City of Sherwood Oregon

*Home of the Tualatin River National Wildlife Refuge*

## ORDINANCE 2016-015

## AMENDING CHAPTER 7 OF VOLUME II OF THE SHERWOOD COMPREHENSIVE PLAN AND ADOPTING THE SHERWOOD STORMWATER MASTER PLAN

**WHEREAS**, the City of Sherwood Stormwater Master Plan is a long range planning document intended to be updated as conditions within the City change; and

**WHEREAS**, the existing Sherwood Stormwater Master Plan was accepted by Resolution 2007-066, on July 17, 2007; and

**WHEREAS**, at the time of acceptance of the Sherwood Stormwater Master Plan the associated information in Chapter 7 of Volume II of the Sherwood Comprehensive Plan was not updated: and

**WHEREAS,** the City has determined that amendments to the Comprehensive Plan and Stormwater Master Plan are necessary and must be coordinated; and

**WHEREAS,** the City contracted with Murray Smith and Associated (MSA) to update the Stormwater Master Plan; and

**WHEREAS,** in the course of updating the Stormwater Master Plan, the City has identified the need to update Chapter 7 of Volume II of the Sherwood Comprehensive Plan as it relates to Stormwater; and

**WHEREAS,** after a public open house and recommendations from the Sherwood Planning Commission, staff has proceeded with public noticing and preparing an amendment to: 1) update certain portions of Chapter 7 of Volume II of the Comprehensive Plan as they relate to the Stormwater Master Plan, so that the information is current; 2) identify the Stormwater Master Plan as an appendix to the Comprehensive Plan; and 3) adopt the Stormwater Master Plan; and

**WHEREAS,** the proposed amendments were reviewed for compliance and consistency with the Comprehensive Plan, as well as regional and state regulations, and found to be fully compliant; and

**WHEREAS,** the proposed amendments were subject to full and proper public noticing requirements, review, and a public hearing held before the Planning Commission on September 13, 2016 and September 27, 2016; and

**WHEREAS,** the Planning Commission voted to forward a recommendation of approval to the City Council for the proposed Stormwater Master Plan and related amendments to Chapter 7 of Volume II of the Comprehensive Plan; and

**WHEREAS,** the City Council held a public hearing on October 4, 2016 and determined that the proposed amendments to the Comprehensive Plan met the Comprehensive Plan criteria and continued to be consistent with regional and state standards; and

**WHEREAS,** the City Council determined that the Stormwater Master Plan addressed existing conditions and identified capital improvements and associated project costs needed to meet the future needs for the Stormwater System over the planning horizon.

**NOW, THEREFORE, THE CITY OF SHERWOOD ORDAINS AS FOLLOWS:**

**Section 1. – Findings:** After full and due consideration of the proposed amendments to Chapter 7 of Volume II of the Comprehensive Plan, the updates to the Stormwater Master Plan, the Planning Commission recommendations, the record of findings which is included as Attachment 1 to the staff report, and evidence presented at the City Council public hearing, the City Council adopts the findings of fact contained in the Planning Commission recommendation, finding that the Stormwater Master Plan and Comprehensive Plan shall be amended as documented on the Attachments 1 and 2.

**Section 2. – Approval** The proposed amendments for the Stormwater Master Plan and Comprehensive Plan (PA 16-XX) identified in Attachments 1 and 2 are hereby APPROVED.

**Section 3. – Planning Department Authorization.** The Planning Department is hereby directed to take such action as may be necessary to document this amendment, including notice of adoption to DLCD.

**Section 4. – Effective Date.** This Ordinance shall become effective 30 days after its enactment by the City Council and approval by the Mayor.

**Duly passed by the City Council this 18th day of October, 2016.**

Krisanna Clark, Mayor — Date 10/18/16

Attest:

Sylvia Murphy, MMC, City Recorder

| | AYE | NAY |
|---|---|---|
| Brouse | ✓ | |
| Robinson | ✓ | |
| Kuiper | ✓ | |
| King | ✓ | |
| Henderson | ✓ | |
| Harris | ✓ | |
| Clark | ✓ | |

# COMMUNITY FACILITIES AND SERVICES

## A. GENERAL INTRODUCTION

Community facilities and services in the Sherwood Planning Area are provided by Washington County, the City of Sherwood, special service districts, semi-public agencies and the State and Federal government, (see Table VII-1). Public facilities and services include sewer, water, fire and police protection, libraries, drainage, schools, parks and recreation, solid waste and general governmental administrative services. Semi-public facilities and services are those which are privately owned and operated but which have general public benefit. They include health facilities, energy and communication utilities, and day care.

Although a small community, Sherwood has learned well the importance of adequate community facilities and services to orderly urban growth. Planning for public facilities and services in response to growth rather than in advance of growth results in gaps in facilities and services. As population growth and density increase in the Sherwood Planning Area, greater facility and service support will be required. In recognition of this basic fact, the Plan stresses the need for provision of necessary facilities and services in advance of, or in conjunction with, urban development.

The Community Facilities and Services element identifies general policy goals and objectives; service areas and providers, problems, and service plans, and potential funding for key public and semi-public facilities and services. Park and recreation facilities are treated in Chapter 5, Environmental Resources. Transportation facilities are treated in Chapter 6, Transportation. This element was updated in 1989 to comply with OAR 197.712(2)(e).

## B. POLICY GOAL AND OBJECTIVES

To insure the provision of quality community services and facilities of a type, level and location which is adequate to support existing development and which encourages efficient and orderly growth at the least public cost.

### OBJECTIVES

1. Develop and implement policies and plans to provide the following public facilities and services; public safety fire protection, sanitary facilities, water supply, governmental services, health services, energy and communication services, and recreation facilities.



ATTACHMENT 1

2. Establish service areas and service area policies so as to provide the appropriate kinds and levels of services and facilities to existing and future urban areas.

3. Coordinate public facility and service plans with established growth management policy as a means to achieve orderly growth.

4. Coordinate public facility and service provision with future land use policy as a means to provide an appropriate mix of residential, industrial and commercial uses.

5. Develop and implement a five-year capital improvements and service plan for City services which prioritizes and schedules major new improvements and services and identifies funding sources.

6. The City will comply with the MSD Regional Solid Waste Plan, and has entered into an intergovernmental agreement with Washington County to comply with the County's Solid Waste and Yard Debris Reduction Plan, 1990.

7. Based on the currently adopted Sanitary Sewer, Water, Stormwater, and Transportation Plan updates, the City shall prepare a prioritized list of capital improvement projects to those systems and determine funding sources to realize the improvements envisioned in those plans.

8. It shall be the policy of the City to seek the provision of a wide range of public facilities and services concurrent with urban growth. The City will make an effort to seek funding mechanisms to achieve concurrency.

## C. PUBLIC AND SEMI-PUBLIC UTILITIES

Public utilities including water, sanitary sewer, drainage, and solid waste, as well as semi-public utilities including power, gas and telephone services are of most immediate importance in the support of new urban development. Water, sewer collection, and drainage facilities are the major services for which the City of Sherwood has responsibility. Service plans for these key services are contained in this section. The other utilities referred to above are the principal responsibilities of those agencies listed in Table VII-1. These agencies have been contacted for the purpose of coordinating their service planning and provision with the level and timing of service provision required to properly accommodate growth anticipated by the Plan.

# TABLE VII-1
# FACILITY AND SERVICE PROVIDERS
# IN THE SHERWOOD PLANNING AREA

1. Public Utilities

   a. Public Water Supply
      City of Sherwood

   b. Sanitary Sewer System
      (1) Clean Water Services
      (2) City of Sherwood

   c. Storm Drainage System
      (1) City of Sherwood
      (2) Clean Water Services
      (3) Washington County
      (4) State of Oregon

2. Private/Semi-Public Utilities

   a. Natural Gas
      Northwest Natural Gas Co.

   b. Electric Power
      Portland General Electric

   c. Solid Waste: Pride Disposal Co.

3. Transportation

   a. Paved Streets, Traffic Control, Sidewalks, Curbs, Gutters, Street Lights
      (1) City of Sherwood
      (2) Washington County
      (3) State of Oregon

   b. Bikeways
      (1) City of Sherwood
      (2) Washington County
      (3) State of Oregon

c. Public Transit
Tri-Met

4. Public Health and Safety

a. Police Protection
(1) City of Sherwood
(2) Washington County
(3) State of Oregon

b. Fire Protection
Tualatin Valley Fire and Rescue

c. Animal Control
Washington County

5. Recreation

a. Parks and Recreation
City of Sherwood

b. Library
City of Sherwood

6. Schools
Sherwood School District 88J

## D. SEWER SERVICE PLAN

### INTRODUCTION

The Sewer Service Plan of the Comprehensive Plan was updated in 2016 and is included as an appendix to the Plan, and is incorporated into this chapter.

### EXISTING SEWER SYSTEM

The City of Sherwood's existing sanitary sewer system is as shown on Figure VII-1. The system is located in Clean Water Services Durham South Basin which consists of two sub-basins are centered around Cedar Creek and Rock Creek, respectively, and will be referred to as the Cedar Creek basin and the Rock Creek basin throughout the remainder of this section.

The City's Sanitary Sewer System Master Plan's three-fold purpose is to 1) evaluate the existing system, 2) identify current and future system deficiencies and needs, along with recommended improvements to correct them, and 3) to provide planning level cost information for general budgeting and the development of a prioritized Capital Improvement Plan (CIP) . The master plan is adopted after each update which occur on a 5 to 7-year time interval. The CIP is updated and adopted each year as part of the City's fiscal year budget adoption process.

#### Sanitary Sewer System Description

The City's sanitary sewer system is divided into 2 main basins; 1) the Cedar Creek Basin; and 2) the Rock Creek Basin. The sanitary sewer master plan provides specific information based on the 3 criteria listed above. In general, the overall sanitary sewer system is operationally sound and has capacity to provide service over the next 20-year planning cycle (2035). General information on the two sanitary sewer basins is provided below.

The Cedar Creek Basin is the City's largest sanitary collection basin, bounded on the north, west, and south sides by the current City limits. The basin's east side boundary is defined by a line running from north to south and generally east of Langer Farms Parkway to the southern boundary of the City. The Brookman Concept Area borders the southern edge of the basin. The Cedar Creek Basin encompasses 2,080 potential acres of tributary area within the UGB, of which 1,054 acres is considered existing developed and sanitary sewer serviced. Sanitary sewerage from the Cedar Creek Basin gravity flows through the 24-inch Sherwood Trunk line to the Sherwood pump station located north of the City.

Residential zoned areas comprise the majority of the sanitary wastewater flow from this basin, with commercial and non-residential area of the basin near the center contributing non-residential flows.

The Rock Creek Basin is the City's second sanitary collection basin, bounded on the north, east, and south sides by the current City limits. The basin's west boundary is defined by a line running from north to south and generally west of Langer Farms Parkway to the southern boundary of the City. The Tonquin Employment Area borders the east side of the basin. The Rock Creek Basin encompasses 1,310 potential acres of tributary area within the UGB, of which 455 acres is considered existing developed and sanitary sewer serviced. Sanitary sewerage from the Rock Creek Basin gravity flows through the 21-inch Rock Creek Trunk line north to the Sherwood pump station.

Residential zoned areas comprise most of the sanitary wastewater from this basin, with light industrial and commercial areas located in the northern half of the basin providing the remainder of the basin's sanitary wastewater flows.

The Rock Creek Trunk Line, the Cedar Creek Trunk Line, and the Sherwood Pump Station are under the jurisdictional control of Clean Water Services (CWS). Sanitary wastewater flows from the Sherwood Pump Station discharge to the Upper Tualatin Interceptor which ultimately flows to the Durham AWWFT for treatment and discharge to the Tualatin River.

The City's Sanitary Sewer Master Plan has identified 22 major projects which fall under the jurisdictional control of the City. There are 4 other projects identified which fall under the jurisdictional control of CWS. The 22 major projects are included in the City's CIP program. The 4 remaining projects which impact the operation of the City's sanitary system are coordinated with CWS for implementation.

insert map

The City of Sherwood Zoning Map was used to determine the amount of acreage of each land use designation. This acreage was then applied to tributary basins contributing to their respective sewers and multiplied by the appropriate land use design unit flowrate in order to generate the total design flowrate. An average of residential densities per tributary basin was used to account for the five different residential zoning densities shown on the current City Zoning Map.

## WATER SERVICE PLAN

### INTRODUCTION

The City draws the majority of its water supply from the Willamette River Water Treatment Plant (WRWTP) in the City of Wilsonville, approximately 6 miles southeast of Sherwood. The City owns 5 million gallons per day (MGD) of production capacity in the existing WRWTP facilities. Sherwood also maintains four groundwater wells within the city limits for back-up supply. Prior to 2011, the City also purchased water from the Portland Water Bureau (PWB) through the City of Tualatin's water system and maintains an emergency connection and transmission piping associated with this supply source.

The City's future water service area is comprised of five different planning areas:
1. Sherwood city limits
2. Tonquin Employment Area (TEA)
3. Brookman Annexation Area
4. West Urban Reserve
5. Tonquin Urban Reserve

Each of these areas has their own land use characteristics, approximate development timelines and existing planning information. Estimates of future growth and related water demand are developed using the best available information for each area including Sherwood buildable lands geographic information system (GIS) data, population growth projections, development area concept plans and current water demand data.

Water demand growth is projected at 10 years, 20 years and at saturation development. Estimated water demands at saturation development are used to size recommended transmission and distribution improvements.

## EXISTING WATER SYSTEM CONDITIONS

### Pressure Zones

The City's existing distribution system is divided into three major pressure zones. Pressure zone boundaries are defined by ground topography in order to maintain service pressures within an

acceptable range for all customers in the zone. The hydraulic grade line (HGL) of a zone is designated by overflow elevations of water storage facilities or outlet settings of pressure reducing valves (PRVs) serving the zone.

The majority of Sherwood customers are served from the 380 Pressure Zone which is supplied by gravity from the City's Sunset Reservoirs. The 535 Pressure Zone, serving the area around the Sunset Reservoirs, is supplied constant pressure by the Sunset Pump Station, and the 455 Pressure Zone serves higher elevation customers on the western edge of the City by gravity from the Kruger Reservoir.

### Storage Reservoirs

Sherwood's water system has three reservoirs with a total combined storage capacity of approximately 9.0 million gallons (MG). Two reservoirs, Sunset Nos. 1 and 2, provide 6.0 million gallons (MG) of gravity supply to the 380 Pressure Zone. The other reservoir, Kruger Road, provides 3.0 mg of gravity supply to the 455 Pressure Zone.

### Pump Stations

Sherwood's water system includes two booster pump stations, the Sunset Pump Station and the Wyndham Ridge Pump Station.

The Sunset Pump Station is located in Snyder Park adjacent to the Sunset Reservoir complex and has an approximate total capacity of 3,770 gallons per minute (gpm). This station provides constant pressure service and fire flow to the 535 Pressure Zone.

The Wyndham Ridge Pump Station is located on SW Handley Street west of Highway 99W. Two 40-hp pumps supply a total capacity of approximately 1,200 gpm from 380 Zone distribution piping to the Kruger Road Reservoir.

### Distribution System

The City's distribution system is composed of various pipe materials in sizes up to 24 inches in diameter. The total length of piping in the service area is approximately 77.4 miles. Pipe materials include cast iron, ductile iron, PVC and copper. The majority of the piping in the system is ductile iron.

## ANALYSIS OF EXISTING WATER SYSTEM

### Water Supply

Sherwood's supply from the WRWTP is sufficient to meet MDD through the 10-year planning horizon with an additional 1 mgd of capacity required at 20 years and an additional 4 mgd needed at build-out. Existing City groundwater wells provide an effective emergency supply to complement emergency storage in the City's reservoirs.

### Pumping and Storage

The City's distribution system has adequate storage and pumping capacity to meet existing service area demands through 2034. Due to significant uncertainty related to long-term growth and system expansion, minor storage and pumping deficiencies at build-out should be re-evaluated with the next Water Master Plan Update or as development warrants. Additional pump stations are recommended to serve proposed high-elevation closed pressure zones in the water service expansion areas: Brookman Annexation and West Urban Reserve.

### Distribution Piping

Sherwood's distribution piping is sufficiently looped to provide adequate fire flow capacity to commercial, industrial and residential customers. Few piping improvement projects are needed to meet fire flow criteria. Extensive large diameter mains will be needed to expand the City's water service area to supply the Brookman Annexation, TEA and West Urban Reserve as development occurs.

## RECOMMENDED IMPROVEMENTS TO EXISTING WATER SYSTEM

Recommended improvements for the City's water system include proposed supply, pump station and water line projects.

### Cost Estimating Data

An estimated project cost has been developed for each improvement project recommended. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule and other factors. The cost estimates presented have an expected accuracy range of -30 percent to +50 percent. As the project is better defined, the accuracy level of the estimates can be narrowed. Estimated project costs include approximate construction costs and an aggregate 45 percent allowance for administrative, engineering and other project related costs.

### Capital Improvement Program

A summary of all recommended improvement projects and estimated project costs is presented in Table ES-3 of the 2015 City of Sherwood Water System Master Plan Update. The table provides for project sequencing by showing fiscal year-by-year project priorities for the first five fiscal years, then prioritized projects in 5-year blocks for the 10-year, 20-year and Beyond 20 year timeframes. The total estimated cost of these projects is approximately $24.6 million through FY 2034. Approximately $19.9 million of the total estimated cost is for projects needed within the 10-year timeframe and $5.4 million of these improvements are required in the next 5 years.

# F. DRAINAGE PLAN

## INTRODUCTION

The City's Stormwater System Master Plan is incorporated into this plan by reference and is an appendix to the City Comprehensive Plan. The Stormwater System Master Plan's three-fold purpose is to present criteria required for; 1) evaluating the system, 2) identifying current and future system deficiencies and needs, including a description of recommended improvements to correct them, and 3) providing planning level cost information for general budgeting and the development of a prioritized Capital Improvement Plan (CIP). The master plan is adopted after each update which occur on a 5 to 7-year time interval. The CIP is updated and adopted each fiscal year as part of the City's fiscal year budget adoption process.

### Stormwater System Description

The City lies within five streamsheds, drained by Cedar Creek, Chicken Creek, Hedges Creek, Rock Creek, and the Upper Coffee Lake Creek, all of which are tributary to the Tualatin River and Willamette River. The master plan covers the area within the current UGB, which includes the Tonquin Employment Area and the Brookman Concept Area. The area covered by the City's stormwater drainage basins covers roughly 3,391 acres and is estimated to be approximately 62 percent developed.

Stormwater management responsibilities for publicly owned collection and conveyance facilities are shared through an Intergovernmental Agreement (IGA) between the City and Clean Water Services (CWS). CWS is responsible for the "District Wide Program" and the City is responsible for the "Local Program".

In general, the master plan indicates that the existing stormwater collection and conveyance systems are in good operational condition. There are deficiencies within the existing system related to stormwater quality treatment where older developed areas within the City do not have any treatment facilities, or the treatment facilities are inadequate to meet current regulatory standards. In the IGA with CWS, the City must comply with the Clean Water Act (CWA), the Endangered Species Act (ESA), and the National Flood Insurance Act (NFIA) for all new developed or redeveloped properties within the UGB.

The 2016 stormwater master plan update has identified 7 major stormwater collection and conveyance system condition projects, and 14 regional stormwater treatment conditions projects. All 22 projects have been included in the City's CIP program.

## SOLID WASTE

Solid waste disposal is a regional concern requiring regional solutions. The City of Sherwood recognizes MSD's responsibility and authority to prepare and implement a solid waste management plan and supports the MSD Solid Waste Facilities Model Siting Ordinance and will participate in these procedures as appropriate. There are no landfills in Sherwood.

The Model Siting Ordinance will be incorporated into this Plan when approved by METRO. In addition, the City conducted extensive hearings on solid waste incineration in 1990 and determined incineration is generally not a form of solid waste disposal environmentally compatible in the community except in limited circumstances. Therefore, solid waste incineration is generally prohibited by this Plan.

### Electrical Power

The Sherwood Planning Area is well served by major power facilities. Portland General Electric Co. (PGE) runs and operates a major regional sub-station in the northern portion of the Planning Area and has a network of major transmission lines which cross the Planning Area. Minor sub-station siting and construction, if needed in response to development, will be coordinated with PGE.

### Natural Gas

The Sherwood Planning Area is served by Northwest Natural Gas Co. (NNG) lines. The existing system consists of a 6" high pressure line extended to the Planning Area via Tualatin-Sherwood Road, So. Sherwood Blvd. and Wilsonville Road. The distribution system is adequate to serve immediate development. NNG reports that the 6" main will be adequate to serve growth projected by the Plan with new lateral line extensions and attention to proper "looping" of existing lines.

### Telephone

General Telephone services the Sherwood Planning Area. Planned improvements should have the capability of handling projected growth demands in the Area.

## H. SCHOOLS

## INTRODUCTION

The Sherwood Planning Area is wholly contained within Sherwood School District 88J. Although the City of Sherwood is the only currently urbanized area within the district, district boundaries include approximately 44 square miles and parts of Washington, Clackamas, and Yamhill Counties. The District is currently predominately rural but, by the year 2000, the Sherwood Planning Area

will contribute most of the total student enrollment.

## FUTURE ENROLLMENT/FACILITY NEEDS

The School District completed a School Enrollment Study (Metro Service District Analysis) in the Fall of 1990. Revisions were made in the Spring of 1991. The study data suggests that school enrollments will be increasing sharply in the coming years. The growth assumption is supported by record-setting residential building permit issuance during 1990. Major arterial road improvements between I-5 and 99W will also cause further growth and development.

## ELEMENTARY AGE STUDENTS (K-5)

J. Clyde Hopkins Elementary School has a capacity to house 600 students. Currently, 670 students are enrolled in grades K-5. Three double portable classrooms and one single portable classroom are utilized to address the growing elementary age population.

## INTERMEDIATE AGE STUDENTS (6-8)

Approximately 300 students are enrolled in grades 6-8. The Intermediate School building capacity is 400 students. This capacity can be accessed by relocating District office services, which occupy a four classroom wing of the building.

## HIGH SCHOOL AGE STUDENTS (9-12)

Sherwood High School has a capacity of 500 students. Approximately 420 students are currently enrolled. No major housing issues exist in this 1971 constructed facility.

## SCHOOL FACILITY PLANNING

The School District is preparing to undertake a detailed facility development plan. The most immediate need for the District is to expand housing of elementary age school children (K-5). During the Fall of the 1990-91 school year, the District completed the purchase of a new elementary school site located within the City limits of Sherwood. The District also owns a school site (purchased in 1971) in the proximity of the Tualatin portion of the school district.

The intent of the District is to seek voter approval of a bond measure to address short and long-term housing needs. The measure is planned to be submitted in the Fall of 1991 or the Spring of 1992 in order to construct an additional elementary school.

# I. PUBLIC SAFETY

## POLICE PROTECTION

The City of Sherwood, Washington County and the State Police co-ordinate police protection within the Planning Area. In 1989 the Sherwood Police Force consisted of five officers. In order to meet future demand it is anticipated that the department will need additional patrolmen proportional to the projected increase in population. The State formula for City police protection is one officer per 500 people. The police force should expand accordingly.

## FIRE PROTECTION

The Planning Area is wholly contained within the Tualatin Valley Consolidated Fire and Rescue District. One engine house is located within the City. The District feels that present physical facilities will be adequate to serve the projected year 2000 growth in the area with some increase in manpower and equipment. The District currently employs a 5-year capital improvement planning process which is updated annually. The City will co-ordinate its planning with the district to assure the adequacy of fire protection capability in the Planning Area.

## J. GENERAL GOVERNMENTAL SERVICES

As a general purpose governmental unit, the City of Sherwood intends to fulfill its responsibilities in the principal areas of general administration, planning, public works, and library services. With expected growth in Sherwood, additional manpower and facilities will be required.

1. Manpower Needs

   In 1989 there are currently seventeen (17) City staff in general governmental services. A review of cities which have reached Sherwood's projected five and twenty year growth levels indicate that new staffing will be needed proportional to population increases in most departments. Using this assumption a full-time staff of 15-20 persons will be required by 1985 and a staff of 20-40 will be needed by the year 2000. Most critical immediate needs are in the area of clerical staff to support existing departmental work loads.

2. Space Needs

   The City offices, water department, police department, planning department and public works, are currently housed in a remodeled turn-of-the-century house. Although the structure is significant historically and should be saved, it may not meet the long term functional or space needs of a City Hall.

   In 1982 the Senior and Community Center was built and provides meeting space for the City Council and Planning Commissions.

## K. HEALTH FACILITIES

The local health system is linked to a number of organizations and institutions that can and do affect how it will develop. The latest planning legislation P.L. 93-641 and its recent amendments has placed Health care delivery systems planning are under the auspices of the State Certificate of Need laws and the Federal Health System Agency (HSA) planning regulations. Sherwood is located in the six county Northwest Oregon Health Systems Agency (NOHS) which is charged with reviewing new service proposals, expenditures involving public funds and the development of a health system plan for the area. The first HSA plan was adopted in 1978. State agencies administer HSA regulations. NOHS established subdistricts within the six county service area. Sherwood is located in the south-rural sub-district (see Figure VII-8). The only hospital located in the sub-district is Meridian Park Hospital in Tualatin.

Sherwood is served by various Metropolitan area hospitals depending on local physician affiliations. The City currently has only one doctor with offices in the Planning Area. St. Vincent's Hospital in Beaverton has expressed interest in establishing a satellite clinic in Sherwood.

The City will encourage the decentralization of Metropolitan health care delivery to assure that a broad range of inpatient, outpatient and emergency medical services are available to Sherwood residents. To that end the City will support the location of a St. Vincent's Satellite Center in Sherwood and encourage the appropriate expansion of Meridian Park facilities to meet the growing needs of the Planning Area.

## L. SOCIAL FACILITIES AND SERVICES

A broad range of social services will be needed in the Planning Area to serve a growing urban population. Sherwood will continue to depend on metropolitan area services for which the demand does not justify a decentralized center. Multi-purpose social and health services and referral are offered by the Washington County Satellite Center in Tigard. The City will encourage the continued availability of such services.

Sherwood is located in Region 8 of the State Department of Human Resources Service Area and benefits from that agency's services. State services are administered through the County's Washington County office located in Hillsboro. In addition to public social service programs, many private organizations serve the Sherwood area.

The City is particularly interested in locating a multi-purpose social and health service referral agency in Sherwood so that residents of Sherwood would be able to get timely information on the available services. The City also supports the development of a Comprehensive Social and health services delivery plan for the Planning Area to identify gaps in needed services and develop an ongoing strategy for their provision. Of particular concern are day care and senior citizens services.

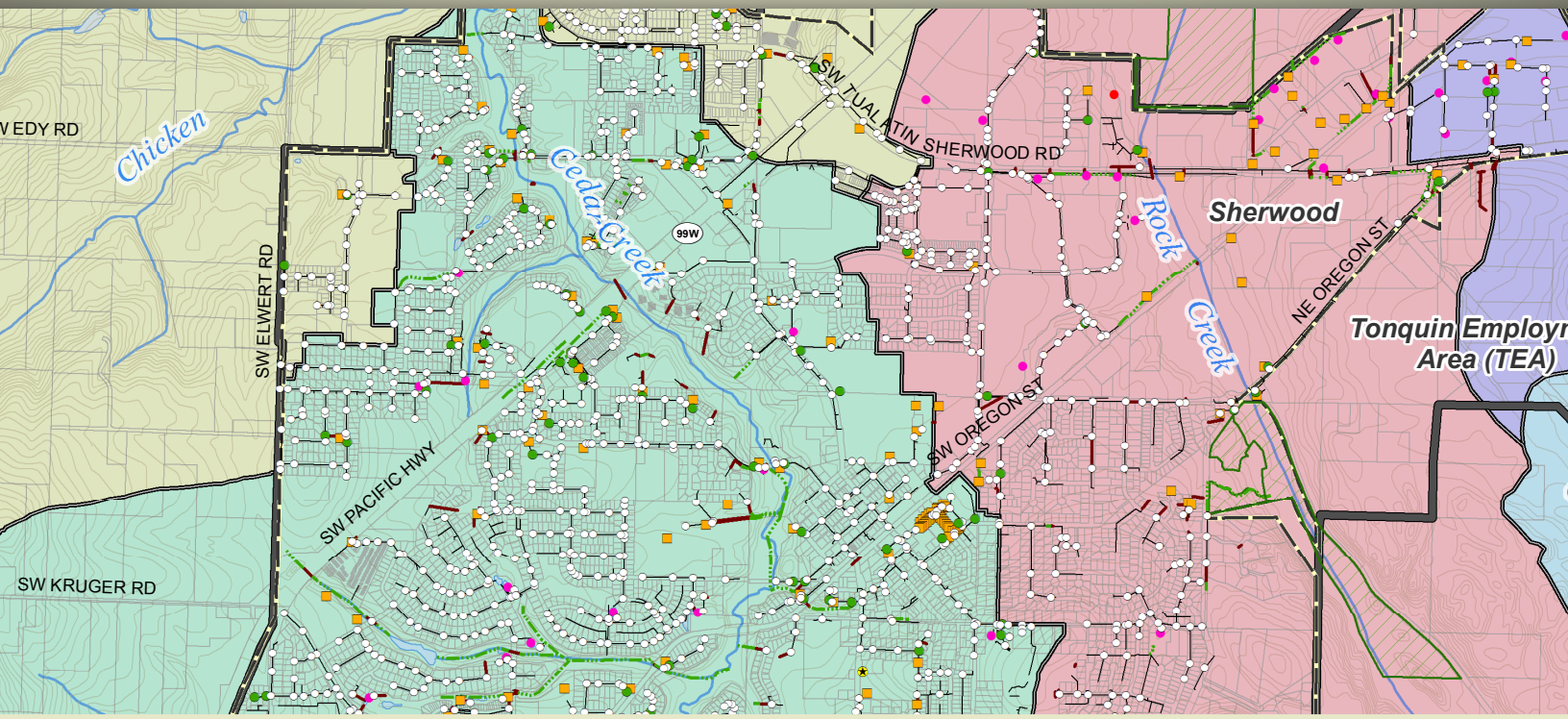
**Day Care**

A growing need exists for day care. State standards for the establishment of day care centers are supplemented by City standards. Currently day care has been carried on by churches and small home operations. The City recognizes and supports the proper siting and housing of day care services.

**Senior Citizens Services**

With an increasing proportion of the Planning Areas population reaching the age of 60, Sherwood will require additional specialized services and facilities for senior citizens. The City was awarded a grant from HUD for a Senior Citizen Community Center was completed in 1982. Community Center functions will be carried out under the authority of the City. It is the intent of the City that the Center be the focus for the Community activities requiring meeting and multi-purpose areas with particular emphasis on Senior Citizens programs and activities.

MSA MURRAY, SMITH & ASSOCIATES, INC.
ENGINEERS | PLANNERS




# CITY OF SHERWOOD
# STORMWATER MASTER PLAN

SEPTEMBER 2016

City of Sherwood Oregon

ATTACHMENT 2

# STORMWATER MASTER PLAN

# FOR

# CITY OF SHERWOOD, OREGON

**SEPTEMBER 2016**

Prepared by:

**MURRAY, SMITH & ASSOCIATES, INC.**
Engineers/Planners
121 SW Salmon, Suite 900
Portland, Oregon 97204

# TABLE OF CONTENTS

## SECTION 3 – EXISTING SYSTEM DESCRIPTION



## SECTION 4 – REGULATIONS AND POLICIES

## SECTION 5 – SYSTEM ANALYSIS



## SECTION 6 – RIPARIAN CORRIDOR EVALUATION



## SECTION 7 – CAPITAL IMPROVEMENT PROGRAM



## APPENDICES

## LIST OF FIGURES



## LIST OF TABLES

# EXECUTIVE SUMMARY

## INTRODUCTION

The purpose of this Stormwater Master Plan (SWMP) is to update the City of Sherwood's (City) previous SWMP adopted in June 2007. The primary goals of this SWMP include: (1) presentation of criteria required for evaluating the system; (2) identification of current and future system deficiencies and description of recommended improvements to correct them, and; (3) provision of planning-level cost information for general budgeting and the development of a prioritized Capital Improvement Program (CIP).

## STUDY AREA

The study area for this SWMP is illustrated in Figure ES-1 and encompasses the current Urban Growth Boundary (UGB), including the Brookman Concept Area and the Tonquin Employment Area (TEA). This study is limited to the stormwater system within the UGB.

The study area is comprised of roughly 3,391 acres and is currently 62 percent developed. Existing developable land use is made up of 39 percent Residential, 6 percent Commercial, 22 percent Industrial, 5 percent Institutional and Public, and 28 percent is deemed non-developable (e.g., Open Space, Wetland, Roadway, and Floodplain).

The City's population was reported at 18,194 during the 2010 census and has historically experienced steady growth (i.e., 6.2 percent average historical growth rate). Population is projected to reach 23,390 at full build-out of the UGB. Portland State University's (PSU) Population Research Center projects a 1 percent growth rate resulting in full build-out by 2036, whereas the historical 6.2 percent reaches capacity by 2019. Population forecasts were based on Metro land use data and population projections (*Certified Population Estimates*, Portland State University, www.pdx.edu/prc/population-reports-estimates; *Regional Forecast Distribution Methodology & Assumptions, Population and Employment, 2010-40 TAZ Forecast Distribution "Gamma Scenario,"* METRO, 2012*)*.

## STORMWATER SYSTEM

Management responsibilities for publicly-owned stormwater collection and conveyance facilities are shared through an Intergovernmental Agreement (IGA) between the City and Clean Water Services (CWS). CWS is responsible for the "District Wide Program" and the City is responsible for the "Local Program." The existing stormwater network is comprised of pipes, open channels, and culverts before discharging to a receiving surface water. Natural drainages through the City consist of 8.60 cumulative miles of creeks. Inventory of stormwater system data yielded approximately 71 miles of existing stormwater drainage piping, 5.0 miles of open channel conveyance, 278 culverts for a total length of 4.23 miles, 256 stormwater outfalls, 44 extended dry detention ponds, 166 swales, 2 retention basins, 1 Low Impact Development Approach (LIDA), and 89 water quality manholes. The City lies within five streamsheds, drained by Cedar Creek, Chicken Creek, Hedges Creek, Rock Creek, and Upper Coffee Lake Creek, that are tributary to the Tualatin River and Willamette River. The basins and the stormwater infrastructure are illustrated in Figure ES-1.

FIGURE ES-1

City of Sherwood Oregon

# CITY OF SHERWOOD

## STORMWATER MASTER PLAN
## EXISTING SYSTEM MAP

MSA Murray, Smith & Associates, Inc. Engineers/Planners
123 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
99W
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW BAKER RD
SW AVE

Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek
Rock Creek

Sherwood
Tonquin Employment Area (TEA)
Brookman Concept Area

**STORMWATER FACILITIES:**
- MANHOLE
- WATER QUALITY MANHOLE
- EXTENDED DETENTION POND
- LIDA
- RETENTION BASIN
- SWALE
- DITCH
- CULVERT
- CITY STORM SEWER LINE

- TUALATIN RIVER NATIONAL WILDLIFE REFUGE
- CITY BOUNDARY
- STUDY AREA*
- BASIN BOUNDARY
- ROCK CREEK BASIN
- CEDAR CREEK BASIN
- CHICKEN CREEK BASIN
- COFFEE LAKE CREEK BASIN
- HEDGES CREEK BASIN

* STUDY AREA = UGB

0 0.25 0.5 Miles

N W E S

G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 3-1_11x17.mxd 8/9/2016 1:49:54 PM Thomas.Walsh

The overall stormwater network is in good condition, though deficiencies from the previous SWMP still exist, as verified through interviews with City staff. These constraints include an undersized pipe in Ladd Hill Road south of Sunset Boulevard, surcharging of a 36-inch diameter culvert crossing under SW Sunset Boulevard near Eucalyptus Terrance, and drainage issues caused by long-term or recurring maintenance problems. The latter includes silted ditches along West Division Street, a repeatedly blown out swale near Columbia Street and Southern Pacific Railroad, a substandard functioning roadside swale along the east side of Ladd Hill Road which drains to a water quality facility located on the west side of Ladd Hill Road, and various open channel conveyances where vegetation control or removal of invasive species is needed.

With respect to water quality facilities, there are areas throughout the UGB lacking treatment. Areas lacking stormwater treatment generally fall into two categories and are good candidates for future stormwater quality improvements:

- Commercial and industrial facilities: Older commercial and industrial developments along Highway 99W and north of Tualatin-Sherwood Road were likely constructed without stormwater treatment facilities. Runoff from these types of development can have significant detrimental impact to surface water quality in locations of high motor vehicle-dependent activities, activities which require large ground disturbances and where materials storage is performed uncovered.

- Older developed residential areas: Two relatively large drainage basins in the southeast portion of the City, west of Murdock Road and south of Oregon Street, drain untreated to Rock Creek. Also, along Cedar Creek, there are several small residential basins that drain directly to the creek with no treatment.

## REGULATIONS & POLICIES

The City is ultimately responsible for management and operation of infrastructure under its jurisdiction in accordance with all known Federal, State, and local regulations. Historic legislation such as the Clean Water Act (CWA), Endangered Species Act (ESA), and National Flood Insurance Act all bear influence on current regulations administrated by the City and CWS within the UGB. These federal mandates, in addition to local planning policies and statutes, form the basis of the current regulatory context for stormwater within the City.

Stormwater regulations have become increasingly stringent since enactment of the CWA, with great strides having been made in pollution reduction from point sources. While point source pollution has been regulated, the root of further surface water degradation can be attributed to non-point source pollution, such as urban stormwater runoff. Federal and State agencies are working to improve the stormwater policies and regulations that address non-point source pollution.

Oregon Department of Environmental Quality (DEQ) recently issued Clean Water Services the renewal to their Municipal Separate Storm Sewer System (MS4) permit. The new requires that post-construction runoff flow control policies address hydromodification of

downstream receiving waters through mimicry of natural hydrology, utilization of green infrastructure (GI) or low impact development (LID), and treatment of 80 percent of the annual average runoff volume. Flow control strategies to address hydromodification have been adopted by the EPA, which require continuous simulation modeling to match the pre-development channel forming discharge or on-site retention of the 90th percentile storm. This storm is close to or less than the water quality storm established in Western Oregon jurisdictions. A detailed memorandum, provided in Appendix B, outlines the policies that are currently effective in protecting stream health, the municipal permit requirements that are likely to come into effect with the recent permit renewal, and recommendations for how the City can best meet these requirements.

## SYSTEM ANALYSIS

The stormwater analysis consisted of hydrologic and hydraulic components, including estimation and routing of the peak flow rates and volumes of stormwater runoff from the drainage areas and throughout the network. A computer model of the stormwater system and drainage basins was developed to evaluate the capacity of the various system components for a range of precipitation events employing the NRCS 24-hour, Type 1A theoretical rainfall distribution. Runoff estimation was determined with the NRCS Dimensionless Unit Hydrograph Method, which uses the runoff curve number, basin hydraulic length, average basin slope, and time of concentration to estimate runoff potential. To maximize the qualitative and quantitative accuracy of the analysis, the model was calibrated by simulating existing precipitation events and verifying with firsthand accounts of locations of known deficiencies.

The model was used to characterize the system sensitivity to precipitation and to provide an overall range of capacity- and quality-related improvements anticipated to be necessary as the City develops towards build-out. The system analysis identified components which do not meet minimum criteria, as defined by the City's *Engineering Design and Standard Details Manual (2010)* and CWS's *Design and Construction Standards (2007).* As per CWS standards, the 25-year, 24-hour rainfall event served as the design storm and was used to establish adequate conveyance. The build-out analysis considered stormwater management within the existing UGB. Risk of flooding and the need for improvement were determined by calculating the available freeboard. These quantities were then used to establish categories of risk, including:

- Critical: Freeboard $\leq$ 0 feet – Improvement needed in all cases.
- High: 0 feet < Freeboard $\leq$ 1 feet – Improvement needed in most cases.
- Moderate: 1 feet < Freeboard $\leq$ 5 feet – Improvement not needed.
- Low: > 5 feet – Improvement not needed.

For conveyance capacity, deficient pipes were identified by examining the maximum flow class result for each pipe segment, with the following classes: free surface, backwater, or exceeds capacity. Free surfaces indicates additional capacity and, during maximum flow conditions, the pipe is not completely full. Backwater identifies one or more pipes downstream of the pipe in question have a flow rate that exceeds the flow capacity and, therefore, pushes water upstream in the network. For backwater conditions, the pipeline

HGL profile was investigated to determine the location causing the backup. A pipe exceeding capacity cannot accommodate the flow entering the upstream node of a pipe segment and is deficient; however, if the deficient pipe has sufficient depth and available freeboard, then the deficiency may not warrant replacement. This was determined on a pipe-by-pipe basis.

Results of the system analysis found no conduits experience backwater conditions that would result in flooding of the upstream manholes under either the existing or build-out conditions. A number of high to moderate risk locations were identified, stemming from conservative runoff characteristics (e.g., limited ponding), flat conveyance slopes, and minimal freeboard. These results are consistent with firsthand accounts of flooding that has occurred for events with returns equivalent to the two year storm. Most of the system deficiencies are caused by deficient pipes in the stormwater system and not necessarily undersized outfall pipes.

Existing regional stormwater quality and quantity facilities were found to be adequately sized to the standards at the time of implementation. It is recommended that the City focus efforts on operations and maintenance of these existing facilities to ensure their continued functionality (i.e., peak flow attenuation, minimization of flooding potential). In instances where the need for facilities was identified though none were currently present, the Tualatin River Urban Stormwater Tool (TRUST) was used to size facilities for the range of precipitation events. TRUST is a tool, developed for CWS, that analyzes the hydromodification impacts of land development projects and sizing solutions to mitigate the related increases in runoff.

## RIPARIAN CORRIDOR EVALUATION

Field investigations were conducted of the City's streams for their general susceptibility to erosion, or hydromodification. The study focused on local stream conditions for the primary surface waters within the Cedar Creek, Chicken Creek, Hedges Creek, Rock Creek, and Upper Coffee Lake Creek streamsheds. All streams were found to be generally healthy and resilient to erosion in conjunction with the City's current stormwater management policies. Of note, however, is the susceptibility of native soils to erosion when exposed to stream velocities exceeding the cohesive and shear strength bounds for extended durations. These results are summarized in a technical memorandum, located in Appendix C.

An analysis of regulatory trends shows that there is increasing attention paid to addressing impacts of hydromodification caused by urbanization. CWS' NPDES MS4 permit, recently renewed by DEQ, includes a requirement that CWS perform a watershed-level hydromodification assessment, then develop, implement and enforce a program that addresses deficiencies. Also, in 2016, a Biological Opinion was issued by National Marine Fisheries Service (NMFS) stating that hydromodification of regulatory floodplains may be in conflict with the Endangered Species Act.

It is anticipated that future regulations will seek to further restrict development within the floodplain, to further reduce impacts to the floodplain and riparian areas due to existing stormwater discharges, and to require post-construction runoff strategies that mimic natural hydrologic processes and treat 80 percent of the annual average runoff volume using green

infrastructure (GI) or low impact development (LID). Recommendations for stormwater management policies and hydromodification reduction strategies are provided in Appendix C to position the City to proactively anticipate future regulatory requirements in a cost-effective manner.

## CAPITAL IMPROVEMENT PROGRAM

The capacity and condition improvement analysis was used to develop a 20-year CIP. The CIP provides a blueprint for forecasting capital expenditures and aids in community development and financial planning. Improvements were analyzed at a planning level of accuracy, categorized according to project type (Condition, Stormwater Management, or Planning), assigned a project driver (Pipe & Manhole Condition, Regulatory, or UGB-Infill), and prioritized into three timeframes. This resulted in priorities for short-term (0-5 years), medium-term (6-10 years), and long-term (11-20 years) planning.

All improvements are funded by utility revenues generated from stormwater rates and are allocated through the City's Stormwater Operating Fund. Capital improvements for future development (i.e., growth) are funded through Sewer Development Charges (SDCs), as dictated by Oregon Revised Statute 223.297 through 223.314 and allocated by the City's Stormwater SDC Fund. The total costs for all City improvements are summarized and presented in Table ES-1 and equate to $4,525,000 over the 20-year planning horizon (in 2015 dollars). Capital improvement projects are illustrated in Figure ES-2.

