegetation coverage. It was assumed that the infiltration parameters with two hydraulic soil group classifications (i.e., A/D) had an initial infiltration associated with the first classification (the drained condition) and a critical infiltration rate associated with the second hydraulic soil group classification (the undrained condition). The infiltration parameters were then estimated assuming dry initial conditions by referencing the hydrologic soil type and vegetation coverage classifications in **Table D.3**, which was developed from the 1988 Storm Water Management Model (SWMM) Version 4 User's Manual (Huber, 1988). Area weighted composite infiltration values were then developed for each subbasin. Since indirectly connected impervious area is lumped with the pervious area in XP-STORM, the composite infiltration values were calculated assuming no infiltration would occur over indirectly connected impervious areas. The decay parameter (k) is generally assumed to be 0.00115 sec-1, and was therefore not involved in the soil type dependent preprocessing (Huber, 1988).

Since there is a significant amount of uncertainty in soil infiltration characteristics and they highly impact the results, they were used as the primary runoff volume calibration parameters.

Table D.2

Surface loss and overland roughness values used in the pre-calibration model

	Total Surface Loss		Overland Flow Roughness		
Land Cover	**Suggested Range[1] (in)**	**Value Used (in)**	**Suggested Range[2]**	**Value Used**	**Notes**
Developed Impervious	0.03-0.2	n/a	0.05-0.15	0.014	
Developed Pervious	0.1-0.5	0.1	0.2	0.2	Assumed light grass cover
Agricultural	0.53-1.83	0.6	0.13-0.22	0.2	Assumed conventional tillage - with residue
Grassland	0.53-1.83	0.6	0.13-0.22	0.2	Assumed conventional tillage - with residue
Forest	0.5-2.0	0.8	0.4	0.4	Assumed dense shrubbery and forest litter

[1](USACE, 1994), Table 6-1, [2](USACE, 1994), **Table 7-1**

Table D.3

Infiltration parameters values used in the pre-calibration model

		NLCD 2014 Hydrologic Soil Group						
Soil Parameter	**Unit**	**A**	**A/D**	**B**	**B/D**	**C**	**C/D**	**D**
F_c	in/hr	0.38	0.03	0.23	0.03	0.1	0.03	0.03
F_o Dry with Little/No Vegetation	in/hr	5	5	3	3	2	2	1
F_o Dry with Dense Vegetation	in/hr	10	10	6	6	4	4	2
k	sec^{-1}	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115	0.00115

From Huber, 1988, **Table 4-7** and **4-9**

DATA COLLECTION AND GIS DATABASE DEVELOPMENT

The GIS based link and node stream network was developed from the City of Salem storm sewer GIS data and the subbasin map. Using the storm sewer GIS network, links and nodes were created from the point of the subbasin outlets to the downstream extent of the model. Each link represented either a natural channel, ditch, pipe, culvert, bridge, or hydraulic structure. Each node represented a manhole, junction, bridge/culvert/channel start point, or bridge/culvert/channel end point.

The City's Hanson Asset Management Database, which contained the most current storm sewer data, was used to update the link and node network. If the Hanson Database was missing required data, the data was extracted from the City's storm sewer GIS attributes. If the GIS attributes did not contain the missing link data, the storm sewer as-builts and available hydraulic models were requested from the City. If the as-builts and models were not available or were incomplete, a field visit was made to verify missing data. Portions of the storms sewer system that had less than 1 square mile of contributing drainage area or were located outside of the UGB were considered low priority and elevation surveys were not included in the field visits at those locations. Instead, elevations were estimated from LiDAR topographic data.

As data were gathered, all relevant modeling data (except for cross section elevations and stationing) were entered into the attributes tables for the link and node GIS coverages. Documentation of the data source, as well of other relevant notes were included in the GIS attribute tables.

