



**CITY OF MOLALLA
CITY COUNCIL - WORK SESSION
AGENDA**

Civic Center | 315 Kennel Avenue Molalla, OR 97038
Wednesday, August 12, 2026 | 5:00 PM

NOTICE: City Council Work Session will hold this meeting in-person and through video live-streaming on the City's [YouTube Channel](#). Work Sessions are open to the public, however closed for Public Comment.

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- 1. CALL TO ORDER & ROLL CALL**
- 2. DISCUSSION ITEMS**
 - a. Stormwater Master Plan Final Draft Review & Discussion
- 3. ADJOURN**



CITY OF MOLALLA

117 N. Molalla Avenue
PO Box 248
Molalla, OR 97038

Staff Report

Agenda Category: General Discussion

August 12, 2026

From: Sam Miller, Engineering Section Manager
Seth Kelly, Water Quality Superintendent

Approved by: Mac Corthell, Assistant City Manager

SUBJECT: Stormwater Masterplan Final Draft Review & Discussion

FISCAL IMPACT: N/A

RECOMMENDATION/RECOMMEND MOTION: N/A

BACKGROUND:

City staff and our engineering consultants at Keller Associates are here to present the final draft Stormwater Master Plan for one last round of Council feedback before bringing it forward to Planning Commission on September 2, 2026, then back for recommended adoption by City Council on September 23, 2026.

Molalla's last comprehensive Stormwater Master Plan update was completed in 2003. Industry best practice recommends that infrastructure master plans utilize a 20-year planning horizon and be updated every 10 years to ensure they continue to reflect current infrastructure conditions, regulatory requirements, and community growth.

The current Stormwater Master Plan no longer reflects current development patterns, infrastructure conditions, regulatory expectations, or the City's long-term stormwater management needs.

City staff have completed a thorough review of the draft Stormwater Master Plan and believe it accurately identifies the City's major stormwater challenges while prioritizing projects based on system needs, risk, and long-term community benefit.

City of Molalla

DRAFT FINAL **STORMWATER MASTER PLAN**

July 2026 | Project No. 223122

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Appendix I – Capital Improvement Plan

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CHAPTER 1 - INTRODUCTION

The City of Molalla (City) contracted with Keller Associates, Inc. (Keller) to complete their stormwater master plan (SWMP). This chapter introduces the planning process and the purpose and need of this study.

1.1. PURPOSE AND NEED

This report was commissioned by the City in an effort to assess the current state of the stormwater system and plan for future needs. The City last completed a SWMP in 2003. Planning is an important task for a public agency to undertake, as it assists with evaluating needs and priorities, properly allocating budgets to address system deficiencies, and planning for future growth. It is generally recommended to update a stormwater plan every 5-7 years or as needed depending on an area's current or anticipated population growth rate. This study is funded by the City.

1.2. REPORT ORGANIZATION

The report organization consists of the following.

- Chapter 1 – Introduction: Discusses the purpose and need for this study. It outlines the extent of the study and discusses community engagement.
- Chapter 2 – Existing Stormwater System: Identifies the location and extent of the project planning area and includes an inventory of the existing stormwater system components.
- Chapter 3 – Project Planning: Establishing planning time periods, historical and projected population growth, regulatory requirements, policies and design standards, design storms, and methodology.
- Chapter 4 – Stormwater Capacity Evaluation: Documents hydrologic and hydraulic model development and includes an evaluation of the existing stormwater system under various design storms. Identifies capacity deficiencies and problem areas.
- Chapter 5 – Future System Evaluation: Documents the evaluation of the future stormwater system under projected development and redevelopment conditions. Identifies potential capacity deficiencies and problem areas that may arise under future design storm scenarios.
- Chapter 6 – Design Standards and Operations and Maintenance (O&M) Evaluation: Provides a summary of the design standards review. Recommends O&M activities for a municipal stormwater system and recommended staffing levels to achieve the target level of service.
- Chapter 7 – Recommended Projects and Programs: Recommends capital improvement projects, annual programs implementation, stormwater utility development and system development charges.