**Table ES-1 Capital Improvement Program Summary (Estimated Total Costs)[1,2,3]**

| Category | Time Frame (Cost) | | | Total Cost |
|---|---|---|---|---|
| | 0-5 Years | 6-10 Years | 11-20 Years | |
| Condition | $0 | $370,000 | $1,740,000 | $2,110,000 |
| Stormwater Management | $320,000 | $580,000 | $1,134,000 | $2,034,000 |
| Planning | $6,000 | $125,000 | $250,000 | $381,000 |
| Total | $326,000 | $1,075,000 | $3,124,000 | $4,525,000 |

Table ES-1 summarizes CIP costs by improvement category with the following notes:

Note 1. Cost estimates represent a Class 5 budget estimate, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 20 percent below the estimate to 100 percent above the estimate. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. They are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate.

Note 2. Cost estimates for new infrastructure improvements assume unit costs for new materials and construction. Cost estimates for pipe upsizing and condition based improvements assume unit costs for replacement materials and construction. All cost estimates include markups for construction contingency, owner administrative costs, and contract costs. Right-of-way acquisition costs, property purchase, and legal condemnation fees are excluded from the estimates.

Note 3. All improvements are sized for build-out of the upstream service area at a planning level of accuracy based on land use assumptions described in Section 5 of this document. Improvement sizing is limited to service within the existing Urban Growth Boundary. Prior to implementation, each project should undergo standard engineering design phases to finalize improvement sizing and location.

**FIGURE ES-2**

City of Sherwood Oregon

# CITY OF SHERWOOD

## STORMWATER MASTER PLAN
## CAPITAL IMPROVEMENT PROGRAM

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 SW Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

**SEPTEMBER 2016**

Note:
Future Concept Plan Facilities were delineated based on Concept Plan locations for the Brookman Concept Area and Tonquin Employment Area.

Call-outs represent Improvement Project IDs. The brown dashed outline approximates the project bounds for Project 20.

SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
SW KRUGER RD
SW TUALATIN SHERWOOD RD
SW MAIN ST
SW SUNSET BLVD
SW BROOKMAN RD
NE OREGON ST
SW BAKER RD
99W
Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Rock Creek
Coffee Lake
Sherwood
Tonquin Employment Area (TEA)
Brookman Concept Area

FUTURE CONCEPT PLAN FACILITY
PROPOSED FACILITY
WATER QUALITY MANHOLE
MANHOLE
EXTENDED DETENTION POND
SWALE
RETENTION BASIN
LIDA
DITCH
CULVERT
CITY STORM SEWER LINE
CONDITION PROJECT
CITY BOUNDARY
STUDY AREA
TAXLOT
WATER BODY
STREAM
WETLAND

N W E S

0 0.5 Mile

G:\PDX_Projects\151638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 7-1_11x17_A.mxd 8/10/2016 8:36:55 AM Thomas.Walsh

# SECTION 1 | INTRODUCTION

## INTRODUCTION

This Stormwater Master Plan (SWMP) is an update to the City of Sherwood's (City's) previous SWMP adopted in June of 2007.

This SWMP:

- Summarizes basic information describing the stormwater system.
- Describes how the system components function.
- Presents technical criteria required for evaluating the system.
- Identifies current system deficiencies and describes recommended improvements to correct them.
- Identifies future system needs to accommodate future growth.
- Contains planning-level cost information for general budgeting and the development of a prioritized Capital Improvement Program (CIP).
- Provides a reference document for City leaders, technical staff, consultants, customers and other interested parties about the existing system and future recommended improvements.
- Incorporates community values and priorities through input from a public open house process.
- Facilitates logical planning decisions and utility coordination relative to other City projects and programs.

## PURPOSE

This SWMP provides a valuable tool to facilitate timely, orderly and efficient management of the City's stormwater collection system over the next 20 years. This document serves as a "Public Facilities Plan" for stormwater collection systems according to Oregon Administrative Rule (OAR) 660, Division 11. This OAR stipulates that facility plans be developed as support documents for the City's Comprehensive Plan.

### How This Plan Should Be Used

*This SWMP serves as the guiding document for future stormwater system improvements, and should:*

- Be reviewed annually to prioritize and budget needed improvements.
- Have its mapping updated regularly to reflect ongoing development and construction.
- Specific system improvement recommendations should be regarded as conceptual.

  The location, size and timing of projects may change as additional site-specific details and potential alternatives are investigated in the preliminary engineering phase of design.
- Be updated and refined as preliminary engineering and final project designs are completed.

## STUDY AREA

The study area encompasses approximately 3,390 acres and includes the current City Urban Growth Boundary (UGB).

## SCOPE

Murray, Smith and Associates, Inc. (MSA) was authorized by the City on January 21, 2015 to provide municipal master planning services related to stormwater collection.

MSA worked closely with the City to develop a Scope of Work that provides the necessary guidance for both current and future stormwater management decisions. The Scope of Work includes the following elements:

- Compile and review maintenance reports, condition assessments, maps, record drawings, aerial photography, topography, system base maps, City standards and other information pertaining to the physical stormwater system.
- Review City-furnished information relating to service study area, hydrologic basins, and land use.
- Develop criteria for analysis of existing stormwater collection systems and the design of future improvements.
- Document current Federal, State and local rules and regulations that relate to the City's stormwater system. Provide a discussion on future anticipated regulations.
- Develop stormwater attributes including soil types, topography, vegetation and other pertinent characteristics for each basin.
- Conduct a hydraulic analysis of existing storm sewer mains.
- Determine existing deficiencies with respect to ultimate service requirements.
- Based on system deficiencies identified, review stormwater system needs and alternatives to meet current and future stormwater flow conditions.
- Develop a CIP which prioritizes short-term and long-term improvements to meet the City's anticipated system needs.
- Develop budget-level cost estimates for those projects identified in the CIP. Funding alternatives will be identified which may be utilized by the City to finance the projects.
- Develop a stormwater facilities plan map showing both existing and proposed stormwater facilities.
- Develop methodology and rate analysis for System Development Charges (SDCs).
- Prepare a SWMP document which describes and illustrates the results of the study.

## ORGANIZATION OF THE STORMWATER MASTER PLAN

This master plan report is organized into sections as described in Table 1-1. Detailed technical information and supporting documents for Sections 4 thru 7 are included in the appendices.

**Table 1-1 | SWMP Organization**

| Section Number | Section Title | Description |
|---|---|---|
| ES | Executive Summary | Summarizes the wider report for readers to rapidly become acquainted the City's stormwater system; includes background information, concise analysis and conclusions of service needs over the study period. |
| Section 1 | Introduction | Explains the purpose and scope of the Stormwater Collection System Master Plan; Provides a summary of each section and overall recommendations. |
| Section 2 | Study Area Characteristics | Outlines the study area characteristics, including geography, topography, climate, general soil conditions, and land use designations within the City. |
| Section 3 | Existing System Description | Presents an overview of the existing system and key facilities, and describes the existing service area and extents of the current urban growth boundary (UGB). |
| Section 4 | Regulations & Policies | Describes applicable policies and guidelines for stormwater collection systems are summarized from Federal, State, and local governance. |
| Section 5 | System Analysis | Provides a summary of the methodology and results of the system analysis, and the alternatives assessment used to identify capital improvements. |
| Section 6 | Riparian Corridor Evaluation | Assesses extent of stream erosion within the City and recommends corrective strategies. |
| Section 7 | Capital Improvement Program | Presents a proposed Capital Improvement Program (CIP) consisting of a prioritized list of recommended improvements to be conducted over the study period. |
| Appendix A | CWS IGA | Includes the current Intergovernmental Agreement (IGA) between the City of Sherwood and Clean Water Services (CWS). |
| Appendix B | Anticipated MS4 Permit Requirements | Outlines existing CWS permit requirements and policies relevant to this SWMP update. |
| Appendix C | Hydromodification Technical Memorandum | Summarizes existing stream information and guides strategies to address hydromodification. |
| Appendix D | Basis of Opinion of Probable Costs | Presents unit cost tables used to develop estimates for projects and the final CIP budgets associated with Section 7. |
| Appendix E | FEMA Letter, National Flood Insurance Act | Letter from the Federal Emergency Management Agency (FEMA) identifying regulations re floodplain protection in part through the National Flood Insurance Act. |

# SECTION 2 | STUDY AREA CHARACTERISTICS

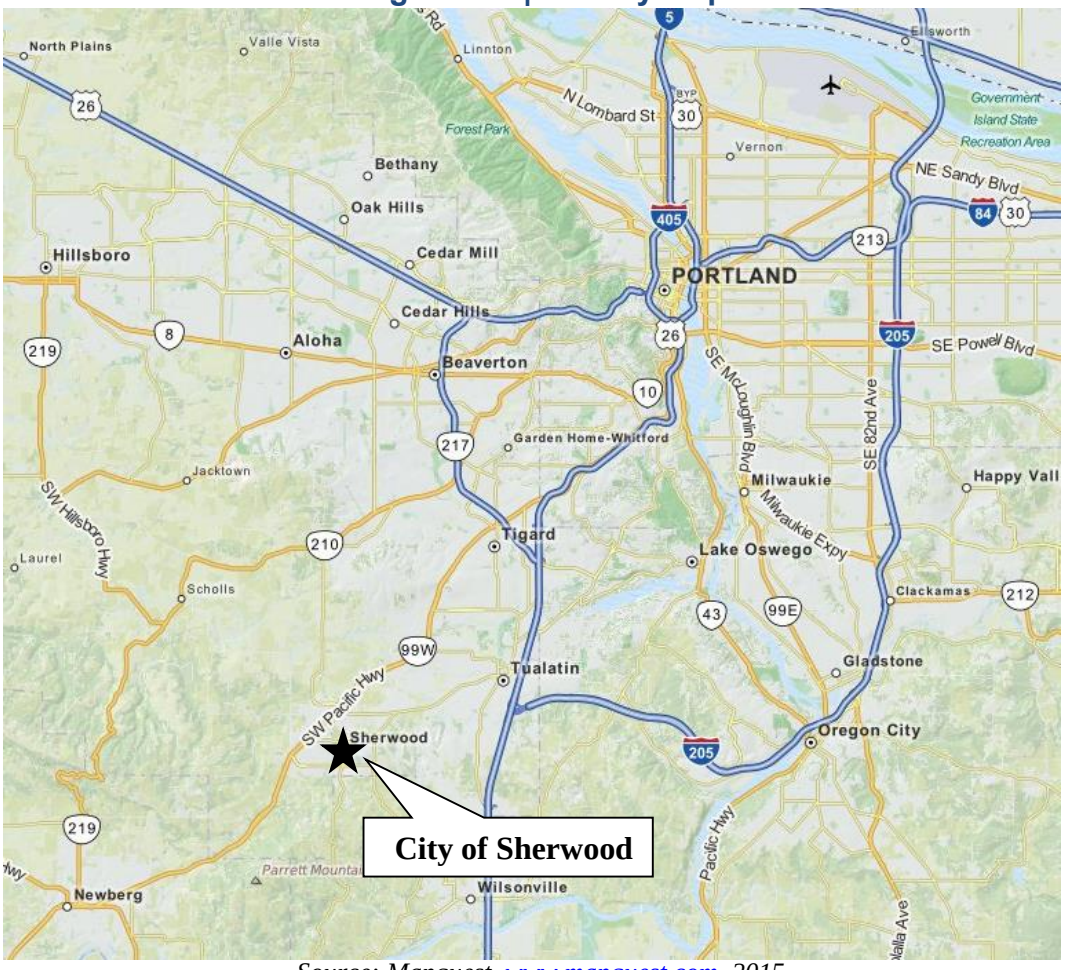
## INTRODUCTION

This section of the Stormwater Master Plan (SWMP) outlines the study area characteristics including geography, topography, climate, general soil conditions, and land use designations within the City of Sherwood (City). Land use designations are of particular interest when planning stormwater system infrastructure, as the stormwater runoff from these areas is highly dependent on land use category and density. The City's socioeconomic conditions are also documented within this section, including a discussion on the major sources of commerce within the City and the existing population.

## GEOGRAPHY

The City is located along Highway 99 in Oregon's Tualatin River Valley, within the southeast corner of Washington County (see Figure 2-1). This location places the City on the southwest edge of the Portland metropolitan area, approximately 16 miles from downtown Portland. Neighboring cities are Beaverton to the north, Tigard to the northeast, Tualatin to the east, and Wilsonville to the southeast. Newberg, in Yamhill County, is approximately 9 miles southwest, along Highway 99.

**Figure 2-1 | Vicinity Map**




*Source: Mapquest, www.mapquest.com, 2015.*

## STUDY AREA

The study area encompasses approximately 3,391 acres and includes the current City Urban Growth Boundary (UGB). The UGB includes the current city limits, the Tonquin Employment Area (TEA), and the Bookman Concept Area. While the study area defines the expected stormwater service boundary over the study period, drainage basins extending upstream of this boundary contribute runoff to the City's five receiving waters. Therefore, information pertaining to these drainage basins is provided throughout this SWMP, as shown in Figure 2-2.

## LAND USE AND ZONING

By state law, Metro is responsible for establishing the Portland metropolitan area's UGB, which includes Sherwood. Metro is a regional government serving nearly 1.5 million people in Clackamas, Multnomah and Washington Counties. The agency was formed to administer growth, infrastructure and development policies that cross local jurisdictional boundaries. Land uses and densities inside the UGB are selected to support urban services such as police and fire protection, roads, schools, and water and sewer systems. Understanding land use and demographic characteristics within the study area is particularly important in stormwater system planning. This is primarily because the land use determines the amount of impervious area within a basin, and stormwater runoff increases with urbanization.

All parcels within the City have land use designations, which involve various categories of commercial, industrial, institutional and residential land uses with specific zoning designations within these broader uses. City zoning is summarized in Table 2-1 for the UGB, which also includes the Brookman Concept Area and the TEA. City zoning is also shown in Figure 2-2.

### *Residential Land Use*

Table 2-2 provides density categories for residential land development within the UGB by land use designation. While Low Density Residential (LDR - 1/5 acre lots) is the dominant residential zoning classification within the City limits, residential zoning classifications are generally spread evenly throughout the City. The southeast corner of the City is zoned Very Low Density Residential (VLDR - 1 acre minimum lot size). Medium Density Residential (MDR) and High Density Residential (HDR) zoning is located between low density residential use zones and commercial use zones. MDR and HDR zoning can also be found toward the center of the City.

Within each of these residential zones are undeveloped, or vacant, areas. The City's vacancy and buildable lands inventory datasets establish the potential for in-fill development within these areas. The resulting existing percent development, by parcel, is presented in Figure 2-3. Approximately 331 acres of the UGB and Concept Plan Areas' residentially zoned 1,314 acres are currently undeveloped (25%). This undeveloped land is composed of approximately 49 acres zoned as VLDR, 40 acres zoned as LDR, 205 acres zoned as

Medium Density Residential (MDRL and MDRH), and 37 acres zoned as High Density Residential (HDR).

| Table 2-1 \| Zoning and Planning Area Summary | | | | |
|---|---|---|---|---|
| **Zoning Category** | **Existing City Limits** | **Brookman Concept Area** | **Tonquin Employment Area** | **Total** |
| **Developable Land (gross acres)** | | | | |
| General Commercial (GC) | 66 | 0 | 0 | 66 |
| Neighborhood Commercial (NC) | 1 | 0 | 0 | 1 |
| Office Commercial (OC) | 29 | 7 | 0 | 36 |
| Retail Commercial (RC) | 101 | 0 | 0 | 101 |
| Institutional and Public (IP) | 169 | 4 | 0 | 173 |
| General Industrial (GI) | 230 | 0 | 0 | 230 |
| Light Industrial (LI) | 198 | 30 | 0 | 228 |
| Employment Industrial (EI) | 0 | 0 | 281 | 281 |
| Very Low Density Residential (VLDR) | 96 | 0 | 0 | 96 |
| Low Density Residential (LDR) | 590 | 0 | 0 | 590 |
| Medium Density Residential Low (MDRL) | 185 | 139 | 0 | 325 |
| Medium Density Residential High (MDRH) | 147 | 7 | 0 | 154 |
| High Density Residential (HDR) | 135 | 15 | 0 | 150 |
| **Subtotal – Developable Land** | **1,947** | **202** | **281** | **2,429** |
| **Non-developable Land (gross acres)[1]** | | | | |
| Open Space (OS) | 238 | 0 | 0 | 238 |
| Wetland | 63 | 0 | 4 | 67 |
| Roadway | 485 | 32 | 20 | 537 |
| Floodplain | 102 | 17 | 1 | 120 |
| **Subtotal - Non-developable Land** | **888** | **49** | **25** | **962** |
| **TOTAL - Developable + Non-developable** | **2,835** | **251** | **306** | **3,391** |
| **Developable Land - Developed vs. Vacant Summary (gross acres)** | | | | |
| Subtotal – Developed Land | 1,508 | 0 | 0 | 1,508 |
| Subtotal - Vacant Land | 439 | 202 | 281 | 922 |

Note 1. Non-developable Land refers to lands in the study area that have a City zoning designation of Open Space (OC), or have been otherwise categorized by Metro RLIS as Wetlands, Roadway, or Floodplain. These additional categories are defined as follows: Wetlands – As identified by Metro RLIS GIS, this includes land in the 1998 National Wetlands Inventory, finished and in-progress local wetland inventories conducted by local jurisdictions, and information/documentation collected during the development of Metro's Title 13 Nature in Neighborhoods Program. Roadway - Land not part of a taxlot, considered to be dedicated to public rights-of-way. These include streets, highways, and railroads. Floodplain - Land in the 100-year floodplain, as delineated by FEMA. Current as of August 2016.

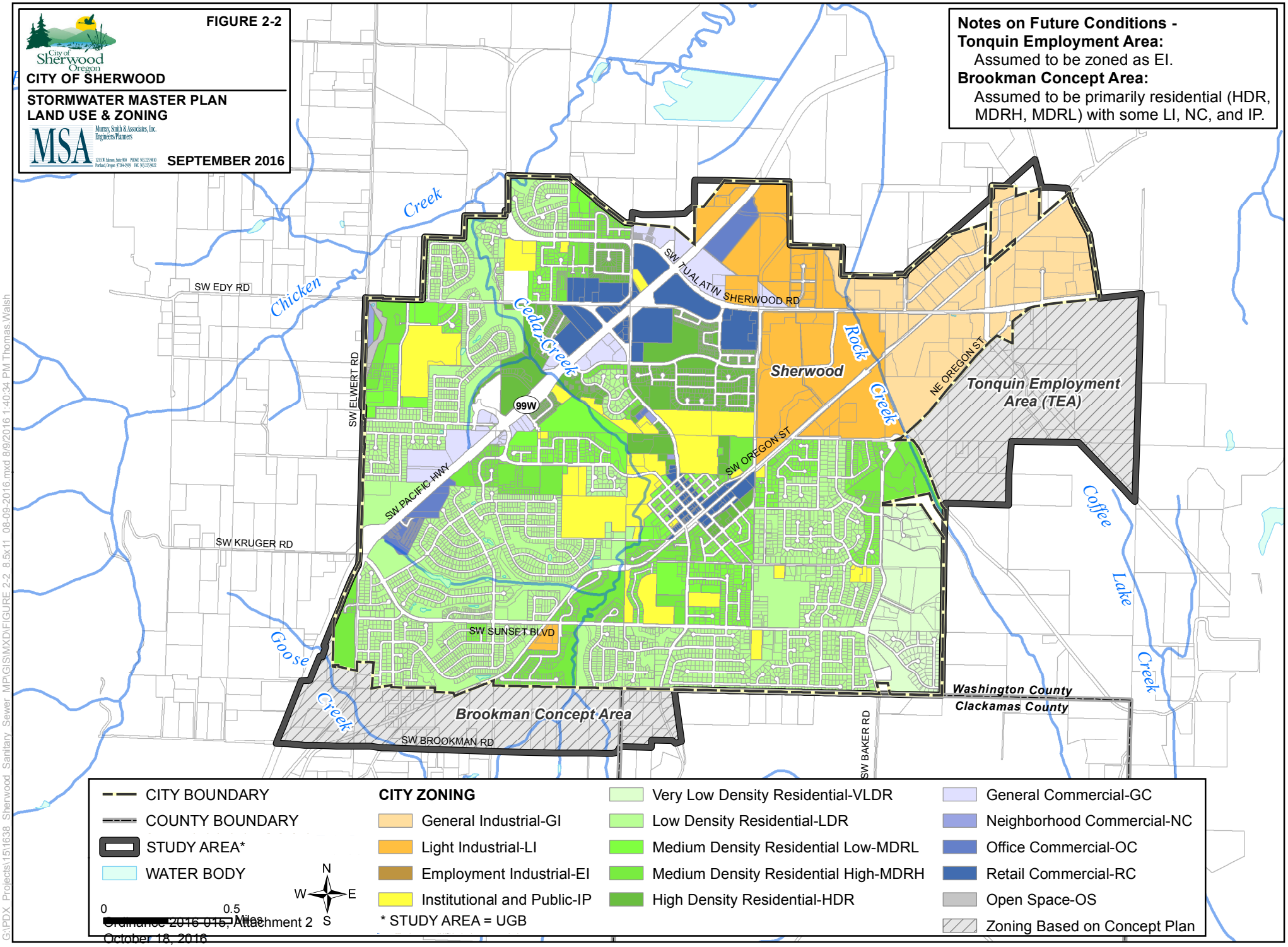
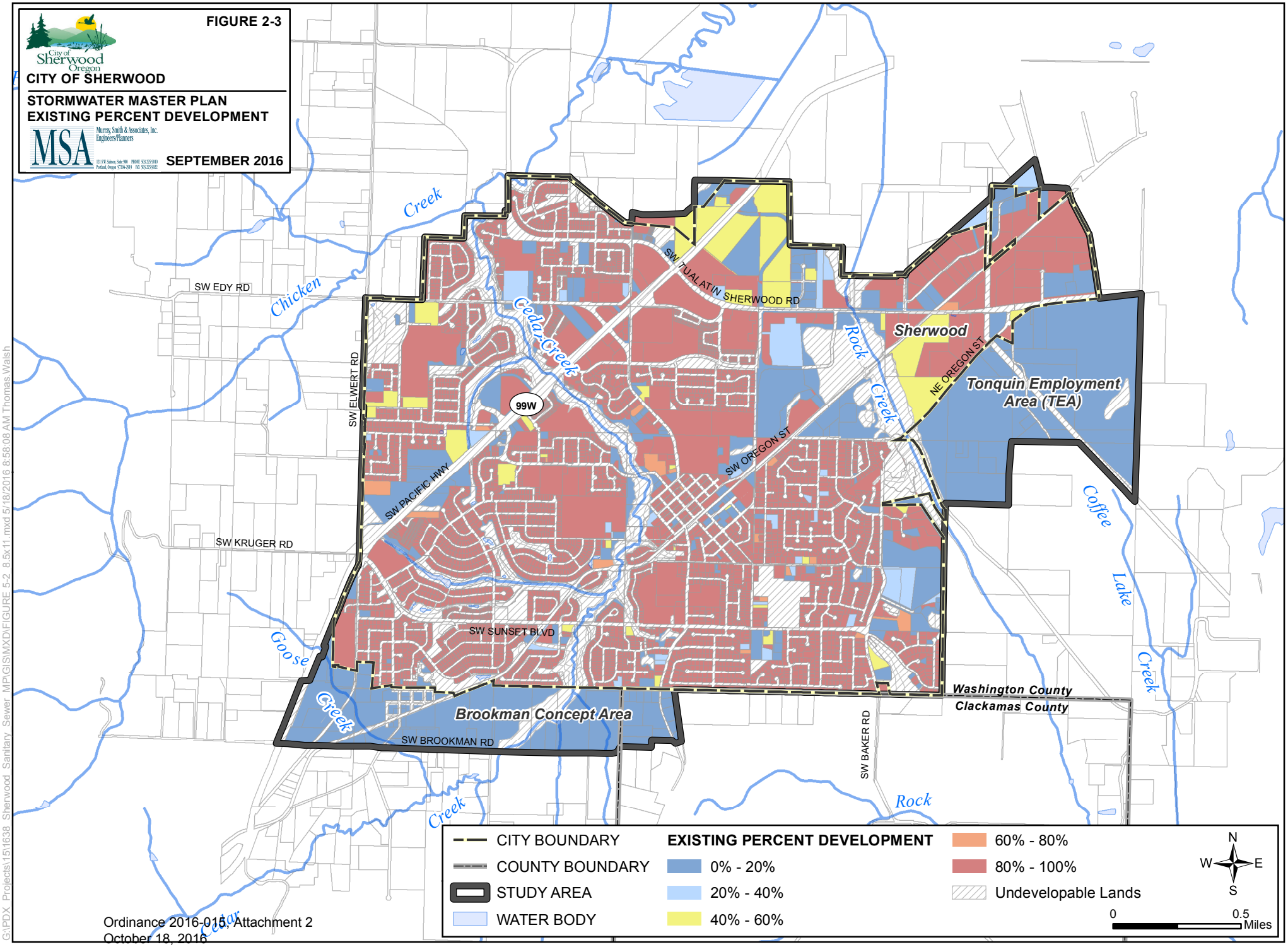


FIGURE 2-2
City of Sherwood Oregon
CITY OF SHERWOOD
STORMWATER MASTER PLAN
LAND USE & ZONING
MSA Murray, Smith & Associates, Inc. Engineers/Planners
SEPTEMBER 2016
Notes on Future Conditions -
Tonquin Employment Area:
Assumed to be zoned as EI.
Brookman Concept Area:
Assumed to be primarily residential (HDR, MDRH, MDRL) with some LI, NC, and IP.
Chicken Creek
Cedar Creek
Rock Creek
Coffee Lake Creek
Goose Creek
SW EDY RD
SW ELWERT RD
SW TUALATIN SHERWOOD RD
SW PACIFIC HWY
99W
SW OREGON ST
NE OREGON ST
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW BAKER RD
Sherwood
Tonquin Employment Area (TEA)
Brookman Concept Area
Washington County
Clackamas County
CITY BOUNDARY
COUNTY BOUNDARY
STUDY AREA*
WATER BODY
CITY ZONING
General Industrial-GI
Light Industrial-LI
Employment Industrial-EI
Institutional and Public-IP
Very Low Density Residential-VLDR
Low Density Residential-LDR
Medium Density Residential Low-MDRL
Medium Density Residential High-MDRH
High Density Residential-HDR
General Commercial-GC
Neighborhood Commercial-NC
Office Commercial-OC
Retail Commercial-RC
Open Space-OS
Zoning Based on Concept Plan
* STUDY AREA = UGB
N
W
E
S
0
0.5
Miles
G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 2-2_8.5x11_08-09-2016.mxd 8/9/2016 1:40:34 PM Thomas.Walsh




G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 5-2_8.5x11.mxd 5/18/2016 8:58:08 AM Thomas Walsh

| Table 2-2 \| Residential Density Ranges | |
|---|---|
| **Land Use** | **Density Range (dwellings/acre)** |
| Low-Density Residential | 4-9 |
| Medium-Density Residential | 6-18 |
| High-Density Residential | 12-35 |
| Overall Average Residential | 7 |

### *Commercial Land Use*

Commercially zoned land is primarily located along Highway 99W and within the downtown commercial district. While most of the commercial zoning classification is general and retail, some office commercial zoning is located on the south side of Highway 99W, north of Sunset Boulevard. Within the UGB plus Concept Plan Areas, a total of 204 acres is classified as commercial land uses (GC, NC, OC, and RC). Of these, 79 acres are currently undeveloped.

### *Industrial Land Use*

The primary industrial zoned area is located along Highway 99W north of Roy Rogers Road/Tualatin-Sherwood Road and along Tualatin-Sherwood Road east of Highway 99W. A single industrial zone is located adjacent to the Southern Pacific Railroad line south of Sunset Boulevard. Within the UGB, 739 acres are classified as industrial land use, with 435 acres as General Industrial and 304 acres as Light Industrial. Of this total, there is approximately 65 percent that is currently undeveloped (484 acres).

Employment Industrial (EI) – This zoning classification is identified for future growth areas of the Tonquin Employment area (306 acres) and includes primarily employment related to industry, but excludes process water typically associated with wet industry applications.

## TOPOGRAPHY

The ground elevations within the City range from approximately 140 feet above mean sea level (MSL) to approximately 420 feet above MSL, with the majority of development occurring between the elevations of 180 to 260 feet above MSL. In general, the elevations are lowest in the northern portions of the City nearing the Tualatin River, and highest in the hilly areas of the southern portions of the City. Elevation change throughout the City is gradual, with typical slopes up to 6 percent. However, some steep slopes, which range up to 25 percent, are located near hills and creek banks. Topographic mapping is shown in Figure 2-4.

## CLIMATE

The City is in the Marine West Coast Climate Zone. Temperatures are moderate year-round due to a marine influence from the Pacific Ocean that produces generally warm, dry

summers and cool, wet winters. Precipitation primarily occurs during the winter months, with the wettest period from October through March. Nearly 41 inches of precipitation occurs annually in the City. July and August are the warmest months, with an average high temperature of 81 degrees Fahrenheit (°F), and December is the coolest month, with an average low temperature of 34 °F. December is also the wettest month, averaging 6.82 inches of precipitation.

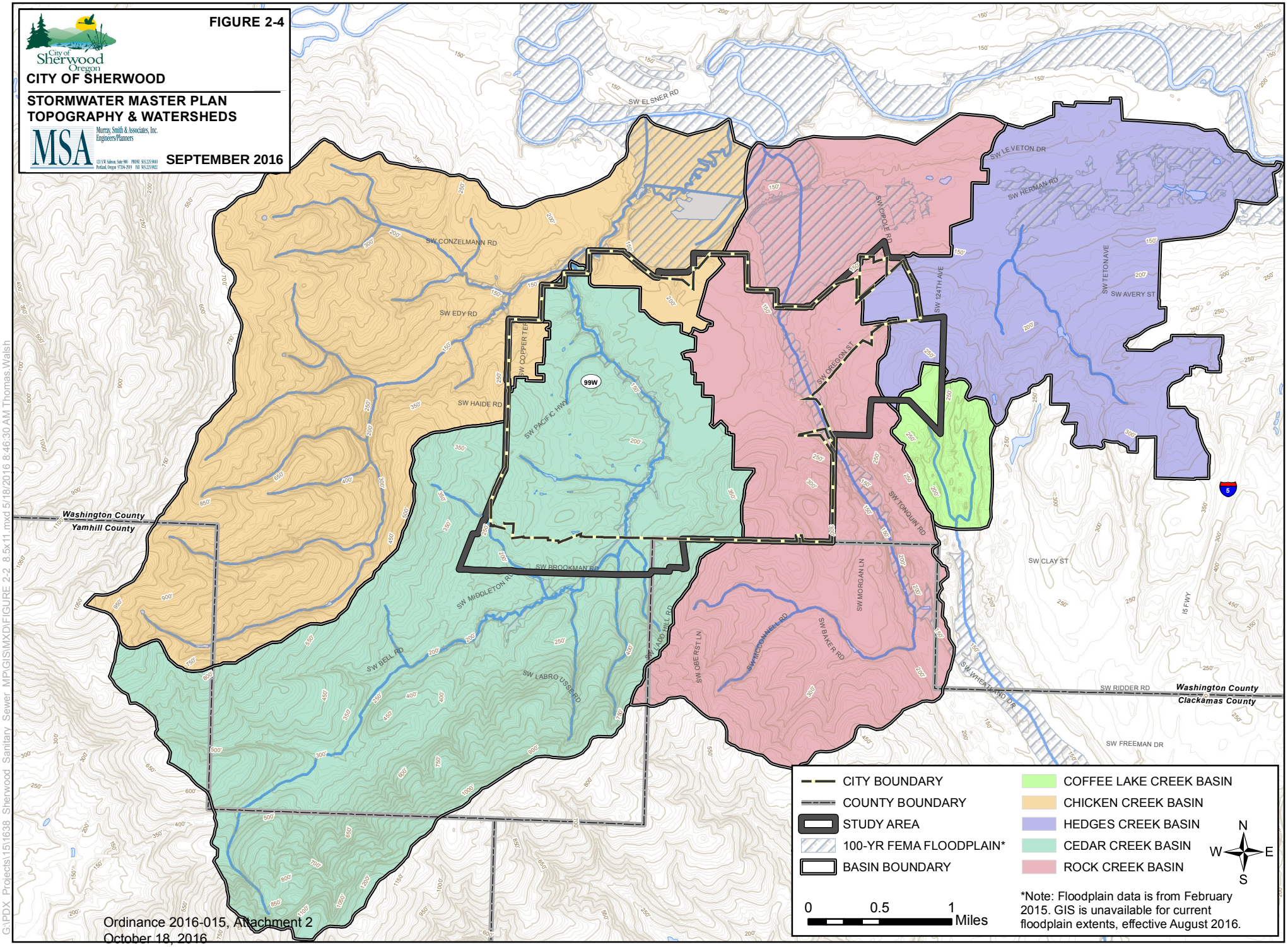


FIGURE 2-4
City of Sherwood Oregon
CITY OF SHERWOOD
STORMWATER MASTER PLAN
TOPOGRAPHY & WATERSHEDS
MSA Murray, Smith & Associates, Inc. Engineers/Planners
SEPTEMBER 2016
SW ELSNER RD
SW CONZELMANN RD
SW EDY RD
SW HAIDE RD
SW COPPER TER
SW PACIFIC HWY
99W
SW BROOKMAN RD
SW MIDDLETON RD
SW BELL RD
SW LABRO USSER RD
SW LADD HILL RD
SW OBERST LN
SW CONNELL RD
SW BAKER RD
SW MORGAN LN
SW TONQUIN RD
SW OREGON ST
SW CIRCLE RD
SW 124TH AVE
SW LEVETON DR
SW HERMAN RD
SW TETON AVE
SW AVERY ST
SW CLAY ST
I5 FWY
SW WHEATLAND DR
SW RIDDER RD
SW FREEMAN DR
Washington County
Yamhill County
Washington County
Clackamas County
CITY BOUNDARY
COUNTY BOUNDARY
STUDY AREA
100-YR FEMA FLOODPLAIN*
BASIN BOUNDARY
COFFEE LAKE CREEK BASIN
CHICKEN CREEK BASIN
HEDGES CREEK BASIN
CEDAR CREEK BASIN
ROCK CREEK BASIN
N
W
E
S
0
0.5
1
Miles
*Note: Floodplain data is from February 2015. GIS is unavailable for current floodplain extents, effective August 2016.
G:\PDX Projects\15\1638 Sherwood Sanitary Sewer MP\GIS\MXD\FIGURE 2-2 8.5x11.mxd 5/18/2016 8:46:30 AM Thomas Walsh

## FUTURE GROWTH AREAS

Future growth areas include a total of 557 acres of land within the study area. Concept planning efforts have been completed for the TEA and Brookman Concept Area within the UGB, with summaries of each described below.

### *Brookman Concept Area*

The Brookman Concept Area is a proposed 251-acre residential, commercial, office and light industrial development zoned tract of land within the southern portion of the City's UGB. There are currently 49 acres of roadway, wetlands, and floodplains designated in the area.

The planning effort for this area was undertaken by the City in 2009. It is primarily located in unincorporated Washington County, with a minor eastern section located in unincorporated Clackamas County where Brookman Road deviates from an east-west alignment at the county border. The area is bound by Brookman Road and the UGB to the south, the existing City limits to the north, Highway 99 to the west, and the UGB to the east. The timeline for actual development within this planning area is anticipated to begin within the next 5 years, and reach saturation at 20 years.

### *Tonquin Employment Area (TEA)*

The TEA is an Employment Industrial zoned 306-acre area on the eastern portion of the City's UGB. Currently, there are 25 acres of roadway, wetlands, and floodplains within the area. The planning effort for this area was undertaken by the City in 2010. It is fully located in unincorporated Washington County. The area is bound by the UGB to the south, the existing City limits to the north and west, and the UGB to the east along SW 124th Avenue. The timeline for actual development within this planning area is anticipated to begin within the next 5 years, and reach saturation after 20 years.

## GEOLOGY, SOILS, AND GROUNDWATER

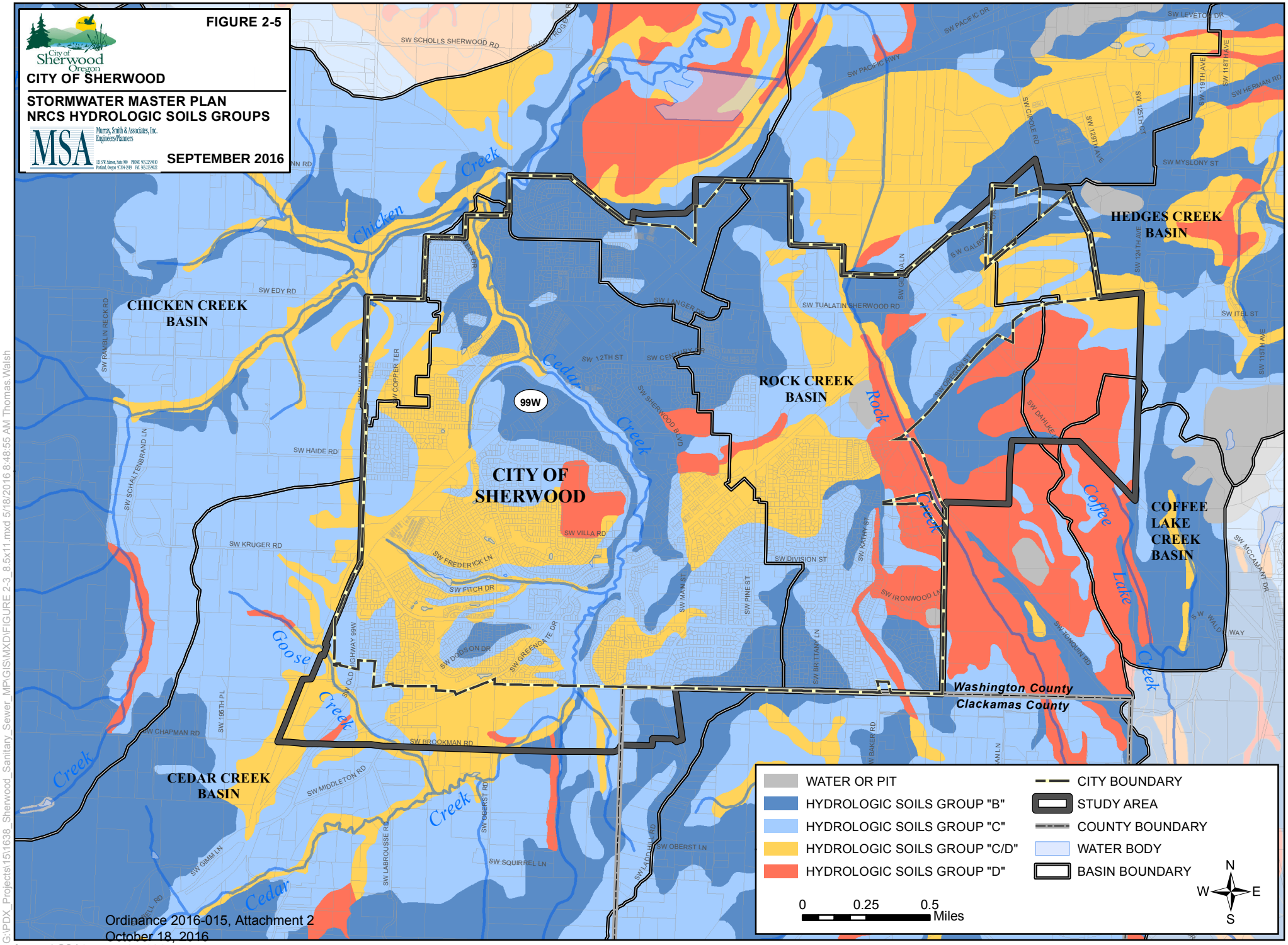
Detailed information on the soils found throughout the entire study area is summarized in the U.S. Soil Conservation Service's *Soil Survey of Washington County, Oregon* (1982), *Clackamas County, Oregon* (1985), and *Survey of Yamhill Area, Oregon* (1974). These surveys identify the soil types for construction considerations and potential runoff response to precipitation. In general, the soils within the study area produce a moderate to high response to rainfall in terms of stormwater runoff. Conversely, these soils typically infiltrate rainfall at a low to moderate rate. The Natural Resources Conservation Service (NRCS) hydrologic soils group classifications are summarized for the study area and presented in Table 2-3. Soils with a percent area less than 0.1 were omitted. The spatial distribution of soils in the study area is exhibited in Figure 2-5.

| Table 2-3 \| Study Area Hydrologic Soils Groups | | |
|---|---|---|
| **Hydrologic Soils Group Classification** | **Details** | **Percent of Study Area** |
| B | Moderately low runoff potential when thoroughly wet. Typically 10%-20% clay and 50%-90% sand, with loamy sand or sandy loam textures. | 24% |
| C | Moderately high runoff potential when thoroughly wet. Typically 20%-40% clay and <50% sand, with loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. | 42% |
| C/D | Dual characteristics of soil groups C and D. Soils type C characteristics under drained conditions and type D characteristics under undrained conditions. | 21% |
| D | High runoff potential when thoroughly wet. Typically >40% clay and <50% sand, with clayey textures. | 13% |
| | Total | 100% |

The NRCS hydrologic soils classification system is used to determine a soil's associated runoff curve number, along with land use, management practices, and hydrologic conditions. The runoff curve number is applied to quantify the direct runoff from rainfall. There are four basic soils groups, represented by A, B, C, and D, and are differentiated by runoff potential. The least potential for runoff is with group A soils, whereas group D soils have the greatest runoff potential. When soil groups are split for an area, as in C/D, the first class applies to the drained condition, while the second applies to the undrained condition. This is a function of the seasonally high groundwater level, within 24 inches of the surface.

The NRCS indicates locations within the study that contain bedrock at the ground surface. This information is supported by well logs referenced from the Oregon Water Resources Department with mixed results. There are several domestic water wells within the study area that report encountering rock within 10 feet of the ground surface. City staff indicate that encountering rock during trench excavation is uncommon within the study area.

Surface water hydrology is relatively consistent within the study area, and is influenced by seasonal rainfall. Generally, groundwater is well below the surface and does not normally impact construction. However, there are some areas in the City where seasonally high groundwater may impact construction during the wet weather season. It is recommended that groundwater investigations be undertaken prior to construction in these areas to identify and address groundwater issues. Two perennial streams, Cedar Creek and Rock Creek, flow through the City. Areas along Cedar Creek and Rock Creek are located within the 100-year flood plain boundary, as defined by the Federal Emergency Management Agency (FEMA). Several tributaries to these creeks are also within the 100-year flood plain. North of the City limits, much of the Tualatin River National Wildlife Refuge (Refuge) is within the 100-year flood plain. The soils in this area are typically saturated year round.