LINK MODELING METHODS

Project No. MC-01G - Replace Ditch Culverts Along Turner Road East of Airport

The modeling of closed conduits required pipe size, shape, material, upstream and downstream invert elevations, entrance and exit losses, and inlet type. Often, the inlet type was unavailable. If this was the case, "Groove End Projecting" was selected as a conservative assumption. Grates and inlets were assumed to be clear of debris. Conduit roughness values used in the model are shown in **Table E.1**.

Table E.1

Conduit roughness assumptions

Material	Manning's "n"
ADS	0.012
Concrete	0.014
CMP	0.024
HDPE	0.01
PVC	0.01
Rubber	0.01
Steel	0.015

Open Channels

Constructed ditches were generally modeled as simple trapezoidal channels, whereas natural channels were modeled with cross sections developed from survey or LiDAR data. Open channel link lengths largely depended on the location of breaks in slope, the location of hydraulic structures, changes in roughness, and significant changes in cross section shape. Since upstream and downstream inverts are required for each link, cross sections were placed near the nodes so that the link inverts would be captured, unless the cross section at that location was not representative of the geometry for the link.

Generally, natural cross section spacing was less than 500 ft. However in long reaches considered to have a low flood risk and that have a generally uniform shape, roughness, and slopes, natural cross section spacing could be as much as 2,000 ft. Since LiDAR data is fairly accurate in floodplain areas where the vegetation is not too dense, surveyed cross sections often did not extend much beyond the top of bank. For those cases, the surveyed portion of the cross section was merged with the cross sections data extracted from LiDAR. Channel and overbank distances were calculated in ArcGIS. Overbank distances were generally measured at a location that is approximately one-third the distance from the channel bank station to the edge of the floodplain. **Table E.2** shows the channel and overbank roughness value assumptions based field visits and available aerial imagery

Table E.2

Channel and overbank roughness value assumptions

Material	Roughness Assumptions	Notes
Channel	0.04	Composite of large channel and bank vegetation
Small Channel	0.05	Composite of Small channel and bank vegetation
Channel with heavy bank vegetation	0.06-0.08	Significant vegetation and some channel blockage
Non-composite channel	0.03	Channel only
Brush	0.07	Medium to dense brush in winter
Grass	0.03	Short grass
High Grass	0.035	High grass
Forest	0.1	Heavy stand of timber
Pasture	0.035	High grass
Road	0.014	Concrete
Grass with Trees	0.06	Mixture of grass and trees
Developed with Grass	0.04	Assumed high than grass since there are some trees, bushes, fences
industrial	0.045	Parking lots and large build-ings
Dense Developed	0.06	Dense developed areas (including buildings)
Crop	0.035	Mature row crops

Bridges

Different methods were used to model bridges, depending on the situation. While XP-STORM is not as robust at modeling bridges as HEC-RAS, for a basin scale model, the capabilities are generally sufficient. The following methods were used to model bridges in XP-STORM.

> *Method 1*: If the low chord of a bridge deck was high enough to avoid contact with water during the maximum modeled flow, then the bridge was modeled as a single link with a natural cross section shape. Included in the links GIS data is a note of the low chord elevation. If piers were present, they were modeled using the cross section's ground station/elevation points to account for the additional wetted perimeter. A contraction/expansion coefficient of 0.3 was used at the bridge. Entrance and exit losses were selected based on the velocity changes upstream and downstream of the bridge.

Method 2: If the bridge deck was in contact with water during high flows and if deck overtopping flows could be modeled as a simple weir, then a bridge link was used. A bridge link models the conveyance under the bridge deck using natural cross sections and/or culverts. Low chords elevations create a lid over the bridge opening and high chord elevations are used to model the overtopping weir crest. Piers were added as needed to account for the increase in wetted perimeter. For deck overtopping flows, a weir coefficient of 2.6 was used.

Method 3: If overtopping flows could not be accurately modeled as a simple weir, multi-links were used to model bridges. To accurately model the conveyance under the bridge, user defined conduits were utilized instead of natural cross sections to allow for pressurized flow and account for low chord roughness. Overflows were either modeled as LiDAR extracted natural cross sections or user defined weirs.