1.3. PROJECT DESCRIPTION

This planning study evaluates the existing system under several design storm events. It consists of an inventory of the existing system, establishes planning/evaluation criteria, includes an existing and future system evaluation, design standards review, O&M evaluation, an alternatives analysis, and a capital improvement plan. These components prepare the City for the next 20 years by maintaining, expanding, and improving its system.



1.4. PUBLIC ENGAGEMENT

A Technical Review Committee (TRC) was established during the planning process to give the City representatives an opportunity to provide input on the decisions and recommendations proposed in this study. The TRC consisted of members of Oregon Department of Transportation, Clackamas County, Clackamas Soil and Water Conservation District, Pudding River Watershed Council, City of Molalla and representatives, and Keller Associates. The TRC meeting was held near the end of the planning process to provide a comprehensive review of the master plan development, process, means and methods, and resulting recommended projects and programs.

The TRC meeting was held on June 15th, 2026. The feedback from the group was positive and no significant items or concerns were raised.

In addition to the TRC meetings, a public open house was held on May 19th. This was advertised by the City of Molalla for any interested individuals to attend and learn about the stormwater master plan. The open house was led by Keller Associates and attended by several City staff. A presentation was provided outlining the master planning process. Additionally, poster boards were set up showing the problem areas and providing an opportunity for residents to provide feedback and provide additional problem areas they have experienced. Less than five residents attended the open house.

Presentations, poster boards, and public feedback are provided in Appendix A – Public Engagement.



CHAPTER 2 - EXISTING STORMWATER SYSTEM

This chapter provides information on the study area, its physical characteristics, and includes an inventory of the existing stormwater conveyance system.

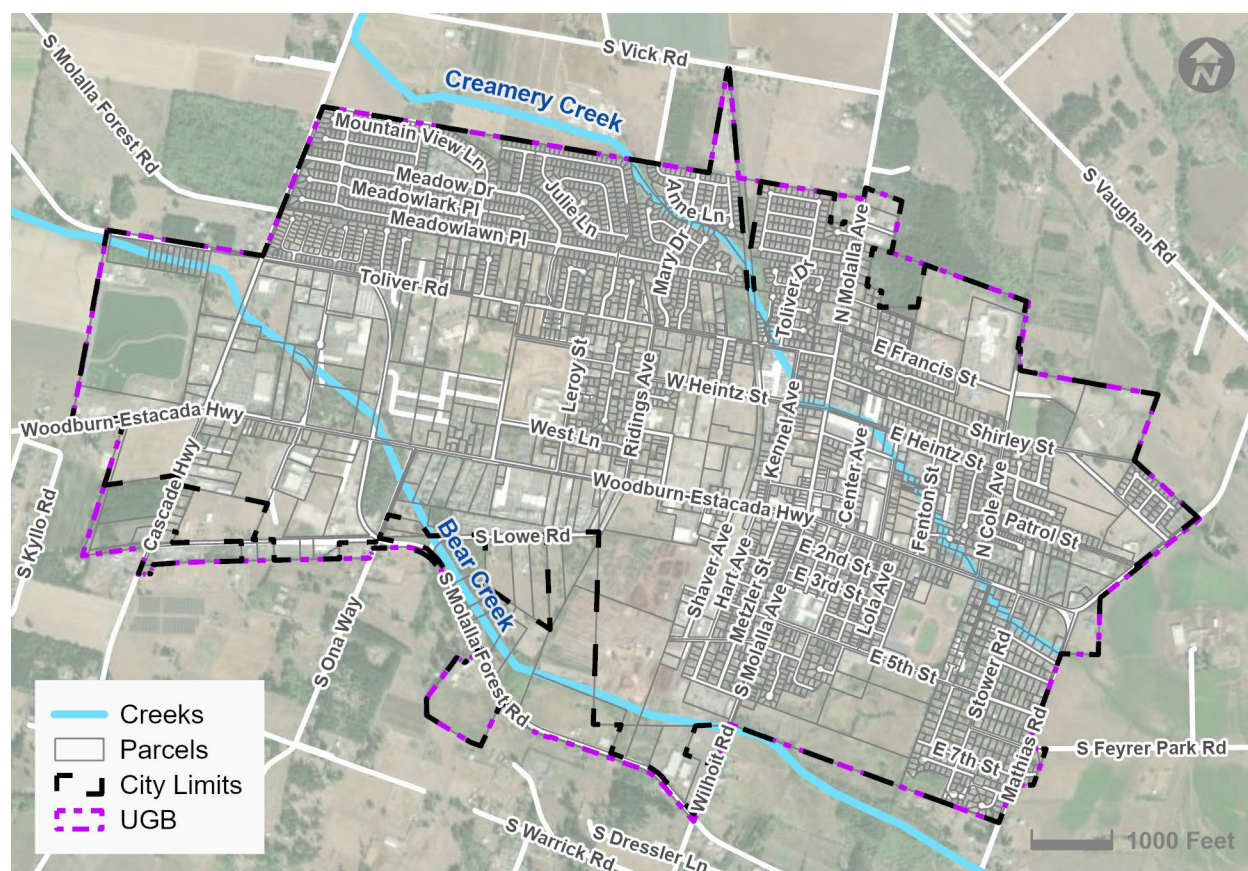
The City owns and operates a municipal stormwater collection system which collects stormwater from within the City limits and areas draining to the City limits and conveys it to outfalls or infiltration facilities. In general, the conveyance system consists of catch basins, manholes, pipes, culverts, storm facilities, open channels/ditches, creeks, and detention storage facilities. Figure 1 in Appendix B illustrates the existing stormwater system.