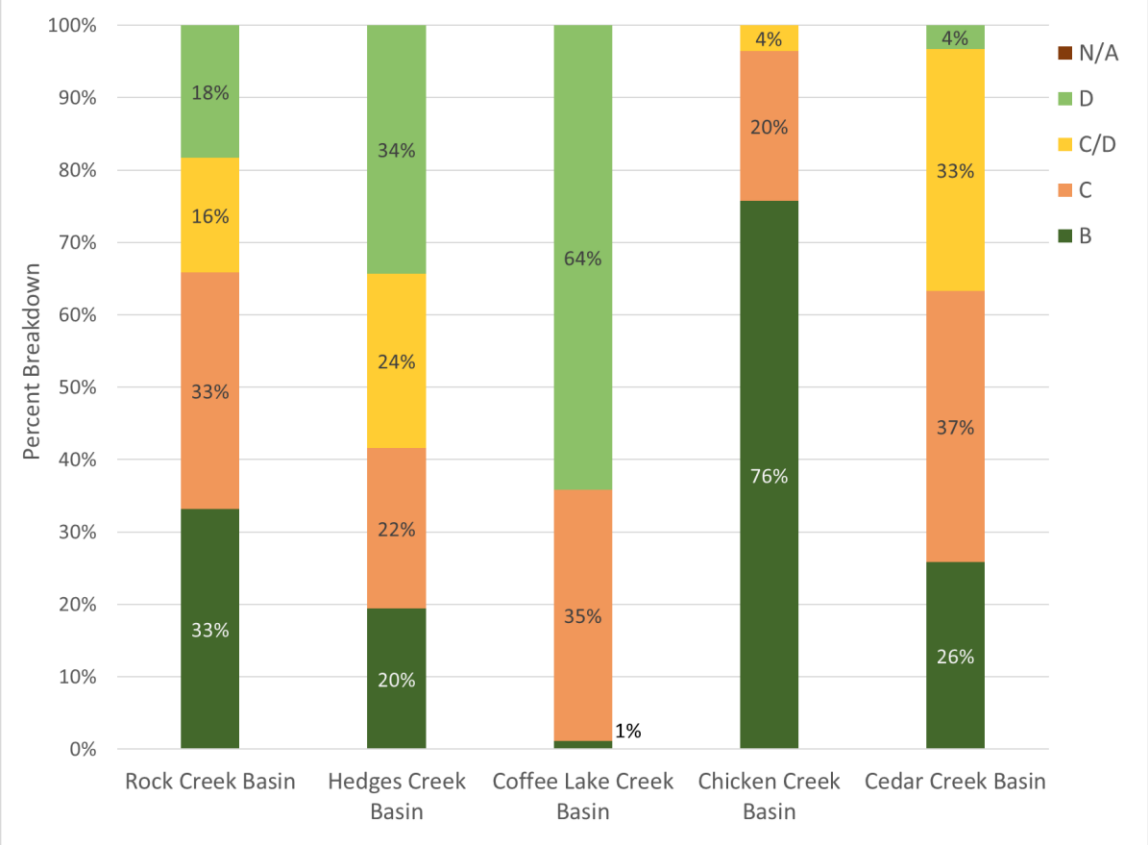

G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 2-3_8.5x11.mxd 5/18/2016 8:48:55 AM Thomas.Walsh

## DRAINAGE BASINS

The City lies within four major subbasins of the Tualatin River drainage basin, and one major subbasin of the Willamette River (as shown in Figure 2-4). These basins are areas of land where surface water from precipitation converges to a single, low-lying elevation to join another water body. The drainage basin acts as a funnel, channeling runoff towards downstream water bodies (e.g., rivers, creeks, and streams). Each drainage basin is hydrologically defined by a perimeter of surrounding topographical barriers, such as mountain ridges, hills, or earthworks. The contributing basin areas for the five receiving waters (Chicken, Cedar, Rock, Hedges, and Upper Coffee Lake creeks) included in this study are tabulated in Table 2-4.

Assessment of basin areas was completed using Geographic Information System (GIS) software and related tools. Data related to hydrologic soils groups were broken down according by drainage basins as presented in Figure 2-6. A brief description of each basin follows.

**Figure 2-6 | Hydrologic Soils Breakdown by Basin and City UGB**



| Table 2-4 \| Drainage Basin Area Summary | | | |
|---|---|---|---|
| **Basin Name** | **Total Basin Area (acres)** | **Area within City UGB (acres)** | **Percent of City's Drainage Area** |
| Cedar Creek | 5,753 | 1,785 | 53 % |
| Chicken Creek | 4,875 | 211 | 6 % |
| Hedges Creek | 2,634 | 222 | 7 % |
| Rock Creek | 4,055 | 1,125 | 33 % |
| Upper Coffee Lake Creek | 367 | 48 | 1 % |
| **Totals** | **17,684** | **3,391** | **100%** |

### *Cedar Creek Basin*

Cedar Creek meanders northward through the City and serves as the main tributary to Chicken Creek, converging northwest of the City. The creek is the dominant feature of the stormwater conveyance system for the western portion of the City, draining roughly 53 percent of the City UGB's 3,391 acres. The Cedar Creek Basin also includes the Brookman Concept Area. The entire Brookman Concept Area, at 251 acres, is drained by Cedar Creek. Cedar Creek is shallow and narrow, flowing through wide, flat floodplains.

The 5,753-acre Cedar Creek Basin includes 1,785 acres of the western half of the City. Within the City UGB, much of the area is developed and encompasses many land uses. Land use within the basin includes a large range of residential densities, including all of the City's High Density Residential zoning. The basin includes public lands such as Sherwood High School and Stella Olsen Memorial Park. Much of the commercially zoned land in the City is located within the basin, including the Old Town district and the commercial area along Highway 99W south of Sherwood Boulevard. A single industrial zone is located in the basin at the intersection of Sunset Boulevard and Greengate Drive. The southwest corner of the Brookman Concept Area includes a small assignment of industrial land. The remaining two-thirds of the basin located outside of the City UGB extends southwest from the City and is largely undeveloped and lightly forested.

The soils in the basin are largely comprised of Group C outside of the City UGB (see Figure 2-5). Within the City UGB, the southern portion of the basin is largely comprised of Group C soils while B soils comprise the majority of the north, with small areas of Group D soils. Within the UGB, slopes are generally less than 10 percent except near the creek where they are approximately 10 percent. Higher slopes, approaching 25 percent, are common in the basin's headwaters. The headwaters of the Cedar Creek basin reach into Yamhill County.

### *Chicken Creek Basin*

Chicken Creek is largely located north and west of the City limits, passing along the northwestern edge of the City. Chicken Creek itself flows northeasterly and feeds into the Tualatin River, draining a total of 4,875 acres. Of that, 6 percent or 211 acres, is contributed directly from within the City's UGB. Of the 211 acres located within the City UGB,

approximately 75 percent of the area has been developed. Roughly half of the basin within the City UGB is a mix of low and medium density residential land uses. The other half is a mix of commercial land uses. Outside of the City UGB, the basin is generally undeveloped and lightly forested.

The hydrologic soils groups in Chicken Creek are largely classified as C beyond the City UGB and B within the City UGB (see Figure 2-5). Within the UGB, slopes are generally less than 10 percent except near the creek where they are approximately 10 percent. Higher slopes, approaching 25 percent, are common in the basin's headwaters. The headwaters of the Chicken Creek basin reach into Yamhill County. Chicken Creek ends at the confluence of Cedar Creek near the northwest edge of the City, due west of SW Roy Rogers Road.

### *Hedges Creek Basin*

The Hedges Creek Basin includes the northeast portion of the City along Tualatin-Sherwood Road. The topography within the City UGB is gently sloping to the northeast, away from the center of the City. The 2,634-acre basin drains roughly 7 percent of the 3,391 acres within the City UGB, covering 222 acres of northeastern Sherwood. Hedges Creek conveys runoff eastward, through the City of Tualatin, before discharging to the Tualatin River. Within the City, the contributing area along Tualatin-Sherwood Road is zoned as commercial and industrial land. A large portion of the basin within the City UGB includes a large number of rock quarries which are zoned for industrial uses. The Hedges Creek Basin is also responsible for draining 38 percent (117 acres) of the TEA. The remaining 2,412 acres of the Hedges Creek Basin are located to the north and east of the City and include developed portions of the City of Tualatin.

The soils in the basin, both within and outside of the City UGB, are a mix of soil groups B, C, and D (see Figure 2-5). Soil groups B and C predominate in the headwaters, with increasing group D soils downstream. The southwestern corner of the basin, which is within the City UGB, is primarily comprised of Group C and Group D soils. The ground slopes within the basin are relatively flat, with slopes generally 10 percent or less over the entire basin.

### *Rock Creek Basin*

Rock Creek flows north by northwest through the City to the Tualatin River. Rock Creek is the dominant surface water feature for the eastern portion of the City, and drains 33 percent of the 3,391 acres within the City UGB. The Rock Creek Basin also encompasses portions of the TEA (140 acres, or 46 percent).

The 4,055-acre Rock Creek Basin includes 1,125 acres within the City UGB. The basin is generally developed within the City limits, and zoned residential in the southern portion with industrial and commercial zoning in the northern portion. The remaining 2,930 acres are located outside of the City UGB, with roughly 1,000 acres located between the City UGB and the Tualatin River (north) and 1,940 acres to the south of the City UGB (partially in Clackamas County).

Soils in the basin are a mix of Groups B, C, and D, with a small percent of unclassified (e.g., water, pits). Group C and B soils are concentrated south of the UGB (see Figure 2-5), with a uniform distribution of soils B, C, and D throughout the UGB. Group D soils are concentrated along the creek, especially north of the UGB and southeast of the Southern Pacific Railroad. The ground has slopes near 10 percent in the regions of the headwaters. The headwaters of the Rock Creek basin extend into Clackamas County. Within the UGB, the slopes are relatively flat except near the creek where they are approximately 10 percent. Some steep slopes of 25 percent or greater are associated with the hills in the southern part of the City.

Rock Creek is shallow and narrow, and flows through wide, flat floodplains. Under severe dry weather conditions, the creek exhibits periods of negligible base flow.

### *Upper Coffee Lake Creek Basin*

The greater Coffee Lake Creek Basin is a large basin, draining 14,765 acres, with a small portion (1%) of its headwaters located in the southeastern portion of the City UGB (367 acres). Coffee Lake Creek is a tributary to the Willamette River and is the only receiving water for the City that is not a tributary to the Tualatin River in the north. Coffee Lake Creek flows southerly from the City and through the City of Wilsonville prior to discharging into the Willamette River. The study area for the basin includes only this small section, which is referred to as the Upper Coffee Lake Creek Basin. Due to the hydrology of this basin, the majority of it is downstream of the study area and was therefore excluded from analysis. Only areas of the basin within the study area were analyzed.

The 367-acre Upper Coffee Lake Creek Basin includes roughly 48 acres within the City UGB, all within the TEA. None of the contributing area within the City UGB is currently served by the existing municipal stormwater system.

The soils in the portion of the basin within the UGB are dominated by Group D in the western third of the basin. Beyond the UGB, the soils are generally classified as Group B (see Figure 2-5). Ground slopes in the Upper Coffee Lake Creek Basin vary from being virtually flat in the northwest corner to being up to and greater than 25 percent over the rest of the basin.

## NATURAL RESOURCE AREAS

Natural resources include air, water, plants, animals and soil. The Tualatin River Valley and its tributary streams provide significant natural resources, as documented in the *Comprehensive Plan* (Ord. 2009-009). There are numerous natural resource areas within and surrounding the study area, as can be seen in Figure 2-7, with descriptions below.

Historically, the City has managed natural resources through the establishment of "Open Spaces" and by inventories of environmental assets. State and federal requirements have resulted in both independent and cooperative identification and inventory of natural resource

areas by multiple Federal, State, and local agencies. The U.S. Fish and Wildlife Service manages the 3,060-acre Tualatin River National Wildlife Refuge roughly located to the north and east of the City. The Refuge was established as an urban refuge providing wetland, riparian, and upland habitats for migratory birds, threatened and endangered species, fish, other resident wildlife, and as a scenic area.

Metro and its member cities also protect other regionally significant natural resources such as the Tonquin Scablands Geologic Area, and other Metro-identified and classified riparian corridors, upland wildlife habitats and aquatic habitats. The majority of these Metro-identified natural resource areas are located alongside or adjacent to creeks, the Refuge, and the Tualatin River. Furthermore, though not formally mapped, Clean Water Services (CWS) *Design and Construction Standards* require a vegetated corridor, or riparian buffer, to be provided and maintained around natural water features upon urban development. The CWS buffer requirement is critical to maintaining and protecting these Metro-identified natural resource areas.

The Metro-identified resources have been recognized in the City's *Comprehensive Plan* (2006) as environmental resources requiring planning and management. The City's *Comprehensive Plan* also identifies a ponderosa pine forest located east of the intersection of Harrison and Middleton streets for preservation. Other City efforts include the acquisition of 300 acres of stream corridor and floodplain for protection from further development. These corridors, in addition to providing protection from flooding, support the functions of the Refuge.

In addition to the statutory recognition of environmentally sensitive areas, grass roots organizations such as the Tualatin Riverkeepers, and Friends of the Tualatin River National Wildlife Refuge have formed to advocate watershed stewardship in the Sherwood area. The City also recognizes that it is located in an area with generally good water quality and riparian habitat, and that the urban footprint can have a large impact on the local environment. Consequently, the City has formed partnerships with several of these organizations to provide educational outreach, stream enhancement projects, and assist in efforts to protect and improve the overall health of the nearby natural resources.

### *Surface Water*

Also at the local level, CWS and its member cities provide for water quality management within the Tualatin River Basin. A large scale inventory and environmental study, the *Watersheds 2000 Program*, was conducted within the urbanized basin in support of cost-effective water quality and environmental management. The *Healthy Streams Plan* (2005) provides general descriptions of watershed areas, and describes the headwaters of Cedar Creek and Chicken Creek as generally undeveloped and in good condition. The plan further identifies that preserving the condition of the headwaters is important to the health of the downstream surface waters and overall watershed, and that development should be managed to protect these upper reaches of the watersheds. Additionally, Chicken, Cedar, and Rock creeks have been identified by the U.S. Environmental Protection Agency (EPA) as

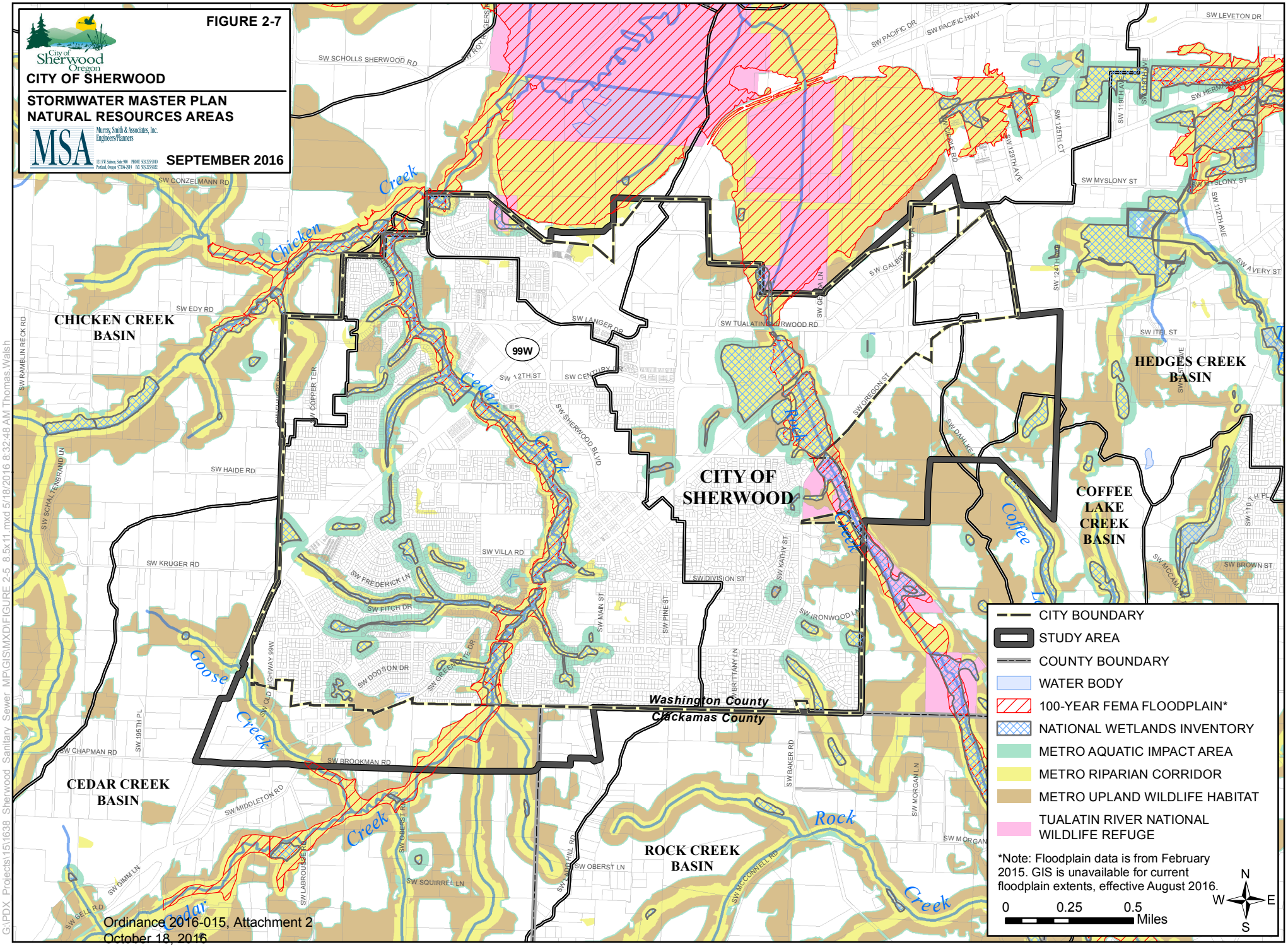


FIGURE 2-7
City of Sherwood Oregon
CITY OF SHERWOOD
STORMWATER MASTER PLAN
NATURAL RESOURCES AREAS
MSA Murray, Smith & Associates, Inc. Engineers/Planners
SEPTEMBER 2016
CHICKEN CREEK BASIN
CEDAR CREEK BASIN
ROCK CREEK BASIN
HEDGES CREEK BASIN
COFFEE LAKE CREEK BASIN
CITY OF SHERWOOD
Washington County
Clackamas County
99W
Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek
SW SCHOLLS SHERWOOD RD
SW CONZELMANN RD
SW EDY RD
SW HAIDE RD
SW KRUGER RD
SW VILLA RD
SW 12TH ST
SW LANGER DR
SW TUALATIN SHERWOOD RD
SW PACIFIC HWY
SW MYSLONY ST
SW ITEL ST
SW AVERY ST
SW OREGON ST
SW DIVISION ST
SW IRONWOOD LN
SW FITCH DR
SW DODSON DR
SW OLD HIGHWAY 99W
SW CHAPMAN RD
SW BROOKMAN RD
SW MIDDLETON RD
SW OBERST LN
SW SQUIRREL LN
SW MCCONNELL RD
SW BAKER RD
SW MORGAN LN
SW BROWN ST
CITY BOUNDARY
STUDY AREA
COUNTY BOUNDARY
WATER BODY
100-YEAR FEMA FLOODPLAIN*
NATIONAL WETLANDS INVENTORY
METRO AQUATIC IMPACT AREA
METRO RIPARIAN CORRIDOR
METRO UPLAND WILDLIFE HABITAT
TUALATIN RIVER NATIONAL WILDLIFE REFUGE
*Note: Floodplain data is from February 2015. GIS is unavailable for current floodplain extents, effective August 2016.
0 0.25 0.5 Miles
N
W
E
S
G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 2-5_8.5x11.mxd 5/18/2016 8:32:48 AM Thomas Walsh

providing habitat for anadromous fish that are listed as threatened under the Federal Endangered Species Act (ESA).

### *Floodplain*

A floodplain is an area of land adjacent to a river or stream that experiences inundation during periods of high discharge (i.e., exceeding the bank full conditions) and serves as a natural place for floodwaters to dissipate energy. To protect the integrity of these benefits from urbanized encroachment and to protect health and human safety during flood events, the City and Washington County have enacted restrictions on development within the floodplains under their jurisdiction.

New regulations are expected in Oregon that will require all floodplain development to comply with the Endangered Species Act (ESA). The City can comply with these new regulations by protecting the floodplains from development and where development must occur, ensuring that it does not impact endangered species. The broad vegetated floodplains adjacent to Sherwood streams have protected the channels from down cutting due to hydromodification.

The Flood Insurance Study (FIS) conducted by the Federal Emergency Management Agency (FEMA) in 1988 indicates that some areas along Chicken, Cedar, and Rock creeks and their tributaries are at risk of flooding during a 1% exceedance (100-year) flood event. While the floodplains largely overlap existing wetlands and creek beds, some individual developed lots lie within the floodplain. North of the City limits, much of the Refuge lies within the 100-year floodplain of the Tualatin River that extends south from the river to the City limits.

Due to the development and growth experienced by the City since the FEMA maps were produced in 2012, FEMA has updated the floodplain maps across Washington County, including the City. These updated FEMA floodplain maps were finalized in 2016, with an effective date of November 4, 2016.

Protecting natural and beneficial functions of floodplains within urban areas provides the following benefits;

- Protects health and human safety during floods,
- Reduces damages to public and provide infrastructure during floods,
- Provides flow storage and attenuation reducing flood risk downstream,
- Protects channel downcutting and erosion,
- Provides critical habitat for fish, wildlife, and birds,
- Improves FEMA Community Rating System score which reduces the cost of flood insurance for constituents.

## HAZARD AREAS

According to the *Washington County Natural Hazards Mitigation Plan* (University of Oregon Community Service Center, 2006), the area surrounding the City is at risk for several types of natural disasters. This plan describes historical impacts, general location, extent, and severity of past natural hazard events, and the probability of future events. Table 2-5 summarizes all the hazards for which the City is at risk, however in terms of the stormwater conveyance system, susceptibility to flood is the greatest concern.

The Natural Hazard Risk Assessment probability scores address the likelihood of a future major emergency or disaster within a specific period of time, as follows:

- High = One incident likely within a 10- to 35-year period.
- Moderate = One incident likely within a 35- to 75-year period.
- Low = One incident likely within a 75- to 100-year period.

The vulnerability scores address the percentage of population or region assets likely to be affected by a major emergency or disaster, as follows:

- High = More than 10% affected.
- Moderate = 1%-10% affected.
- Low = Less than 1% affected.

**Table 2-5 | Probability and Vulnerability Assessment – Washington County**

| Hazard | Probability | Vulnerability |
|---|---|---|
| Drought | Moderate | Low |
| Earthquake | Low | High |
| Extreme Heat | Moderate | Moderate |
| Fires | Moderate | Moderate |
| Flood | High | Moderate |
| Landslides | High | Low |
| Volcano | Low | High |
| Wind Storm | Moderate | Low |
| Winter Storm | High | Moderate |

## MUNICIPAL WASTEWATER COLLECTION SYSTEM

Developed areas within the City are presently served by publicly owned wastewater collection and conveyance facilities, operated through an Intergovernmental Agreement (IGA) between the City and CWS. Under the IGA, the City owns, maintains, and operates the wastewater collection and conveyance system within the City limits. All of the wastewater collection facilities within the City limits flow by gravity; there are no pumps or pressurized pipes in the system. The stormwater system is operated as a Municipal Separate Storm Sewer System (MS4), and interconnections between the stormwater and sanitary sewer systems are not allowed.

## SOCIOECONOMIC ENVIRONMENT

### *Economic Conditions and Trends*

The City is located between Oregon's "Wine County" and the Portland metropolitan area. Sherwood's *Economic Development Strategy* (2006) finds that the City of Sherwood is highly suited to support the following industries: small to mid-size light manufacturing; specialty contractors and construction firms; creative services; amusement, recreation, sporting and lodging hospitality; educational facilities; and nursing and health care support services and facilities.

Sherwood's Economic Development Department reports that the City exceeds several economic and educational metrics, as follows:

- Data from 2012 reports show that the City's median household income of $79,209 exceed Oregon's average of $49,850.
- The percentage of the City's (25 and older) population who have a bachelor's degree or higher is 43.4 percent. This surpasses the State of Oregon's average metric of 29.7 percent.

The City's education system is primarily served by the Sherwood School District 88J, which currently serves 5,119 students and 477 staff in 7 schools (retrieved August 9, 2016, from www.sherwood.k12.or.us/district/fast-facts). The School District's boundary extends past the study area of this SWMP, serving students in less populated areas between Tualatin and Wilsonville.

### *Historic and Future Population Data*

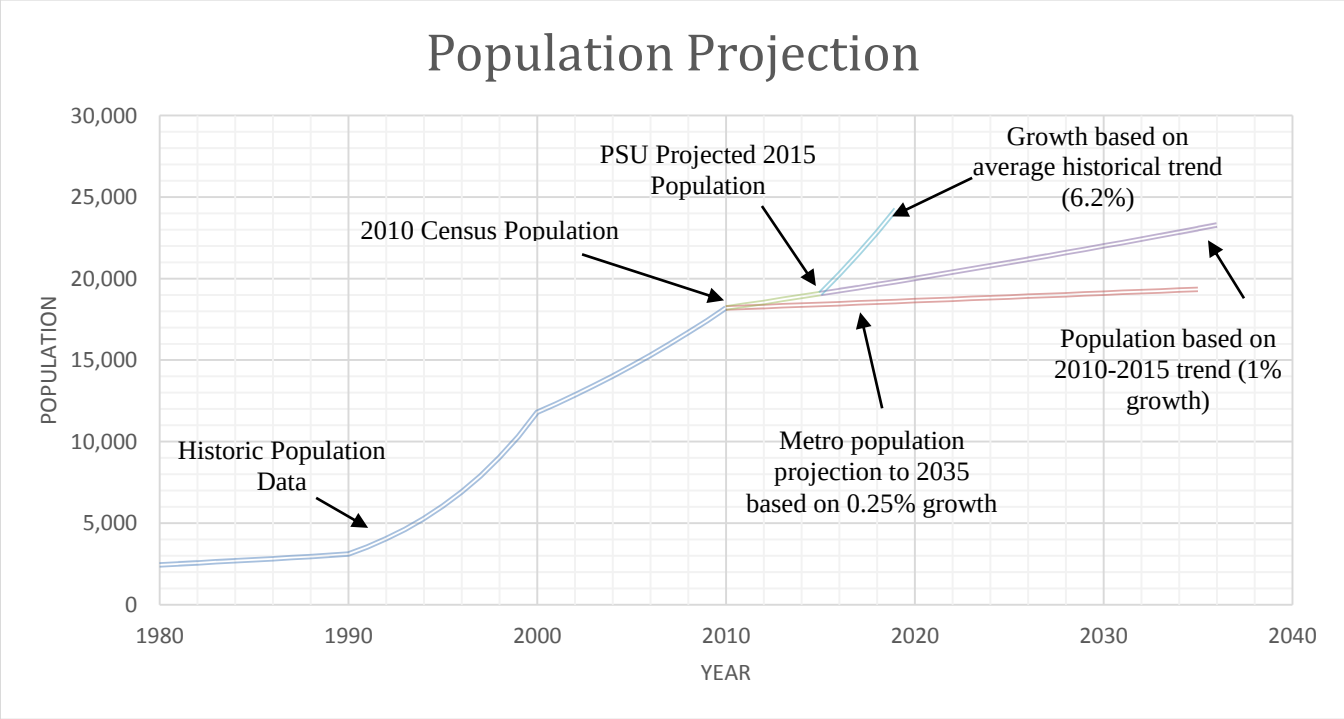
In projecting future growth and associated land use impacts, the SWMP relies upon several sources of historical and projected population data, such as the United States (U.S.) Census Bureau data, Portland State University (PSU) certified population estimates, and Metro population projections. Additional discussion on population and land use is provided in Section 5 – System Analysis, which explains how these factors affect stormwater runoff characteristics.

Historic data and the U.S. Census demonstrate that the City's population has experienced steady growth over time, with a reported population of 18,194 for the 2010 census. The growth rates vary by decade with 2.4% growth in the 1980's, 14.3% growth in the 1990's, and 4.4% growth in the 2000's.

Metro's projected annual populations for Oregon cities is applied to growth estimates through 2035 as shown in Figure 5-1. The growth rate between 2010 and 2035 based on the Metro 2035 population projection of 19,342 is approximately 0.25% and significantly lower than the 6.2% average historical rate of growth for the City (*Certified Population Estimates*, Portland State University, www.pdx.edu/prc/population-reports-estimates; *Regional Forecast Distribution Methodology & Assumptions, Population and Employment, 2010-40 TAZ Forecast Distribution "Gamma Scenario,"* METRO, 2012).

The population at build-out of the UGB is estimated at 23,390. This projection is based on in-fill of all residential tax lots assuming average housing densities by zoning classification and the Metro projected number of 2.66 people per household. Portland State University (PSU) Population Research Center's certified population estimates for 2015 indicate a growth rate of approximately 1% between 2010 and 2015 with a 2015 population estimate of 19,080. Extrapolating growth to build-out at the 1% growth rate results in build-out occurring around 2036. Extrapolating growth to build-out at the average historic rate of 6.2% results in build-out occurring around 2019. The *Sherwood Housing Needs Analysis, 2015 to 2035* (Draft March 2015), concludes that growth projections require development of the Brookman Concept Area and potential UGB expansion. The Brookman Concept Area is included in the SWMP population projections. UGB expansion is not considered in the SWMP.

**Figure 2-8 | Population Projections for the City**




Sources: *Certified Population Estimates*, Portland State University, www.pdx.edu/prc/population-reports-estimates; *Regional Forecast Distribution Methodology & Assumptions, Population and Employment, 2010-40 TAZ Forecast Distribution "Gamma Scenario,"* METRO, 2012.

# SECTION 3 | EXISTING SYSTEM DESCRIPTION

## INTRODUCTION

This section provides an overview of the City of Sherwood's (City's) existing storm drainage system, location, general management, and physical infrastructure. An inventory of the existing stormwater conveyance system under the City's jurisdiction is provided below. The inventory includes pipes, open channel conveyances, culverts, water quality and quantity management features.

## UTILITY MANAGEMENT STRUCTURE

Developed areas within the City are presently served by publicly owned stormwater collection and conveyance facilities. Ownership, capital financing and maintenance responsibilities for these facilities is defined through an Intergovernmental Agreement (IGA) between the City and Clean Water Services (CWS). Under the IGA (see Appendix A) the City owns, maintains, and operates the "Local Program" stormwater collection and conveyance system within the City limits. The Local Program elements generally consist of stormwater conveyance piping, open channels and regional surface treatment or control facilities managing runoff from less than one acre. While the IGA stipulates that while the City maintains the public creeks and open channels, CWS remains responsible for water quality within the creeks.

CWS is responsible for the "District Wide Program" elements defined under the IGA. This program pertains to regional surface treatment or control facilities where the tributary area is equal to, or greater than, one acre. CWS also maintains roadside ditches and stormwater piping systems outside the City limits with financing provided by Washington County. The IGA places ownership of existing or future stormwater culverts exceeding 36 inches in diameter with either Washington County or the Oregon Department of Transportation (ODOT), depending on the road authority. In addition, Washington County currently owns and maintains a water quantity facility (pond) located northwest of the intersection of Tualatin-Sherwood Road and Highway 99W. ODOT operates a facility just northwest of the intersection of Kruger/Elwert Roads and Highway 99W.

Operating within the Public Works Department, the City's stormwater collection system provides utility service to its customer accounts. The Department's Operations Supervisor and maintenance staff members are responsible for conducting stormwater collection system operation and maintenance.

## STORMWATER CONVEYANCE SYSTEM OVERVIEW

The existing stormwater conveyance system is illustrated in Figure 3-1. This infrastructure network is a gravity system and does not contain lift stations, force mains, flow control weirs or sanitary sewer interconnections. Stormwater runoff is collected from residential, commercial, industrial and institutional lands via catch basins, roof and area drains, and ditch inlets. The stormwater runoff is then conveyed through a collection of stormwater piping,

FIGURE 3-1

City of Sherwood Oregon

# CITY OF SHERWOOD

## STORMWATER MASTER PLAN
## EXISTING SYSTEM MAP

MSA Murray, Smith & Associates, Inc. Engineers/Planners
123 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
99W
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW BAKER RD
SW AVE

Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek
Rock Creek

Sherwood
Tonquin Employment Area (TEA)
Brookman Concept Area

**STORMWATER FACILITIES:**
- MANHOLE
- WATER QUALITY MANHOLE
- EXTENDED DETENTION POND
- LIDA
- RETENTION BASIN
- SWALE
- DITCH
- CULVERT
- CITY STORM SEWER LINE

- TUALATIN RIVER NATIONAL WILDLIFE REFUGE
- CITY BOUNDARY
- STUDY AREA*
- BASIN BOUNDARY
- ROCK CREEK BASIN
- CEDAR CREEK BASIN
- CHICKEN CREEK BASIN
- COFFEE LAKE CREEK BASIN
- HEDGES CREEK BASIN

* STUDY AREA = UGB

0 0.25 0.5 Miles

N W E S

G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 3-1_11x17.mxd 8/9/2016 1:49:54 PM Thomas.Walsh



August 20[illegible]7

open channels, and culverts before discharging to a receiving surface water. Receiving waters include the natural creek and pond systems, as well as manmade detention facilities.

In numerous locations throughout the City, stormwater runoff is treated by a water quality facility prior to discharge from the storm drainage system. In general, all developments built since 1991 include water quality facilities and, in some cases, water quantity or detention facilities.

## EXISTING DRAINAGE FACILITIES

The planning area is presently drained by a system of natural features, as previously discussed in Section 2, in combination with piped storm sewers, roadside open channels, culverts and swales. Drainage throughout the City is dominated by the cumulative 8.60 miles of natural creek present within the City, including the Cedar Creek (6.40 linear miles), Chicken Creek (0.50 linear miles), Rock Creek (1.06 linear miles), Upper Coffee Lake Creek (0.14 linear miles), and a tributary of Cedar Creek (0.51 linear miles). An inventory of stormwater system data, provided by the City, includes approximately 71 miles of existing storm drainage piping, 5.0 miles of open channel conveyance, a total of 121 vegetated swales, 278 culverts for a total length of 4.23 miles, and 256 stormwater outfalls.

The historic development of stormwater conveyance throughout the majority of the City has followed modern standards through the construction of curbs, gutters, and centralized storm sewers as property was developed.

While this SWMP reflects the City's ongoing effort to record and document stormwater infrastructure, data gaps still exist relative to the City's better defined water and sewer utility systems. These gaps primarily pertain to open channel conveyances, such as creeks, pipe age and material. There are a handful of system locations of unknown pipe sizes and slopes. Interviews with City staff were conducted to help fill in some of the missing information where feasible. The City intends to continue to add to and refine the stormwater GIS over time.

### *Gravity Pipelines and Other Infrastructure*

Construction materials in the existing storm water system vary. Generally, pipes and culverts are either concrete or plastic. Summaries of stormwater pipe materials and sizes found within the planning area are shown in Tables 3-1 and 3-2.

### *Open Channel Conveyance*

There are numerous roadside ditches, creeks, ponds, and streams within the study area, comprising approximately 11 miles of stormwater conveyance. While these natural and constructed open channels are significant in terms of overall length and capacity, the effort to survey and model these channels was excluded from the scope of this SWMP.

| Table 3-1 \| Existing Storm Sewer Pipeline Materials Summary | | | |
|---|---|---|---|
| **Pipe Material** | **Length (feet)** | **Length (miles)** | **Percent of System** |
| Circular Concrete (CSP, RCP or RCSP) | 102,594 | 19.4 | 27% |
| Cylindrical Concrete (CCP) | 23,535 | 4.5 | 6.3% |
| Aluminum | 153 | 0.0 | 0.0% |
| Corrugated Metal Pipe (CMP) | 616 | 0.1 | 0.2% |
| Ductile Iron Pipe (DIP) | 6,806 | 1.3 | 1.8% |
| Plastic* | 210,953 | 40 | 56% |
| Perforated Pipe | 6,326 | 1.2 | 1.7% |
| Other (CDP, RMCP, VSP) | 3,496 | 0.7 | 0.9% |
| Unreported | 21,666 | 4.1 | 5.8% |
| Total | 376,181 | 71.2 | 100% |

*Note: Plastic includes the following pipe materials: ABS, ADS, C-900, CPP, HDPE, PPP, and PVC.

| Table 3-2 \| Existing Storm Sewer Pipeline Size Summary | | | |
|---|---|---|---|
| **Pipe Diameter (inches)** | **Length (feet)** | **Length (miles)** | **Percent of System** |
| 72 | 153 | 0.0 | 0.04% |
| 60 | 190 | 0.0 | 0.05% |
| 54 | 60 | 0.0 | 0.02% |
| 48 | 255 | 0.0 | 0.07% |
| 42 | 1,328 | 0.3 | 0.35% |
| 36 | 6,451 | 1.2 | 1.7% |
| 30 | 10,729 | 2.0 | 2.9% |
| 27 | 2,668 | 0.5 | 0.71% |
| 24 | 31,704 | 6.0 | 8.4% |
| 21* | 1,867 | 0.4 | 0.50% |
| 18 | 35,603 | 6.7 | 9.5% |
| 15** | 35,794 | 6.8 | 9.5% |
| 12 | 180,631 | 34 | 48% |
| 10 | 22,850 | 4.3 | 6.1% |
| Less than 10*** | 29,814 | 5.6 | 7.9% |
| Unreported | 16085 | 3.0 | 4.3% |
| Total | 376,181 | 71.2 | 100% |

*Note: This includes pipes with reported diameters of 21 and 20 inches.
**Note: This includes pipes with reported diameters of 15 and 16 inches.
***Note: This includes pipes with reported diameters of 8, 6, and 4 inches.

### *Water Quality Facilities*

Water quality treatment of stormwater typically refers to the physical, chemical, and/or biological removal of pollutants from surface water runoff. These pollutants consist of sediments; sand, silt and other suspended solids; dissolved metals, such as copper, lead, and zinc; nutrients, such as nitrogen and phosphorus; pathogens, such as bacteria; and organic matter, such as petroleum, hydrocarbons, and pesticides. Facility design and implementation is a function of many parameters, including the targeted pollutant(s), the land use, the topography, and the characteristics of the site. Such systems can rely on more natural processes for pollutant removal, such as with an engineered wetlands, or they can employ manufactured or precast infrastructure, such as separators placed within vaults.

There are currently 166 vegetated swales and 44 extended dry detention ponds mapped throughout the City that provide collection and treatment for approximately 408 acres of tributary area[1]. Of these, the City owns and maintains approximately 122 of the vegetated swales and 21 of the extended dry detention ponds. The City inspects, but does not maintain, another 18 facilities owned by homeowner associations and other private ownership interests. Also, as development occurs within the City, some facilities have their operations responsibilities transferred from the developers and owners to the City after a two-year warranty and vegetation establishment period.

**Table 3-3 | Existing Storm Detention & Treatment Infrastructure Summary**

| Type(s) | Ownership | Number | Percent of Type |
|---|---|---|---|
| Extended Dry Detention Pond | City | 21 | 15% |
| | Private | 23 | |
| Swale | City | 122 | 55% |
| | Private | 44 | |
| Retention Basin | Private | 2 | <1% |
| Low Impact Development Approaches (LIDA) | Private | 1 | <1% |
| Unknown | Private | 1 | <1% |
| Water Quality Manhole | City | 68 | 29% |
| | Private | 21 | |
| Total | | 303 | 100% |

In addition to the existing stormwater ponds that the City inspects, there are a total of 71 private facilities operated and maintained by the facility owner. Most of these private facilities were constructed after 1991 when new development standards were adopted. While the City does not possess detailed structural information for these facilities, it does maintain the location, ownership, year built, service life, and total site area (acres) for the units.

Of the 89 water quality manholes within the City, 21 are owned and maintained by multiple stakeholders, including the Oregon Department of Transportation (1), Washington County (6), and private entities (14). The City also owns and maintains 68 water quality manholes.

[1] *Stormwater Annual Report* (November 2014). Clean Water Services.

In most cases, these manholes are installed prior to vegetated water quality facilities to provide pre-treatment by sedimentation per CWS standards.

### *Flow Control Facilities*

The City currently maintains a total of 21 stormwater extended dry detention ponds as part of its stormwater collection system. There are also two locations where stormwater detention is provided in underground, oversized storm sewer pipes, located on Smith Road and west of Murdock Road.

The City-inspected water quality and quantity facilities and City-owned water quality manholes are shown on Figure 3-1.

## STORMWATER SYSTEM CONDITION

### *Conveyance System Condition Assessment*

Conveyance system condition assessment is based on previous master plan CIP lists, input from City staff and TV inspection of portions of the system utilizing NASSCO ratings. The NASSCO rating system is described below.

NASSCO Ratings-

- Structural and Operation/Maintenance scores are calculated for each pipe segment based on the number and severity of defects. Expresses a weighted score for each pipe segment based on the individual defects within a given pipe.

$$NASSCO\ Rating\ for\ Pipe\ X = \frac{\sum_{Defect\ 1}^{Defect\ n}(Defect\ 1 * Defect\ 1\ Score\ ) \ldots (Defect\ n * Defect\ n\ Score)}{Total\ Number\ of\ Defects\ in\ Pipe\ Segment}$$

- Defect grades range from 1 to 6, with 6 being the most severe. This range is used for both structural and operational/maintenance (O&M) defects. The severity of defects is documented during TV inspection of pipelines.
- Structural Defects include cracks, fractures, holes, deformations, collapses, joint and surface defects and failure of linings or previous repairs. In the Sherwood system documented structural defects range from grade 1 to 4 and include pipe defects (bulges), surface spalling, joint offsets, longitudinal and circumferential cracks and joint separation.
- Documented O&M defects in the Sherwood system range from grade 1 to 5 and include gushing and running infiltration, protruding objects, root intrusion, and deposits including sand and gravel.

Figure 3-2 documents system condition projects that have been identified and includes NASCCO ratings where they are available. The ratings have been grouped into the following categories:

- Rating 1 – 2: Lowest priority
- Rating 3 – 4: Moderate priority
- Rating 5 – 6: Highest priority

Figure 3-2 also documents the location of known condition issues provided by City staff. Table 3-4 summarizes condition based projects by pipe length and diameter.

FIGURE 3-2

City of Sherwood Oregon

# CITY OF SHERWOOD

## STORMWATER MASTER PLAN
## EXISTING SYSTEM - CONDITION

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 SW Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

SW EDY RD
SW ELWERT RD
SW ROY ROGERS RD
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW PACIFIC HWY
99W
SW MEINECKE RD
SW KRUGER RD
SW MAIN ST
SW SUNSET BLVD
W CHAPMAN RD
SW BROOKMAN RD
SW BAKER RD

Sherwood
Tonquin Employment Area (TEA)
Brookman Concept Area

Cedar Creek
Rock Creek
Coffee Lake Creek
Goose Creek
Chapman Creek
Rock Creek

1
2
3
4
5
6

**OM Rating**
- Lowest Priority
- Moderate Priority

**STR Rating**
- Lowest Priority
- Moderate Priority
- Highest Priority
- CITY BOUNDARY
- STUDY AREA
- STREAM
- CITY STORM SEWER LINE
- ROCK CREEK BASIN
- CEDAR CREEK BASIN
- CHICKEN CREEK BASIN
- COFFEE LAKE CREEK BASIN
- HEDGES CREEK BASIN

Note:
"OM" refers to operational and maintenance issues.
"STR" refers to structural defects.
Call-outs identify the Project ID.

0 0.25 Miles

N W E S

G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 3-2_11x17.mxd 8/9/2016 4:06:29 PM Thomas Walsh

August 2016

| Table 3-4 I Condition Improvements | | | | | |
|---|---|---|---|---|---|
| Project ID | Project Description | Basin(s) | Driver | Improvement Length (feet) | Improvement Diameter (inch) |
| 1 | SW Willamette St & SW Norton Ave, & SW Martin Ct, & SW Lincoln St & SW Oregon St | Rock Creek | Pipe & Manhole Condition | 962 | 10 - 24 |
| 2 | SW Merryman St, North to SW Oregon St (beneath properties) | Rock Creek | Pipe & Manhole Condition | 2,102 | 10 - 36 |
| 3 | SW Lower Roy St to SW Oregon St, SW Hall Street & SW Merryman St, & SW Lower Roy St & SW Brickyard Dr, & SW Hall St, SW Nottingham Ct to SW Oregon St | Rock Creek | Pipe & Manhole Condition | 1,252 | 8 - 36 |
| 4 | SW Galbreath Dr, Northeast of 13910 SW Galbreath Dr, & SW Tualatin Sherwood Rd & SW Dahlke Ln | Rock Creek | Pipe & Manhole Condition | 398 | 10 - 12 |
| 5 | 16956 SW Meinecke Rd (beneath property), & SW Meinecke Rd & SW Lee Dr, & 16956 SW Meinecke Rd (beneath property) | Cedar Creek | Pipe & Manhole Condition | 291 | 12 |
| 6 | SW Sherwood Blvd & SW Langer Dr, & SW Jonquil Ter, Across from 20649 SW Jonquil Ter, & SW Roy Rogers Rd, Behind 17438 SW Roosevelt St | Cedar Creek, Chicken Creek | Pipe & Manhole Condition | 683 | 12 - 30 |

### *Pipeline Improvement Techniques*

The following discussion summarizes common pipeline improvement techniques that may be applied to the City's condition-based improvements.

*Chemical Grouting* - Chemical grouting is commonly used to seal leaking joints in structurally sound pipe and manholes. The equipment consists of a sealing packer and television camera pulled inside the conveyance pipe with cables and winches. Because the sealing is done inside the pipe, excavation is not required unless unique problems develop.

The chemical grouts typically used are acrylamide, acrylate, or urethane gel. The chemicals necessary to form the gels are usually mixed in two separate tanks and pumped through separate hoses to the joint to be sealed. One tank is used to mix and dispense the grouting chemical and the other tank is used to mix and dispense a catalyst. The catalyst initiates a chemical reaction when mixed with the chemical grout. The materials are injected simultaneously into a leaking joint, a gel is formed and the leak is stopped. Urethane gel differs from acrylamide and acrylate gels in that water is the catalyst for the urethane gel material.