Control Structures

XP-STORM contains a variety of multi-link options to model control structures. With a combination of the orifice and weir functions, complex hydraulic control structures were modeled. Since computational errors could occur for weirs, some of the weirs were modeled as natural cross sections to reduce instabilities.

Overflow Links

When flows exceeded the capacity of the pipes, channels, and bridges, overflow links were added to route the overtopping flow. Links were added to account for flows along roadways and other flow conveyances until the flow rejoined the drainage network. Roadway overflows were modeled as trapezoidal channels, and natural overflow were modeled as natural cross sections that were extracted from the LiDAR topography.

NODE MODELING METHODS

Every node requires an invert elevation and a spill crest elevation. The lowest invert of connected links was used for the node invert. For storage nodes, when the bottom elevation of the storage curve was lower than the invert of connected links, then the storage curve bottom elevation was used for the node invert.

Spill crest elevations represent the highest elevation that water is accounted for at a node. If a spill crest elevation is too low, water can escape from the system, which introduces potentially significant volume inaccuracies into the model. If a spill crest elevation is too high, the water may unrealistically pile up or “smoke stack”. To eliminate the risk of water escaping from the model, spill crest elevations were artificially increased to very high elevations. To ensure that water did not “smoke stack” at nodes, a database of the maximum elevation that water reached at each node was developed. The spill crest elevation was initially set at the overflow elevation. For pipe networks, this is the manhole rim elevation. For channels, this is the elevation that the water starts to spill out of the channel. For culverts and bridge, this is the minimum overflow elevation. The model was then run, and the resulting maximum water surface elevation at each node was compared to the spill crest elevation in the database. If the peak water surface elevation exceeded the spill crest elevation, then overflow links were added, which increased the spill crest elevation to the crown of the overflow link. The model was then rerun, and the process was repeated until all of the model's peak water surface elevations were below the spill crest elevation at each node.

Storage Nodes

Detention basins and other storage areas that were not accounted for in links were modeled using storage nodes. The majority of the stage-surface area relationships were developed from the LiDAR topographic data in 1 foot increments using tools in ArcGIS. Several of the smaller storage areas were developed by manually measuring the storage surface at various elevations. When developing the stage-surface area curves, storage areas that were already modeled within the links were not included in order to avoid double counting the available storage.

TWO-DIMENSIONAL MODELING

One-dimensional (1-D) links are usually sufficient when modeling creeks, pipes, ditches, and simple overflows. However, high flows combined with nearly flat terrain often create spatially complex scenarios that require two-dimensional (2-D) modeling. The 2-D modeling component in XP-STORM provides dynamic linking of a 2-D gridded model to the 1-D stormwater drainage network. The 2-D component of XP-STORM, XP-2D, uses a 2-D finite difference grid that runs on the TUFLOW engine.

2-D modeling requires the creation of a digital terrain model (DTM), which can be developed from LiDAR and/or ground survey data. Once the DTM is created for the area of interest, the grid is created with a cell size small enough to capture import hydraulic features within the model. Where appropriate, ridges and gully's can be applied to the DTM to assure that certain features that would otherwise be masked are represented in the grid. Cells in those portions of the grid that are modeled in 1-D are set as inactive, and 1-D to 2-D connections are created at the interface. This includes raising the grid cell elevations along the 1-D/2-D interface to match the 1-D channel bank elevations.

The 2-D model also requires a land use coverage in order to spatially distribute the correct overland roughness values. For each land cover, tables were created for roughness based on depth. At small depths, the roughness values are higher and are based on values from the XP-2D manual. As the depths increase, the roughness values decrease toward the lower values recommended in the document "Revision Project 15: Two Dimensional Simulations in Urban Areas" (Engineers Australia, 2012). Buildings were modeled with roughness of 0.3 to account for storage, without providing significant conveyance.

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