2.1. STUDY AREA

The City of Molalla is located in southwest Clackamas County, Oregon, approximately 30 miles southeast of Portland. It is situated within the northern Willamette Valley and lies within the Molalla-Pudding Subbasin of the Willamette River Basin. Major transportation corridors serving the City include Oregon Highway 213 (Cascade Highway), which provides north-south regional connectivity, and Oregon Highway 211 (Main Street/Woodburn-Estacada Highway), which traverses the City east-west and serves as a principal transportation corridor. These state highways, along with their associated roadway drainage facilities and stormwater infrastructure, are owned and maintained by the Oregon Department of Transportation (ODOT). Consequently, portions of the City's stormwater system interface with ODOT-managed drainage facilities, requiring coordination between the City and ODOT to manage runoff, maintain roadway drainage, and protect downstream water quality and hydraulic capacity.

The study area of this SWMP is comprised of the City limits and the Urban Growth Boundary (UGB). The City's UGB encompasses approximately 1,780 acres, including about 1,640 acres within City limits and 140 acres outside the City limits. Figure 2-1 illustrates the study area boundaries; a full-size version is also provided in Appendix B as Figure 2. Additional information on the study area's climate, soils, topography, flood hazards, wetlands, and drainage boundaries is provided in the following sections.

FIGURE 2-1: STUDY AREA BOUNDARIES



2.1.1. Climate

The City of Molalla's climate is mild, characterized by dry temperate summers and cool wet winters. The rainy season typically extends from October through April and accounts for more than 80% of the area's average annual precipitation. Rainfall is generally most frequent and consistent between November and January. The City does not see a significant amount of snow accumulation but if snow occurs, it will typically melt within a couple of days. Table 2-1 summarizes the average monthly climate data for the study area.

TABLE 2-1: CLIMATOLOGICAL DATA

Metric	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum/Avg
Precipitation (in) ¹	5.9	4.3	5.2	4.5	3.4	2.1	0.6	0.6	2.0	4.3	6.9	6.7	46.4
Average High (°F) ¹	47	51	56	61	68	72	81	82	77	64	53	46	65
Average Low (°F) ¹	35	36	39	42	47	51	56	56	52	46	39	35	45

1) From NOAA station Molalla 7NW, 1991-2020 period of record

2.1.2. Soils and Topography

The study area is generally flat, with a gentle slope to the northwest. Ground elevations range from approximately 290 to 430 feet, with the center of the City at an elevation of 375 feet. Slopes range



from 0% to 18%, with an average slope of 1%. A topographic map of the City is provided in Figure 3 of Appendix B.