Chemical grouting does not improve the structural strength of the pipeline. This rehabilitation technology should not be used on pipes that are broken or deteriorated. If the ground water table drops below the level of the pipe, the chemical grout may become dehydrated and its useful life shortened. When used appropriately, rehabilitation by chemical grouting has a useful life of 10 to 15 years.

The costs for chemical grouting vary depending upon the number of grouting locations and the quality of sealant used. The chemical grouting process generally includes pipelines cleaning, television inspection, testing all joints, sealing deficient joints, and sealing leaking manholes where needed. The television inspection will occasionally locate a section of pipe not repairable by chemical grouting. A point excavation is required to repair such a leak.

Grouting must be repeated approximately every 10 years because of the limited life of chemical grout. For portions of the system conducive to chemical grouting, one application performed initially and at the end of 10 years should effectively seal the pipeline during the planning period.

*Conventional Pipe Replacement* - Pipeline replacement by conventional, open-cut excavation and backfill is normally done when the existing pipeline is deteriorated so badly that other methods of rehabilitation are not feasible. Replacement provides the opportunity to correct misalignments, increase the hydraulic capacity of the line by increasing the pipe diameter, repair service connections, and eliminate sags or stormwater entry points. Replacing pipelines can also remove any "incidental" minor leaks that would not be cost-effective to remove. A rehabilitation alternative that is similar to complete pipe replacement is point repairs or spot repairs, which involve excavation, backfill, and pipe replacement for selected areas.

The advantage of pipe replacement is that service life with modern materials and methods is generally greater than 50 years. The cost of replacement is generally high. The replacement has associated inconveniences, and restoration requirements that may be costly in developed areas.

*Pipe Bursting* - Pipe bursting consists of expanding and breaking in-ground pipe and towing in segments of new polyethylene (PE) or polyvinyl chloride (PVC) pipe. For the pipe cracking operation, a modified soil displacement hammer is pulled through a pipe run via an above-ground winching system. Cutting blades of different size are fixed on the hammer to break the existing pipe. An expander fitted on the rear of the hammer enlarges the original bore so that pipe of equal or larger diameter can be pulled behind the pipe cracking process. The new pipe is fitted into the trailing end of the hammer unit. As the hammer advances through the old main, it cracks the pipe and the fragments are displaced laterally. Simultaneously, the new liner/pipe is then towed in. If a liner is required, the new conduit pipe is then towed in after the entire length of old main has been cracked and lined.

Pipe bursting is most often used under highways, railroads, and other structures where excavation is not possible or cost-effective. The service life is virtually identical to a new sewer pipe (50 years), since new pipe is actually being installed. Spot excavations are required to connect service laterals. Sliplining is not typically used for gravity pipelines where pipe slopes are relatively flat. This is due to high likelihood of creating "bellies", or localized low spots, in the pipe invert where solids can deposit.

*Sliplining* - Sliplining involves inserting a slightly smaller new flexible pipeline, usually polyethylene, into the existing pipe. This method is typically used where the existing pipes are extensively cracked such as in areas with unstable soil conditions, where the lines are badly deteriorating, or in lines with relatively flat grades. Sliplining will reduce the inside diameter of pipe and reduce its flow capacity. Sliplining is generally used on mainlines larger than 8 inches in diameter.

Slip lining involves minimum excavation and accompanying dewatering work. Excavations are required only at insertion pits and for service lateral re-connections. For this reason, sliplining is advantageous in inaccessible or difficult areas, or under landscaping or structures. Sliplining can be installed in existing pipelines having moderate horizontal or vertical deflections. Flows within the pipe may be allowed to continue while sliplining operations occur.

The liner pipe is commonly pulled through the existing pipe with a winch assembly placed at a manhole and the liner pipe fed into the existing pipe through an insertion pit. The pipe is pulled by steel cable with the cable attached to a pulling head at the pipe end. The polyethylene pipe will stretch during pulling (one foot per 100 feet is common) and a relax procedure is required after pulling and before connection at manholes. Increased temperatures will also tend to stretch the pipe.

The service life of a sliplined sewer is similar to a new sewer replaced by conventional trench excavation and backfill, which is about 50 years. The new liner pipe is a pressure-

capable pipe itself. A disadvantage of sliplining is that excavations are required at service laterals. This is often times consuming, labor intensive, and correspondingly expensive.

*Inversion Lining* - Inversion lining installs a flexible lining material against the existing pipe that is thermally hardened and requires access to the sewer pipe at a manhole. The liner is fed through the manhole and into the sewer pipe by filling the pipe and manhole with water. As water is pumped into the manhole, the flexible fabric is pushed through the pipe and inverted into place. The water is heated to cure and harden the thermo-setting resins.

Inversion lining is appropriate for pipelines requiring minor structural repair or with misalignments and for correcting corrosion problems. Because this method of rehabilitation does not require excavations, it may be used under highways and buildings. A television inspection of the existing sewer typically precedes the inversion lining work. Video inspection during a period of high groundwater table should be performed following lining to make sure laterals are not leaking or other small holes were not introduced into the side of the liner during lateral cutting. The life of an inversion lined pipe has been claimed by the lining manufacturers to be 50 years. Installations with almost 30 years of service are known to exist.

The inversion lining will reduce the inside diameter of an 8-inch pipe by up to ¾-inch depending on the service requirements. Flow capacity of the pipe may be reduced by the reduced pipe cross-sectional area, or increased by smoothing the flow channel.

# SECTION 4 | REGULATIONS AND POLICIES

## INTRODUCTION

The City of Sherwood (City) is ultimately responsible for management and operation of infrastructure under its jurisdiction in accordance with all known Federal, State, and local regulations. This section summarizes the regulations applicable to the conveyance system and serves as the basis for the content and recommendations in this Stormwater Master Plan (SWMP).

## FEDERAL STATUES, REGULATIONS AND PERMITS

### *Clean Water Act*

The Clean Water Act (CWA) is the principal Federal law in the United States governing water pollution and provides the basis for the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) permit program. This program regulates pollutants discharged from point sources into waters of the United States through water quality based effluent limits. Other regulations related to the mission of the NPDES program include the Safe Drinking Water Act, Endangered Species Act, National Environmental Policy Act, National Historic Preservation Act, Coastal Zone Management Act, Wild and Scenic Rivers Act, Fish and Wildlife Coordination Act, and Essential Fish Habitat Provisions.

The Clean Water Act Section 404 Permit requires studies into wetland delineation, impact assessment, and mitigation plans for projects including filling or dredging existing wetlands. Through Section 404, the U.S. Army Corps of Engineers (USACE) also has jurisdiction over the construction of utility crossings such as culverts through navigable waters and wetlands. Final construction of projects within the City through wetlands and waterways will need to be coordinated with the USACE.

### *NPDES Phase I Stormwater Permits*

The Oregon Department of Environmental Quality (DEQ) administers the state's NPDES permit program on behalf of the federal government. Under Phase I of the NPDES Stormwater Permit Program, certain cities within Oregon are required to obtain a permit on their stormwater conveyance system for discharging runoff into state waters. These conveyances, referred to as Municipal Separate Storm Sewer Systems (MS4), consist of roads with drainage systems, municipal streets, catch basins, curbs, gutters, manmade channels, and storm drains. Phase I targets areas primarily within the Portland metropolitan region with populations exceeding 100,000.

Clean Water Services (CWS) is the NPDES permit holder for the region within Washington County draining to the Tualatin River. Being the permit holder, CWS is ultimately responsible under NPDES Permit No's 101141, 101142, 101143, 01144 and MS4 (File No. 108014) manage stormwater flows from Municipal Separate Storm Sewer Systems within its jurisdiction. The permit was renewed in 2016, and will be in effect until May 31, 2021.

Similar to the previous permit, the new NPDES permit requires that post-construction runoff strategies be implemented to mimic natural hydrology, utilize green infrastructure (GI) or low impact development (LID), and treat 80% of the annual average runoff volume. The permit also requires retrofit of several stormwater outfalls that currently do not have appropriate post-construction controls. CWS will coordinate with the City of Sherwood and the other jurisdictions under this permit to select and construct appropriate retrofit projects.

In addition to these provisions, the permit also includes a new requirement to address hydromodification. The permit requires CWS to first complete a watershed-level hydrmodification assessment, and then develop, implement and enforce a program to control post-construction stormwater runoff based on the findings of the assessment.

### *National Flood Insurance Act*

The Federal Emergency Management Agency (FEMA) regulates floodplain protection in part through the National Flood Insurance Act. FEMA's Region X, located in Bothell, Washington, has regulatory oversight over the City. The agency facilitates the National Flood Insurance Program (NFIP), which provides federally subsidized insurance to properties within flood hazard areas.

In response to a lawsuit filed against FEMA in 2009, the National Marine Fisheries Service (NMFS) performed a Biological Opinion (BiOp) regarding impacts the NFIP was having on Endangered Species Act-listed species. This BO was provided by NMFS in April 2016, and documented in a letter to the City of Sherwood, dated June 13, 2016 (See Appendix). The letter states that NMFS has concluded that the implementation of the NFIP in Oregon jeopardizes the continued existence of 18 ESA-listed species and adversely modifies their critical habitat. NMFS considers the issuance of floodplain development permits that do not avoid or compensate for detrimental impacts to ESA-listed species or their critical habitat as noncompliant with the ESA. NMFS identifies certain private floodplain development activities as harmful to listed species, including the addition of fill, structures, levees and dikes, the addition of impervious surfaces, removal of vegetation, and bank armoring. As a result of the BiOp, FEMA is implementing significant revisions to the NFIP to ensure compliance with ESA. It is anticipated that the City of Sherwood will implement those changes into the City's development code to retain full compliance with the FEMA NFIP so that the community's eligibility in the program is maintained.

With specific regards to stormwater regulations, NFIP will include provisions for minimizing stormwater and hyporheic impacts of the floodplain from impervious surfaces installed with development. This will mainly be accomplished through a number of strategies already being utilized, such as Low Impact Development Approaches (LIDA), Green Infrastructure (GI), minimizing net impervious area, and enhancement of riparian vegetation. Since all of the City's stormwater is ultimately discharged to the 100-year floodplain of the Tualatin River or its tributaries, the new NFIP requirements will likely widen the breadth of use of these approaches for future development in the City. The City is recommended to work closely with CWS in development and refinement of stormwater facilities design to ensure compliance with NPDES as well as NFIP requirements.

### *Endangered Species Act*

Endangered and threatened species can be found in this study area. These include:

- Bald eagle, *Haliaeetus leucocephalus* (threatened; proposed delisted)
- Chinook salmon, *Oncorhynchus tshawytscha* (threatened; Upper Willamette River Evolutionary Significant Unit)
- Steelhead, *Oncorhynchus mykiss* (threatened; Upper Willamette River Evolutionary Significant Unit)

Construction in the 100-year floodplain and/or within listed species habitat may require a Biological Assessment, and appropriate construction windows will need to be determined to minimize potential impacts to salmon spawning and/or to eagle nesting periods. The primary consideration for construction around Chicken Creek, Cedar Creek, Rock Creek and the Tualatin River will be allowing adequate lead time to coordinate with regulatory agencies and establish appropriate construction periods.

### *Safe Drinking Water Act*

The Safe Drinking Water Act (SDWA) is the principal federal law in the United States intended to ensure safe drinking water for the public. Pursuant to the act, the EPA is authorized to regulate underground injection of stormwater to safeguard drinking water quality. The Oregon DEQ's Underground Injection Control (UIC) Program regulates injection wells that place fluids underground for storage or disposal under the SDWA.

## OREGON STATUTES, REGULATIONS AND PERMITS

### *Oregon Drainage Law*

Oregon court rulings have been largely responsible for developing Oregon's drainage law. While no legislative action has been passed putting a particular law into effect, court decisions dictate that:

- Adjoining landowners are entitled to have the normal course of natural drainage maintained.
- Owners of low-lying land must accept water that naturally drains onto their land from higher elevations, but are entitled not to have the normal drainage changed or substantially increased.
- Owners of low-lying land may not obstruct the runoff from the higher-elevated land, if the landowner of the higher-elevated land has properly discharged the water.

Like any private landowner, the City must comply with Oregon drainage laws. Any public projects, such as roadway embankments, municipal developments, storm drainage systems,

or culverts would be required to maintain the same natural flow pattern of runoff as before development occurred.

### *OAR 141, Division 85 and 86*

This Oregon Administrative Rule (OAR) contains Oregon's Removal-Fill Law, which requires developers who plan to remove or fill material in state waters to obtain a permit from the Department of State Lands (DSL). Drainage projects conducted within the City may be subject to the oversight of this law if the project involves 50 cubic yards of fill or excavation to occur within a regulatory waterway. Projects conducted within essential salmon habitat are required to obtain a permit, regardless of the quantity of earthwork. Several waterways within the City's boundary meet this designation, such as Cedar Creek, Chicken Creek, Hedges Creek and Rock Creek. Due to overlapping jurisdictional boundaries with the USACE pertaining to work within waters of the state, these permits are typically called Joint Permit Applications and are administrated by both the DSL and USACE.

### *OAR 340, Division 40*

The CWA and SDWA are the basis for this OAR, which assigns the DEQ numerous responsibilities pertaining to regulating State waters. The DEQ designates beneficial uses and establishes Total Maximum Daily Loads (TMDLs) for watersheds falling under these rules. It also outlines the requirements for UIC facilities as they relate to groundwater quality protection. Presently, the DEQ has documentation for 9 properties with UIC installations within the City.

DEQ is authorized to establish TMDLs for local rivers and streams under this rule, which in turn prohibits such activities as discharging waste from industrial and commercial activities without a permit. Pollutant monitoring and testing conducted by the DEQ has resulted in the listing of several surface waters within the City's urban growth boundary (UGB) as quality impaired. These impaired streams and their pollutants are summarized in Table 4-1. The pollutants within these streams originate from sources such as animal wastes, chemical fertilizers, pesticides, and urban development.

In addition to establishing TMDLs, this OAR outlines the DEQ's responsibility for issuing NPDES discharge permits intended to limit the release of pollutants to levels the receiving water can sustain. Construction stormwater permits (1200-C), and industrial stormwater permits (1200-Z) are authorized through the NPDES program.

Both the construction and industrial permits require site operators to implement stormwater best-management practices and ensure that stormwater runoff leaving their site does not violate in-stream water quality standards.

| Table 4-1 \| 303(d) Water-Quality Impaired Surface Waters | | | | | |
|---|---|---|---|---|---|
| Pollutant/Source | Cedar Creek | Chicken Creek | Hedges Creek | Rock Creek | Tualatin River |
| Arsenic | | | | ● | |
| Ammonia | | ● | | ● | ● |
| Aquatic weeds/algae | | | | | ● |
| Biological Criteria | ● | | ● | ● | ● |
| Chlorophyll-a | ● | | | ● | ● |
| Copper | | | | | ● |
| Dissolved Oxygen | ● | ● | ● | ● | ● |
| Fecal coliform or E. Coli | ● | ● | ● | ● | ● |
| Iron | | ● | | ● | ● |
| Lead | | ● | | ● | ● |
| Mercury | | | | | ● |
| Phosphorus | ● | ● | ● | ● | ● |
| Temperature | ● | | ● | ● | ● |
| Zinc | | | | | ● |

### *OAR 635, Division 412*

This rule states that no obstruction may be placed across state waters that are currently or historically inhabited by native migratory fish without providing passage for these fish.

For existing culverts, additional verbiage under this rule stipulates that if over 50 percent of an existing fish passage barrier within, below, or above a channel is cumulatively removed, replaced, filled, or added to through time, the existing barrier (i.e., culvert) will require replacement to current standards. This condition should be evaluated for relevancy on a case-by-case basis for any future road widening project lead by the City.

### *OAR 660, Division 10*

This state rule establishes Statewide Planning Goals (goals 5 through 7) to be carried out by the Department of Land Conservation and Development. These goals, structured to protect natural resources and conserve scenic and historical areas and open spaces, are summarized as follows:

- Goal 5 - Local governments shall adopt programs that will protect natural resources and conserve scenic, historic, and open space resources for present and future generations. Stream flow and water levels should be protected and managed at a level adequate for fish, wildlife, pollution abatement, recreation, aesthetics and agriculture.
- Goal 6 - All waste and process discharges from development shall not threaten, degrade or violate applicable environmental quality statutes, rules and standards.

- Goal 7 - Local governments shall adopt comprehensive plans to reduce risk to people and property from natural hazards, including floods. Local governments should consider programs to manage stormwater runoff as a means to help address flood and landslide hazards.

### *OAR 660, Division 11*

OAR 660 requires Oregon's cities and counties to adopt pubic facility plans for any UGB areas with a population greater than 2,500. A public facility plan (PFP) helps assure that development within the UGB is guided and supported by the types and levels of urban facilities and services appropriate for the needs and requirements of the areas to be served, and that those facilities and services are provided in a timely, orderly and efficient arrangement, as required by Goal 11 and its implementing administrative rule at OAR 660-011. This SWMP has been developed in conformance with this rule and will act as a supporting document for the City's Comprehensive Plan.

### *Oregon Revised Statute 223*

This Oregon Revised Statute (ORS) allows the City to recover the costs of a new development's share of the system capacity by collecting system development charges (SDCs). Under this statute, new developments must pay a proportional share of expenses to meet the increased demands that they place on the system. SDC fees can be imposed to offset the expense of any system accommodations made necessary by the new development.

## LOCAL ORDINANCES, AGREEMENTS AND RELATED PLANNING POLICIES

### *Metro 2040 Regional Framework Plan*

The City's planning programs are required to support Metro's (formerly Metropolitan Service District) 2040 Regional Framework Plan, a document intended to direct and control the region's urban growth and development. This plan was adopted by Metro council in 1995. This SWMP aids the City in meeting Metro's requirements for infrastructure planning, necessary before an area can be added to the official UGB.

### *Washington County*

Washington County lacks any specific regulation or rule that would apply towards the stormwater system within the City.

### *Clean Water Services*

CWS is a water resources management utility serving more than 551,000 customers within Washington County and small portions of Clackamas and Multnomah Counties. This agency is committed to protecting water resources in the Tualatin River Watershed so that its customers may enjoy clean water and healthy rivers and streams. The health of the watershed is upheld by CWS through their wastewater and stormwater services, flood management projects, water quality enhancement projects, and fish habitat protection.

CWS has developed several planning policies and standards in meeting with their NPDES Permit requirements. The City has adopted these standards and applies them as enforcement tools for developers seeking building permits within their jurisdiction. These policies and standards include the current *Design and Construction* Standards (DCS), *Low Impact Development Approaches (LIDA) Handbook*, and the Outfall Retrofit Program. Proposed regional facilities within the Capital Improvement Plan (CIP) section of this SWMP can be used to meet the regulatory requirements of the Outfall Retrofit Program when treating previously untreated impervious area. Detailed information summarizing CWS current policies and standards applicable to the City in Appendix B.

### *City of Sherwood, Comprehensive Plan*

The Sherwood Comprehensive Plan is an official statement of the goals, policies, implementation measures and physical plans for the City's development. A partial plan revision was adopted by City Council Ordinance 2009-009 to include a number of amending ordinances, as summarized below.

### *City of Sherwood, Stormwater Master Plan (June 2007)*

This document, prepared by Murray, Smith & Associates, Inc., (MSA) serves as an important starting point for development of this new SWMP, as it summarizes all of the previous stormwater planning efforts to date. The report contains the current Capital Improvement Program (CIP) for the stormwater system and details the analysis used in developing recommended improvements.

### *City of Sherwood, Brookman Addition Concept Plan (June 2009)*

The Brookman Addition Concept Plan is a guide to the creation of a new 250-acre community in southwest Sherwood. The central theme of the plan is to create a livable community that is an extension of existing Sherwood. To realize this vision, the document outlines the general location and intensity of future land uses to include residential, mixed use commercial, employment, parks and open space. Basic infrastructure systems to support these land uses are integrated into the planning effort for transportation, trails, utilities and stormwater management.

The concept plan indicates a local network of stormwater facilities will be needed to completely serve the Brookman Addition. Stormwater management strategies under the concept plan include conveying runoff from properties to piped systems within the right-of-way. These conveyances will then direct runoff towards six regional detention and treatment systems located along Cedar Creek, and will use the creek as the ultimate discharge point for stormwater runoff originating within the area.

### City of Sherwood, Tonquin Employment Area Preferred Concept Plan

The Tonquin Employment Area (TEA) Preferred Concept Plan is intended to guide future employment needs within the concept plan area and within Sherwood. The Preferred Concept Plan identifies the anticipated employment types this area will best accommodate, the associated number of jobs, and the key infrastructure needs that will support this future employment population.

The TEA is within the Hedges Creek, Rock Creek and Upper Coffee Lake Creek drainage basins. Stormwater management described under this plan includes estimation of runoff flowrates and sizing of three regional water quality treatment facilities. Each of the three drainage basins will be served by a regional treatment facility. A central assumption of this concept plan is that developers will provide water quantity detention on-site, therefore the regional facilities were designed for treatment purposes only.

### City of Sherwood, Municipal Code

Titles 13, 15 and 16 of the Municipal Code form the basis of drainage policy within the City. These sections adopt CWS standards and allow the City to collect fees, or system development charges (SDCs) from residents for drainage and flood control infrastructure.

Title 16 of the City's Municipal Code is typically referred to as the "Zoning and Community Development Code," but is also known as the Development Code or Zoning Code. It is enacted to promote the general public welfare by ensuring procedural due process in the administration and enforcement of the City's Comprehensive Plan, zoning, design review, land division, and development standards.

### City of Sherwood, Development Standards

Drainage standards have been adopted by the City to set forth uniform material and workmanship criteria applicable to infrastructure under the City's jurisdiction. Implementing standards streamlines the administration and construction of drainage facilities and also minimizes maintenance by unifying the materials and equipment used for repairs. These standards are documented in the City's *Engineering Design and Standard Details Manual (2010).*

Chapter VI of this manual pertains specifically to the storm drainage design and construction standards applicable within the City, which have been adopted from CWS *Design and Construction Standards*. These standards outline the City's requirements for: engineering; design; reporting; material, technical and construction specifications; and testing procedures for storm sewers.

### Intergovernmental Agreements

The City has an intergovernmental agreement (IGA) with CWS for the operation of sanitary sewer and surface water facilities. This IGA summarizes responsibilities for maintenance, capital improvement funding and revenue collection. Specific noteworthy elements of the

City-CWS IGA with respect to the stormwater system and capital improvements are highlighted below. Appendix A contains the full text of the IGA.

- CWS is the NPDES permit holder for the MS4, and ultimately responsible for its operational conformance with all laws and regulations. Compliance with all CWS orders, standards, specifications, work programs, reporting requirements and performance criteria (CWS Standards) shall be absolute defense to any stormwater regulatory related claim made against the City, provided these CWS Standards are enforced. Inadequate funding shall not constitute a justification for the City's failure to comply with the CWS Standards.
- Both CWS and the City may set rates and charges to finance their respective District Wide and Local Programs. Each shall establish separate accounts for stormwater and wastewater programs for the purposes of accounting.
- The City may issue no new permit for the construction within, or modification to, a wetland, floodway or floodplain without first receiving he written approval by CWS.
- The City is responsible for maintenance of all stormwater system piping within its assigned service area, with the exception of the culverts exceeding 36-inch diameter that are maintained by Washington County.
- CWS is responsible for components classified under the District Wide Program, such are regional surface treatment or control facilities where the treatment area is 1 acre or larger.

## FUTURE REGULATIONS

Since enactment of the CWA, stormwater regulations are becoming more stringent, and great strides have been made in pollution reduction from point sources. While point pollution sources have been regulated, the growing source of degradation of surface waters can typically be attributed to non-point pollution sources such as urban stormwater runoff. To address these non-point sources, Federal, and State agencies are working to improve their stormwater policies and regulations; current efforts applicable to the City are noted below.

### *Federal Regulation Considerations*

The EPA announced in the spring of 2014 that it would postpone issuance of new national stormwater rules in an attempt to overhaul the federal stormwater program. The agency had previously indicated that the rules would expand the NPDES program and adopt a retention-based national performance standard for new development and redevelopment.

Instead, the EPA will direct its attention on strengthening partnerships with other federal agencies, promoting nationwide stormwater education, and bolstering existing incentive programs and greater enforcement of the current MS4 NPDES program.

Cities often struggle to finance construction of new stormwater infrastructures while concurrently rehabilitating aging stormwater systems. To assist in this challenge, the EPA is

promoting integrated planning practices as a method of demonstrating compliance with the requirements of the CWA while keeping in mind the cities' limited financial resources. In some instances, SDWA expenditures have been able to qualify for relief from obligations under the CWA through the integrated planning process.

The EPA is currently initiating a pilot project for five communities to receive technical assistance in establishing integrated planning policies, with the aim of identifying efficiencies and prioritizing capital improvements that will better promote objectives of the CWA. Results from the pilot project will help develop practical examples for how to implement steps in developing an integrated plan. More information pertaining to this topic can be found at the EPA's website: http://www.epa.gov/.

### State Regulation Considerations

In addition to the federal government enacting retention-based stormwater management standards promulgated by the Energy Independence and Security Act, 18 states have legislated stormwater standards aimed at requiring a retention-based metric. While the federal stormwater rulemaking has been deferred, many states are imposing stricter stormwater standards. The DEQ has yet to indicate its position on enacting a retention-based standard, making these types of requirements within the state uncertain.

### Local Agency Regulation Considerations

A detailed memorandum provided in Appendix B outlines what policies are currently effective in protecting stream health, what MS4 permit requirements are likely to come into effect with the next permit renewal, and recommendations for how the City can best meet these requirements. A summary of this memorandum is provided below.

Recent MS4 permits in Oregon have required that post-construction runoff flow control policies address hydromodification of downstream receiving waters through mimicry of natural hydrology, utilization of green infrastructure (GI) or low impact development (LID), and treatment of 80% of the annual average runoff volume. Flow control strategies being adopted by the EPA to address hydromodification require continuous simulation modeling to match the pre-development channel forming discharge or on-site retention of the 90th percentile storm. This storm is close to or less than the water quality storm in Western Oregon jurisdictions.

During the next NPDES Permit renewal, CWS' LIDA Handbook could be updated to meet future hydromodification flow control requirements using a percentile storm approach. This approach is unlikely to require any increase in GI or LID facility design since the sizing factor used by CWS currently meets the updated EPA's National Stormwater Calculator requirements for rain gardens in cohesive soils. Analysis would be necessary to demonstrate that GI or LID facilities designed under the LIDA Handbook can meet these hydromodification flow control requirements, however the resulting information could reduce the pressure to adopt continuous simulation detention strategies.

Hydromodification assessments require analysis of regional hydrology, soils, topography and stream erodability to determine susceptibility of streams to hydromodification impacts and identify tools to address such impacts. Additional analysis measuring the City's stream erodibility and modeling runoff with various flow control methods (percentile storm retention using LIDA vs detention using continuous simulation) could be compared with existing HEC RAS models to determine the risk of erosion. Stream resiliency methods such as protected floodplains and riparian vegetation could also be compared.

# SECTION 5 | SYSTEM ANALYSIS

## INTRODUCTION

This section describes the analysis methodology used to develop and model the City of Sherwood (City) stormwater system under existing and future build-out conditions and summarizes the findings of analyses performed. The analysis methodology used in the SWMP is consistent with the requirements of the City's *Engineering Design and Standard Details Manual* (2010) and Clean Water Services' (CWS) *Design and Construction Standards* (2007). Analysis results are summarized for the hydraulic model, conveyance system deficiencies (via City observations), and water quality facilities. The results from this analysis are used to guide the improvement recommendations presented in Section 7 – Capital Improvement Plan.

## EXISTING STORMWATER PROBLEM AREAS

### *Conveyance System Deficiencies*

Existing system deficiencies were identified qualitatively through consultation with previous planning documents and interviews with City staff. The existing conveyance constraints revealed through this process were used to calibrate the model. These constraints are listed below.

- Under certain significant storm events, an undersized storm sewer pipe in Ladd Hill Road just south of Sunset Boulevard has caused the conveyance system to surcharge, and forced the manhole cover to be lifted off its frame.

- A 36-inch diameter culvert crossing under SW Sunset Boulevard near Eucalyptus Terrace appears to surcharge under larger storm events.

- Known areas where drainage problems are caused by long-term or recurring maintenance problems include:

  – Silted in ditches along West Division Street
  – Repeatedly blown out swale near Columbia Street and Southern Pacific Railroad
  – Non-functional swale southwest of the intersection of Ladd Hill Road and Sunset Boulevard
  – Various open channel conveyances where vegetation control or removal of invasive species is needed

City staff have also indicated that there is one known location where a public storm drainage pipe is located under a private residence. This pipe is located along Park Street near 1st Street.

### *Developed Areas Lacking Water Quality Facilities*

In 1991, CWS began requiring stormwater management facilities for treatment of runoff from impervious surfaces prior to discharge to any surface water. A significant portion of the City has been developed since 1991, and it is assumed that runoff from these areas is routed through stormwater treatment facilities in accordance with CWS rules at that time. Those portions of the City developed prior to 1991 generally lack treatment of stormwater before discharging to surface waters. These areas were identified as part of this master planning effort, and are shown in Figure 5-1.

Generally, the developed portions of the City currently lacking stormwater treatment fall into two categories:

- Commercial and industrial facilities: Older commercial and industrial developments along Highway 99W and north of Tualatin-Sherwood Road were likely constructed without stormwater treatment facilities. Runoff from these types of development can have significant detrimental impact to surface water quality in locations of high motor vehicle-dependent activities, activities which require large ground disturbances and where materials storage is performed uncovered.

- Older developed residential areas: Two relatively large drainage basins in the southeast portion of the City, west of Murdock Road and south of Oregon Street, drain untreated to Rock Creek. Also, along Cedar Creek, there are several small residential basins that drain directly to the creek with no treatment.

These untreated areas are good candidates for future stormwater quality improvement projects. Although few data sets are available specifically from the City, studies across the United States have correlated urbanization to increases in the types and quantities of pollutants in receiving waters. Regardless of the climatic setting, development within urbanized areas such as roadway pavements and industrial, commercial, and residential construction can contain many different pollutants. Each of these activities can be generalized as follows:

- Pavement runoff is contaminated with pollutants such as oil and grease from motorized vehicles, polynuclear aromatic hydrocarbons (PAHs), lead, zinc, copper, cadmium, sediments (soil particles), road salts, and other anti-icers. Pavements also generate runoff flows that have short, intense peaks.

- Residential areas contribute the same pavement-based pollutants to runoff, as well as herbicides, pesticides, nutrients (from fertilizer and animal waste), bacteria, viruses, and other pathogens (from animal wastes). Residential areas contain a higher percentage of pervious landscaped area compared to industrial and commercial areas, with runoff characteristics of longer, less intense peak flows.

- Runoff from industrial areas typically contains heavy metals, sediments, and a variety of man-made organic pollutants, including phthalates, PAHs and other petroleum

hydrocarbons. Since industrial areas typically consist of a large percentage of impervious area, runoff can be characterized with short, intense peak flows.

- Runoff from commercial areas contains concentrated pavement-based pollutant runoff and may also contain other contaminants typical of industrial and/or residential areas. Commercial areas typically consist of a large percentage of impervious area, and runoff can be characterized with short, intense peak flows.

FIGURE 5-1

CITY OF SHERWOOD

STORMWATER MASTER PLAN
AREAS LACKING WATER QUALITY FACILITIES

Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2910 FAX 503.225.9022

SEPTEMBER 2016

Chicken Creek
SW EDY RD
SW ELWERT RD
Cedar Creek
99W
SW TUALATIN SHERWOOD RD
Rock Creek
Sherwood
NE OREGON ST
Tonquin Employment Area (TEA)
SW OREGON ST
SW PACIFIC HWY
SW KRUGER RD
SW SUNSET BLVD
Coffee Lake
Goose Creek
Brookman Concept Area
SW BROOKMAN RD
Washington County
Clackamas County
SW BAKER RD
Rock Creek

STORMWATER FACILITIES:
- WATER QUALITY MANHOLE
- MANHOLE
- EXTENDED DETENTION POND
- SWALE
- RETENTION BASIN
- LIDA
- CITY STORM SEWER LINE
- DITCH
- CULVERT
- CITY BOUNDARY
- COUNTY BOUNDARY
- STUDY AREA*
- AREAS LACKING WATER QUALITY TREATMENT
- WATER BODY
- FACILITIES ESTABLISHED IN CONCEPT PLAN

*STUDY AREA = UGB

0 0.5 Miles

N W E S

G:\PDX_Projects\151\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 5-3_8.5x11.mxd 8/9/2016 3:56:51 PM Thomas.Walsh

May 2016

## HYDROLOGIC ANALYSIS METHODOLOGY

Once the land uses and existing deficiencies for the planning area have been defined, the hydrologic analysis of the stormwater system begins through definition of runoff characteristics. These characteristics are used to estimate the volume and peak flow rate of stormwater runoff entering the stormwater conveyance system as a function of rainfall events (e.g., intensity and duration), basin characteristics (e.g., topography, soil type, and impervious area), and flow routing (e.g., overland, channels, and pipes).

### *Runoff Estimation Method*

The Natural Resources Conservation Service (NRCS) Method was selected to estimate runoff due to its widespread use and its acceptance by CWS as a viable planning and design tool. Additionally, basin characteristics data required for the NRCS Method was readily available.

To perform the hydrologic analysis, the Innovyze InfoSWMM$^{TM}$ software (version 14) was utilized. InfoSWMM$^{TM}$ uses the U.S. Environmental Protection Agency (EPA) software, Storm Water Management Model (SWMM), as its hydrologic engine. SWMM is a CWS accepted program and is widely used for the purposes of stormwater simulation and analysis. The runoff model used in this study is the NRCS Dimensionless Unit Hydrograph, which uses the runoff curve number, basin hydraulic length, average basin slope, and time of concentration to estimate runoff potential (time to peak and peak flow rate).

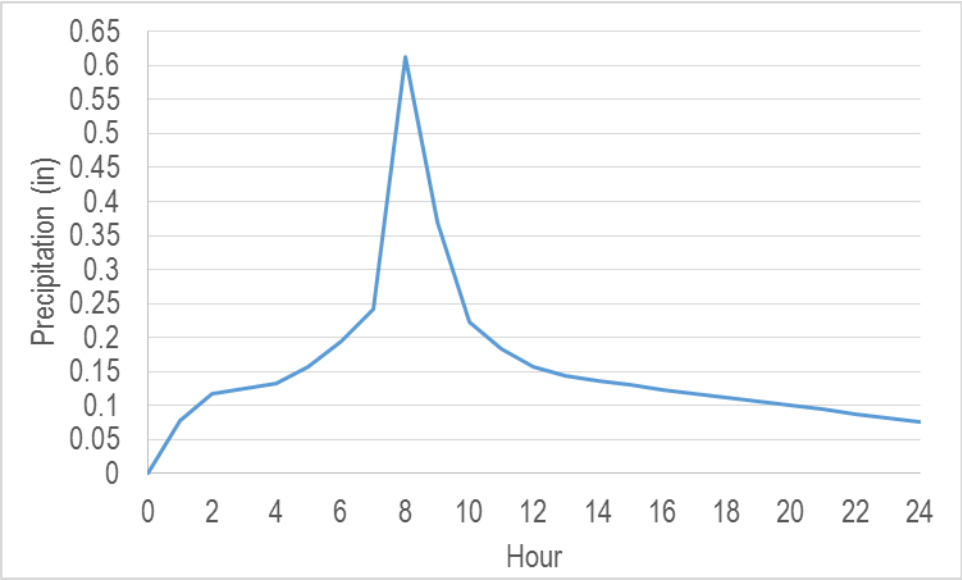
### *Precipitation*

Storm event depth, intensity, and time distribution drive the generation of runoff. CWS standards prescribe total rainfall depths for 24-hour events spanning the 2- to 100-year recurrence intervals. These depths, as a function of recurrence interval, are summarized for the City in Table 5-1.

The NRCS 24-hour, Type 1A theoretical rainfall distribution is specified by CWS standards for application of the NRCS Method and is indicative event rainfall distributions in the Tualatin River Valley. The Type 1A storm is characterized by a peak rainfall intensity at approximately eight hours over the 24 hour range. Figure 5-2 exhibits the hourly rainfall distribution for the 25-year, 24-hour event depth of 3.90 inches. For this study, the 2-year, 25-year, and 100-year, 24-hour design storm events were simulated.

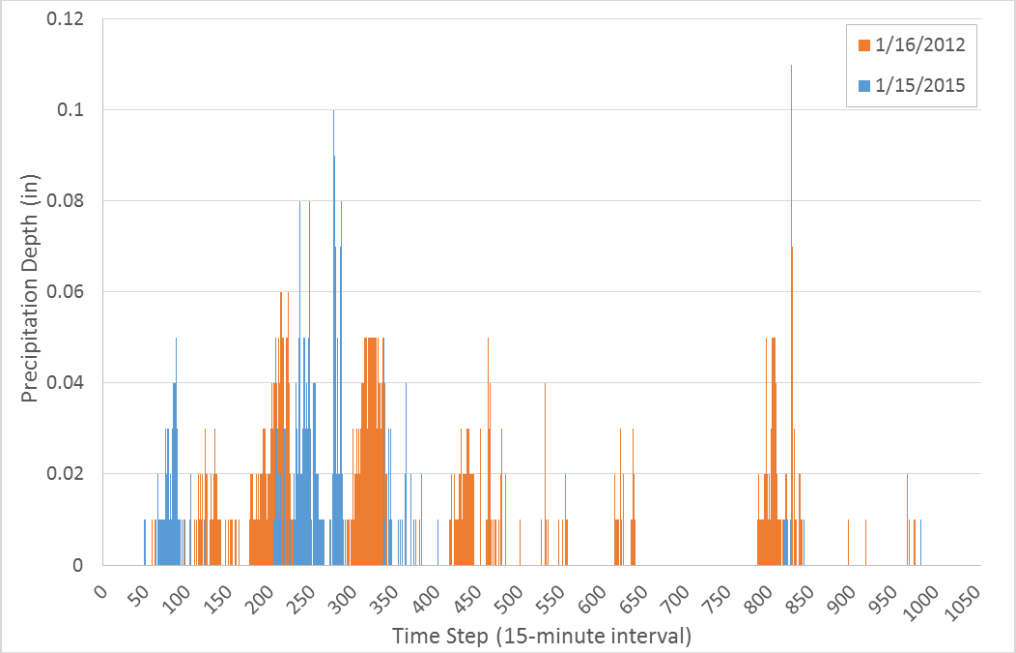
| Table 5-1 \| Rainfall Event Depths for 24-Hour Durations | |
|---|---|
| **Recurrence Interval (years)** | **24-Hour Rainfall Depth (inches)** |
| 2 | 2.50 |
| 5 | 3.10 |
| 10 | 3.45 |
| 25 | 3.90 |
| 50 | 4.20 |
| 100 | 4.50 |

**Figure 5-2 | 25-year, 24-hour Design Storm, NRCS Type 1A Distribution**




To assess the system's response under actual precipitation events and to calibrate the model to City staff comments, a total of two historical events were simulated. These continuous, ten day events, at 15-minute time step intervals, commenced on 1/16/2012 and 1/15/2015. Simulations were allowed to proceed for ten days following the start date. These events' hyetographs are presented in Figure 5-3.

**Figure 5-3 | Historical Storm Simulation Hyetographs**




## *Basin Characteristics*

The primary drainage basin boundaries within the City are documented in Section 2, "Study Area Characteristics" (see Figure 2-4). These basins are divided into 405 subbasins used to construct a model that receives runoff at key locations within the City's conveyance system. Attributes impacting the hydrologic response of a subbasin include the area, overland flow path width, percent imperviousness, average ground slope, land cover, depression storage, and infiltration potential of soils. The subbasins range in size from 0.21 acres to 171.6 acres, with the average subbasin size being 8.54 acres.

The NRCS classifies soil hydrologic groups through the assignment of runoff curve numbers (CN). Weighted CN values were calculated for each subbasin relative to the land use type, the development percent, hydrologic soils group, soils conditions, and overall area. For residential land uses, the density of development (i.e., dwelling units per gross acre) were applied in extracting a CN. Table 5-2 shows the percent imperviousness assigned to each land use type for this study, and the associated CN for each hydrologic soils group for that type of land use. Generic zoning includes Commercial, Industrial, Open Space, and Residential. CN values were published in the *Urban Hydrology for Small Watersheds* Technical Release (TR-55) referenced by CWS standards. The OS land use category is assigned to areas zoned as public parks, open space, and undeveloped or undevelopable areas.

| Table 5-2 \| Percent Imperviousness and NRCS Curve Number by Land Use | | | | | | |
|---|---|---|---|---|---|---|
| City Land Use(s) | Generic Zoning | Percent Imperviousness; Soil Condition | Curve Numbers for Hydrologic Soils Groups | | | |
| | | | A | B | C | D |
| GC, NC, OC, OC – PUD, RC, RC – PUD, OC/LI, NC/LI, NC/LI/HDR | Commercial | 85%; N/A | 89 | 92 | 94 | 95 |
| GI, IP, LI, LI – PUD | Industrial | 72%; N/A | 81 | 88 | 91 | 93 |
| OS, Floodplain | Open Space | 0%; Poor | 68 | 79 | 86 | 89 |
| | | 0%; Fair | 49 | 69 | 79 | 84 |
| | | 0%; Good | 39 | 61 | 74 | 80 |
| VLDR, VLDR – PUD | Residential | 20%; Good | 51 | 68 | 79 | 84 |
| LDR, LDR – PUD | | 45%; Good | 64 | 78 | 86 | 89 |
| MDRL, MDRL – PUD | | 65%; Good | 77 | 85 | 90 | 92 |
| MDRL/MDRH | | 68%; Good | 79 | 86 | 91 | 93 |
| MDRH | | 70%; Good | 81 | 87 | 91 | 93 |
| HDR, HDR – PUD | | 87%; Good | 87 | 93 | 96 | 98 |

## HYDRAULIC ANALYSIS METHODOLOGY

Following definition of hydrologic characteristics for each subbasin, a hydraulic analysis was conducted for both existing and build-out conditions for the existing Urban Growth Boundary (UGB). The hydraulic component routes the stormwater runoff from the hydrologic analysis through the conveyance system. The hydraulic analysis is dependent upon conveyance geometry (e.g., size, shape, and slope) and other characteristics of the pipe and channel system to estimate capacity. Through the use of these defining system parameters, the analysis considers the capacity of system infrastructure to pass a storm event and is used to identify potential areas prone to flooding or surcharging. Conveyance constraints are dynamically calculated in the model and take into account backwater effects, manhole losses, surcharging (i.e., pressurization) in pipes, and channel storage.

In accordance with CWS standards, the 25-year, 24-hour rainfall event was used as the design storm to establish adequate conveyance. Thus, the total depth of 3.90 inches was applied to the NRCS 24-hour, Type 1A rainfall distribution to yield precipitation as a function of individual time step intervals (e.g., 1 hour). Pipe capacity during this storm event was used as the primary deficiency criteria. Risk of flooding and the need for improvement were determined by calculating the available freeboard, with the following categories:

- Critical: Freeboard $\leq$ 0 feet – Improvement needed in all cases
- High: 0 feet < Freeboard $\leq$ 1 feet – Improvement needed in most cases
- Moderate: 1 feet < Freeboard $\leq$ 5 feet – Improvement not needed
- Low: > 5 feet – Improvement not needed

### Conveyance Facility Characteristics

Conveyance facilities within the study area include pipes and open channel constituents. The City and CWS provided conveyance system data, including: pipe invert elevation, diameter, material, and connectivity. When datasets were incomplete for network components, such as node inverts and pipe conditions, data gaps were interpolated where possible. When data neither existed nor could be interpolated, assumptions based on CWS minimum velocity design standards established invert elevations in conjunction with outlet elevations and ground surface elevations. If the application of the minimum slope was found to result in inadequate capacity, the ground surface slope was commonly used to estimate the pipe slope.

CWS design standards prescribe a Manning's roughness coefficient, *n*, of 0.013 for all storm pipe materials. Open channels, including ditches, were analyzed when connecting upstream and downstream pipes using an *n* value of 0.020. Due to the topography of the receiving surface waters, the City's stormwater outfalls are outside of the 100-year flood plain elevations. As a result, this study assumed that the City's outfalls would be assigned a free discharge condition, with no backwater effects caused by the receiving surface water bodies.

Manhole surcharging and overflows can identify pipes where flow exceeds capacity. This was one factor used to assess potentially problematic pipe sections, though many assumptions were made regarding pipe depth and, therefore, manhole depth. Ultimately, deficient pipe sections were identified by examining the hydraulic grade line through pipe sections.

For the detailed InfoSWMM™ model, deficient pipes were identified by examining the maximum flow class result for each pipe segment. Three classes are used: free surface, backwater, and exceeds capacity. Free surface indicates additional capacity within the pipe; during maximum flow conditions, the pipe is not completely full.

A backwater condition identifies that one or more pipes downstream of the given location has a flow rate that exceeds the pipe's flow capacity and as a result, water is backing up in the system. For pipes tagged with this flow condition, the pipeline HGL profile is investigated to determine the location causing the backup. A pipe exceeding capacity cannot accommodate the flow entering the upstream node of a pipe segment and is deficient, but if the deficient pipe has sufficient depth and available freeboard, the deficiency may not warrant replacement. This was determined on a pipe-by-pipe basis.

### Surface Waters and Floodplains

All runoff entering the conveyance system ultimately discharges to one of the City's five surface water features (i.e., creeks, floodplains, wetlands). These surface water features and hydraulically connected culverts are under the jurisdiction of CWS and would be modeled by that agency. Thus, a hydraulic analysis of the surface water system was not included in the scope of this study.

### Model Calibration

Hydraulic and hydrologic models are typically calibrated to verify that the model produces results consistent with the physical system. For this system, no measured flow data was available. Thus, the calibration was based on comparing model results to firsthand accounts of the system during rain events occurring between 1/16/2012 – 1/27/2012 (5.96 inches) and 1/15/2015 – 1/26/2015 (2.97 inches). These events provided a significantly large amount of continuous rainfall, as well as a more recent result for City staff to have documented. During these events, several areas experienced overflow caused by either manhole flooding or lack of drainage from surfaces due to the system being at capacity.

Measured rainfall data from the calibration events was loaded into the model, and results were compared to the firsthand accounts provided by the City. Initial loss, CN and subcatchment delineation, and loading distribution were adjusted until the model results provided a reasonable approximation of the actual system performance during the calibrated rain event. A comparison between model results and the flooding locations from the January 2012 rain event is shown in Figure 5-4.

FIGURE 5-4

City of Sherwood Oregon

# CITY OF SHERWOOD

## STORMWATER MASTER PLAN
## JANUARY 2012 EVENT, RISK MAP

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 SW Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
SW KRUGER RD
SW SUNSET BLVD
SW BROOKMAN RD
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW BAKER RD
99W
Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek
Rock Creek

JANUARY 2012 EVENT LEVEL OF RISK:
- HIGH RISK
- MODERATe - HIGH
- LOW - MODERATE
- VERY LOW - LOW
- VERY LOW RISK

STORMWATER FACILITIES:
- MANHOLE
- WATER QUALITY MANHOLE
- DITCH
- CULVERT
- CITY STORM SEWER LINE
- CITY BOUNDARY
- STUDY AREA

0 0.25 Miles
N W E S

G:\PDX_Projects\151638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 5-4A_8.5x11.mxd 8/9/2016 4:05:45 PM Thomas Walsh



August 2012 - 15-2007

### *Water Quality and Flow Control Facilities*

As documented in Section 3, "Existing System Description," numerous water quantity and quality facilities throughout the study area are both privately and publicly owned. These facilities have an impact on storage and, therefore, the attenuation of peak runoff rates. Where deficiencies were found to exist in conjunction with a lack of water quality or flow control facilities being present, the Tualatin River Urban Stormwater Tool (TRUST), version data 2015/11/6, was used.

TRUST is a tool, developed for CWS, that analyzes the hydromodification impacts of land development projects and sizing solutions to mitigate the related increases in runoff. TRUST was used to size the proposed regional facilities based on the predeveloped (i.e., existing conditions) and the mitigated (i.e., future conditions) scenarios. TRUST uses a range of historical precipitation events, continuously simulated, to assess the ability of the facility to mitigate events' rates and durations from 50 percent of the 2-year flow (e.g., water quality event) up to the 100-year peak flow. These regional facilities and their resultant sizes, from TRUST, can be found in the CIP.

## ANALYSIS RESULTS

Results of the hydraulic analysis showed that a significant portion of the City's existing stormwater facilities are adequate to convey the 25-year, 24-hour storm event under both existing and future, build-out conditions. The hydraulic modeling identified numerous locations where existing water quality and quantity facilities appear to be providing important stormwater detention and peak attenuation.

### *Conveyance System Deficiencies*

InfoSWMM™ was used to simulate the design storms within Table 5-1 for the existing and build-out conditions. Results of system capacity deficiencies identified by the model simulations are shown in Figure 5-5. For reporting purposes, the 25-year flows were used to identify risk of overflow.

Based on the hydraulic model results, no conduits were found to experience backwater conditions that would result in flooding of the upstream manholes under either existing or build-out conditions. A number of high to moderate risk locations were identified based on conservative runoff characteristics (limited ponding), flat conveyance slopes, and minimal freeboard. This is consistent with the firsthand accounts of flooding that has occurred under a rain event with approximately a two-year recurrence interval. Most of the system deficiencies are caused by deficient pipes within the stormwater system and not necessarily undersized outfall pipes.

FIGURE 5-5

CITY OF SHERWOOD

STORMWATER MASTER PLAN
SYSTEM DEFICIENCY RISK MAP

Murray, Smith & Associates, Inc.
Engineers/Planners
121 SW Salmon, Suite 900 PHONE 503.225.9010
Portland, Oregon 97204-2919 FAX 503.225.9022

SEPTEMBER 2016

SW EDY RD
SW ELWERT RD
SW KRUGER RD
SW BROOKMAN RD
SW SUNSET BLVD
SW PACIFIC HWY
SW TUALATIN SHERWOOD RD
SW OREGON ST
NE OREGON ST
SW BAKER RD
99W
Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake Creek
Rock Creek

FUTURE LEVEL OF RISK (25-YR EVENT):
- HIGH RISK
- MODERATE - HIGH
- LOW - MODERATE
- VERY LOW - LOW
- VERY LOW RISK

STORMWATER FACILITIES:
- MANHOLE
- WATER QUALITY MANHOLE
- DITCH
- CULVERT
- CITY STORM SEWER LINE
- CITY BOUNDARY
- STUDY AREA

N W E S

0 0.25 Miles

G:\PDX_Projects\151638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 5-4_8.5x11.mxd 8/9/2016 4:07:14 PM Thomas.Walsh



August 2016 151638

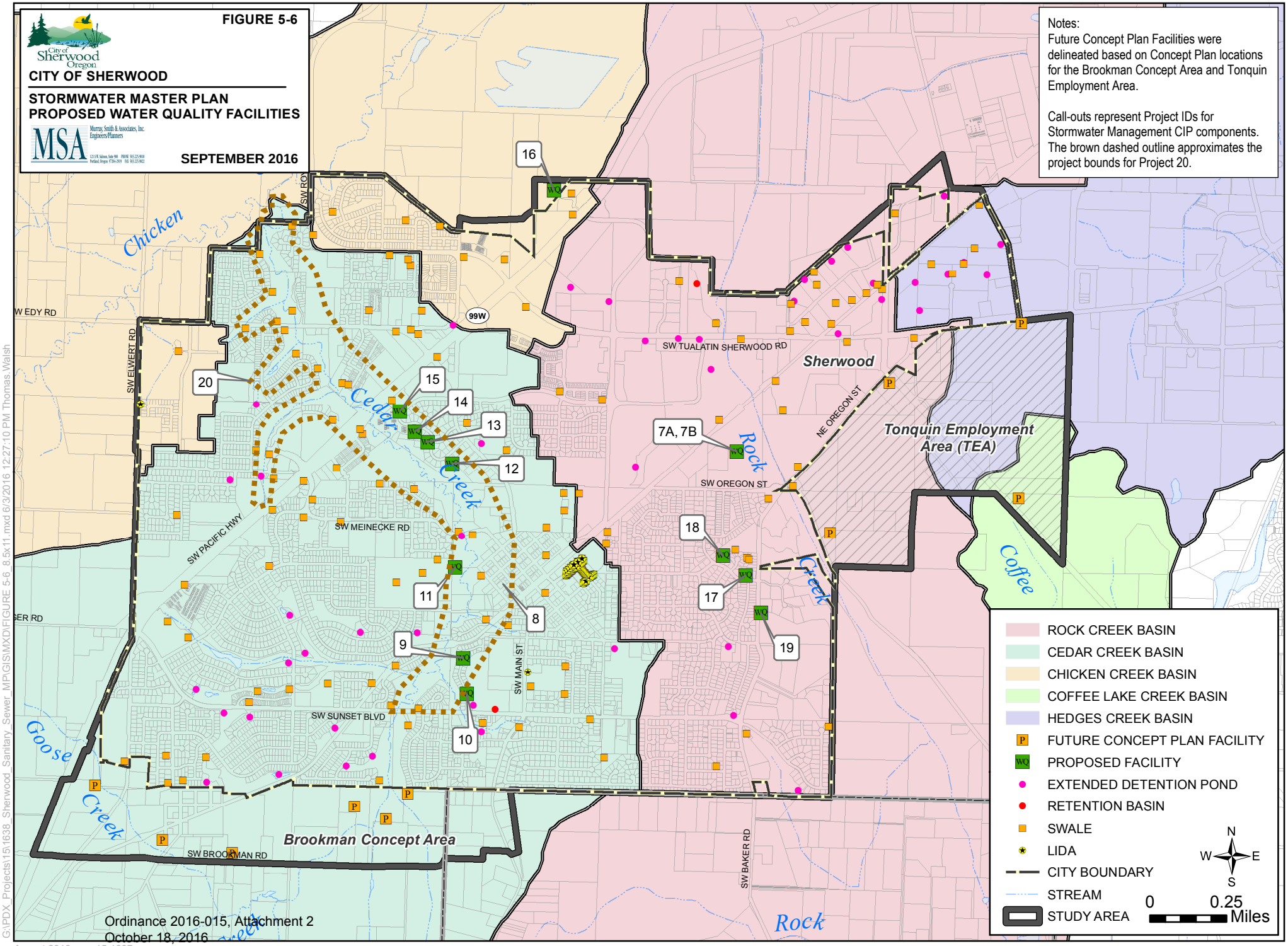
The model results were reviewed with City staff in February 2016. City staff provided comment and discussion about each flooded area as identified through the model simulations. These areas were then used to refine both the model and the analysis of results to arrive at the documented system deficiencies including less conservative runoff characteristics.

As documented in Section 3, "Existing System Description," an assessment of conditions was provided for affected conveyance infrastructure, with ratings ranging from 1 ("Minor Defect Grade") to 5 ("Most Significant Defect Grade"). Condition assessment was based on both Operations and Maintenance (O&M), and Structural ratings.

### *Regional Stormwater Facilities & Developed Areas Lacking Water Quality Facilities*

Regional stormwater quality and quantity facilities were analyzed for areas of future development or existing development without current facilities. Where the implementation of a regional facility would mitigate deficiencies, the TRUST model was used to size these facilities for the range of precipitation events. These project types, their locations, sizes, and the drivers behind their selection are identified in Table 5-3. Locations of proposed facilities are presented in Figure 5-6.

Existing water quality and quantity facilities are adequately sized to the standards at the time of implementation. It is recommended the City focus attention on the operations and maintenance of these existing facilities to ensure their continued function (e.g., peak flow attenuation, minimization of flooding potential).



| Table 5-3 \| Water Quality Facilities for Future Development | | | | |
|---|---|---|---|---|
| **Project ID** | **Type** | **Project Limits** | **Driver** | **Sizing Information** |
| 7A | Extended Detention Basin; Existing Ponds (Predesign) | 14647 SW Oregon St | UGB-Infill | TBD |
| 8 | Stormwater Facility Rehab (Design) | NW 2nd Street and NW Park St | Regulatory - Treatment | TBD |
| 9 | Facility, Proprietary Catch Basin | 23249 SW St Charles Way, West of 23159 SW St Charles Way | Regulatory - Treatment | 2 x 2-Cartridge Catch Basin. |
| 10 | Facility, Proprietary Catch Basin | 23249 SW St Charles Way, West of 23385 SW St Charles Way | Regulatory - Treatment | 2 x 2-Cartridge Catch Basin; Consideration of vault if Archer Glen Elementary School discharge is treated. |
| 11 | Facility, Swale | West edge of 22257 SW Washington St & 16956 SW Meinecke Rd | Regulatory - Treatment | Designed with TRUST Model, Bottom Area: 1,820 $ft^2$; Side Slopes: 4 to 1 (H to V); Effective Depth: 1.0 ft |
| 7B | Facility, Extended Detention | Existing Ponds, 14647 SW Oregon St | UGB-Infill | Existing site should be investigated for redevelopment as extended detention facility. |
| 12 | Facility, Extended Detention | Southeast of 16518 SW Gleneagle Dr | Regulatory - Hydromodification | Designed with TRUST Model, Bottom Area: 9,000 $ft^2$; Side Slopes: 3 to 1 (H to V); Effective Depth: 3.0 ft |
| 13 | Facility, Proprietary Vault | Southwest of 16574 SW Gleneagle Dr | Regulatory - Treatment | 8-Cartridge Vault. |
| 14 | Facility, Proprietary Catch Basin | Southwest of 16678 SW Gleneagle Dr | Regulatory - Treatment | 1 x 4-Cartridge Catch Basin, 1 x 1-Cartridge Catch Basin. |
| 15 | Facility, Proprietary Catch Basin | Southwest of 16738/16748 SW Gleneagle Dr | Regulatory - Treatment | 1 x 2-Cartridge Catch Basin. |
| 16 | Facility, Extended Detention | 20015 SW Pacific Hwy (Northwest of buildings) | Regulatory - Hydromodification | Designed with TRUST Model, Bottom Area: 12,000 $ft^2$; Side Slopes: 3 to 1 (H to V); Effective Depth: 4.5 ft |
| 17 | Facility, Swale | 14645 SW Willamette St | Regulatory - Treatment | Designed with TRUST Model, Bottom Area: 2,400 $ft^2$; Side Slopes: 4 to 1 (H to V); Effective Depth: 1.0 ft |
| 18 | Facility, Swale | 22210 SW Murdock Rd | Regulatory - Treatment | Designed with TRUST Model, Bottom Area: 2,000 $ft^2$; Side Slopes: 4 to 1 (H to V); Effective Depth: 1.0 ft |
| 19 | Facility, Extended Detention | Northwest corner of 22900 SW Murdock Rd | UGB-Infill | Designed with TRUST Model, Bottom Area: 12,544 $ft^2$; Side Slopes: 3 to 1 (H to V); Effective Depth: 3.5 ft |

### Brookman Concept Area

The Brookman Concept Area plan highlights collecting and conveying all site runoff, primarily within the road right-of-way, to regional detention and water quality facilities. After detention and treatment, the water will be discharged to the natural drainage network (i.e., creek system) adjacent to the facility. Facility design will be integrated within the urban and natural areas to provide additional habitat value and/or public open space for recreation. Low Impact Development Applications (LIDA) are encouraged for new development, though not required.

The Brookman Concept Area plan identifies a total of six potential locations for regional facilities. These locations target mitigation for multiple properties, and placement within open space to reduce costs and buildable land area impacts where feasible. The proposed Stormwater Infrastructure Plan (SWIP) is summarized in a 2009 technical memorandum, prepared by Otak, Inc. Facilities were sized per CWS *Design and Construction Standards*, which require:

- The 2-, 10-, and 25-year post-development runoff rates do not exceed flows under pre-developed conditions for regional detention facilities, and
- Capture of the water quality design storm flows (e.g., 0.36 inches over four hours applied to 100 percent of the new impervious area) for regional water quality facilities

All six facilities were designed as regional water quality facilities, with areal footprints ranging from 1,872 square feet ($ft^2$) to 7,500 $ft^2$. See Table 5-4 for a summary of the final parameters set forth in the SWIP. Financing for these facilities is assumed to be provided by private developers.

**Table 5-4 | Brookman Concept Area Water Quality Facility Parameter Summary**

| Basin | Water Quality Flow (cfs) | Water Quality Volume ($ft^3$) | Length (ft) | Width (ft) | Footprint Area ($ft^2$) | Longitudinal Slope (ft/ft) |
|---|---|---|---|---|---|---|
| **1 (BCA_1)** | 1.81 | 26,031 | 184 | 9 | 4,116 | 0.01 |
| **1 (undetained)** | 0.19 | 2,859 | 105 | 4 | 1,872 | 0.01 |
| **2 (BCA_2)** | 4.31 | 57,467 | 238 | 18 | 7,500 | 0.015 |
| **3 (BCA_3)** | 0.73 | 10,437 | 122 | 4.5 | 2,211 | 0.005 |
| **4 (BCA_4)** | 2.15 | 31,004 | 226 | 8.5 | 4,879 | 0.015 |
| **5 (BCA_5)** | 1.3 | 18,662 | 178 | 6 | 3,420 | 0.01 |
| **6 (BCA_6)** | 2.4 | 34,624 | 189 | 12 | 4,824 | 0.01 |

### Tonquin Employment Area

The TEA stormwater management strategy is guided by the *Tonquin Employment Area Market Analysis, Business Recruitment Strategy and Implementation Plan* (2015), prepared

by Mackenzie. Development in the TEA is anticipated to phase outward from existing service boundaries in conjunction with the transportation network. Storm management provided by regional treatment facilities located to target existing drainage pathways (i.e., creeks) to achieve channel improvements as well as runoff treatment. The TEA strategy highlights the consolidation of treatment areas rather than relying on individual property owner facilities.

The TEA concept plan identified a total of three potential locations for regional facilities, sized according to CWS *Design and Construction Standards* for water quality treatment and flow control. It was assumed that developers would provide on-site detention. LIDA is encouraged for new developments to minimize the size of the regional facilities. Proposed storm projects, including storm piping and facilities, were grouped into three phases as shown in Table 5-5. Financing for these facilities is assumed to be provided by private developers.

**Table 5-5 | TEA Storm Infrastructure Summary**

| Phase | Details |
|---|---|
| 1 | Construct 18-inch storm line, south to Tonquin Road<br>Construct 2.25-acre regional treatment facility (TEA_1) |
| | Construct 18-inch storm line through site<br>Construct 1.0-acre regional treatment facility (TEA_2) |
| 2 | Construct 18-inch storm line within Blake Road, along southwest frontage<br>Construct 1.0-acre regional treatment facility (TEA_3) |
| 3 | Construct 18-inch storm line within Blake Road, along northwest and southwest frontages<br>Construct 0.75-acre treatment facility adjacent to wetlands (TEA_4) |

# SECTION 6 | RIPARIAN CORRIDOR EVALUATION

## INTRODUCTION

This section of the Stormwater Master Plan (SWMP) summarizes field investigations conducted of the riparian corridors within the study area. The evaluations resulting from this field work document the existing conditions of the City of Sherwood's (City) streams and qualitatively describe their general susceptibility to erosion, or hydromodification.

The U.S. Environmental Protection Agency (EPA) defines hydromodification as the "… alteration of the hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources." This process includes changes to the natural system of water flow in an urban landscape, including water conveyance, surface water runoff, sediment transport, and water quality. The stream erosion caused by hydromodification leads to habitat and water quality degradation and risks to infrastructure from bank failure and incision.

A visual assessment of the stream's hydromodification resiliency is an important first step in identifying the strategies needed to prevent further erosion. The field investigations conducted as part of the SWMP begin this process and are summarized within this section. The information obtained through this field work also provides guidance towards stormwater management policies the City may implement in the future.

The primary objectives of this riparian corridor evaluation include the following:

- Determine the extent of stream erosion within the Study Area.
- Recommend strategies to address hydromodification that are effective and appropriate for local conditions.
- Identify future regulatory trends and anticipated requirements applicable to the City's streams.
- Recommend stormwater management policies that align local stream conditions with expected future regulatory requirements.

## METHODOLOGY

### *Local Stream Conditions*

All of the City's primary surface waters (Cedar Creek, Chicken Creek, Hedges Creek, Rock Creek and Upper Coffee Lake Creek) were evaluated for stream resilience through review of channel geomorphology, soil conditions, contributing hydrology, corridor vegetation, and signs of active erosion. Detailed field work and assessment for each conducted by Wolf Water Resources is provided within the *Hydromodification Technical Memorandum* (June 2015), contained in Appendix C.

This field work revealed the City has generally healthy streams that are resilient to erosion. Due to the streams' low gradient, adjacent floodplains, intact riparian vegetation and buffer separation from adjacent urban development, the surface water system is generally not susceptible to hydromodification. These physical characteristics, in conjunction with the City's current stormwater management policies have contributed to the general good health of the streams.

Native soils throughout the City are generally fine-grained, "tight" silts and clays. These cohesive soils are typically indicative of a high response of rainfall runoff and result in a low potential for infiltration. The streams within the City are comprised of similar soils and are typically susceptible to erosion when exposed to stream velocities exceeding their cohesive and shear strength over extended durations.

### *Regulatory Trends*

As previously outlined in Section 4, the new NPDES MS4 permit was renewed as of June 1, 2016. The permit requires CWS to first complete a watershed-level hydromodification assessment, and then develop, implement and enforce a program to control post-construction stormwater runoff based on the findings of the assessment.

Generally, the trend in stormwater regulations is in minimizing hydromodification impacts. A review of other recent NPDES permits issued for neighboring Oregon communities was conducted by Wolf Water Resources and is summarized in the *Anticipated MS4 Permit Requirements* memorandum contained within Appendix B. It mentions that several new permits are requiring hydromodification assessments. From there, the permittees will be expected to adapt their post-construction stormwater runoff requirements to minimize or prevent further hydromodification of the receiving stream.

As also described in Section 4, additional regulations should be anticipated regarding development within the 100-year regulatory floodplain, which includes all of Sherwood's major receiving streams. The 2016 NFMS Biological Opinion states that hydromodification of the regulatory floodplains in Oregon can now be considered an impact to endangered species and/or their critical habitat. This will serve to further bolster the regulatory trend toward reducing post-construction runoff impacts to pre-development conditions.

## RECOMMENDATIONS

One goal for this SWMP is to proactively anticipate future regulatory requirements so that they may be implemented in a cost-effective manner. The following recommendations achieve this goal and are based upon field research of the streams within the study area, review of recent NPDES permits issued to neighboring Oregon communities, and interviews with City staff.

### Stormwater Management Policies

The City's current stormwater management policies are effectively preventing stream erosion and are based upon the current, 2007 CWS *Design and Construction Standards* (DCS). This document requires that riparian buffers be maintained, floodplains be protected from development, and that the conveyance capacity of the downstream system be adequate for development. It is recommended that these policies continue to be enforced.

Since the City's streams exhibit erosion stability under existing developed conditions, future stream hydromodification can be prevented by managing stormwater runoff from redevelopment and new development. In addition to the current DCS for stormwater management, it is recommended that all redevelopment and new development retain the water quality storm event on-site. The water quality storm event should follow Oregon DEQ's definition of 50% of the 2-year storm event. For Sherwood, this would correlate to 1.12-inches of rainfall over 24-hours with an NRCS Type 1A distribution. This on-site retention may be achieved through rainwater harvesting or infiltration into native soils using GI or LID. Where existing developed areas were constructed without stormwater treatment facilities, it is recommended these areas be retrofitted with regional GI or LID systems that retain stormwater to the maximum extent feasible, up to the water quality storm.

Stormwater detention exceeding the current DCS requirements is not recommended. Current DCS standards require detention primarily when the capacity of the downstream conveyance system is insufficient to support development. Detaining stormwater in excess of DCS standards will increase the duration of flow within the City's streams and expose the native cohesive soils to longer time periods of shear stress that exacerbate hydromodification.

Adopting these standards will position the City to more easily implement anticipated future NPDES permit requirements. A policy of retaining the water quality storm event on-site simplifies the analysis and review of stormwater management facilities under the City's purview. This storm event is expected to meet the treatment requirements issued to other Oregon communities under recent NPDES permits for 80% of the annual average runoff volume.

The City is also recommended to continue support for the CWS best management policy in place that promotes beaver habitat. Beavers are effective in stabilizing streams, especially in areas with broad active floodplains where risk to infrastructure is low. These floodplain areas are prevalent along the City's major stream corridors. Beaver dams and ponds also act as bed control by preventing the stream from down-cutting and help to attenuate and store flows from storm events, respectively.

### Hydromodification Reduction Strategies

The policy recommendation to retrofit existing developed areas with regional treatment systems should incorporate GI and LID based designs. The regional treatment facilities described in Section 7 – Capital Improvement Plan (CIP) assume a GI/LID design approach. During future engineering design of these facilities, infiltration to the maximum extent

feasible may be realized through considerations pertaining to native soils characteristics, available property area, groundwater mounding performance, grading limitations, flow line invert elevations, etc. Providing treatment for stormwater from existing developed areas within the City will improve the quality of the runoff and help meet TMDL requirements of the receiving waters. These regional treatment facilities will also help alleviate increased runoff from infill development over time, which may otherwise cause stream erosion.

An extensive supply of woody riparian vegetation is a necessary component of beaver habitat and also adds to stream stability by strengthening banks and slowing overbank flow. In meeting with the policy recommendations to encourage beaver activity, a budgeting tool is provided in the CIP for riparian planting. Planting of trees within riparian corridors will increase the supply of the woody vegetation necessary to foster beaver habitat.

The new NPDES permit requires that CWS must conduct a hydromodification assessment of the watershed. However, it is not clear whether CWS will require their jurisdictions such as the City of Sherwood to participate financially in conducting the assessment. Furthermore, anticipated changes to the FEMA NFIP could result in the City, as an NFIP program participant, needing to perform an independent assessment of their floodplain corridors as part of a baseline hydromodification assessment.

As a conservative measure, the cost of such a study has been included in the CIP for budgeting purposes. The study would typically involve continuous simulation of storm runoff to estimate natural, existing, and proposed runoff pre- and post-development. A critical component of the hydromodification assessment would be to determine the range of channel forming flows that would be important to target for flow control. The results of this study could then be used to update City policies for stormwater management in meeting with NPDES permit requirements.

# SECTION 7 | CAPITAL IMPROVEMENT PROGRAM

## INTRODUCTION

This section summarizes the City of Sherwood (City) Capital Improvement Program (CIP), which consists of a list of prioritized stormwater system projects and estimated costs in 2015 dollars. The CIP is a blueprint for forecasting capital expenditures and is one of the most important means of meeting the City's obligation towards community development and financial planning.

The CIP is a direct result of the condition analysis described in Section 3, "Existing System Description" and the capacity analysis described in Section 5, "System Analysis." All projects were analyzed at a planning level of accuracy based on land use assumptions described in Section 2, "Study Area Characteristics". Prior to implementation, each project should undergo standard engineering design phases to finalize improvement sizing and location.

Improvements associated with the "Future Growth Areas," discussed in Section 2, are excluded from this CIP. As these future planning areas are urbanized, private developers are anticipated to fund the improvements required to serve their respective projects. As the City reviews development applications within the planning areas, opportunity will be provided to compare proposed conveyance and water quality treatment improvements against their concept plans.

## STORMWATER CAPITAL IMPROVEMENTS PROGRAM

The City's CIP is organized into categories based on project type and prioritized based on system age and risk of design criteria violation. Project descriptions and cost estimates are provided in Table 7-1 and presented in Figure 7-1. The major categories include Condition, Stormwater Management, and Planning and are described below.

### *Project Type*

- *Condition* – These improvements include the replacement and repair of existing manholes or pipelines to address aging infrastructure.
- *Stormwater Management* – These improvements include regional treatment and/or detention facilities that address water quality degradation caused by existing and future development.
- *Planning* – This SWMP will eventually become outdated due to future development, expansion of the Urban Growth Boundary (UGB), and modification of regulatory policies over time. These projects provide a framework for future development and assess changes in the regulatory environment that influence future improvement needs.

### Project Prioritization

Improvements were prioritized into three timeframes, including the short-term (0-5 years), medium-term (6-10 years), and long-term (11-20 years). Condition-based improvement prioritization is based on the following guidelines:

- Improvements to repair and replace pipelines and manholes are assumed to occur at a similar rate of investment for each 5-10 year period.
- Improvements are prioritized based on relational groupings. Clusters of projects in close proximity to each other are anticipated to require reduced construction mobilization and staging costs, therefore will result in a greater economy of scale during construction and assigned a higher priority. Where the opposite is true, remote and scattered project grouping are anticipated to have economy of scale and therefore are assigned a lower priority.

For Stormwater Management project types, improvements are prioritized based on the following guidelines:

- Improvements identified in the City's current CIP for the next five years are identified in the 0-5 year timeframe.
- Improvements are assumed to occur at a similar rate of investment for each 5-10 year period.

For Planning projects types, capital expenditures are prioritized based on the following guidelines:

- Expenditures identified in the City's current CIP for the next five years are identified in the 0-5 year timeframe.
- Expenditures anticipated to result from updates to regulatory permit requirements are assigned the highest priority.

### Project Driver

The CIP also identifies the project catalyst, or driver, in addition to the prioritization categories and timeframes. Project timeframes can be delayed without impacting the performance of the stormwater system should the driver not materialize. Often, phased development may be allowed without fully implementing a project. Likewise, if the project driver occurs sooner than the assumed timeframe, some improvement projects may require acceleration. Notes are provided in the CIP tables to assist the City in understanding project timing related to specific development. Common drivers include:

- *Pipe & Manhole Condition* – As the City updates its condition assessment of existing infrastructure, critical degradations are prioritized over others.
- *Regulatory* – The projects identified in the CIP are strategically located to either manage stormwater originating from existing impervious areas, or address future hydromodification permit requirements. Completing these projects is anticipated to meet future outfall retrofits and hydromodification NPDES permit requirements (see

Section 4). Alternatively, these projects can be implemented as available funding materializes to improve water quality within the City's streams.

- *UGB-Infill* – Projects classified by this driver result from infill development within the UGB. As redevelopment occurs in these largely undeveloped areas, hydromodification effects may be triggered by stormwater runoff originating from increased impervious surfaces. Extended detention basins are located to manage stormwater runoff from large tracts of land, while riparian plantings placed along the City's streams encourage beaver activity (see Appendix C).

It is important to note that areas with established Concept Plans, such as the Brookman Concept Area and the Tonquin Employment Area (TEA), have been excluded from the CIP. These projects have not been included since they will be driven by development in these areas and, therefore, will be the responsibility of developers. This responsibility includes funding and submission for review to the City of planning and design components related to stormwater management and the stormwater network.

### *Cost Estimation*

Costs presented in the CIP tables are estimated using an approach outlined in the Basis of Opinion of Probable Cost, contained in Appendix D. This document contains the assumptions used in developing project costs, addressing such items as unit costs for materials, labor and construction, contingency factors, and the City's administrative costs.

All project descriptions and cost estimates in this document represent a Class 5 budget estimate, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 50-percent below the estimate to 100-percent above the estimate.

The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035 which define "rough cost estimates" for facility plans as "approximate costs expressed in current-year dollars." These estimates are intended to "provide an estimate of the fiscal requirements to support the land use designation" and "for use by the facility provider in reviewing the provider's existing funding mechanisms." They are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate. The CIP cost estimates should be reevaluated periodically to account for changes in inflation. It is important to note that the CIP omits costs for routine maintenance.

## CAPITAL IMPROVEMENT PROGRAM FUNDING

Capital improvements within the City are primarily funded through the following mechanisms:

- The City funds capital improvements impacting existing customers through utility revenues generated from stormwater rates. These costs are allocated to the City's Stormwater Operating Fund.
- Capital improvements for future development, or growth are funded through System Development Charges (SDCs) as allowed under Oregon Revised Statute 223.297 through 223.314. These costs are allocated to the City's Stormwater SDC Fund.

The City may also seek funding and financing of specific projects through these additional internal and external sources:

- Business Oregon, including Community Development Block Grants, the Stormwater program, and the Special Public Works Funds
- Developer dedications
- Oregon Immediate Opportunity Program
- Oregon Industrial Development Revenue Bonds
- Oregon Infrastructure Bank
- City General Obligation Bonds
- City Local Improvement Districts
- City Stormwater Revenue Bonds
- City Urban Renewal Program

### *SDCs and Percent Related to Growth*

For each improvement project, a growth percentage is provided in the CIP table to aid the City in establishing SDCs for the stormwater system. For improvements that benefit both current and new customers, the growth percentage can be applied to the project cost to allocate funding requirements through collection of SDCs.

The methodology used to calculate the growth percentage for a proposed project employs a formula (shown below) based on the ratio of existing and future flows.

*Percent related to growth = 1 – (Existing Impervious Area / Developed Impervious Area).*

The growth percentage relates directly to SDC percentage. The percentage not related to growth is funded through stormwater rates (e.g. Stormwater Operating Fund).

**Table 7-1 | Capital Improvement Program**

| Project Type | Project ID | Project Description | Basin(s) | Time Frame | Driver | Length (ft.) / Improvement Diameter (in.) Sizing Information (Stormwater Management) | | Growth Ratio[4] | Estimated UGB Cost [1,2,3] |
|---|---|---|---|---|---|---|---|---|---|
| Condition | 1 | SW Willamette St & SW Norton Ave, & SW Martin Ct, & SW Lincoln St & SW Oregon St | Rock Creek | 10-year | Pipe & Manhole Condition | 962 | 10 - 24 | N/A | $370,000 |
| | 2 | SW Merryman St, North to SW Oregon St (beneath properties) | Rock Creek | 20-year | Pipe & Manhole Condition | 2,102 | 10 - 36 | N/A | $680,000 |
| | 3 | SW Lower Roy St to SW Oregon St, SW Hall Street & SW Merryman St, & SW Lower Roy St & SW Brickyard Dr, & SW Hall St, SW Nottingham Ct to SW Oregon St | Rock Creek | 20-year | Pipe & Manhole Condition | 1,252 | 8 - 36 | N/A | $580,000 |
| | 4 | SW Galbreath Dr, Northeast of 13910 SW Galbreath Dr, & SW Tualatin Sherwood Rd & SW Dahlke Ln | Rock Creek | 20-year | Pipe & Manhole Condition | 398 | 10 - 12 | N/A | $80,000 |
| | 5 | 16956 SW Meinecke Rd (beneath property), & SW Meinecke Rd & SW Lee Dr, & 16956 SW Meinecke Rd (beneath property) | Cedar Creek | 20-year | Pipe & Manhole Condition | 291 | 12 | N/A | $70,000 |
| | 6 | SW Sherwood Blvd & SW Langer Dr, & SW Jonquil Ter, Across from 20649 SW Jonquil Ter, & SW Roy Rogers Rd, Behind 17438 SW Roosevelt St | Cedar & Chicken Creeks | 20-year | Pipe & Manhole Condition | 683 | 12 - 30 | N/A | $330,000 |
| | | | | | | | | | |
| Stormwater Management | 7A [5] | Extended Detention Basin; Existing Ponds, 14647 SW Oregon St (Predesign) | Rock Creek | 5-year | UGB-Infill | TBD | | 0% | $35,000 |
| | 8 [5] | NW 2nd Street and NW Park Street Stormwater Facility Rehab (Design) | Cedar Creek | 5-year | Regulatory - Retrofit | TBD | | 0% | $35,000 |
| | 9 | Proprietary Catch Basin; 23249 SW St Charles Way, West of 23159 SW St Charles Way | Cedar Creek | 5-year | Regulatory - Retrofit | 2 x 2-Cartridge Catch Basin. | | 0% | $70,000 |
| | 10 | Proprietary Catch Basin; 23249 SW St Charles Way, West of 23385 SW St Charles Way | Cedar Creek | 5-year | Regulatory - Retrofit | 2 x 2-Cartridge Catch Basin; Consideration of vault if Archer Glen Elementary School discharge is treated. | | 0% | $70,000 |
| | 11 | Swale; West edge of 22257 SW Washington St & 16956 SW Meinecke Rd | Cedar Creek | 5-year | Regulatory - Retrofit | Designed with TRUST Model, Bottom Area: 1,820 ft$^2$ Side Slopes: 4 to 1 (H to V); Effective Depth: 1.0 ft | | 2% | $110,000 |
| | 7B | Extended Detention Basin; Existing Ponds, 14647 SW Oregon St | Rock Creek | 10-year | UGB-Infill | Existing site should be investigated for redevelopment as extended detention facility. | | 19% | $150,000 |
| | 12 | Extended Detention Basin; Southeast of 16518 SW Gleneagle Dr | Cedar Creek | 10-year | Regulatory - Hydromodification | Designed with TRUST Model, Bottom Area: 9,000 ft$^2$ Side Slopes: 3 to 1 (H to V); Effective Depth: 3.0 ft | | 17% | $170,000 |
| | 13 | Proprietary Vault; Southwest of 16574 SW Gleneagle Dr | Cedar Creek | 10-year | Regulatory - Retrofit | 8-Cartridge Vault. | | 1% | $110,000 |
| | 14 | Proprietary Catch Basin; Southwest of 16678 SW Gleneagle Dr | Cedar Creek | 10-year | Regulatory - Retrofit | 1 x 4-Cartridge Catch Basin, 1 x 1-Cartridge Catch Basin. | | 0% | $80,000 |
| | 15 | Proprietary Catch Basin; Southwest of 16738/16748 SW Gleneagle Dr | Cedar Creek | 10-year | Regulatory - Retrofit | 1 x 2-Cartridge Catch Basin. | | 4% | $70,000 |
| | 16 | Extended Detention Basin; 20015 SW Pacific Hwy (Northwest of buildings) | Chicken Creek | 20-year | Regulatory - Hydromodification | Designed with TRUST Model, Bottom Area: 12,000 ft$^2$ Side Slopes: 3 to 1 (H to V); Effective Depth: 4.5 ft | | 39% | $220,000 |
| | 17 | Swale; 14645 SW Willamette St | Rock Creek | 20-year | Regulatory - Retrofit | Designed with TRUST Model, Bottom Area: 2,400 ft$^2$ Side Slopes: 4 to 1 (H to V); Effective Depth: 1.0 ft | | 7% | $120,000 |
| | 18 | Swale; 22210 SW Murdock Rd | Rock Creek | 20-year | Regulatory - Retrofit | Designed with TRUST Model, Bottom Area: 2,000 ft$^2$ Side Slopes: 4 to 1 (H to V); Effective Depth: 1.0 ft | | 0% | $120,000 |
| | 19 | Extended Detention Basin; Northwest corner of 22900 SW Murdock Rd | Rock Creek | 20-year | UGB-Infill | Designed with TRUST Model, Bottom Area: 12,544 ft$^2$ Side Slopes: 3 to 1 (H to V); Effective Depth: 3.5 ft | | 57% | $330,000 |
| | 20 | Riparian Area Planting: Confluence to SW Sunset Boulevard | Cedar Creek | 20-year | Regulatory - Hydromodification | N/A | | 0% | $344,000 |
| | | | | | | | | | |
| Planning | 21 [5] | Master Plan Update | All | 5-year | UGB Growth & Expansion | N/A | | N/A | $6,000 |
| | 22 | Hydromodification Study | All | 10-year | UGB Growth & Expansion | N/A | | N/A | $125,000 |
| | 23 | Master Plan Update | All | 20-year | UGB Growth & Expansion | N/A | | N/A | $250,000 |
| | | | | | | | | **Total** | **$4,525,000** |

## SUMMARY

This section presents a proposed City CIP for the 20-year period between 2015 and 2035, as shown in Table 7-1 and Figure 7-1. Improvements are defined to address condition issues within the existing system and future growth within the City's UGB. The total estimated project costs are summarized in Table 7-2.

**Table 7-2 | Capital Improvement Program Summary (Estimated Total Costs)[1,2,3]**

| Project Type | Time Frame (Cost) | | | Total Cost |
|---|---|---|---|---|
| | 0-5 Years | 6-10 Years | 11-20 Years | |
| Condition | $0 | $370,000 | $1,740,000 | $2,110,000 |
| Stormwater Management | $320,000 | $580,000 | $1,134,000 | $2,034,000 |
| Planning | $6,000 | $125,000 | $250,000 | $381,000 |
| Total | $326,000 | $1,075,000 | $3,124,000 | $4,525,000 |

### *Notes for Tables 7-1 and 7-2*

Note 1. Cost estimates represent a Class 5 budget estimate, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 20 percent below the estimate to 100 percent above the estimate. The cost estimates are consistent with the definition of OAR 660-011-0005(2) and OAR 660-011-035. They are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate.

Note 2. Cost estimates for new infrastructure improvements assume unit costs for new materials and construction. Cost estimates for pipe upsizing and condition based improvements assume unit costs for replacement materials and construction. All cost estimates include markups for construction contingency, owner administrative costs, and contract costs. Right-of-way acquisition costs, property purchase, and legal condemnation fees are excluded from the estimates.

Note 3. All improvements are sized for build-out of the upstream service area at a planning level of accuracy based on land use assumptions described in Section 5 of this document. Improvement sizing is limited to service within the existing UGB. Prior to implementation, each project should undergo standard engineering design phases to finalize improvement sizing and location.

Note 4. The growth percentage is an estimate of the percentage of the build-out flow associated with future development within the existing UGB, calculated by the formula: *Percent related to growth = 1 – (Existing Impervious Area / Developed Impervious Area).*

Note 5. This project is a pre-existing budget item.

City of Sherwood Oregon

**FIGURE 7-1**

**CITY OF SHERWOOD**

**STORMWATER MASTER PLAN**
**CAPITAL IMPROVEMENT PROGRAM**

MSA Murray, Smith & Associates, Inc. Engineers/Planners
123 NW Kearney, Suite 900 PHONE 503.225.9010
Portland, Oregon 97209-2919 FAX 503.225.9022

**SEPTEMBER 2016**

Note:
Future Concept Plan Facilities were delineated based on Concept Plan locations for the Brookman Concept Area and Tonquin Employment Area.

Call-outs represent Improvement Project IDs. The brown dashed outline approximates the project bounds for Project 20.

SW EDY RD
SW ELWERT RD
SW PACIFIC HWY
SW KRUGER RD
SW SUNSET BLVD
SW MAIN ST
SW TUALATIN SHERWOOD RD
NE OREGON ST
SW BAKER RD
SW BROOKMAN RD
99W

Chicken Creek
Cedar Creek
Rock Creek
Goose Creek
Coffee Lake
Rock Creek

Sherwood
Tonquin Employment Area (TEA)
Brookman Concept Area

16 6 15 14 13 20 12 5 11 8 9 10 7A, 7B 2 3 4 18 17 19 1

FUTURE CONCEPT PLAN FACILITY
PROPOSED FACILITY
WATER QUALITY MANHOLE
MANHOLE
EXTENDED DETENTION POND
SWALE
RETENTION BASIN
LIDA
DITCH
CULVERT
CITY STORM SEWER LINE
CONDITION PROJECT
CITY BOUNDARY
STUDY AREA
TAXLOT
WATER BODY
STREAM
WETLAND

N W E S

0 0.5 Mile

G:\PDX_Projects\15\1638_Sherwood_Sanitary_Sewer_MP\GIS\MXD\FIGURE 7-1_11x17_A.mxd 8/10/2016 8:36:55 AM Thomas.Walsh

# APPENDIX A | INTERGOVERNMENTAL AGREEMENT

# AMENDMENT TO INTERGOVERNMENTAL AGREEMENT BETWEEN CITY OF SHERWOOD AND CLEAN WATER SERVICES

THIS AMENDMENT is made and entered into as of the 1st day of July, 2008, between the **City of Sherwood,** a municipal corporation of the State of Oregon, hereinafter referred to as "City," and **Clean Water Services**, a municipal corporation and county service district, hereinafter referred to as the "District."

WHEREAS City and District entered into an Intergovernmental agreement (IGA) on January 4, 2005 for the operation of sanitary sewer and surface water facilities; and

WHEREAS Section 7 of that IGA allows the agreement to be amended upon approval of the governing bodies of both parties; and

WHEREAS that IGA is now in need of amendment.

NOW, THEREFORE, it is agreed that the IGA be amended as follows:

1. In the recitals, revise the second "Whereas" statement to read:

   WHEREAS as a county service district organized under ORS 451, the District has the legal authority for the sanitary sewerage and storm water (surface water) management programs within its boundaries consistent with relevant laws, rules and agreements. The District performs watershed, sub-basin and facility planning, develops standards and work programs, is the permit holder, and operates and maintains wastewater treatment facilities, ~~surface water collection system and~~ the public sanitary sewer conveyance systems, and the public surface water collection systems within ~~unincorporated areas and within certain cities within~~ its boundaries~~. The District also performs various ancillary functions throughout the basin and within various cities~~; and

2. In Section 1, Definitions, add the following new definitions, number them alphabetically, and renumber the existing definitions:

   A. Local Program – The elements of the work program that are available for the City to perform.

   B. District Wide Program – The elements of the work program that are performed exclusively by the District in all areas within the District's boundary.