Soils data were obtained from the Web Soil Survey, produced by the National Cooperative Soil Survey and administered by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The City's soils are predominantly classified as silt loam, with a smaller area of silty clay loam located along the western portion of Bear Creek (see Figure 4 in Appendix B). These soils are generally poorly drained and are classified within Hydrologic Soil Groups C and D. The weighted-average saturated hydraulic conductivity is approximately 0.4 inches per hour, indicating relatively low permeability and a high potential for surface runoff. Consequently, infiltration-based stormwater management practices may have limited applicability and should be evaluated based on site-specific soil and groundwater conditions. The weighted-average soil pH is 5.6, with values ranging from 5.4 to 6.1, indicating moderately acidic conditions.

2.1.3. Major Drainage Basins

Molalla's stormwater system discharges primarily to Bear Creek and Creamery Creek, with a small area in the northeast conveyed north through ditches that ultimately discharge to the Molalla River. The boundaries of these drainage basins are illustrated in Figure 5 of Appendix B, and their respective areas are summarized in Table 2-2.

TABLE 2-2: TOTAL DRAINAGE AREA FOR EACH MAJOR BASIN

Basin	Bear Creek	Creamery Creek	Molalla River
Area (acres)	3,180	736	146
Percent of Total Drainage Area	78%	18%	4%

Bear Creek flows along the southern edges of the City, generally from southeast to northwest, before discharging into the Pudding River east of the City of Hubbard, approximately 8 miles downstream of Molalla. Bear Creek is primarily an open channel system, with flow conveyed through roadway culverts at many crossings within and near the City.

Creamery Creek also flows from southeast to northwest, passing through the central downtown area and exiting the City's northern boundary. Within the City, Creamery Creek is conveyed through a combination of open channel segments and piped reaches beneath roadways and developed areas. Downstream, it continues northward before discharging into the Molalla River south of the City of Canby.

The Pudding and Molalla Rivers converge downstream prior to their combined discharge into the Willamette River.

2.1.4. Flood Hazards

The Molalla River flows from south to north about a mile east of the City. Because the river is located outside the study area, it is not a significant source of flood risk within the City or the UGB. The 100- and 500-year floodplains associated with the Molalla River are shown in Figure 6 in Appendix B.

Although the Molalla River does not pose a significant flood hazard within the City, several locations along Bear Creek and Creamery Creek have experienced flooding. These locations are shown in Figure 2-2.