   C. Roadside Facilities include all of the following stormwater facilities within road rights of way:

1. Roadside Ditches and Swales are man-made ditches on one or both sides of roadways, within the road right-of-way and generally intended for the collection and conveyance of storm and surface water runoff from the road.

2. Driveway Culverts are short pipes passing under driveways connecting two sections of roadside ditch.

3. Roadside Ditch Cross Piping is the piping system connecting a roadside ditch or roadside piping system on one side of the road to a roadside ditch or roadside piping system on the other side of the road, and being at the grade of the roadside ditches or piping systems.

4. Roadside Piping Systems are shallow pipes and inlets on one or both sides of a road, which are generally at a similar grade as typical roadside ditches, and generally lack manholes.

3. Revise Section 2 to read:

"Section 2. Determination of Programs, Rules, Policies and Standards

The District is responsible for the management and operation of the public sanitary sewer and storm and public surface water systems within its boundary, and is the designated permittee who shall obtain and enforce timely compliance with relevant Federal and delegated State Clean Water Act permits for treatment plants, collection systems, and stormwater. The District, after considering input from the cities, shall adopt orders, standards, specifications, work programs, reporting requirements, and performance criteria for the proper and effective operation of the sanitary sewer and storm and surface water systems and to comply with State and Federal permits, laws and regulations. In addition, the District, after considering input from the cities, shall have the authority to make changes to its orders, work programs, reporting requirements, and performance Standards. Any such changes to work programs, reporting requirements, and performance standards that the Board determines are necessary to meet or are required by state and/or federal permits or regulations will become effective 90 days from the date of notice to City by District or as mutually agreed to. Any changes to work programs, reporting requirements, and performance standards, not required by state and/or federal permits and regulations, shall be mutually agreed to by the District and City before they become effective. Proposed changes not required by state and/or federal permits and regulations should be communicated between the District and the City in or before December of the year before they are to be implemented to allow District and City to budget appropriately for the following fiscal year.

A. City agrees to follow and enforce the Orders, Standards, specifications, work programs, reporting requirements, and performance criteria promulgated by the District, subject, however, ~~to program funding and~~ to the extent that City may be lawfully authorized to act. The City shall not be responsible for any failure to act or defect in performance caused by ~~lack of adequate program funding,~~ inadequacies in the Work Program and Performance Standards as adopted by the District, or lack of lawful authority to act. ~~Lack of adequate~~

~~funding from the District and~~ Compliance with the Work Program and Performance Standards as adopted by the District shall be absolute defenses to any claim against the City under this Agreement. City further agrees to notify District of apparent violations of the subject Orders, Standards, specifications, work programs, and performance criteria, of which it has knowledge, which may require District legal action or enforcement.

4. Revise Section 3.A.1 to read:

   The purpose of this agreement is to delegate to and contract with the City to perform specific ~~functions~~portions of the Local Program. The responsibilities of the District and City are defined in this Section and Appendix A. Exhibit A is a map showing boundaries of responsibility between the District and City and is hereby made a part of Appendix A and incorporated into this agreement.

5. Revise Section 3.B.2 to read:

   Responsibilities defined in this Section and Appendix A may be modified by the District Board after receiving input from the City and determining the change is necessary to meet or comply with State or Federal permits, laws or regulations. The District Board shall not reduce the total scope of City responsibilities without consent of the City unless there is a change in the program or funding requiring the reduction, or unless the Board determines the City has failed to correct identified instances of nonperformance related to the adopted standards that are necessary to meet or comply with state or federal permits, laws or regulations. The District Board may adopt procedures regarding determination of nonperformance.

6. Revise Section 3.B.3 to read:

   Upon reasonable notice from City to District, District shall assume responsibility for any portion of the Local Program defined in this Section and Appendix A. Reasonable notice shall be at least 6 months, unless agreed to in writing by the District and City. Corresponding adjustments to the revenue allocation shall be made to reflect the change in responsibility upon implementation of such changes. City shall be responsible for correcting or paying to have corrected any deficiencies in the system resulting from non-performance of the programs under its responsibility~~, subject, however, to funding availability~~. For any Local Program activity the City previously elected to be performed by the District, the City may at any time request that activity be transferred back to being a City responsibility by following the procedures in Section 3.B.1 above. The District shall approve the request unless the District determined the City can not provide a reasonably equivalent level of overall efficiency. The date of the transfer of responsibility shall be as mutually agreed to, or in no case longer than one year from the date of the request.

7. Revise Section 3.C.2 to read:

   Require persons who are proposing 'development', as defined in the District's Design and Construction Standards Resolution and Order, to obtain a Service Provider Letter from the District. City shall not issue a stormwater connection permit without verification that the District has issued a Service Provider Letter.

8. Revise Section 3.C.6 to read:

   Inform the District in writing not less than 30 days prior to initiating or entering into any agreement for the financing or incurring of indebtedness relating to the storm and surface water system or the sanitary sewerage system. Revenues ~~allocated by the District to the City~~ defined in Section 4 of this agreement for the performance of functions identified in Appendix A are considered restricted, and may only be used to perform those functions (including reasonable administration) delegated to the City for such things as operation and maintenance of the sanitary or storm and surface water system. City shall not obligate any assets or facilities of the District's sanitary or storm and surface water system for any debt. For purposes of debt funding, the District's asset schedule for storm and surface water and sanitary sewer facilities shall be the basis for determining ownership within City boundaries. In general, sanitary sewer lines 24" and over are the property of the District regardless of location, as are sanitary treatment plants and pump stations, and storm and surface water quality and quantity facilities that are one acre or greater in surface area.

9. Revise Section 4 to read:

   Section 4. Determination of Monthly Service Charge Rates and System Development Charges; ~~and Division of Revenue;~~ Operating Procedures and Rules Relating to Revenue and Reporting

   A. ~~After consultation between City and district staff, the District Board shall determine and certify annually for both the sanitary sewerage system and for the storm and surface water system the monthly service charge and system development charge. The City agrees to impose these charges as a minimum. The City may impose additional charges as allowed in Section 4.E.4.~~

   B. ~~After consultation between City and district staff, the District Board shall determine and certify annually for both the sanitary sewerage system and for the storm and surface water system the portion of the monthly service charge and system development charge to be retained by the City for performance of the functions defined in this Agreement and for the City's share of annual debt service payment. Except as provided in Section 4.D, District shall notify City by the September preceding the start of the next Fiscal Year of any proposed decrease in the monthly service charge and system development charge to be retained by the City and any other proposed changes that could affect the City's 5-Year Sanitary Sewer or Stormwater Financial Forecast Plans.~~

~~C. The District Board shall not implement any significant change in the division of monthly service charge revenue from that shown in the Rates and Charges Resolution and Order No. 01-34 effective Fiscal Year 2001/2002 until July 1, 2004 with the following exceptions:~~

~~1. The Board may make routine principal and interest adjustments for debt service repayment.~~

~~2. The Board may make adjustments in response to significant increases or decreases in program responsibilities~~

A. Setting of Rates and Charges

1. After consultation between City and District staff, the District Board shall determine and certify for the Storm and Sanitary Sewer programs:

   a. District Wide System Development Charges that apply in all areas within the District boundary.
   b. Local System Development Charges that apply to areas outside of the City Limits.
   c. District Wide Monthly Service Charge Rates that apply in all areas within the District boundary.
   d. Monthly Service Charge Rates for the Local Program that apply to the areas outside the City limits.
   e. Funding levels for elements of the Local Program performed by the District within the City's Area of Geographic Responsibility.
   f. Funding levels for elements of the Local Program performed by the District within the City Limits but outside of the City's Area of Geographic Responsibility.
   g. Funding levels for elements of the Local Program performed by the City outside of the City Limits but inside the City's Area of Geographic Responsibility.
   h. Funding levels for elements of the Local Program performed by the District within the City Limits but outside of the City's Area of Geographic Responsibility where the City identifies a higher level of service than in the District's adopted standards.
   i. Elements within items "e" through "h" of this subsection may be expressed in terms of monthly service charge rates or rates per unit of facility.

2. The City shall set for the Storm and Sanitary Sewer programs:
   a. Local System Development Charges that apply to areas inside the City Limits.
   b. Monthly Service Charge Rates for the Local Program that apply to the areas inside the City Limits.

B. Collection of Rates and Charges as set in Section A above

1. The District shall collect for both the Storm and Sanitary Sewer programs:
   ~~a. System Development Charges in areas where the District issues connection~~ permits.

b. Local and District Wide Monthly Service Charges in areas where the District provides the billing function.

2. The City shall collect for both the Storm and Sanitary Sewer programs:
   a. Local and District Wide System Development Charges in areas where the City issues connection permits.
   b. The Monthly Service Charges for the District Wide Rate and the Local Rate in areas where the City provides the billing function.

C. Transfer and Remittance of Funds

1. The District shall transfer to the City the portion of the Storm and Sanitary Sewer revenue from the Local Rate collected for the elements of the Local Program performed by the City in areas that are inside the City's Area of Geographic Responsibility, but where the District does the billing.

2. The City shall transfer to the District for the Storm and Sanitary Sewer Programs:

   a. Revenue from the District Wide System Development Charges collected by the City.
   b. Revenue from the District Wide Monthly Service Charge Rate collected by the City.
   c. The portion of the revenue from fees and the Local Monthly Service Charge rate for the elements of the Local Program performed by the District within the City Limits and within the City's Area of Geographic Responsibility.
   d. The portion of the revenue from fees and the Local Monthly Service Charge rate for the elements of the Local Program performed by the District within the City Limits but outside the City's Area of Geographic Responsibility.
   e. Funds for performance of elements of the work program by the District within the City Limits but outside the City's Area of Geographic Responsibility where the City has identified a higher level of service than in the adopted District standards.

D. ~~Changes in the division of revenue will typically be made as a part of the annual Fiscal Year budget process. However, the division of revenue may be adjusted by the District to recognize changes in responsibilities that occur outside the normal budget cycle after coordination and communication with the Cities. Any such mid-year changes in the division of revenue initiated by the District Board shall only be implemented when the Board determines such a change is necessary to comply with State or Federal permits, laws or regulations. If there is a mid-year change in responsibilities, which the District determines to be significant, the District Board may, upon 60 days notice to City, adjust the division of revenue outside of the annual budget process.~~ Determination by the District of the items in Section 4.A.1 will typically be made as a part of the annual Fiscal Year budget process. However, these rates and funding levels may be adjusted by the District to recognize changes that occur outside the normal budget cycle after coordination and communication with the Cities. Any such mid-year changes initiated by the District Board shall only be implemented when the Board determines such a change is

necessary to comply with State or Federal permits, laws or regulations, or that are due to changes in responsibility.

E. Operating Procedures Relating to Revenue

~~1. City shall remit to the District the portion of sanitary sewer service charges and systems development charges collected, and storm and surface water service charges and systems development charges collected, less the City Portion, as identified in Section 4.B.~~

1. Payments shall be remitted on a monthly basis, with a report on District designated forms.

2. Payments ~~to the District~~ of revenue collected by the billing party shall be due within 20 days following the end of each month, unless the payment has been appealed by the billing party.

3. City may charge and collect a Local Monthly Service Charge or System Development Charge at a higher rate per DUE and ESU than that set by the District when the City determines it is needed for the Local ~~City~~ Program elements performed by the City. ~~system. The City shall retain 100% of these additional revenues collected.~~ Such additional charge shall be consistent with the services provided by City and with applicable federal rules in order to preserve eligibility for grants and other funding programs.

~~4. City may request District to perform permit and inspection services for private development construction of public storm and surface water facilities and sanitary sewer facilities, and for erosion control. City shall remit to the District the fee set forth in District's Rates and Charges to compensate District for its costs for such services performed relative to these fees, as prescribed by District Order or separate agreement with City.~~

4. For Industrial Waste fees, District shall remit to City 5 percent ~~a percentage~~ of system development charges, and 15 percent of the volume, and monthly service charges collected within the City's Area of Responsibility~~equal to the percentages of service charges retained by the City as defined in Section 4.B~~. District shall retain one hundred percent (100%) of the annual Industrial Waste permit fee, and any penalty fees, COD, SS (as those terms are defined in the Rates and Charges) and other fees related to Industrial Waste that may be assessed.

5. City will institute administrative procedures to diligently maintain regular billings and collection of fees, adjust complaints thereto, and pursue delinquency follow-ups and take reasonable steps for collection thereof.

~~6. City and District shall each establish separate accounts for the storm and surface~~ water program and sanitary sewerage program for the purpose of accounting for

service charges and systems development charges collected and received pursuant to this agreement.

7. District or City may at any reasonable time upon reasonable notice inspect and audit the books and records of the other with respect to matters within the purview of this Agreement.

8. City and District shall each prepare and submit to each other a performance report of the storm and surface water functions, and the sanitary sewer functions for which each is responsible. After consultation with the City, District will specify the requirements, frequency, and content of the performance report.

9. The City and District may, each at its own cost, install permanent and temporary volume and quality monitoring stations, and other monitoring equipment, to determine the effectiveness of City and District programs.

10. Interest shall accrue on late monthly payments as specified in Section 4.C~~E.1~~ at a rate of 1.25 times the monthly Local Government Investment Pool (LGIP) earnings rate as posted for the previous month, and will be applied each month to the unpaid balance.

11. The City and District will form a CIP Review Committee along with representatives from other Cities within the District's boundary for the purpose of recommending the prioritization and funding of sanitary sewer and Stormwater collection system projects. Board will adopt the CIP funding and project selection only after holding a public hearing to allow the Cities to provide additional input to the Board.

10. Revise Section 5.G to read:

District and City acknowledge that District may receive notices of violation or fines from state or federal agencies for violations of state or federal rules. As the permittee and the entity that establishes standards and controls payment, District shall be responsible for responding to notices of violations and for payment of all fines. District shall invite the City to participate in any discussions with State and Federal agencies regarding notices of violation involving City actions or responsibility. City will cooperate with District in the investigation and response to any notice of violation involving actions relating to actions or responsibilities of the City. If a fine is imposed, City shall reimburse District to the extent that the fine results from non-performance of adopted programs or non-compliance with District, State, or Federal rules or policies by the City and those acting on behalf of the City. If possible, the City shall reimburse the District prior to the date due for payment of the fine. ~~The City shall not be responsible for reimbursement if the City's non-performance or non-compliance was caused by lack of adequate funding by District.~~ If more than one party is responsible, the City's responsibility for reimbursement payment will be allocated based on the degree of responsibility and degree of fault of the City. Disputes over the amount of reimbursement shall be resolved by the dispute resolution process set out in Section 6 of this Agreement. ~~To the extent that the City is required to perform any work to correct a violation,~~

~~District shall provide adequate funding for the work to be performed, unless the violation was caused by the City's omission or misconduct.~~

11. Revise Section 7 to read:

1. This Agreement shall supersede all prior agreements of similar scope and subject matter, including amendments and the "City Committee Agreement" between the parties with respect to sanitary sewerage and service, storm and surface water management; provided that, except as expressly modified herein, all rights, liabilities, and obligations of such prior agreements shall continue. This agreement shall be effective upon its execution by both parties hereto, and unless terminated earlier, shall end at the end of the day on June 30, 2027 ~~and shall continue in effect for four renewable terms of five years each~~.

2. ~~This Agreement shall be deemed automatically renewed for a single succeeding five year term up to a limit of 25 years, unless either party gives the other written notice not less than one year prior to the nominal expiration of term of its intent not to renew this agreement~~. This agreement may be terminated when either party gives the other written notice per the dates in the table below of its intent not to renew this agreement, and the agreement shall then terminate on June 30 of the following calendar year.

| Notice given on or prior to June 30 of | Termination effective at the end of the day on June 30 of |
|---|---|
| 2009 | 2010 |
| 2010 | 2011 |
| 2011 | 2012 |
| 2016 | 2017 |
| 2021 | 2022 |

3. The notice of termination may be withdrawn at any time prior to the termination date with written approval of the City's Chief Executive Officer and District General Manager.

4. If District enters into an intergovernmental agreement with any other city in its territory covering the same subject as this Agreement and if any of the provisions of the other agreement differ from this Agreement, the City may elect to replace any provision of this Agreement with the parallel provision from the other agreement, with the exception of Appendix A and Exhibit A. The replacement shall be effective on receipt by District of written notice from the City. This Agreement may not otherwise be modified except by written amendment or as otherwise specified in this Agreement.

IN WITNESS WHEREOF, this instrument has been executed in duplicate by authority of lawful actions by the Council and District's Board of Directors.

CLEAN WATER SERVICES

By _____
FOR General Manager

Approved as to Form:

_____
Attorney for District

CITY OF SHERWOOD, OREGON

By _____
City Manager

Attest: _____
City Recorder

_____
City Attorney

AMENDMENT TO CITY AGREEMENT

The City of Sherwood (City) and Clean Water Services (District) have entered into an Intergovernmental Agreement dated January 4, 2005. Section 3.B of that agreement allows the parties to modify Appendix A of that agreement (the Responsibility Matrix) with the approval of the District's General Manager and the City's Administrator/Mayor. The revised Appendix A is attached and will take effect July 1, 2008. Both parties hereby acknowledge amending Appendix A to change the effective date to July 1, 2008.

Approved by both parties on July 1, 2008.

CLEAN WATER SERVICES

By _____
For General Manager

CITY of Sherwood, OREGON

By _____
City Administrator/Mayor

Approved as to Form:

_____
District Counsel

_____
City Attorney

| APPENDIX A | | | | V12b 4/14/08 |
|---|---|---|---|---|
| Sherwood | | | | |
| | | | | |
| **DIVISION OF RESPONSIBILITIES** | **EFFECTIVE JULY 1, 2008** | | | |
| | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" | Effective Dates. Unless shown differently, activities are effective July 1, 2008 and continue through the term of the agreement |
| I. Sanitary Maintenance | | | | |
| A. Local Program | | | | |
| Lines under 24" | | | | |
| Line Cleaning | City | City | District | |
| Manhole and lid maintenance and adjustment (excluding sealing) | City | City | District | |
| Root Cutting and Chemical Control | City | City | District | |
| Maintenance TV inspection (See Engineering Section for new construction TV) | City | City | District | |
| Vector Control | City | City | District | |
| Surface Inspection, marking, self closing lids, of lines in stream corridors | City | City | District | |
| Easement and Access Road Maintenance | City | City | District | |
| Siphon maintenance where line leading to siphon is under 24" | City | City | District | |
| Overflow and Complaint response, investigation, and reporting | City | City | District | |
| Emergency response | City | City | District | |
| Utility Locates | City | City | District | |
| Minor repairs including point repairs and individual laterals | City | City | District | |
| | | | | |
| B. District Wide Program | | | | |
| Lines 24" and Larger | | | | |
| All O&M on lines 24" and larger | District | District | District | |
| Siphon maintenance where line leading to the siphon is 24" and larger | District | District | District | |
| | | | | |
| All Lines and All Areas | | | | |
| Compilation of TV reports and system-wide evaluation | District | District | District | |
| Non-structural line sealing (pressure grouting) | District | District | District | |
| Manhole rehabilitation (sealing) | District | District | District | |
| Treatment Plant O&M | District | District | District | |
| Pump Station O&M | District | District | District | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| II. CIP (Service Charge Rate and SDC Funded) | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" | |
|---|---|---|---|---|
| A. Local Program | | | | |
| Lines Under 24" | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements | City | District | City | This row is effective July 1, 2008 through June 30, 2009*** |
| Repairs and rehabilitation to abate I&I | City | District | City | This row is effective July 1, 2008 through June 30, 2009*** |
| | | | | |
| Lines Under 12" | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements (except projects for Collection system I&I abatement projects) | City | District | City | This row is effective beginning July 1, 2009 and continues through the term of the agreement.*** |
| | | | | |
| | | | | |
| B. District Wide Program | | | | |
| Lines 24" and Larger | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements | District * | District * | District * | This row is effective July 1, 2008 through June 30, 2009*** |
| | | | | |
| Lines 12" and Larger | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements | District * | District * | District * | This row is effective beginning July 1, 2009 and continues through the term of the agreement.*** |
| | | | | |
| | | | | |
| All Lines and All Areas | | | | |
| Treatment Plant CIP | District | District | District | |
| Pump Station CIP | District | District | District | |
| Collection system repairs and rehabilitation to abate I&I | District * | District * | District * | This row is effective beginning July 1, 2009 and continues through the term of the agreement.*** |
| | | | | |
| | | | | |
| | | | | |

| III. SWM Maintenance | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" | |
|---|---|---|---|---|
| **A. Local Program** | | | | |
| Line Cleaning | City | City | District | |
| Manhole maintenance and adjustment | City | City | District | |
| Manhole repair and grouting | City | City | District | |
| Root Cutting | City | City | District | |
| TV inspection (except related to new construction) | City | City | District | |
| Catch Basin cleaning | City | City | District | |
| Water quality manhole cleaning | City | City | District | |
| Local surface retention/detention facility maintenance | City | City | District | |
| Filter vault inspection and maintenance | City | City | District | |
| Complaint response, investigation, and reporting | City | City | District | |
| Storm and emergency response | City | City | District | |
| Roadside ditches and piping system in City Roads | City | None | City | |
| Street Sweeping | City | City | District | |
| Placement of sweeper, catch basin and other material from storm system structures into drop boxes or other designated locations (excluding leaves) | City | City | District | |
| Maintenance of public streams/creeks/open channels | City | City | District | |
| Proactive leaf management program including leaf collection, hauling, processing and disposal | City | City | District | |
| Hauling, processing and disposal of sweeper, catch basin and other material from storm system structures | City - Sweeper Material<br>District - All Others | City | City - Sweeper Material<br>District - All Others | |
| Culvert maintenance under 36" in City Roads | City | City | District | |
| Culvert maintenance 36" and larger and bridge maintenance in City Roads | City | None | City | |
| Culvert maintenance under 36" in County Roads | City | City | District | |
| Culvert maintenance 36" and larger and bridge maintenance in County Roads | County | County | County | |
| Vector Control including mosquito treatment, beaver, nutria, rats and others that impact the storm system | City | City | District | |
| Utility Locates | City | City | District | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements | City | District | City | This row is effective July 1, 2008 through June 30, 2009**** |
| | | | | |
| **B. District Wide Program** | | | | |
| Regional surface treatment or control facilities where the treatment area is 1 acre or larger | District | District | District | |
| Roadside ditches and piping system maintenance in County Roads | District through County funding | District through County funding | District through County funding | |
| Compilation of TV reports and system-wide evaluation | District | District | District | |

| IV. ENGINEERING, INSPECTION, AND SUPPORT ELEMENTS | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" | |
|---|---|---|---|---|
| **A. Local Program** | | | | |
| Maintaining local GIS information | City | District | City | |
| Maintaining local system mapping | City | District | City | |
| Maintaining Engineering records of systems | City | District | City | |
| MMIS | City | City | District | |
| Service Provider Letter Pre-screening | District | District | District | |
| Service Provider Letters Issuance | District | District | District | |
| Development Process (development review, plan review, land use) | City | District | City | |
| Sanitary Sewer connection permit issuance | City | District | City | |
| SWM connection permit issuance | City | District | City | |
| Erosion control permit issuance | City | District | City | |
| 1200C Permit | City | District | City | |
| Inspection of developer projects and new construction | City | District | City | |
| Erosion control inspection | City | District | City | |
| Post construction TV | City | District | City | |
| 1-year warranty TV | City | District | City | |
| Fat, Oil and Grease Program | City | District | City | |
| Preparing and revising local sanitary sewer masterplans | City | District | City | |
| Preparing and revising local SWM masterplans | City | District | City | |
| Formation and Administration of LID's | City | District | City | |
| Cross connection investigation and response | City | City | District | |
| Inspection of Private Facilities | City | District | City | |
| Fixture Counting | City | District | City | |
| Billing and collection of monthly service charges | City | District | City | |
| Response to customer billing inquiries | City | District | City | |
| | | | | |
| **B. District Wide Program** | | | | |
| Industrial Waste Program | District | District | District | |
| Maintaining system-wide GIS and mapping | District | District | District | |
| Preparing and maintaining system-wide storm and sanitary masterplans | District | District | District | |
| Public information, newsletters, etc., for SWM and Sanitary programs** | District | District | District | |
| Flow Monitoring | District | District | District | |
| Sanitary sewer connection permit issuance authorization | District | District | District | |
| SWM connection permit issuance authorization | District | District | District | |

Notes

1. Where "District *" is shown, this does not preclude a City funding a project with its own source of funds and also does not limit the ability for District and City to agree as to who actually performs the work.
2. ** "Public Information" is the overall ad and public information campaigns (TV, radio, brochures, etc.) and does not include the activities related to local projects and local maintenance which are a part of those activities

***Scheduled to be finalized and adopted by governing bodies by December 31, 2008, to reflect local and District Wide funding.

****Scheduled to be reviewed with changes adopted by governing bodies during fiscal year 2009.

Clean Water Services
Our commitment is clear.

May 15, 2009

Craig Sheldon
Public Works Director
City of Sherwood
22560 SW Pine Street
Sherwood, OR 97140

Dear Mr. Sheldon:

Jan Kingsfather of our office sent you by email a draft of modified Appendix A, Division of Responsibilities, to the Operating Inter-Governmental Agreement, utilizing Beaverton as an example, on April 29, 2009. Since then, the Service Delivery Study (SDS) project committee has worked on its finalization. So, I would consider the attached document as a final draft of Appendix A. If you have any concerns with any of the functions contained in it, please do not hesitate to contact me to discuss.

Also enclosed is an Amendment to City Agreement, which formally modifies and approves Appendix A. As stated in it, Appendix A may be modified by the parties with the approval of the City Manager. In our SDS committee meetings, however, we discussed the fact that some cities may choose to present it to their City Councils for approval because it represents a tremendous amount of work by the representatives of the seven large Cities and District. We leave it up to each individual city regarding presentation to its Council.

Since Appendix A has an effective date of July 1, 2009, time is of the essence for approving it. I would appreciate receiving a response from you regarding the City's time line for approving it. Thank you in advance for your staff's and your help and cooperation in completing the new and, hopefully, better Appendix A.

Sincerely,

Robert C. Cruz
Deputy General Manager

Enclosure

2550 SW Hillsboro Highway • Hillsboro, Oregon 97123
Phone: (503) 681-3600 • Fax: (503) 681-3603 • www.CleanWaterServices.org

AMENDMENT TO CITY AGREEMENT

The City of Sherwood (City) and Clean Water Services (District) have entered into an Intergovernmental Agreement dated January 4, 2005. Section 3.B. of that agreement allows the parties to modify Appendix A of that Agreement (the Responsibility Matrix) with the approval of the District's General Manager or Designee and the City Manager. The revised Appendix A is attached and will take effect July 1, 2009. Both parties hereby acknowledge amending Appendix A to change the effective date to July 1, 2009.

Approved by both parties on _____, 2009.

CLEAN WATER SERVICES

By _____
General Manager or Designee

CITY OF SHERWOOD, OREGON

By _____
City Manager

Approved as to Form:

_____
District Counsel

_____
City Attorney

| APPENDIX A | EFFECTIVE JULY 1, 2009 | | V3 Revised 6/16/09 | |
|---|---|---|---|---|
| Sherwood | | | | |
| | | | | |
| **DIVISION OF RESPONSIBILITIES** | | | | |
| | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" | |
| I. Sanitary Maintenance | | | | |
| A. Local Program | | | | |
| Lines under 24" | | | | |
| Line Cleaning | City | City | District | |
| Manhole and lid maintenance and adjustment (excluding sealing) | City | City | District | |
| Root Cutting and Chemical Control | City | City | District | |
| Maintenance TV inspection (See Engineering Section for new construction TV) | City | City | District | |
| Vector Control | City | City | District | |
| Surface Inspection, marking, self closing lids, of lines in stream corridors | City | City | District | |
| Easement and Access Road Maintenance | City | City | District | |
| Siphon maintenance where line leading to siphon is under 24" | City | City | District | |
| Overflow and Complaint response, investigation, and reporting | City | City | District | |
| Emergency response | City | City | District | |
| Utility Locates | City | City | District | |
| Minor repairs including point repairs and individual laterals | City | City | District | |
| | | | | |
| B. District Wide Program | | | | |
| Lines 24" and Larger | | | | |
| All O&M on lines 24" and larger | District | District | District | |
| Siphon maintenance where line leading to the siphon is 24" and larger | District | District | District | |
| | | | | |
| All Lines and All Areas | | | | |
| Compilation of TV reports and system-wide evaluation | District | District | District | |
| Non-structural line sealing (pressure grouting) | District | District | District | |
| Manhole rehabilitation (sealing) | District | District | District | |
| Treatment Plant O&M | District | District | District | |
| Pump Station O&M | District | District | District | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| II. Sanitary CIP (Service Charge Rate and SDC Funded) -- See Attachment 1 for detailed responsiblility | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" | |
|---|---|---|---|---|
| A. Local Program | | | | |
| Lines 12" and Under | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements (except projects for Conveyance system I&I abatement projects). Project Management to be determined by the City, with the exception of the middle column | City | District | City | |
| B. District Wide Program | | | | |
| Lines Larger than 12" and under 24" | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements except projects for Conveyance system I&I abatement projects; Funding responsibility only; Project management to be determined by the City, with the exception of the middle column | District * | District * | District * | |
| Lines 24" and Larger | | | | |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements | District | District | District | |
| All Other Facilities (Project Management to be determined by District) | | | | |
| Treatment Plant CIP | District | District | District | |
| Pump Station CIP | District | District | District | |
| C. I&I Repairs and Rehabilitaion | | | | |
| Conveyance system repairs and rehabilitation to abate I&I; Funding responsibility only; Project management to be determined by the City with the exception of the middle column | City and District 50/50 Funding* | District Funding* | City and District 50/50 Funding* | |

| III. SWM Maintenance | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" |
|---|---|---|---|
| **A. Local Program** | | | |
| Line Cleaning | City | City | District |
| Manhole maintenance and adjustment | City | City | District |
| Manhole repair and grouting | City | City | District |
| Root Cutting | City | City | District |
| TV inspection (except related to new construction) | City | City | District |
| Catch Basin cleaning | City | City | District |
| Water quality manhole cleaning | City | City | District |
| Local surface retention/detention facility maintenance | City | City | District |
| Filter vault inspection and maintenance | City | City | District |
| Complaint response, investigation, and reporting | City | City | District |
| Storm and emergency response | City | City | District |
| Roadside ditches and piping system in City Roads | City | None | City |
| Street Sweeping | City | City | District |
| Placement of catch basin and other material from storm system structures into drop boxes or other designated locations (excluding leaves) | City | City | District |
| Maintenance of public streams/creeks/open channels | City | City | District |
| Proactive leaf management program including leaf collection, hauling, processing and disposal | City | City | District |
| Hauling, processing and disposal of sweeper material | City | City | District |
| Hauling, processing and disposal of catch basin and other material from storm system structures | District | District | District |
| Culvert maintenance under 36" in City Roads | City | City | District |
| Culvert maintenance 36" and larger and bridge maintenance in City Roads | City | None | City |
| Culvert maintenance under 36" in County Roads | City | City | District |
| Culvert maintenance 36" and larger and bridge maintenance in County Roads | County | County | County |
| Vector Control including mosquito treatment, beaver, nutria, rats and others that impact the storm system | City | City | District |
| Utility Locates | City | City | District |
| Repairs, replacements, reconstruction, rehabilitation, CIP construction and improvements. Note: It is anticipated these responsibilities will change to more closely match the CIP shown under Sanitary beginning July 1, 2009 | City | District | City |
| **B. District Wide Program** | | | |
| Regional surface treatment or control facilities where the treatment area is 1 acre or larger | District | District | District |
| Roadside ditches and piping system maintenance in County Roads | District through County funding | District through County funding | District through County funding |
| Compilation of TV reports and system-wide evaluation | District | District | District |

| IV. ENGINEERING, INSPECTION, AND SUPPORT ELEMENTS | Inside City, and Inside "Areas of Assigned Service Responsibility" | Outside City, and Inside "Areas of Assigned Service Responsibility" | Inside City, and Outside "Areas of Assigned Service Responsibility" |
|---|---|---|---|
| **A. Local Program** | | | |
| Maintaining local GIS information | City | District | City |
| Maintaining local system mapping | City | District | City |
| Maintaining Engineering records of systems | City | District | City |
| MMIS | City | City | District |
| Service Provider Letter Pre-screening | District | District | District |
| Service Provider Letters Issuance | District | District | District |
| Development Process (development review, plan review, land use) | City | District | City |
| Sanitary Sewer connection permit issuance | City | District | City |
| SWM connection permit issuance | City | District | City |
| Erosion control permit issuance | City | District | City |
| 1200C Permit | City | District | City |
| Inspection of developer projects and new construction | City | District | City |
| Erosion control inspection | City | District | City |
| Post construction TV | City | District | City |
| 1-year warranty TV | City | District | City |
| Fat, Oil and Grease Program | City | District | City |
| Preparing and revising local sanitary sewer masterplans | City | District | City |
| Preparing and revising local SWM masterplans | City | District | City |
| Formation and Administration of LID's | City | District | City |
| Cross connection investigation and response | City | City | District |
| Inspection of Private Facilities | City | District | City |
| Fixture Counting | City | District | City |
| Billing and collection of monthly service charges | City | District | City |
| Response to customer billing inquiries | City | District | City |
| | | | |
| **B. District Wide Program** | | | |
| Industrial Waste Program | District | District | District |
| Maintaining system-wide GIS and mapping | District | District | District |
| Preparing and maintaining system-wide storm and sanitary masterplans | District | District | District |
| Public information, newsletters, etc., for SWM and Sanitary programs** | District | District | District |
| Flow Monitoring | District | District | District |
| Sanitary sewer connection permit issuance authorization | District | District | District |
| SWM connection permit issuance authorization | District | District | District |
| Preparation of five-day letter | District | District | District |
| | | | |
| Notes | | | |
| 1. Where "District *" is shown, this does not preclude a City funding a project with its own source of funds and also does not limit the ability for District and City to agree as to who actually performs the work. | | | |
| 2. ** "Public Information" is the overall ad and public information campaigns (TV, radio, brochures, etc.) and does not include the activities related to local projects and local maintenance which are a part of those activities | | | |

# SANITARY CAPITAL IMPROVEMENT PROGRAM FUNDING RESPONSIBILITY

| Pipe Size, New | Responsibility | SDC Eligible |
|---|---|---|
| 12-inch and smaller | Local | Yes, 100% |
| Larger than 12 inches | District-Wide* | Yes, 100% |

| Pipe Size, Replacement/Upsize | Responsibility | SDC Eligible |
|---|---|---|
| From 12-inch and smaller to 12-inch and smaller | Local | Yes, Proportional to new capacity provided |
| From 12-inch and smaller to larger than 12-inch | Shared cost based on proportionate capacity* | Yes, Proportional to new capacity provided |
| From larger than 12-inch to larger than 12-inch | District-Wide | Yes, Proportional to new capacity provided |

*Note: A Local share is required based on the capacity of a 12-inch pipe

# APPENDIX B | ANTICIPATED MS4 PERMIT REQUIRMENTS

# City of Sherwood
# Stormwater Master Plan Update
## Anticipated MS4 Permit Requirements

June 2015

Cover photo Tributary to Cedar Creek

**Contributing Authors:**

**Wolf Water Resources**
Marjorie Wolfe, PE, CFM

# Table of Contents



# Table of Figures



# List of Acronyms

BiOP – Biological Opinion
BMP – Best Management Practice
CSM – Continuous Simulation Model
CSO –Combined Sewer overflow
CWA – Clean Water Act
CWS –Clean Water Services
DEQ – Oregon Department of Environmental Quality Ecology – Washington State Department of Ecology
DCS – CWS Design and Construction Standards
EPA – Environmental Protection Agency
ESA – Endangered Species Act
GIS – Geographic Information Systems

HEC-HMS - Hydrologic Engineering Center (U.S. Army) Hydrologic Modeling System
HMP – Hydromodification Plan
HSPF – Hydrologic Simulation Program Fortran
KCRTS – King County Runoff Time Series LID – Low Impact Development
MS4 – Municipal Separate Storm Sewer System
NFIP – National Flood Insurance Program
NPDES - National Pollutant Discharge Elimination System
$Q_2$ – Discharge Rate with a 2-year return interval
SBUH – Santa Barbara Urban Hydrograph
SEM – Stream Evolution Model
SWMM – Storm Water Management Model
TMDL – Total Maximum Daily Load
WWHM – Western Washington Hydrology Model
VC- Vegetated Corridor

# 1. Introduction

The City of Sherwood is regulated the Clean Water Services (CWS) MS4 permit that was last issued in July of 2005. This is a unique watershed based permit that combines both stormwater and wastewater NPDES discharge permit requirements. One of the advantages of the watershed based permit is that it allows the use of distributed watershed based strategies to offset point discharge impacts. For instance, planting tributary stream corridors that provide shade as well as a suite of other habitat and water quality benefits to offset temperature impacts at the waste water treatment plant outfalls.

This report outlines existing CWS permit requirements and policies relevant to the City of Sherwood Stormwater Master Plan Update. These are compared to anticipated new requirements based on more recently issued Phase 1 permits for neighboring Oregon jurisdictions. These include;

- **Multnomah County, Gresham Group, City of Salem, City of Eugene** -Reissued Dec. 30, 2010
- **Portland Group (City of Portland and Port of Portland)** -Reissued Jan. 31, 2011
- **Clackamas County Group (Clackamas County DTD, City of Gladstone, City of Johnson City, City of Lake Oswego, City of Milwaukie, City of Oregon City, City of West Linn, City of Wilsonville, Oak Lodge Sanitary District, CCSD #1, City of Happy Valley, SWMACC and City of Rivergrove)** -Reissued Mar. 16, 2012

The language of these permits outlining requirements is consistent across permits. Some of these jurisdictions have adopted standards and policies to meet these new permit requirements. A unified and consistent set of standards and policies across jurisdictions is easier to negotiate with the Department of Environmental Quality (DEQ) and provides simplicity and assurance to developers. This must be balanced with the unique needs and site specific constraints of particular jurisdictions and watersheds. For instance, the City of Portland requires high levels of infiltration to reduce stormwater runoff. This is necessary to reduce flows to the combined sewer overflow (CSO) system and large parts of Portland is underlain with soils that have high infiltration rates. By contrast Sherwood and much of the Tualatin basin has tight soils that do not infiltrate well and there is a separate storm sewer system. Unlike the City of Portland, Sherwood has not piped the streams and has maintained much of the floodplain while enhancing riparian vegetation. As a result stream health in Sherwood is impressive for urban watersheds.

The health of Sherwood streams is due in part to past stormwater and floodplain management policies. As regulatory requirements increase Sherwood is in a position to choose policies that meet these requirements in a manner that minimizes cost while protecting natural aquatic resources. This memo outlines what policies are currently effective in protecting stream health, what MS4 permit requirements are likely to come into effect with the next permit renewal, and recommendations for how Sherwood can best meet these requirements. This report focuses on those regulations that fall within Capital Improvement or structural BMPs for Post Construction Site Runoff.

# 2. Clean Water Services Existing Stormwater Requirements and Policies

In 2005 CWS was issued an innovative watershed based permit that combined MS4 and wastewater discharges. This permit initiated a number of strategies that focused on temperature that also had additional benefits to stream health and water quality. The next permit renewal is an opportunity to refine these policies that continues to protect streams cost effectively and in a manner that is suited to natural watershed conditions.

## Vegetated Corridors

The NPDES watershed based permit allows for water quality trading for temperature and oxygen demanding parameters. To meet this requirement CWS engages in riparian planting projects as well as programs that partner with the agricultural community to enhance riparian vegetated corridors. In addition, vegetated corridor requirements in the CWS Design and Construction Standards (DCS) meet statewide planning goal 5 to protect natural resources and conserve scenic and historic areas and open

spaces. As a result of these regulations vegetated buffers in Sherwood have been protected and in some cases enhanced. Vegetated riparian corridors provide additional benefits to urban streams beyond water quality. These include;

- streambank stabilization that reduces erosion and turbidity,
- attenuation of overbank flows that encourages settlement of sediment on the floodplain,
- filtering of pollutants from runoff that flows overland across the buffer,
- a source of large wood habitat to the stream,
- a source of detritus to aquatic food web, and
- reduction of runoff through infiltration and evapotranspiration.

Often stormwater outfalls are piped through the riparian corridor to the stream edge which significantly reduces the benefits of the buffer. Outfalls should daylight at the edge of the buffer or floodplain whenever possible. Occasionally steep slopes will require piping to the edge of the stream to prevent erosion.

*Figure 1. Outfall piped to the edge of Rock Creek*

*Figure 2 Outfall to swale at the edge of the Cedar Creek floodplain*

## Vegetated Water Quality Facilities

*Figure 3. Streetside Vegetated Swale*

The City of Sherwood uses the CWS Design and Construction Standards (DCS) for post construction water quality treatment requirements. These standards promote the use of vegetated swales, extended dry basins, or constructed water quality wetlands to meet stormwater treatment requirements. These vegetated facilities likely also provide infiltration, evapotranspiration, and flow attenuation benefits. These facilities are also likely to be considered green infrastructure by DEQ in subsequent MS4 permits. Continued use of these facilities is highly recommended for regulatory compliance and stream protection. These designs could be modified to maximize infiltration through the use of uncompacted soils, gravel/rock sub layer, and small berms to retain a portion of the flow in the bed of the facility. Recent approaches to flow control for hydromodification developed by the Environmental Protection Agency (EPA) that oversees DEQ require retention of the 90$^{th}$ percentile storm which is close to or less than the water quality storm in Western Oregon jurisdictions. With analysis that demonstrates that the existing or modified versions of the vegetated facilities can meet these hydromodification flow control requirements could reduce the pressure to adopt continuous simulation detention strategies.

## LIDA Manual

The City of Sherwood has adopted the CWS Low impact development Approaches LIDA manual for compliance with stormwater standards. This manual is expected to meet anticipated requirements for green infrastructure and low impact development. It could also be updated to meet hydromodification flow control requirements using the percentile storm approach. This approach is unlikely to require any increase in facility sizing based on preliminary review comparing the 6% sizing factor used in the LIDA Handbook with the EPA National Stormwater Calculator (SWC).[1] This calculator looks up rainfall, evapotranspiration, soil, and slope data anywhere in the country and sizes a limited number of LID controls to meet percentile storm requirements. It uses a SWMM model that can incorporate additional LID designs.

## Outfall Retrofit Program

The City of Sherwood participates in the CWS districtwide outfall retrofit program which has a goal of six outfall retrofits per year. These projects target areas with limited structural treatment facilities prioritizing high load areas. Tracking measures include the number of outfall retrofits in planning, design, construction or completed including type of BMP, location, and area treated. Proposed regional facilities within the updated Stormwater Master Plan can be used to meet this regulatory requirement when treating previously untreated impervious area.

# 3. Recent Oregon Phase 1 Permit Requirements and Adopted Policies

## Post-Construction Site Runoff

Recent MS4 permits in Oregon have required that post construction runoff strategies mimic natural hydrology, utilize green infrastructure (GI) or low impact development (LID), and treat 80% of the annual average runoff volume. This language describes flow control requirements that would address hydromodification impacts from increased impervious area and creates a uniform water quality design storm approach.

**DEQ Permit Language:**

***f. Post-Construction Site Runoff:*** *The permittee must continue to implement their post-construction stormwater pollutant and runoff control program.*

*i. By (date varies by permit) the post-construction stormwater pollutant and runoff control program applicable to new development and redevelopment projects that create or replace (area varies by permit) of impervious surface must meet the following conditions:*

*1) Incorporate site-specific management practices to mimic natural surface or predevelopment hydrologic functions as much as practicable. The site-specific management practices should optimize on-site retention based on the site conditions;*

*2) Reduce site specific post-development stormwater runoff volume, duration and rates of discharges to the municipal separate storm sewer system (MS4) to minimize hydrological and water quality impacts from impervious surfaces;*

*3) Prioritize and include implementation of Low-Impact Development (LID), Green Infrastructure (GI) or equivalent planning, design and construction approaches; and,*

*4) Capture and treat 80% of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity.*

[1] EPA National Stormwater Calculator http://www2.epa.gov/water-research/national-stormwater-calculator

*iii. To reduce pollutants and mitigate the volume, duration, time of concentration and rate of stormwater runoff, the permittee must develop or reference an enforceable post-construction stormwater quality management manual or equivalent document that, at a minimum, includes the following:*

*3) Applicable LID, GI or similar stormwater runoff reduction approaches, including the practical use of these approaches.*
*4) Conditions where the implementation of LID, GI or equivalent approaches may be impracticable.*[2]
*An innovative way to meet all of these requirements is to use green infrastructure to treat a water quality design storm depth that also meets hydromodification requirements. The recent Hydromodification Assessment for Salem demonstrated that infiltration of their water quality design storm of 1.38" in 24hrs was equivalent to flow control using continuous simulation for ½ the 2yr to the 10 year. The same report also demonstrated the feasibility of infiltration for the water quality design storm even in tight soils. This approach simplifies compliance by meeting both flow control and water quality treatment in a single facility that can be incorporated into site landscaping.*

### Hydromodification Assessments

**DEQ Permit Language:**
*Hydromodification Assessment: The permittee must conduct an initial hydromodification assessment and submit a report by November 1, 2014 that examines the hydromodification impacts related to the permittee's MS4 discharges, including erosion, sedimentation, and/or alteration to stormwater flow, volume and duration that may cause or contribute to water quality degradation. The report shall describe existing efforts and proposed actions the permittee has identified to address the following objectives:*

*a. Collect and maintain information that will inform future stormwater management decisions related to hydromodification based on local conditions and needs;*
*b. Identify or develop strategies to address hydromodification information or data gaps related to waterbodies within the permittee's jurisdiction;*
*c. Identify strategies and priorities for preventing or reducing hydromodification impacts related to the permittee's MS4 discharges; and,*
*d. Identify or develop effective tools to reduce hydromodification*[3]*.*

## 4. Recent Flow Control Strategies Being Adopted in Oregon

Most jurisdictions have adopted some type of continuous simulation model to match pre- and post-development flows within a defined channel forming discharge range. The channel forming discharge is typically ½ the 2 year to the 10 year though often a flood control requirement is added. This approach requires complex continuous simulation modeling tools that are typically developed by jurisdictions for developers and designers to size facilities. They are based on theoretical relationships of channel forming flow with very little actual data. Resulting facilities are typically 2 to 5 times the size of traditional detention facilities. In an attempt to make these facilities more feasible jurisdictions have adopted policies that can dramatically reduce the performance of these facilities in preventing stream erosion. Two such policies include;

- A minimum orifice size
- Defining pre-development as existing condition rather than the natural forest or forest/meadow.

If the minimum orifice size is larger than that needed to meet the detention flow requirements the facility will potentially release flows within the channel forming range over a longer period of time actually increasing erosion potential. The pre-development condition is tied to the channel forming discharge and

[2] NPDES MS4 Permits issued by DEQ since 2011
[3] NPDES MS4 Permits issued by DEQ since 2011

changes dramatically between a natural and developed condition. For instance, ½ the 2 year flow under developed conditions can be 2-3 times ½ the 2 year under natural forested or forest meadow conditions. These goal of flow control for hydromodification is to recreate the natural channel forming flows and a pre-development condition that is already developed does not meet this goal. As a result the flows released from facilities that use a developed condition as pre-development are likely to release flows high enough to erode downstream channels over a longer duration potentially increasing the risk of stream erosion. Both the BMP sizing tool and the Tualatin River Urban Stormwater Tool define pre-development as existing conditions. Additional analysis particularly measuring the stream erodibility would determine if these tools have targeted the appropriate channel forming discharge for the defined pre-development conditions. The channel forming discharge of ½ 2 year to the 10 year is based on theoretical relationships for sand bed streams. Studies in Salem and the Tualatin basin have shown that the channel forming flows for cohesive soils can vary dramatically and can often be less than ½ the 2 year especially in headwater streams.

Locally developed continuous simulation model sizing tools include the following;

**BMP sizing tool** developed by Clackamas County WES and adopted by City of Wilsonville
This tool is based a multiple runs of a continuous simulation model that generates a series of sizing factors based on soils, slopes, and change in development condition.

**Tualatin River Urban Stormwater Tool (TRUST)** for use in the River Terrace Development is a modified version of the Western Washington Hydrologic Model (WWHM) and actually runs a continuous simulation program to size the facility.

Variations on both of these tools are being implemented in California and Washington. These tools are suitable for sizing facilities that use a natural forested or forest meadow condition as pre-development and a channel forming discharge of ½ to the 10 year for sand or gravel bed receiving streams. If unacceptably small orifice sizes are sized for detention then regional detention or infiltration strategies should be used instead of using a minimum orifice size. These tools should not be used to protect receiving streams with erodible cohesive soils or to match a developed pre-development condition without further stream erodibility analysis. Such applications could increase stream erosion by extending the duration of actual channel forming flows.

# 5. Additional Policies that Protect Water Quality

### Beaver

*"The District's beaver management policy supports the Oregon Plan for Salmon and Watershed guidelines, as follows:*

- *The construction and maintenance of dams by beaver is a natural process benefiting salmon and other fish and wildlife species by creating beneficial pool and wetland habitat in many stream reaches.*
- *The goal of management efforts should be to maintain or improve the distribution and amount of beaver pond habitat without creating unacceptable risks of damage to other public and private resources.*
- *Lethal control is usually only a temporary solution. Beaver populations are at or near carrying capacity and removing a beaver only opens up living space for a new beaver.*

*If a beaver dam affects drainage pipes or culverts and creates a substantial flood risk to a structure or other significant property damage, the affected property owner may remove or modify the beaver dam to restore flow."*[4]

[4] Clean Water Services Integrated Pest Management Plan pp5-6.

Beaver are very good at stabilizing streams especially in areas with broad active floodplains where risk to infrastructure is low. The dams act as bed control preventing the stream from downcutting and the ponds

*Figure 3. Beaver ponds along Cedar Creek tributary*

help attenuate and store flows from storm events. Some neighborhoods have adopted beaver colonies by managing and monitoring the dams to reduce flood risk. An extensive supply of woody riparian vegetation is a necessary component of beaver habitat and also adds to stream stability by strengthening banks and slowing over bank flow. Many urban streams in Washington County were stabilized by beaver after Clean Water Services adopted a pest management policy that supported their presence.[5]

### Natural and Beneficial Functions of Floodplains

Several plaintiff's sued the Federal Emergency Management Agency (FEMA) for not adequately consulting on Endangered Species Act (ESA) issues in managing floodplain development. As a result of a 2010 light settlement FEMA must consult with the National Marine Fisheries Service (NMFS) to comply with the ESA on all floodplain development applications. NMFS will issue a Biological Opinion (BiOP) which will provide specific guidance for FEMA on what is required to comply with the ESA. A similar lawsuit in the Puget Sound Washington has resulted in must more protective floodplain development measures including green stormwater infrastructure, extensive setbacks, and riparian enhancement requirements. At the same time flood insurance rates are scheduled to increase dramatically to sustain the National Flood Insurance Program (NFIP). These two changes in floodplain management regulations will have the effect of making development in the floodplain much more expensive both to build and to insure. Local jurisdictions will be required to either adopt more protective regulations or require independent ESA consultation with each floodplain development application. It makes sense to adopt policies that will meet both the FEMA ESA requirements and MS4 permit requirements for hydromodification while continuing to protect the long term health of Sherwood's streams.

# 6. Recommendations

## Flow Control Recommendations

[5] Pers. Com. Kendra Smith, Clean Water Services 2009

Flow control will likely be required in the new DEQ MS4 permits for all phase 1 jurisdictions. At a minimum this would include flow control requirements that optimize on site retention and mimic natural runoff volumes and durations. For the City of Sherwood we recommend that the flow control focus on retention of the water quality storm (assuming this meets the 80% average annual runoff volume). The tight cohesive soils on Sherwood landscapes would have naturally low infiltration rates. If the City were to adopt the percentile storm approach the hydromodification design storm would likely be close to the water quality design storm. Vegetated facilities designed to infiltrate a depth of 1"-1.5"/24 hrs. would meet both water quality and flow control. The volume of water would be infiltrated in 24 hours would be equivalent to 1-1.5 inches over the impervious area. This is generally feasible with infiltration rates as low as 0.5 inches per an hour.

**Recommendation:** Develop a flow control storm using the percentile storm approach that meets both hydromodification and water quality requirements. Use vegetated facilities to infiltrate the water quality/flow control design storm. This is expected to meet all new requirements for post construction run off control and could be a hydromodification tool.

### Hydromodification Assessment Recommendations

Our preliminary assessment has determined that Sherwood streams have relatively high resilience to erosion with very few problem areas. We expect that continue and even improve with the adoption of minimal infiltration flow control requirements, enhancement of riparian buffers, and continued protection of floodplains. A full hydromodification assessment would still be required by DEQ. This would involve continuous simulation of runoff modeling to estimate natural, existing, and proposed runoff regimes under expected development. The existing HEC-RAS models could be used to compare base line (2006) conditions to today and see if stream cross sections have changed significantly. We could also use these models to determine the change in shear stress of the receiving channels under increased runoff and how various strategies perform in reducing stream shear stress. A critical component of the hydromodification assessment would be to determine the range of channel forming flows that would be important to target for flow control. Based on recent studies in Salem and the Tualatin basin these could be less than ½ the 2 year event for cohesive soils. If that is the case adopting a tool that uses large detention facilities that release flows at ½ the 2year could increase channel erosion by extending the duration of erosive flows at great expense to the City and developers.

**Recommendation:** Complete a hydromodification assessment analysis that;

- Quantifies expected increase in runoff volumes and durations,
- Determines erodibility of stream channels and channel forming flow range
- Identifies reaches of stream that are susceptible to erosion from increased runoff
- Assess hydromodification tools that are best suited to Sherwood conditions and are cost effective
- Develop a monitoring plan that identifies and addresses data gaps while collecting information critical to hydromodification decision making.

## 7. References

Booth, D.B., D. Hartley, and R. Jackson. 2002. Forest cover, impervious surface area, and the mitigation of stormwater impacts. Journal of the American Water Resources Association. Vol. 38 No. 3. Pp 835-645.

Castro, JC, and PL Jackson. 2001. Bankfull discharge recurrence intervals and regional hydraulic geometry relationship: patterns in the Pacific Northwest, USA. 37(5):1249-1262.

Clean Water Services, November 2012, Integrated pest Management Plan http://www.cleanwaterservices.org/Content/Documents/Watershed%20Info/Integrated%20Pest%20Management%20Plan.pdf

Clean Water Services, February 2005 Temperature Management Plan. http://www.cleanwaterservices.org/Content/Documents/Projects%20and%20Plans/Temperature%20Management%20Plan.pdf

Clean Water Services, Stormwater Annual Report, November 2014, http://www.cleanwaterservices.org/Content/Documents/Permit/Stormwater%20Annual%20Report%202014.pdf

Cluer, B. and C. Thorne. 2013. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications. DOI: 10.1002/rra.2631.

Environmental Protection Agency (EPA). 2007. National Management measures to Control Nonpoint Source Pollution from Hydromodification. EPA 841-B-07-002. http://www.epa.gov/owow/NPS/hydromod/

EPA 2012. U.S Environmental Protection Agency. 2012. Draft Functional Assessment Framework Excerpt: Attributes, Considerations, Criteria. U.S. Environmental Protection Agency, Region 10, Portland, OR.

EPA National Stormwater Calculator (SWC) http://www2.epa.gov/water-research/national-stormwater-calculator

Henshaw P.C. and Booth D.B. 2000. Nature restabilization of stream channels in urban watersheds. Journal of the American Water Resources Association, 36: 1219–1236. doi: 10.1111/j.1752-1688.2000.tb05722.

**NPDES MS4 discharge permits issued by DEQ :**
**http://www.deq.state.or.us/wq/stormwater/municipalph1.htm#permit**

Clackamas County issued March 2012
City of Gresham issued December 2010
City of Salem issued December 2010
City of Portland issued January 2011
City of Eugene issued December 2010
Clean Water Services issued July 2005

# APPENDIX C | HYDROMODIFICATION

# City of Sherwood
# Stormwater Master Plan Update
## Hydromodification Technical Memorandum

### Preliminary Stream Review and Recommended Approaches

May 2015

WOLF WATER RESOURCES



Cover photos various streams in Sherwood

**Contributing Authors:**

**Wolf Water Resources**
Marjorie Wolfe, PE, CFM
Nicole Czarnomski, PhD

# Table of Contents

# Table of Figures



# List of Acronyms

BiOP – Biological Opinion
BMP – Best Management Practice
CSM – Continuous Simulation Model
CSO –Combined Sewer overflow
CWA – Clean Water Act
CWS –Clean Water Services
DEQ – Oregon Department of Environmental Quality Ecology – Washington State Department of Ecology
EPA – Environmental Protection Agency
ESA – Endangered Species Act
GIS – Geographic Information Systems
HEC-HMS - Hydrologic Engineering Center (U.S. Army) Hydrologic Modeling System
HMP – Hydromodification Plan
HSPF – Hydrologic Simulation Program Fortran
KCRTS – King County Runoff Time Series LID – Low Impact Development
MS4 – Municipal Separate Storm Sewer
NFIP – National Flood Insurance Program
NPDES - National Pollutant Discharge Elimination System
$Q_2$ – Discharge Rate with a 2-year return interval
SBUH – Santa Barbara Urban Hydrograph
SEM – Stream Evolution Model
SWMM – Storm Water Management Model
TMDL – Total Maximum Daily Load
WWHM – Western Washington Hydrology Model

# Executive Summary

The City of Sherwood is embarking upon a Stormwater Master Plan to identify and prioritize stormwater infrastructure projects that improve conveyance and water quality. These projects are intended to protect health and public safety and meet regulatory requirements of the National Pollution Discharge Elimination system (NPDES) Municipal Separate Storm Sewer System (MS4) permit and Total Maximum Daily Loads (TMDLs) that have been established for water bodies located within and downstream of the city boundaries. To address these requirements in an integrated cost effective manner, the City is embarking on a preliminary hydromodification assessment to determine the extent of stream erosion and recommend strategies to address hydromodification that are appropriate and effective in local conditions.

The purpose of this technical memorandum is to summarize existing stream information and guide strategies to address hydromodification. The term hydromodification is used to describe alterations to the natural system of water flow in an urban landscape, including changes to water conveyance, surface water runoff, sediment transport, and water quality. Hydromodification causes stream erosion leading to habitat and water quality degradation, and risks to infrastructure from bank failure and incision. There are a variety of approaches that can be implemented to offset impacts of hydromodification that control hydrology, retain coarse sediment supply, and improve stream resiliency. Several examples of these approaches, implementation tools, and lessons learned from other Oregon communities, as well as from Washington and California, are provided in this report.

There are five streams within the City and adjacent urban growth boundary and reserve areas: 1) Chicken Creek, 2) Cedar/Goose Creek, 3) Rock Creek, 4) Coffee Lake Creek, and 5) Hedges Creek. Based on existing information these stream systems share common characteristics related to stormwater runoff and hydromodification:

- Streams are low gradient with steeper sections in some headwater reaches.
- Streams have adjacent active floodplains located in broad ravines with development along adjacent higher bluffs.
- Riparian vegetation is diverse and largely native supporting a wide variety of songbirds and wetland habitats along many streams within the City.

The City of Sherwood has generally healthy urban streams that are resilient and not very susceptible to hydromodification due to the low gradient, adjacent floodplains and intact riparian vegetation. In addition, the fine soils limit infiltration in both the natural and developed condition. Cedar Creek has the most developed watershed and yet shows indications of the healthiest stream due to the protected floodplains and significant riparian vegetation. This demonstrates that measures supporting stream resiliency are effective in protecting Sherwood streams from hydromodification impacts. Implementing rigorous detention measures to match pre-development flow duration thresholds would be expensive and require significantly larger footprints for stormwater facilities without significant benefits to downstream conditions. In lieu of detention, improved riparian vegetation and protection of floodplains are likely to be much more effective in protecting streams. Using green stormwater infrastructure for water quality treatment such as swales, raingardens, and planters mimic natural hydrology of forest on tight soils by providing some infiltration and flow attenuation. The streams should be monitored and targeted problem areas addressed to prevent excessive bank erosion or headcut migration.

# 1. Introduction

The City of Sherwood endeavors to protect water resources and meet permit requirements as directed by Clean Water Services (CWS) who holds the MS4 permit. The adoption and implementation of CWS guidelines and standards is informed by local conditions within the City. Though a hydromodification assessment is not currently required, the City has requested a preliminary assessment to address hydromodification in an integrated cost effective manner in conjunction with the updated Stormwater Master Plan. This preliminary assessment addresses three main components:

1. Preliminary look at the condition of City streams in terms of active erosion and stream resilience.
2. A review of hydromodification strategies used by other jurisdictions.
3. Recommendations for integrated and effective hydromodification strategies for City stream conditions.

# 2. Background

## Regulatory Permit Requirements

The City of Sherwood is a Municipal Separate Storm Sewer System (MS4) municipality that falls under the Phase I rules established by the U.S. Environmental Protection Agency (EPA) for surface water management. These regulations are currently covered by a NPDES watershed-based waste discharge permit issued to Clean Water Services (CWS) that includes "All existing and new discharges of storm water from the MS4 within the storm water service area of Clean Water Services and within the urban growth boundary of Washington County."

Other Oregon Phase 1 permittees with more recent permits have been required to implement specific requirements to assess hydromodification. As an example, the 2012 MS4 permit for Gresham included specific permit requirements:

1. Examine the hydromodification impacts related to the City's MS4 discharges, including erosion, sedimentation, and/or alteration to stormwater flow volume and duration that may cause or contribute to water quality degradation.
2. Describe existing efforts and proposed actions the City has identified to address the following objectives:

    a) Collect and maintain information that will inform future stormwater management decisions related to hydromodification based on local conditions and needs;
    b) Identify or develop strategies to address hydromodification information or data gaps related to water bodies within the City's jurisdiction;
    c) Identify strategies and priorities for preventing or reducing hydromodification impacts related to the City's MS4 stormwater discharges; and,
    d) Identify or develop effective tools to reduce hydromodification.

3. Develop a retrofit strategy and plan that applies to developed areas that impact water quality and which are underserved or lacking stormwater quality controls.

In addition, design standards must comply with the MS4 permit requirements to implement a post-construction stormwater program that meets the following identified objectives:

a) Mimics natural surface or pre-development hydrologic functions,
b) Reduces site specific stormwater runoff volume, duration and rates to minimize hydrologic and water quality impacts from impervious surfaces, and
c) Prioritizes use of vegetated stormwater treatment systems (e.g., green infrastructure (GI)) and low impact development (LID) approaches that emphasize stormwater infiltration and evapotranspiration.

## Existing City Efforts

### Clean Water Services Design and Construction Standards and Low Impact Development Approaches (LIDA) Manual

The City has adopted the CWS Design and Construction Standards and LIDA manual to regulate and guide stormwater management for new development. These standards require vegetated corridor enhancement with streamside development. Water quality facilities include stormwater manholes for pre-treatment and vegetated swales, extended dry basins, or constructed water quality wetlands for treatment. These facilities likely provide some level of infiltration and flow attenuation that will reduce hydromodification impacts to some extent even though this was not the original intent of the design. The LIDA manual is available to developers who wish to integrate stormwater facilities throughout the landscape such as rain gardens, green roofs, pervious pavement, and planters.

### Retrofit through Regional Facilities

As initial steps in addressing a retrofit strategy and plan, the City has begun preliminary work in identifying opportunities for regional facilities to treat previously untreated stormwater runoff or oversized facilities that add treatment for untreated areas with new development. Retrofit projects are priorities across the CWS District on an annual basis.

## Regional Hydromodification Strategies

This section provides an overview of regulations and hydromodification strategies from Washington, California, and other locations in Oregon, including future trends in hydromodification management. This information is used to provide a suite of established approaches and methodologies. Since the early 1990s, stormwater management manuals throughout the west coast have been developed to mitigate the impacts of development on stream hydrology and water quality, focusing largely on reduction of peak flow events using structural, end-of-pipe techniques (Booth et al. 2002). Studies have concluded that there is little evidence that traditional stormwater management practices are protective of physical, chemical, or biological processes (Maxted and Shaver 1997; Maxted 1999; Horner et al. 1999, 2002). It is likely that traditional stormwater management approaches are unsuccessful because they fail to account for stream processes. The processes occur at multiple spatial scales and are controlled by regional

landscapes (NRC 1992). In 2007, the EPA decided that Phase I and Phase II NPDES permits should require elements of watershed planning instead of relying entirely on traditional end-of-pipe approaches for managing surface water runoff in urban area. According to the EPA, watershed planning also includes feedback loops based on monitoring data to ensure that the goals established in the permits are being met.

Because each state is responsible for implementing policies and regulations to meet the intent of the CWA, there is some variation in how hydromodification regulations are developed, how they are responding to new scientific and technical advances, and how they are evolving to meet new regulatory expectations. Unlike Washington and California, Oregon, DEQ is looking to individual jurisdictions to identify strategies and tools to address hydromodification rather than identifying a one size fits all solution. The future trends of all three States are likely to influence DEQ's direction and acceptance of particular solutions.

### Western Washington

In Washington State, the Department of Ecology (Ecology) is the regulatory agency responsible for meeting the intent of the Clean Water Act (CWA). In Washington, hydromodification is generally defined to mean changes in the frequency, magnitude and duration of flows as a result of increases in impervious surface and increased density and connectivity of the drainage network. The regulatory driver for hydromodification requirements is the update of NPDES MS4 permits. As part of the NPDES permit, Ecology requires that jurisdictions located in Western Washington adopt the Western Washington Stormwater Management Manual, or develop an equivalent model. This manual focuses on several aspects of hydromodification including source control, flow control, and water quality treatment and also emphases Low Impact Development (LID) and Green Infrastructure (GI).

The first Washington hydromodification requirements were in the 1990 King County Stormwater Management Manual; followed by the 1992 Ecology Stormwater Management Manual. These manuals were based on peak flow matching using the Santa Barbara Urban Hydrograph (SBUH) modeling method. In 1998, King County updated their manual and switched to a flow duration standard, which was supported by the King County Runoff Timeseries Model (KCRTS), a disk operating system (DOS) interface with Hydrologic Simulation Program-Fortran (HSPF) and a stormwater BMP sizing tool. Also in 1998, several species of Puget Sound salmon were listed on the endangered species list. This listing was linked to urban stormwater runoff and significantly more emphasis was placed on increasing the standards for stormwater runoff. Ecology revised their manual in 2005, requiring a flow duration standard supported by the Western Washington Hydrologic Model (WWHM). These two manuals have subsequently been revised to include elements of LID and emerging technology. The 2012 Ecology Manual now includes a low flow threshold of 8% of the 2-yr flow (0.08Q2) to increase the focus on infiltration.

Washington NPDES Phase 1 MS4 permits that went into effect in August 2013 put an increased focus on LID, through stormwater low flow standards, building codes, and land use codes. The new permits also put additional focus on monitoring, private facility inspections, and watershed planning.

- The 2012 Stormwater Manual from the Department of Ecology, finalized in 2013, includes a new LID flow control standard, which requires site developers to match flow rates between 8% and 50% of the forested $Q_2$, in addition to other flow control standards that target durations from 50% of $Q_2$ up to $Q_{50}$. This manual continues to include a flow control standard specific to wetlands, based on continuous modeling. It requires the applicant to demonstrate that the wetland hydroperiod, which is

the duration and frequency of wetland saturation/inundation, will not be impacted by stormwater discharges.

## California

In California, hydromodification strategies are confined to restoring hydrologic processes. While there is an implicit understanding that these physical changes are intertwined with biological functions, and that biological functions are often the stream Beneficial Uses that are being protected, California Hydromodification Management Plans (HMPs) have been slow to explicitly bring ecological criteria into HMPs. The regulatory driver for HMPs is the update of MS4 permits. As MS4s have been renewed over the last decade, permittees have been required to develop HMPs, starting with large municipalities in Phase I and extending to smaller communities in Phase II.

The first California HMP was completed for the Santa Clara Valley (north Santa Clara County) in 2005. This HMP created many of the precedents that were subsequently followed and refined across the San Francisco Bay Area, in Southern California and Sacramento. These include the use of flow duration control between a high flow threshold (always $Q_{10}$) and a low flow threshold associated with the onset of creek erosion (locally variable but between 0.1 and $0.5Q_2$). Flow duration control required the use of continuous hydrologic simulations, and the first set of HMPs saw the development and refinement of models based on the WWHM as well as LID sizing factors and design tools that were based on continuous modeling conducted in HSPF and HEC HMS. Most of the HMPs following Santa Clara can be viewed as direct technical descendants that refined, optimized for local conditions, and in some cases simplified the key approaches. The main departure from this trend is the Central Coast HMP, which took a very different approach based on retention and infiltration of certain percentile storms.

## Future trends in California

- MS4 stormwater permits may seek to unify disparate approaches to manage water quality, flooding and hydromodification, based on retention and infiltration of certain percentile storms (as Central Coast has done).
  - More focus on biological functions rather than just erosion and sediment.
  - More focus on sediment depletion, especially bedload.
- Align regulations with off-site mitigation programs such as regional detention facilities or stream restoration projects that manage or safely convey excess flows.

## Oregon

- Recent Phase 1 MS4 stormwater permits require a hydromodification assessment to determine susceptibility and risk of hydromodification impacts and to identify tools and strategies to address them.
  - MS4 stormwater permit encourages use of LID.
  - Portland is well known as a leader in LID though early efforts were primarily driven by CSO issues and water quality improvement for permit compliance rather than hydromodification.
- WES and Wilsonville are in the process of adopting a BMP sizing tool based on HSPF continuous modeling for hydromodification flow control.

# 3. An Integrated Watershed Approach to Hydromodification

Urban development alters natural pre-development hydrology by decreasing vegetation (especially forested areas) and increasing impervious area; reducing both evapotranspiration and infiltration and resulting in increased runoff (Figure 1). This increased runoff is conveyed to stream channels rapidly, especially where curb and gutter development directs flow to a piped storm system that outfalls into the nearest receiving water.

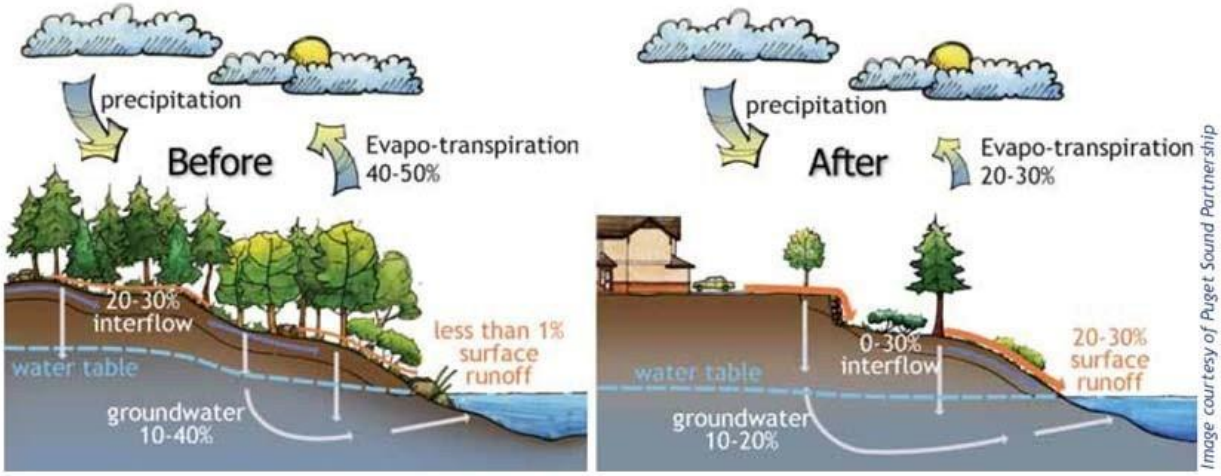



**Figure 1. Hydrologic cycle in an undeveloped and urbanized landscape.**

Size of arrows represents magnitude of inputs/outputs. (Puget Sound Partnership 2012). In the Pacific Northwest, average evapotranspiration can account for 40 percent of average precipitation[1]. Urbanized landscapes influence watershed and stream processes through multiple stressors and successful hydromodification strategies target multiple impaired or at risk processes. These stressors are intricately linked often resulting in a domino effect of impacts. For instance, piping streams both increases flows and reduces coarse sediment supply resulting in increased stream power. The increased stream power drives bank and bed erosion reducing water quality and habitat complexity. The urban stressors that drive stream erosion can be broadly categorized as increased volumes and peaks of surface runoff, reduced coarse sediment supply, and reduced stream resiliency.

When hydromodification was first identified as a problem, the strategies tended to focus exclusively on restoring natural hydrology. More recently it has been recognized that controlling hydrology, particularly reliance on detention, does not adequately address hydromodification impacts. Hydrologic control requirements only affect new and re-development projects. Even when flow control accurately targets channel forming flow it takes decades for redevelopment to restore "natural" hydrology to an urban watershed and even longer for these watershed level changes to show improvement in streams.

For these reasons, more recent hydromodification strategies include elements that address coarse sediment supply and stream resilience in addition to hydrologic controls. Strategies that address

[1] http://geochange.er.usgs.gov/sw/changes/natural/et/

hydrology, coarse sediment supply, and stream resilience are likely to be more effective in improving stream health over the long term and also have the potential to meet multiple regulatory requirements. Restoring watershed and stream processes has the added benefits of reducing maintenance costs, minimizing risks to health and human safety, reducing flood risk and infrastructure failure risk, and improving habitat in addition to regulatory compliance.

Table 1 summarizes hydromodification factors addressed by various strategies and ranks effectiveness for City of Sherwood conditions. This summary can be used as a tool for the City evaluate strategies and identify potential barriers (i.e. codes, etc.) to implementation.

**Table 1.Matrix of relationships between hydromodification strategies and factors**

| Strategies | Hydromodification Factors | | | |
|---|---|---|---|---|
| | Flow Reduction | Flow Attenuation | Coarse Sediment Supply | Stream Resilience |
| Infiltration | High | Minimal | N/A | High |
| Ditch Conveyance | Variable | High | High | High |
| Detention Facilities | Minimal | High | N/A | Variable |
| Setbacks | Variable | High | High | High |
| Riparian Corridors | High | High | High | High |
| Wetlands | High | High | Minimal | High |
| Floodplains | High | High | High | High |
| Tree Canopy | High | Minimal | N/A | High |

This table indicates that riparian corridors and floodplains have the most significant effect on hydromodification impacts in the City as these strategies affect all four factors that influence stream erosion. This is demonstrated by the lack of stream erosion in reaches where riparian corridors are well established with diverse native vegetation and floodplains and frequently activated. In a couple of cases the effect of a particular strategy is variable depending on site conditions and design. For instance, ditch conveyance can potentially have a high impact on flow reduction but often ditches are compacted to minimize infiltration. Likewise, detention facilities can improve stream resilience by reducing peak flows but if release rates are within channel forming flow thresholds these can actually increase erosion by extending the duration of high flows in the streams. There are only a few strategies that can improve or retain coarse sediment supply which makes these strategies more important. In Sherwood where soils are generally fine and the streams are low gradient coarse sediment supply is less critical than in steeper streams with gravel and cobble substrates.

# 4. City of Sherwood Stream Conditions

The City of Sherwood geology presents a unique backdrop to stream conditions. As shown in figure 2, the established stream beds are mapped as **alluvium (Qalf)** of smaller streams consisting of unconsolidated clay, silt, sand, and minor gravel. The surrounding landscape including the floodplains and uplands where most of the development has occurred are mapped as main body of **fine-grained Missoula flood deposits (Qff2)**.

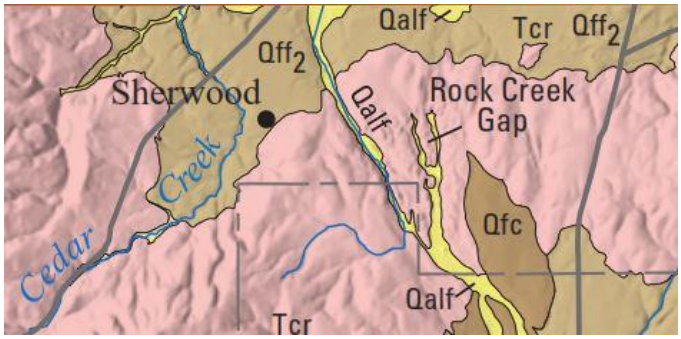



**Figure 2. Geological Map of Sherwood**

This planar undulating surface consists of clay, silt, and minor gravel forming benches. The surrounding foothills to the South and West are mapped as **Columbia River Basalt Group (Tcr)** which are weathered lava flows including small areas of alluvium, colluvium, loess, and landslide debris. This area provides a source of coarse sediments to the streams where surface water runoff connections exist. The stream channels throughout the City have down cut through upland to form wide inset floodplains that are largely free from fill and development. This has preserved stream resiliency even as the uplands have been developed. Figure 3 shows the general topography of the Sherwood vicinity, the inset floodplains of Rock, Cedar, and Chicken Creek and the proximity to the Tualatin River. Watershed boundaries are mapped in Figure 2-2 at the end of this report.

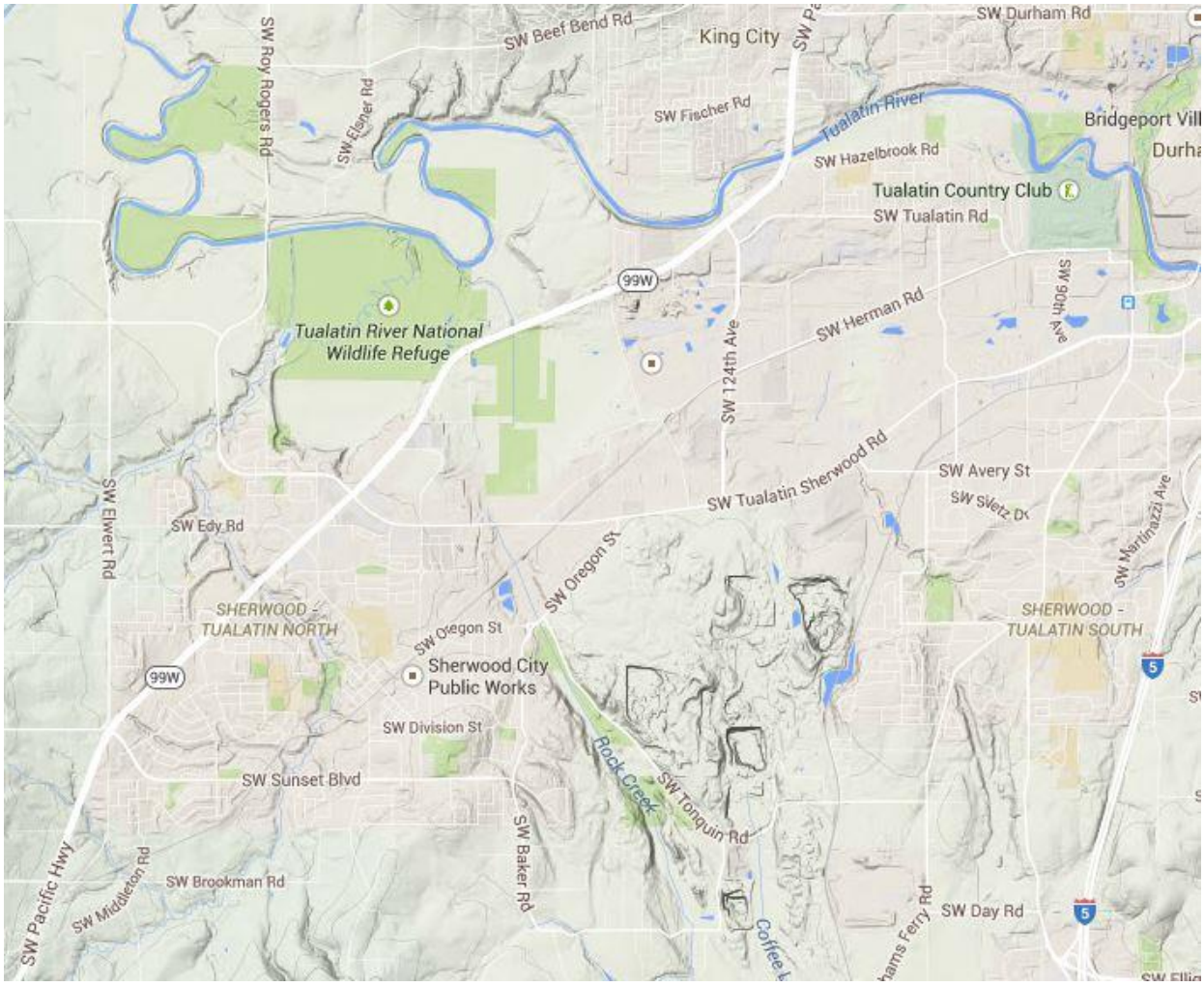



**Figure 3. Topography of Sherwood Vicinity**

## Rock Creek

Rock Creek flows North East through the City as a straightened channel through a broad inset floodplain. Much of the floodplain is choked with invasive reed canary grass and large patches of Himalayan blackberry. There are few trees along the channel except along the East side North of SW Tualatin Sherwood Road. There have been recent plantings of willow on the floodplain upstream which are relatively sparse but getting established. Minor beaver activity was observed. The channel does not appear to be incised likely due to the low gradient and adjacent floodplain. Much of the upland draining to Rock Creek is likely to see increased development through the expansion of the urban growth boundary to the East and the Tonquin Urban Reserve Area. The surrounding landscape soils are largely silt loams with low infiltration rates. The straightened channel is still susceptible to incision and as incision separates the channel from the floodplain it could begin to rapidly erode.

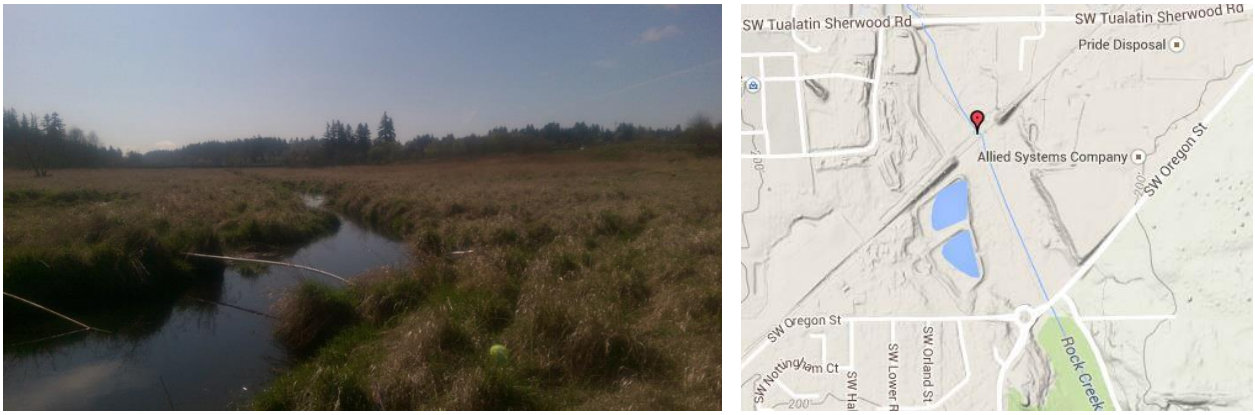



**Figure 4. Rock Creek with wide floodplain**

Signs of minor incision were observed just upstream of SW Tualatin Sherwood Road where beaver activity and a weir are providing some streambed stability. There is a piped outfall that enters a rock stilling basin directly adjacent to the stream. The outfall appears to drain a pond to the East of SW Century Dr. It could be beneficial to relocate this outfall to the edge of the floodplain where flow can be distributed in a manner that increases infiltration, water quality, and flow attenuation. It could also add to habitat diversity in the floodplain by creating a wetter area along the floodplain fringe. The indications of minor incision were observed downstream of this outfall.


**Figure 5. Minor bank erosion at instream weir on Rock Creek**

**Existing Conditions:**

- Some signs of minor incision just upstream of SW Tualatin Sherwood Road.
- Straight homogeneous channel
- Active floodplain protects the channel from incision
- Riparian vegetation is largely invasive reed canary grass and blackberry with few trees and willows.

**Figure 6. Outfall piped across floodplain to Rock Creek**

**Recommendations:**

- Protect the floodplain from further fill and development
- Continue to establish native riparian planting throughout the floodplain
- Consider restoring stream channel sinuosity to reduce risk of downcutting and increase habitat diversity.
- Encourage beaver activity
- Consider retrofitting stormwater outfall to make use of floodplain and riparian area to provide flow attenuation and improve water quality.

## Chicken Creek

Chicken Creek borders the West side of Sherwood and flows through the Sherwood West Urban Reserve Area. Existing uplands are largely agricultural fields with remnant forest blocks and scattered residential developments. The stream flows through an inset floodplain but unlike Rock Creek retains natural sinuosity. Overhead power lines follow the Creek corridor through this section likely prevents reestablishment of a forest canopy. Much of the floodplain is a monoculture of reed canary grass.

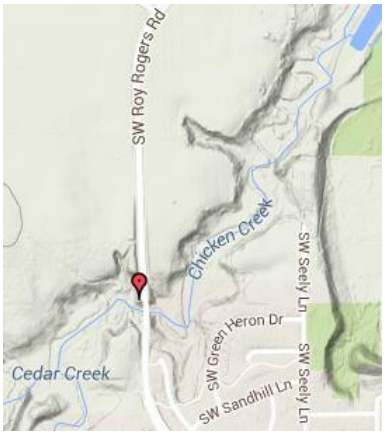



**Figure 7. Chicken Creek Floodplain Vegetation**

**Existing Conditions:**

- Active floodplain with sinuous channel
- Riparian vegetation is largely invasive reed canary grass with patches of forest.

**Recommendations**:

- Protect the floodplain from further fill and development
- Re-establish native riparian planting throughout the floodplain
- Encourage beaver activity
- Retain adjacent forests


**Figure 8. Chicken Creek Reed Canary Grass Floodplain**

## Cedar Creek

Cedar Creek flows through the center of Sherwood with urban development along both sides and some tributary headwaters within the City. Stella Olson Memorial Park near the center of town features extensive wetland, floodplain, and riparian habitat alongside trails and recreation facilities that bring the public in contact with this rich natural resource.

Cedar Creek demonstrates the stabilizing effect of an active floodplain that supports diverse mature native vegetation and encourages wetland habitats.

There are three areas of concern at the headwaters of Cedar Creek Tributaries where localized erosion was observed. These sites should be monitored and corrected as necessary. Two of the sites are located along the tributary that flows under Wildlife Haven Court adjacent to downtown where water quality facilities built in the floodplain have confined the main channel.

**Figure 9. Cedar Creek Wetland a Public Amenity**

There is a new water quality facility built at the headwaters adjacent to Main Street that appears to provide treatment and flow attenuation for a large volume of water likely originating from downtown. The channel is confined to a deep straight ditch alongside the facility behind residential buildings. This channel is prone to incision due to confinement depending on the flows that it is subject to. This channel should be monitored for incision and bed control measures implemented if necessary to protect adjacent infrastructure.

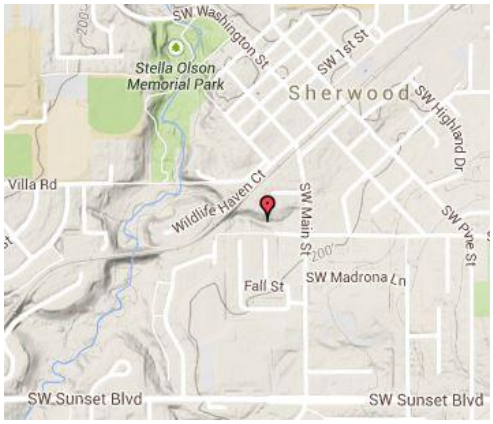



**Figure 10. Water quality facility confines stream**

Just downstream of Wildlife Haven Court a water quality swale was constructed using large concrete blocks to separate it from the main channel. As a result the straightened confined channel is incising and the bank protection only drives the incision further. This site could be retrofitted with local bed control to prevent further incision that may undermine the water quality swale. Revegetation in the riparian corridor would also slow the flows reducing erosion and protecting water quality.


**Figure 11. Water quality swale confines stream**

The third area of concern is likely caused by a road culvert that is not aligned with the stream forcing the flow up against one bank. This tributary was inaccessible due to blackberry and steep banks so it is uncertain whether the erosion continues downstream. The


**Figure 12. Bank erosion on tributary**

headwater tributaries are more prone to erosion then the main streams due to the steeper gradients and higher percentage increase in runoff. These areas are often neglected and isolated. Re-vegetation and monitoring is recommended to identify and correct issues early on. In areas that have public access riparian buffers are better maintained and erosion is easily monitored.