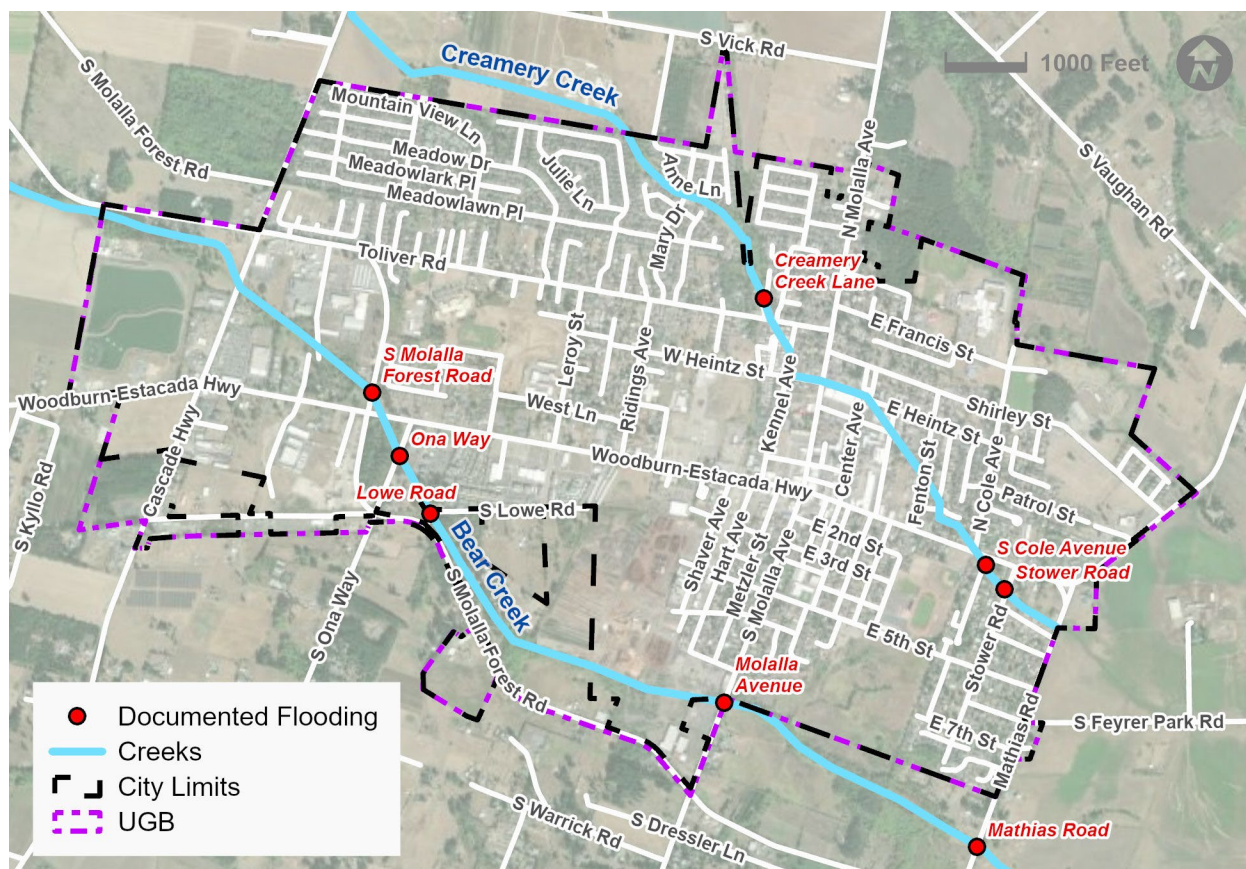
The City has identified six roadway culverts along Bear Creek that have flooded in recent history. The culvert at Highway 213 was recently upgraded and is not expected to flood under current conditions. The remaining five culverts are located at South Molalla Forest Road, Ona Way, Lowe Road, Molalla Avenue, and Mathias Road. The Mathias Road crossing is located outside the City



limits and UGB and is maintained by Clackamas County. At the time of this report, the Molalla Avenue culvert is being replaced. Additional flooding may occur at private crossings along Bear Creek, although the extent of flooding at these locations is unknown.

Along Creamery Creek, documented flooding has occurred at the crossings of South Cole Avenue, Stowers Road, and Creamery Creek Lane.

FIGURE 2-2: HISTORICAL FLOODING AT CREEK CULVERTS



2.1.5. Wetlands

Figure 6 in Appendix B also shows potential wetlands identified by the U.S Fish and Wildlife Service's National Wetlands Inventory and the Local Wetland Inventory completed by Pacific Habitat Services, Inc. in March 2004. The majority of wetlands identified within the UGB are adjacent to or along Bear Creek and Creamery Creek. Some wetlands shown on this map have since been developed.

Wetlands provide important environmental and community benefits, including flood storage, stormwater attenuation, water quality improvement, groundwater recharge, and fish and wildlife habitat. Because of these functions, wetlands and other waters are protected under state and federal regulations. Wetland mapping presented in this chapter is based on available inventory data and is intended for planning purposes only. Inventory data represent approximate wetland and water resource locations and do not constitute a regulatory wetland delineation or jurisdictional determination. Actual wetland boundaries may differ from mapped locations, and unmapped wetlands or other waters may be present. Site-specific investigations and coordination with applicable regulatory agencies may be required to accurately identify wetland boundaries and determine permitting requirements for activities that could affect wetlands or other waters.