There is a great example of a water quality swale within the natural area of Cedar Creek South of SW Sunset Blvd on the East side of the Creek. This swale does not confine the channel and adds to the diversity of the floodplain habitat.
Wetland complexes along a significant tributary of Cedar Creek adjacent to SW Fitch Dr provide rich native habitat and enhanced flow storage and attenuation. Tributaries are well forested with a diverse native understory. Trails along the edge of the corridor are actively used by the neighborhood and this likely contributes to the investment in the natural resource.


**Figure 13. Water quality swale that does not confine the channel**

Beavers enhance wetlands by expanding storage and also prevent incision as their dams act as natural bed control. The management and integration of beavers in urban environments can be a hydromodification strategy. At times beaver deceiver devices may be required to mitigate flood risk. These devices act as a hidden silent culvert that allow higher flows to pass through the dam. The inset floodplains will minimize the need for these. A neighborhood in Tigard adopted a beaver colony and actively monitors for flood risk to ensure that the beavers stay a part of the community. Beaver can be encouraged by enhancing woody vegetation along the streams and in the floodplains.

**Figure 15. Vibrant riparian understory of native plants along Cedar Creek tributaries and public paths**

**Figure 14. Beaver activity and wetlands store flow and improve habitat on Cedar Creek tributaries**

There is a well-established floodplain forest upstream of SW Sunset Blvd that provides rich habitat, a source of large wood and shade for the channel and enhanced floodplain storage and flow attenuation. Trails along the edge of the forest provide a beautiful neighborhood amenity. Floodplain wetlands store water and provide much needed habitat for amphibians including Western pond and painted turtles and red legged frogs.

There is a forested tributary to Cedar Creek South of subdivision development that SW Brookman Rd crosses. This is a small stream with a wide floodplain that should be protected from development preserving the wide riparian forested corridor. The loss of the riparian forest and floodplain typically leads to rapid incision of the stream.


**Figure 16. Forested Cedar Creek tributary with wide floodplain**

### Existing Conditions:

- Active floodplain with sinuous channel and wetlands
- Riparian vegetation is well established native vegetation with blackberries established in some tributaries.
- A significant tributary flows through a series of wetland complexes with a forest canopy and beaver activity.
- Public access along both Creeks provides an educational opportunity for these rich natural areas.

### Basin Specific Recommendations:

- Protect the floodplain from further fill and development
- Monitor headwater tributaries where incision has been observed and stabilize as necessary
- Encourage beaver activity
- Retain adjacent forests
- Protect tributary headwaters from development.
- Protect Tributary Headwaters from development

## Coffee Lake Creek

Coffee Lake Creek is a very low gradient stream between wetland complexes and lakes. The adjacent agricultural areas have many ditches draining to the creek. As a result Coffee Lake Creek is not prone to

incision but provides great flow storage and habitat. Wetland areas should be preserved and where dominated by reed canary grass native plants should be reestablished. Adjacent floodplain and upland natural areas should be preserved to maintain food webs and enhanced flow attenuation with increased runoff. Confined wetlands are more vulnerable to invasive species and altered hydrology due to development or climate change.

**Figure 17. Coffee Lake Creek wetlands forested and developed edges**

### Existing Conditions:

- Active floodplain with straightened channel and network of tributary ditches draining agricultural land
- Riparian vegetation is well established in patches but large expanses of reed canary grass remain.

### Basin Specific Recommendations:

- Protect the floodplain from further fill and development
- Encourage beaver activity
- Retain adjacent forests
- Provide setbacks to connect wetland to adjacent upland habitat for sustainability

**Figure 18. Coffee Lake Creek wetlands**

## Hedges Creek

There is a small portion of the Sherwood Urban Growth Boundary that drains to Hedges Creek. Other developed tributaries to Hedges Creek in Tualatin are incised and have been confined by development. Hedges Creek is very low gradient with many adjacent wetland areas downstream. The best way to protect this stream from incision would be to establish a riparian buffer on the headwaters and protect and restore the downstream wetland areas. There is currently an average buffer of 100ft from the stream to agricultural areas. This could be maintained as a set-back for development instead of requiring detention to hydromodification standards.


**Figure 19. Bing bird's eye view of the Hedges Creek tributary**

**Existing Conditions:**

- Low gradient stream with existing setbacks to agricultural fields
- Some native riparian vegetation.

**Basin Specific Recommendations:**

- Protect the floodplain and riparian corridor from further fill and development
- Encourage beaver activity
- Retain adjacent forests

# 5. Conclusions and Recommended Actions

Sherwood streams currently exhibit very few locations of incision or bank erosion. All the locations where stream erosion was observed the channel was either confined by streamside infrastructure or there were localized hydraulic influences such as an outfall or culvert that forced flow up against the bank. There are unique natural features of the Sherwood landscape that protect these streams from hydromodification.

1. The tight soils of these watersheds mean that even under forested conditions the streams receive more runoff than streams with contributing areas that naturally infiltrate most of the rainfall.
2. The streams are low gradient which significantly slows the flow.
3. Most of the streams have significant inset and undeveloped floodplains that are activated at moderate flows.
4. Many reaches are protected by significant riparian vegetation. These reaches are the most resilient.
5. The most prevalent water quality treatment is the vegetated swale which likely provides some infiltration benefits especially during low flows.

**Figure 20. Cedar Creek riparian vegetation provides habitat and shade improving water quality**

Given that the streams in Sherwood are holding up well to current levels of development, it is recommended that protecting and restoring the natural features that maximize stream resiliency should be the highest priority. The recommended hydromodification strategies for Sherwood fall into three categories and all meet additional exiting and/or expected regulations:

1. Mimic natural hydrology by providing water quality treatment through green stormwater infrastructure,
2. Enhance riparian buffers with native vegetation to protect stream banks, and
3. Protect and enhance floodplains to preserve storage and flow attenuation.

Water quality treatment is required and should be provided by vegetated swales, rain gardens, planters or other types of green stormwater infrastructure. These facilities provide both infiltration and flow attenuation that mimic the natural hydrology of a low gradient forest with tight soils. All floodplain areas should be protected from development and fill. These areas are critical for providing flood storage and flow attenuation. Floodplains should be revegetated with native woody species which will improve water quality and habitat as well as restore natural hydrology. Detention strategies are not recommended as a hydromodification tool for Sherwood as this is likely to be very costly to build and maintain with very little benefit to the streams. Floodplains need to be inundated at relatively low flows with less than a two-year discharge ($Q_2$) or on average every other year. Any infrastructure that separates the stream from the floodplain or confines the channel will increase the risk of incision. If placed incorrectly, water quality swales can confine the channel. Instead, swales can be designed to integrate with the floodplain without confining the channel.

**Figure 21. Floodplain habitat and storage along Cedar Creek**

Recommendations provided in this document have the added benefit of meeting upcoming MS4 and FEMA regulations. Recent MS4 permits in Oregon have required mimicking natural hydrology and green stormwater infrastructure. The water quality swales and LIDA manual that Sherwood currently encourages developers to use meet this requirement and protect streams from hydromodification. FEMA floodplain regulations in Oregon will soon require Endangered Species Act consultation and regulations that protect natural and beneficial functions of floodplains from hydromodification and will also protect endangered species. At the same time, flood insurance rates for properties within the floodplain are expected to increase dramatically making floodplain development less economically viable.

Sherwood has minimized stormwater capital and maintenance costs by encouraging regional facilities. Riparian and floodplain areas of Sherwood streams can be seen as regional facilities that will address hydromodification. By continuing to protect and restore these areas, Sherwood can expand the network of regional trails and natural park amenities, meet multiple regulatory requirements, and reduce costs and developable surface areas required for stormwater management.

A future hydromodification plan could demonstrate through modeling and analysis the cost and benefits of implementing stream resilience strategies compared to the conventional detention and infiltration hydromodification tools. This would combine flow duration modeling with existing HEC-RAS models to correlate increased runoff with shear stress on the channel bed and banks. The HEC-RAS models would be run with various levels of active floodplain and riparian vegetation to compare watershed detention to stream resilience strategies in reducing shear stress at channel forming flows. The hydromodification plan would also compare capital and maintenance costs of watershed detention vs stream resilience strategies.

Specific Stormwater Master Plan recommendations include regulations that

- encourage green stormwater infrastructure such as swales or LIDA to treat water quality,
- protect floodplains from development by requiring no rise certification, balanced cut and fill, and endangered species act compliance with all proposed floodplain development
- protect headwater streams and wetlands with buffer requirements

Capital projects would include;

- purchase and restoration of flood prone properties,
- revegetation of floodplains and riparian buffers with native woody vegetation

Sherwood streams are holding up well to with existing developed watershed and this is largely due to the riparian vegetation and active floodplains that improve stream resiliency. In addition, these streams have adapted to higher rates of runoff due to tight soils. Therefore, it is unnecessary to require additional detention or infiltration requirements to address hydromodification. Instead efforts should be focused on continuing to protect and enhance floodplains, wetlands, and riparian corridors.

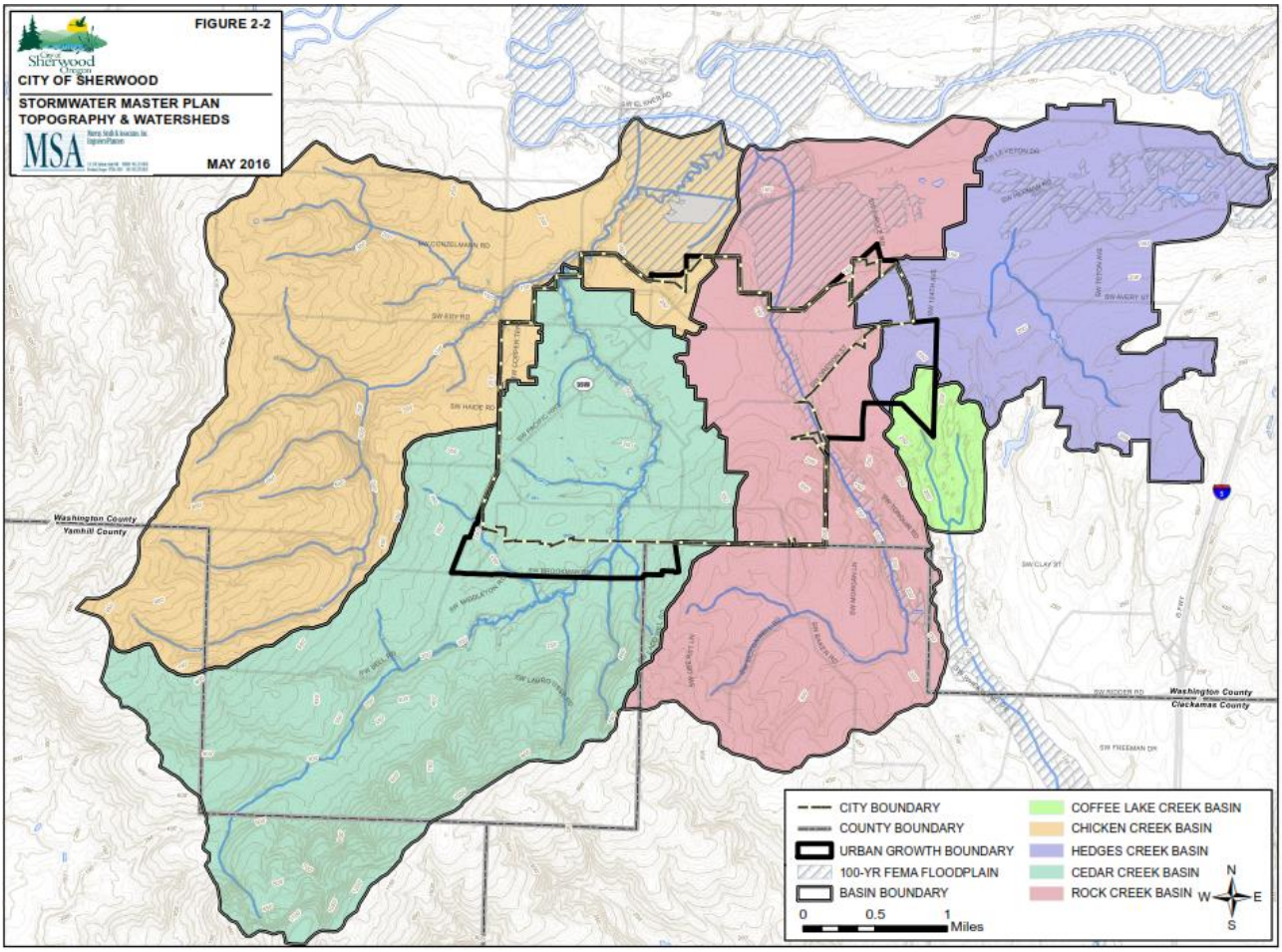



**Figure 22 Sherwood Watershed Boundaries**

# 6. References

Booth, D.B., D. Hartley, and R. Jackson. 2002. Forest cover, impervious surface area, and the mitigation of stormwater impacts. Journal of the American Water Resources Association. Vol. 38 No. 3. Pp 835-645.

Castro, JC, and PL Jackson. 2001. Bankfull discharge recurrence intervals and regional hydraulic geometry relationship: patterns in the Pacific Northwest, USA. 37(5):1249-1262.

Central Coast Regional Water Quality Control Board, 2011. Development and Implementation of Hydromodification Control Methodology. Prepared by TetraTech and Stillwater Sciences.

Cluer, B. and C. Thorne. 2013. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications. DOI: 10.1002/rra.2631.

Contra Costa County Clean Water Program. 2005. Hydrograph Modification Management Plan. Prepared by PWA and Brown & Caldwell.

Environmental Protection Agency (EPA). 2007. National Management measures to Control Nonpoint Source Pollution from Hydromodification. EPA 841-B-07-002. http://www.epa.gov/owow/NPS/hydromod/

EPA 2012. U.S Environmental Protection Agency. 2012. Draft Functional Assessment Framework Excerpt: Attributes, Considerations, Criteria. U.S. Environmental Protection Agency, Region 10, Portland, OR.

Henshaw P.C. and Booth D.B. 2000. Nature restabilization of stream channels in urban watersheds. Journal of the American Water Resources Association, 36: 1219–1236. doi: 10.1111/j.1752-1688.2000.tb05722.

Horner RR, May CW, Livingston EH, Maxted J. 1999. Tampa, Florida: Proceedings of The Sixth Biennial Stormwater Research and Watershed Management Conference. Impervious Cover, Aquatic Community Health, and Stormwater BMPs: Is There a Relationship? September 14-17, 1999.

Horner R, May C, Livingston E, Blaha D, Scoggins M, Tims J, Maxted J. 2002. Structural and Non- Structural BMPs for Protecting Streams. In: Urbonas Ben R., editor. Linking Stormwater BMP Designs and Performance to Receiving Water Impact Mitigation. Reston, Virginia: ASCE; 2002. pp. 60–77. Proceedings of an Engineering Foundation Conference, August 19-24, 2001, Snowmass Village, CO.

Jim E. O'Connor, Andrei Sarna-Wojcicki, Karl C. Wozniak, Danial J. Polette, and Robert J. Fleck. 2001 Geologic Map of Quaternary Units in The Willamette Valley, Oregon. U.S. Department of The Interior, U.S. Geological Survey

King County. 2009. Surface Water Design Manual. King County Department of Natural Resources and Parks. January 9, 2009

Maxted J. 1999.The Effectiveness of Retention Basins to Protect Downstream Aquatic Life in Three Regions of the United States. In: Malone M, editor. Comprehensive Stormwater and Aquatic Ecosystem Management. Auckland, New Zealand: Auckland Regional Council; pp. 215–222. Conference Proceedings Volume 1. First South Pacific Conference, February 22-26, 1999.

# APPENDIX D | BASIS OF OPINION OF PROBABLE COST

## INTRODUCTION

This section summarizes the approach used in development of unit costs and project costs used in the Capital Improvement Program (CIP).

All project descriptions and cost estimates in this document represent a Class 5 budget estimate, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +30 to +100 percent on the high end, meaning the actual cost should fall in the range of 50-percent below the estimate to 100-percent above the estimate.

Cost estimates are intended to be used as guidance in establishing funding requirements based on information available at the time of the estimate. The procedure used to generate cost information presented herein is consistent with the definition of "rough cost estimates" under OAR 660-011-0005(2) and OAR 660-011-035. The final cost of individual projects will depend on actual labor and material costs, site topography, existing utility installations within the limits of work, competitive market conditions, regulatory requirements, project schedule, contractor bidding strategies, and other factors. All cost estimates are in 2015 dollars.

Due to the project definition maturity level at this phase in system planning, the following considerations are excluded from the opinion of costs:

- Land or Right-of-Way Acquisition;
- Studies, planning or modeling of the Transportation System, Collection System, Water System, or Stormwater System;
- Borrowing or finance charges during the planning, design, or construction of assets;
- Improvements to distribution, conveyance, pumping, storage, or treatment facilities in response to changes in regulatory standards or rules;
- Remediation or fines associated with system violations.

## PROJECT COST DEVELOPMENT

Project costs were developed through a progression of steps, starting with development of construction costs. Construction costs consist of the sum of materials, labor and equipment of easily identifiable features of a project such as piping, manholes, trench work, and road work. The estimated costs for each improvement are based on averages from the *RS Means Heavy Construction Cost Data* (Reed Construction Data, 2015), supplemented with quotes from local suppliers, City input and construction costs for similar projects near the City of Sherwood. Information from RS Means is derived from a national average of construction cost indexes from over 700 cities. To correlate these costs to local market conditions, a

Portland market location factor was applied to both materials (98.8) and labor (100.4). The historical cost index for the date of publication is 206.7 (January 2015).

## Component Unit Costs

The unit costs are applied to improvement pipe lengths for varied depths and manhole spacing at approximately 400 feet. The unit costs account for the materials, labor, and equipment necessary to complete the improvements. Unit costs for stormwater collection system improvements are shown in Tables D-1 through D-5. These costs include considerations for:

- Trench saw cutting, excavation and hauling of waste;
- Importing and placement of pipe zone bedding;
- Importing and placement of trench backfill when encountering rock excavations;
- Pipe material and installation labor;
- Trench safety systems (temporary shoring or trench box);
- Testing and video inspection;
- Surface restoration of unpaved streets, or paved local versus arterial roads;
- Dewatering;
- Bypass pumping on pipe replacement projects;
- Subcontractor's markup for profit and overhead.

The CIP presents projects defined according to three categories: existing system capacity upgrades, condition based improvements, and new infrastructure for future development. The unit costs were applied according to the CIP project's category, as summarized below:

- Cost estimates for projects specifying replacement of existing pipes for condition utilize the unit costs tabulated in Tables D-1, D-2, and D-3.
- Cost estimates for projects specifying pipe trunk line upsizing or new infrastructure utilize the unit costs contained within Tables D-1, D-4 and D-5.

| Table D-1 \| 2015 Unit Costs for Surface Restoration of Pipelines ($/linear-foot) | | |
|---|---|---|
| Surface Restoration Cost with Road Category | | |
| Local – 4" Asphalt | Arterial – 6" Asphalt | Unpaved |
| $51 | $65 | $4 |

| Table D-2 \| 2015 Unit Costs for Condition Based Replacement of Existing Gravity Pipelines ($/linear-foot) | | | | | |
|---|---|---|---|---|---|
| Pipe Diameter (inch) | Material Cost | Installation and Equipment Cost with Depth Category | | | |
| | | <10 ft | 10-15 ft | 15-20 ft | 20-25 ft |
| 8 | $7 | $68 | $124 | $235 | $402 |
| 10 | $12 | $71 | $127 | $238 | $405 |
| 12 | $13 | $73 | $129 | $240 | $407 |
| 15 | $13 | $81 | $136 | $247 | $414 |
| 18 | $15 | $88 | $144 | $255 | $422 |
| 21 | $21 | $95 | $151 | $262 | $429 |
| 24 | $27 | $102 | $158 | $269 | $436 |
| 27 | $37 | $160 | $216 | $327 | $494 |
| 30 | $50 | $172 | $227 | $338 | $505 |
| 36 | $66 | $201 | $257 | $368 | $535 |
| 42 | $84 | $226 | $282 | $393 | $560 |
| 48 | $102 | $252 | $307 | $419 | $585 |

| Table D-3 \| 2015 Unit Costs for Condition Based Repair of Existing Manholes ($/each) | | |
|---|---|---|
| Manhole Diameter (inch) | Corresponding Pipe Size | Installation and Equipment Cost |
| 48 | Pipe Ø< 24” | $1,528 |
| 60 | 24” ≤ Pipe Ø < 48” | $1,813 |
| 72 | Pipe Ø ≥ 48” | $2,181 |

| Table D-4 \| 2015 Unit Costs for New and Upsized Gravity Pipelines ($/linear-foot) | | | | | |
|---|---|---|---|---|---|
| Pipe Diameter (inch) | Material Cost | Installation and Equipment Cost with Depth Category | | | |
| | | <10 ft | 10-15 ft | 15-20 ft | 20-25 ft |
| 8 | $7 | $61 | $111 | $212 | $362 |
| 10 | $12 | $62 | $113 | $214 | $364 |
| 12 | $13 | $64 | $115 | $215 | $365 |
| 15 | $13 | $70 | $121 | $221 | $372 |
| 18 | $15 | $76 | $127 | $228 | $378 |
| 21 | $21 | $82 | $132 | $233 | $383 |
| 24 | $27 | $87 | $138 | $238 | $388 |
| 27 | $37 | $129 | $179 | $280 | $430 |
| 30 | $50 | $136 | $187 | $288 | $438 |
| 36 | $66 | $158 | $209 | $310 | $460 |
| 42 | $84 | $177 | $227 | $328 | $478 |
| 48 | $102 | $195 | $246 | $346 | $497 |

| Table D-5 \| 2015 Unit Costs for New Manholes ($/each) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Manhole Diameter (inch) | Corresponding Pipe Size | Material Cost with Depth Category | | | | Installation and Equipment Cost with Depth Category | | | |
| | | <10 ft | 10 to 15 ft | 15 to 20 ft | 20 to 25 ft | <10 ft | 10 to 15 ft | 15 to 20 ft | 20 to 25 ft |
| 48 | Pipe Ø< 24" | $3,088 | $5,002 | $5,637 | $6,272 | $3,062 | $5,258 | $8,072 | $17,867 |
| 60 | 24" ≤ Pipe Ø < 48" | $5,236 | $8,180 | $9,580 | $10,980 | $3,539 | $8,600 | $13,035 | $18,517 |
| 72 | Pipe Ø ≥ 48" | $6,595 | $10,230 | $12,130 | $14,030 | $4,669 | $10,710 | $16,098 | $22,731 |

## Unit Cost Notes Applicable to Tables D-1 through D-5:

1. Unit costs exclude lateral tie-ins.
2. Unit costs exclude utility relocation associated with potential conflicts.
3. Road resurfacing assumes:
   a. Local = 4-inch AC + 8-inch base course + 2-inch leveling course
   b. Arterial = 6-inch AC + 10-inch base course + 2-inch leveling course
   c. Unpaved = 4-inch base course.
4. All trench work is assumed to be vertical (no side slope) with either trench box or temporary shoring.
5. The pipe material for gravity sewer was assumed to be PVC (ASTM D-3034, SDR 35) for 15-inch diameter pipe and smaller, and Class III (ASTM C-76) reinforced concrete for pipe with a diameter greater than 15 inches.
6. Manhole installation assumes that surface restoration effort is covered under the surface restoration cost associated with the pipeline (Table D-1).
7. The bypass pumping is for above grade application (no trenchwork) and includes the cost of the piping, installation and removal.

## Rock Excavation

Specific geotechnical investigations were not provided during this master planning effort; however the geologic mapping and the Natural Resource Conservation Service (NRCS) Soil Survey were referenced for any obvious conflicts for pipe installation with lithic bedrock. Additionally, well logs were referenced from the Oregon Water Resources Department with mixed results. There are numerous domestic water wells within the study area reporting encountering rock within 10 feet of the ground surface.

Basalt rock near the ground surface appears prevalent in the southeast corner of the City, and there are no projects within the CIP needed within this area. For this reason, unit costs associated with construction of new and upsized pipelines exclude rock excavation. Pipeline replacement costs for condition-based improvements also exclude rock excavation since presumably any rock encountered during installation of the existing pipeline has been removed and replaced with granular backfill.

## Trenchless Construction Methods

Where existing pipes are recommended to be replaced with new larger pipes, upsizing within two pipe diameters of the original size is assumed to be a candidate for pipe bursting. In the absence of site specific geotechnical information, which would preclude this construction practice, a trenchless approach is typically less expensive than open trench construction. However, pipe bursting costs are highly variable and rely upon site specific influences, such as soil type, installation depth, length of construction, and ability to excavate departure and receiving pits.

The information presented in Table D-6 is provided for the City's reference in budgeting future pipe replacement projects utilizing the pipe bursting approach. Due to the absence of geotechnical information for the projects presented in the CIP, these prices have been excluded from use during preparation of project cost estimates.

**Table D-6 | 2015 Unit Costs for Replacing Existing Gravity Pipelines Using Pipe Bursting ($/linear-foot)**

| | From Existing Pipe Dia. To New Pipe Dia. (Inch) | Material Cost | Installation and Equipment Cost |
|---|---|---|---|
| Increase One Pipe Diameter | 8 to 10 | $19 | $47 |
| | 10 to 12 | $26 | $53 |
| | 12 to 15 | $41 | $61 |
| | 15 to 18 | $46 | $70 |
| | 18 to 21 | $48 | $95 |
| | 21 to 24 | $66 | $107 |
| | 24 to 27 | $74 | $125 |
| | 27 to 30 | $89 | $143 |
| Increase Two Pipe Diameter | 8 to 12 | $26 | $81 |
| | 10 to 15 | $41 | $90 |
| | 12 to 18 | $46 | $102 |
| | 15 to 21 | $48 | $115 |
| | 18 to 24 | $66 | $155 |
| | 21 to 27 | $74 | $172 |
| | 24 to 30 | $89 | $198 |
| | 27 to 36 | $130 | $225 |

## Stormwater Treatment and Detention

The CIP presents Water Quality and Quantity Facility projects to manage stormwater runoff originating from existing unmanaged impervious areas. These facility locations will also manage runoff from future redevelopment within the UGB. The unit costs presented in Table D-7 account for the materials, labor, and equipment necessary to complete the improvements.

| Table D-7 \| 2015 Unit Costs for Stormwater Treatment and Detention | |
|---|---|
| **Swales and Extended Dry Basins** | |
| Excavation and Embankment | $25/cubic-yard |
| Treatment Topsoil – 18" minimum | $50/cubic-yard |
| Geotextile | $3/square-yard |
| Landscaping | $50,000/acre |
| Emergency Overflow | $5,000/each |
| Fencing | $30/linear-foot |
| Access Road with Gate | $11,000/each |
| Pretreatment Sediment Manhole | $12,000/each |
| Inlet Structure | $6,000/each |
| Flow Control Outlet Structure | $14,000/each |
| **Proprietary Systems** | |
| Catch Basin System, 1-cartridge | $8,600/each |
| Catch Basin System, 2-cartridge | $15,300/each |
| Catch Basin System, 3-cartridge | $21,000/each |
| Catch Basin System, 4-cartridge | $26,300/each |
| Vault System, 8-cartridge | $48,200/each |

### Riparian Planting

The CIP presents a budget for riparian planting to promote beaver habitat (see Appendix C for more information). The cost to install riparian buffers varies widely and can depend on a number of site specific conditions (number of plants, cost of materials, land ownership, etc.). Riparian Planting costs contained within the CIP are based on Oregon DEQ guidance[1] and Clean Water Services correspondence[2] for the Middle and Baker-Heaton restoration projects. The $15,000 per acre unit cost applied in the CIP includes site planning, installation, materials and labor for restoration within an urban setting, and excludes land acquisition considerations. Projects are recommended to be constructed at a minimum of 4-acre increments to remain cost effective.

## CONSTRUCTION COST ALLOWANCES

Costs for commonly occurring general work elements in stormwater collection projects were factored into the construction costs through the use of assumed allowances. Table D-8 presents a summary of these allowances. When combined with the unit costs and multiplied by the improvement lengths, these allowances create an estimated "bid price" for the work. Detailed information justifying the assumed allowance values is provided below.

[1] Michie, Ryan. "Cost Estimate to Restore Riparian Forest Buffers and Improve Stream Habitat in the Willamette Basin, Oregon." Oregon DEQ. March 2010.
[2] Emanuel, Robert. "Riparian Planting Costs." Message to Marjorie Wolfe. 31 May 2016. Email.

| Table D-8 \| Construction Cost Allowances | |
|---|---|
| **Additional Cost Factor** | **Percent** |
| Traffic Control | 3% |
| Erosion Control | 1% |
| General Contractor's Overhead | 10% |
| General Contractor's Profit | 8% |
| Mobilization | 7% |
| Clearing and Grubbing | 2.5% |
| Removal of Structures and Obstructions | 4% |

## Traffic Control

Traffic control will be required for all projects that occur in roadways. The traffic control mark-up is intended to account for costs, such as signage, flagging and temporary barriers, pavement markings, lane delineators, and lighting at flagging locations.

## Erosion Control

The erosion control mark-up accounts for materials and practices to protect adjacent property, stormwater conveyance systems, and surface water in accordance with regulatory requirements. The City's NPDES Permit stipulates that construction site runoff control is required for activities that result in a land disturbance exceeding 500 square feet. More complex projects may require the development of a stormwater pollution prevention plan, 1200-C permit application and reporting, installation of erosion control best management practices (BMPs), and routine maintenance, testing and inspection of all installed BMPs.

## General Contractors Overhead

Overhead costs associated with the General Contractor's day-to-day operations, such as staff salary, taxes, benefits, insurance, marketing, and proposal preparation, are an inherent cost of everyday business. Contractors will typically markup their subcontractor's costs as a management expense to keep their business running.

## General Contractors Profit

Beyond overhead costs, contractors will typically markup their subcontractors to realize a profit for their effort. This is one of the most highly variable parts of a budget and depends upon the type of project, the size of the project, the amount of risk involved, how much money the contractor wants to make, the general market conditions, and bidding strategies.

## Mobilization

Before construction of a project may begin, setup and preparatory activities are necessary. Mobilization is a general term used to capture numerous variables, but typically relates to:

- Moving staff, equipment, supplies, and incidentals to the project site;

- Establishing site trailers, offices, or other facilities necessary for the project;
- Incurring costs as necessary before beginning work on the project, which may include expenses associated with acquisition of bonds and insurance.

## PROJECT COST ALLOWANCES

The project cost is the sum of construction component unit costs and any additional cost allowances for contingency, engineering, permitting, legal and administration fees. Table D-9, below, presents the cost allowances for each additional project cost. These project cost allowances are factored into the total construction cost and not the individual unit costs. The engineering costs include design and surveying. Construction administration is the cost associated with managing the construction of the project. The administration and legal costs are those associated with the City providing financial and legal oversight of the contract.

| Table D-9 \| Project Cost Allowances | |
|---|---|
| **Additional Cost Factor** | **Percent** |
| Engineering, Legal, Permitting and Construction Services | 20% |
| Contingency | 30% |
| City Internal Overhead | 12% |

### Engineering, Legal, Permitting and Construction Services

This category is intended to capture the costs needed for development of all the upfront project related documentation to make a project bid ready. Construction drawings, specifications and permit applications are both time and resource intensive, often requiring months of preparatory work before a project may be bid. Additional services typically provided by the engineering team during construction include site inspections, assisting the contractor in interpretation of the contract documents, and preparation of record drawings.

Costs for engineering, legal, permitting and construction services can vary widely based on the unique scope of work for each project. A cost factor approach is an appropriate assumption for most projects of the size and character within the CIP, however the cost factor is not well suited for projects with construction costs below $300,000. For these smaller projects, the engineering, legal, permitting and construction services costs should be evaluated by the City on a case-by-case basis for project budgeting.

### Contingency

A contingency was included in each project's cost to account for the uncertainties inherent within the preliminary level of the estimate. Contingency is a term used in estimating that refers to costs that will likely occur based on past experience, but with some uncertainty regarding the amount. This factor was applied to all estimated project costs except for the City Internal Overhead. The contingency is provided to account for factors, such as:

- Unanticipated utilities;
- Relocation and connection to existing infrastructure;
- Minor elements of work not addressed in component unit cost development;

- Details of construction;
- Changes in site conditions;
- Variability in construction bid climate.

The contingency excludes:

- Major scope changes such as end product specification, capacities and location of project;
- Extraordinary events such as strikes or natural disasters;
- Management reserves;
- Escalation and currency effects.

### City Internal Overhead

The City has an assortment of departments and personnel involved in the realization of a construction project. The City Internal Overhead cost allowance is intended to capture the effort needed on the part of the City related to project management, plan review, permit processing, code compliance, construction inspections, and financial management.

## PROJECT COST MULTIPLIER

For simplicity in estimating overall project costs, a multiplier can be applied against the construction costs determined from unit pricing. This multiplier accounts for the allowances for both construction costs and project costs into one easily used factor. An example calculation showing how this multiplier was developed and is provided in Table D-10 below.

| Table D-10 \| Project Cost Multiplier | | |
|---|---|---|
| **Construction and Project Cost Allowances** | **Allowance Factor** | **Cost** |
| Example Construction Cost Total | - | $1,000,000 |
| | | |
| Mobilization | 7% | $70,000 |
| Erosion Control | 1% | $10,000 |
| Clearing and Grubbing | 2.5% | $25,000 |
| Traffic Control | 3% | $30,000 |
| Removal of Structures and Obstructions | 4% | $40,000 |
| | *MOB Subtotal* | *$175,000* |
| General Contractor's Overhead | 10% | $117,000 |
| General Contractor's Profit | 8% | $94,000 |
| Engineering, Legal, Permitting and Construction Services | 20% | $234,000 |
| | *Contractor Cost Subtotal* | *$1,615,000* |
| | *Construction Subtotal* | *$1,615,000* |
| Contingency | 30% | $466,500 |
| | *Subtotal* | *$2,021,500* |
| City Internal Overhead | 12% | $242,580 |
| | **Project Cost Subtotal** | **$2,264,080** |

| Project Cost Multiplier | |
|---|---|
| Total Project Cost divided by | $2,264,080 |
| Unit Construction Costs | $1,000,000 |
| **= Project Cost Multiplier** | **2.26** |

# APPENDIX E | FEMA LETTER, FLOODPLAIN IMPACTS

**U.S. Department of Homeland Security**
FEMA Region 10
130 – 228th Street, SW
Bothell, Washington 98021

FEMA

June 13, 2016

Honorable Mayor Krisanna Clark
22560 SW Pine St.
Sherwood, OR 97140

Dear Honorable Mayor Clark,

In 2009, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) was sued by the Audubon Society of Portland, the National Wildlife Federation, the Northwest Environmental Defense Center, and the Association of Northwest Steelheaders for failure to consult under Section 7 of the Endangered Species Act (ESA) with respect to the effects of the implementation of the National Flood Insurance Program (NFIP) on certain ESA-listed species in the state of Oregon. On July 12, 2010, the United States District Court, District of Oregon at Salem, required FEMA to consult with the National Marine Fisheries Service (NMFS) on impacts the NFIP was having on ESA listed species. FEMA complied by submitting a Biological Assessment in July of 2011 to NMFS, which concluded the NFIP may affect, but does not adversely affect, the ESA-listed species considered in the assessment.

On April 14, 2016, NMFS provided a Biological Opinion in which they concluded that the implementation of the NFIP in Oregon jeopardizes the continued existence of 18 ESA listed species and adversely modifies their critical habitat. Federal agencies are prohibited by the ESA from causing jeopardy to ESA-listed species or adversely modifying the designated critical habitat of such species. Although the NMFS Biological Opinion's determination is written for FEMA, the Endangered Species Act (ESA) applies to everyone, whether a federal agency, state agency, local jurisdiction, or individual. We all have a legal responsibility to ensure our actions do not cause a take (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) to threatened or endangered species. Under Section 9 of the ESA, actions or decisions enacted by you and your officials are subject to this take prohibition regardless of federal involvement. Additionally, any person can be subject to criminal or civil penalties for causing a take of threatened or endangered species. NMFS considers the issuance of floodplain development permits that do not avoid or compensate for detrimental impacts on ESA-listed species or their critical habitat as noncompliant with the Endangered Species Act. NMFS identifies certain private floodplain development activities as harmful to listed species, including the addition of fill, structures, levees and dikes, the addition of impervious surfaces, removal of vegetation, and bank armoring. NMFS has determined that these activities impair natural floodplain functions and thereby negatively impact the survival and recovery of ESA-listed species.

With a jeopardy determination, NMFS is obligated to provide a Reasonable and Prudent Alternative (RPA), which are program changes to the NFIP that will allow the program to be implemented in a manner that avoids jeopardy to ESA-listed species and adverse modification

of their critical habitat. For details on these program changes, please see the RPA attached to this letter or the complete NMFS Biological Opinion at http://www.westcoast.fisheries.noaa.gov/habitat/conservation/index.html.

As envisioned by NMFS, the RPA is intended to be implemented in stages, with two different sets of program changes that will need to be implemented by FEMA and the NFIP participating communities. The first set of program changes are interim measures found in Element 2 of the RPA, which must be implemented within 2 years of the issuance of the Biological Opinion (April 14, 2018). These measures will remain in place until FEMA and the participating communities implement the second set of program changes (Elements 3-6 of the RPA), which are the permanent program changes to the NFIP required by the RPA. NMFS requires the interim measures in Element 2 to be superseded by the permanent floodplain management criteria in RPA Element 4 that do not require regulatory revisions (such as revising the Code of Federal Regulations) by January 1, 2019. All elements of the RPA that do not necessitate regulatory revisions are to be implemented by September 15, 2019 and complete implementation, including regulatory revisions, is required to occur by January 1, 2021.

The NMFS Biological Opinion authorizes a certain amount of jeopardy or adverse modification to ESA-listed species or their habitat during the time necessary for FEMA and participating NFIP communities to implement the complete RPA. During this interim time and until all permanent RPA elements are in place, your community may either choose to voluntarily impose a temporary moratorium on all floodplain development that adversely impacts ESA listed species or their habitat, or voluntarily implement the interim measures found in RPA Element 2. Oregon DLCD and FEMA will develop guidance to help your community implement these interim requirements.

FEMA and Oregon DLCD will be inviting you and other interested stakeholders to participate in workgroups to identify options and methods that communities can implement, with respect to the RPA. These implementation options may include guidance, training, and technical assistance. One example is the development of a model ordinance that would meet FEMA's minimum criteria while also incorporating the requirements of the RPA. Once this model ordinance is finalized, it will be shared with all interested communities.

The RPA comprises six elements or sections, and a full copy of the RPA is provided as an attachment to this letter. Element 1 involves notice, education, and outreach regarding the outcome of FEMA's consultation with NMFS on the implementation of the NFIP in Oregon. This letter is part of that requirement for FEMA to provide Notice of the Biological Opinion and RPA. RPA Element 1encourages communities to send data or information on locally identified flood-related hazards due to erosion or inundation, including anticipated flooding patterns influenced by build-out, climate change or sea level rise, which are not currently reflected on effective Flood Insurance Rates maps (FIRMs) to the FEMA Region X office by August 12, 2016. In addition, the RPA recommends that substantially improved and new structures (as defined in the RPA) placed in the Special Flood Hazard Area should be elevated by methods other than fill, and that proponents of projects that involve adding fill exceeding 50 cubic yards should pursue CLOMR-Fs prior to LOMR-Fs to ensure ESA compliance is obtained prior to undertaking floodplain development. This element also requires FEMA to

provide guidance to communities regarding elevating structures in a manner that minimizes the adverse effects to natural floodplain functions. For information on elevating structures, please see the attached Frequently Asked Question document - Elevating Structures Without Fill.

In Element 2 of the RPA, NMFS has laid out a set of Interim Measures expected to be implemented within 2 years and requires that all development in the SFHA be mitigated to achieve no net loss of natural floodplain functions. Element 2 includes requirements for mitigation ratios, impervious surfaces, stormwater, floodplain management standards, riparian buffers, LOMCs and CLOMCs, and floodplain development permit reporting. FEMA will be working to provide you with guidance regarding how to achieve the requirements listed in RPA Element 2.

Additionally, to help minimize the time and effort imposed upon your staff resulting from the floodplain development permit reporting requirement, FEMA intends to use a Microsoft Excel based reporting tool that will be sent to each community to track all new development occurring in floodplains. Once the interim RPA requirements are in place, if communities issue floodplain development permits without reporting said development or without mitigating for adverse effects on ESA listed species or their habitat, FEMA will be required, in coordination with NMFS acting under their own authority, to initiate appropriate enforcement action.

Element 3 requires use of revised mapping protocols and methodologies for the stated purpose of improving the identification of special hazard areas. The RPA also requires several additions to the Flood Insurance Rate Maps, including the future conditions floodplain, erosion zones, and channel migration zones.

Element 4 requires revisions to the floodplain management criteria to, among other things:

- Include a generally applicable ESA performance standard;
- Prohibit almost all development in an area known as the High Hazard Area (floodway, V-Zone, LiMWA, erosion zone);
- Prohibit re-drawing of the floodway to accommodate floodplain development;
- Require a 60 year erosion setback area with very limited uses (agricultural, open space, temporary structures); and
- Significantly restrict subdivisions of lots.

Element 4 also requires extensive compensatory mitigation requirements in the areas where floodplain development is not otherwise prohibited. FEMA will be working to provide you with guidance regarding how to achieve the requirements listed in RPA Element 4.

Element 5 requires data collection and describes reporting requirements needed to accurately track floodplain development impacts and RPA implementation. Element 6 speaks to compliance and enforcement requirements of the RPA and the associated timelines for compliance.

FEMA recognizes that many of you have already been implementing measures that compensate/mitigate floodplain development actions affecting ESA-listed species and their habitat. However, for others, these requirements may pose an additional workload on your

community. We will work diligently with you, State resource agencies, and NMFS to offer guidance and resources that will help facilitate this transition. We will keep you advised and look forward to working with interested stakeholders to develop our strategy for implementation. If you have any questions, please email FEMA-R10-ESAcomments@fema.dhs.gov or contact Scott Van Hoff, Senior NFIP-ESA Specialist at 425-487- 4677.

Sincerely,

Mark Carey,
FEMA Region X Mitigation Division Director

cc: FPA
State NFIP Coordinator
Kim Kratz, NMFS

Attachments: Oregon NFIP Reasonable and Prudent Alternative (RPA)
FAQ- Elevating Without Fill

SVH: jg

U.S. Department of Homeland Security
Region X
130 228th Street SW
Bothell, WA 98021-9796

FEMA

**June 10, 2016**

**FAQ: How can I elevate my new structure without fill?**

National Marine Fisheries Service's (NMFS) Biological Opinion (BiOp) on the NFIP implementation in Oregon requires FEMA to issue guidance on a variety of issues. Element 1 of the Reasonable and Prudent Alternative (RPA) requires FEMA to issue a letter to all communities that provides notice of the findings in the BiOp, interim measures, and guidance regarding elevating new structures in a manner that minimizes adverse effects of fill as an elevation technique to natural floodplain functions. This Frequently Asked Question (FAQ) document provides resources to find more detailed guidance on elevating new structures. There will be additional guidance documents provided as FEMA implements the BiOp, however this specific guidance is required by element 1 of the RPA.

FEMA has the following web-based and publications available to help understand some of the available options:

- FEMA 54-Elevated Residential Structures
  - This document contains design characteristics and recommendations for pilings, posts, piers, and other open foundation systems; several case studies are provided.
- FEMA P-259-Engineering Principles and Practices of Retrofitting Floodprone Residential Structures
  - Section 5E offers some elevation techniques for retrofitting a home.
- FEMA 15- Design Guidelines for Flood Damage Reduction
  - This document offers various pre-construction design considerations.
- FEMA P-347-Above the Flood: Elevating Your Flood Prone House
  - This document is largely targeted to existing structures and does not include post or pier elevating, but still offers alternatives to using fill.
- FEMA P-312-Homeowner's Guide to Retrofitting 3rd Edition
  - This document is also mainly targeted to existing structures and the example method 2 in Chapter 3 shows an open foundation.
- FEMA P-499-Home Builder's Guide to Coastal Construction
- FEMA P-55-Coastal Construction Manual
- Technical Bulletin 5-Free-of-Obstruction Requirements


MSA

MURRAY, SMITH & ASSOCIATES, INC.
ENGINEERS|PLANNERS