2.2. EXISTING STORMWATER SYSTEM INVENTORY

2.2.1. Stormwater Conveyance

The City's mapped stormwater collection system consists of approximately 31 miles of pipeline and 5 miles of open channel. The open channel system is composed primarily of sections of Bear Creek and Creamery Creek that pass through the City but also includes roadside ditches that collect and convey stormwater runoff. An inventory of the mapped piped stormwater collection system is summarized in Table 2-3 by pipe diameter. Approximately 60% of the piped stormwater system is constructed of plastic pipe (PVC and HDPE), 25% is concrete pipe, and the remaining 15% consists of ductile iron pipe, corrugated metal pipe, and pipe segments with unknown material.

TABLE 2-3: EXISTING PIPED CONVEYANCE SYSTEM INVENTORY

Size	Total Length (ft)	% of Total
8-inch or less	22,500	14%
10- to 12-inch	77,200	47%
15- to 18-inch	27,800	17%
21- to 24-inch	17,100	10%
30-inch or larger	16,800	10%
Unknown Diameter	3,200	2%
Total	164,600	100%

2.2.2. Stormwater Structures

In addition to pipe and open channel, the stormwater system consists of catch basins, manholes, and outfalls. An inventory of the existing stormwater structures is provided in Table 2-4.

Catch basins collect stormwater from the surface and route it into the conveyance system. Manholes are generally located at street intersections or every few hundred feet to provide maintenance access to the pipe system and an easy connection point for catch basins. The City's stormwater system includes flow control manholes, which typically have an orifice and overflow weir to control flows coming out of a storage facility. Outfalls refer to the outlet of a stormwater network to a receiving water body or open channel/ditch. In this study area, outfalls discharge mostly to Creamery Creek and Bear Creek.

TABLE 2-4: STORMWATER STRUCTURES INVENTORY

Type	Number	% of Total
Catch Basin	1,036	61%
Access Manhole	492	29%
Flow Control Manhole	25	1%
Outfall	138	8%
Total	1,691	100%



2.3. DETENTION/INFILTRATION FACILITIES

The City has approximately 31 detention/infiltration facilities throughout their existing stormwater system. An inventory of these existing facilities is summarized in Table 2-5 and is shown in Figure 1 in Appendix B. The City is currently tasked with maintaining 21 detention facilities.

Detention facilities detain peak runoff rates by providing stormwater storage and releasing flows at a controlled rate. The detention facilities may have other functions such as infiltration or water quality treatment. The detention facilities documented in the study area are maintained either by the City or private entities, such as property owners, private developments, or homeowners' associations (HOA). Ongoing maintenance of detention facilities is critical to the proper operation of the facility. Recommended maintenance activities for detention facilities are provided in Chapter 6.

2.4. WATER QUALITY FACILITIES

Water quality treatment is currently required for all new developments in the City, which is typically achieved with water quality facilities. Water quality facilities in some cases are combined with detention facilities to save space. The current water quality and detention facilities in the City GIS database are included below in Table 2-5.

Water quality facilities are designed to be the first line of treatment prior to discharging into the conveyance system or waters of the state. Ongoing regular maintenance is critical to effectively maintain the facilities' ability to provide anticipated levels of treatment. These facilities may be maintained by the City, an HOA, or another private entity; Table 2-5 denotes who maintains each facility in the City.

Additional information on water quality is provided in Chapter 3.



TABLE 2-5: DETENTION/INFILTRATION FACILITIES INVENTORY

Name	Type	Maintained By	Outlet Control	Water Quality
213/Big Meadow	Surface Water Ditch	Public Works	No	No
Anne Lane	Surface Water Detention Pond	Public Works	Yes	Yes
Bear Creek Estates	Surface Water Detention Pond	Public Works	Yes	Yes
Columbia Drive	Surface Water Detention Pond	Public Works	Yes	Yes
Commercial Drive East Side	Surface Water Detention Pond	Public Works	Yes	Yes
Commercial Drive West Side	Surface Water Detention Pond	Public Works	Yes	Yes
Fenton Ave Swales	Surface Water Detention	Public Works	No	No
Fox Park	Surface Water Ditch	Public Works	No	No
Harvey/June	Surface Water Detention Pond	Public Works	Yes	Yes
Hauser Ct	Surface Water Detention Pond	Public Works	Yes	Yes
Ivor Davies Ditchline	Surface Water Ditch	Public Works	No	No
June	Surface Water Detention Pond	Public Works	No	No
Kennel Ave Swales	Surface Water Detention	Public Works	No	No
Lynn LN Ditchline	Surface Water Ditch	Public Works	No	No
McEachran Subdivision	Underground Storage Modules	Public Works	Yes	Yes
Molalla River Estates	Surface Water Detention Pond	Public Works	Yes	Yes
Pegasus	Surface Water Detention Pond	Public Works	No	Yes
Shops Pond	Surface Water Detention Pond	Public Works	Yes	Yes
Stowers/Alyssa	Surface Water Detention Pond	Public Works	Yes	Yes
Twin Meadows	Underground Storage Modules	Public Works	Yes	Yes
West Lane	Surface Water Detention Pond	Public Works	Yes	Yes
Andrian Estates	Surface Water Detention Pond	HOA	Yes	Yes
Bear Creek Subdivision 1	Surface Water Detention Pond	HOA	Yes	Yes
Bear Creek Subdivision 2	Surface Water Detention Pond	HOA	Yes	Yes
Bear Creek Subdivision 3	Surface Water Detention Pond	HOA	Yes	Yes
Trinity Estates	Surface Water Detention Pond	HOA	Yes	Yes
5th Street Behind Stadium	Underground Storage Modules	Private	Yes	Yes
Fountain Valley	Surface Water Ditch	Private	No	No
Glory Lane	Surface Water Ditch	Private	No	No
Safeway	Surface Water Detention Pond	Private	Yes	Yes
W Main Storage Facility	Surface Water Detention Pond	Private	Yes	Yes

2.5. UNDERGROUND INJECTION CONTROL (UIC) INVENTORY

UIC facilities are used to infiltrate stormwater below the ground surface often when few other disposal options are available. DEQ administers a UIC program which has a primary goal to protect freshwater



aquifers from contamination due to UICs. DEQ maintains an inventory of registered UIC's and issues rule authorization letters for systems that meet program requirements.

The City has one registered and one unregistered UIC. A summary of the UICs is included in Table 2-6. Figure 7 in Appendix B shows the approximate locations and status of the UICs within the City.

TABLE 2-6: UIC INVENTORY

UIC ID (per DEQ database)	Description	Address	Status ¹	Type
14258	Buckeroo Ford	213 West Main Street	Not Registered	Unknown
10740	Molalla High School	357 Frances Street	Registered & RA	Unknown
1) RA = Rule Authorized				



CHAPTER 3 - PROJECT PLANNING

Stormwater system planning criteria establish fundamental principles and performance standards to evaluate the existing system and plan for future improvements. These criteria include key considerations such as growth projections, land use, regulatory requirements, design standards, design events, and modeling methodology.

The planning criteria for this evaluation were selected by reviewing industry standards, applicable state and federal stormwater regulations, and practices of neighboring communities to identify an approach best suited to the City of Molalla. The City's existing Public Works Design Standards, last updated in 2020, serve as the primary foundation for establishing planning criteria and recommended updates to the standards were developed and are summarized in Chapter 6.

3.1. HISTORICAL AND FUTURE GROWTH

3.1.1. HISTORICAL AND FUTURE POPULATIONS

Molalla's certified population estimate on July 1, 2025, was 10,491 as reported by Portland State University's (PSU) Population Research Center. As shown in Table 3-1 and Figure 3-1, the City's population increased steadily from approximately 6,000 in the early 2000s to nearly 10,500 by 2025, representing an average annual growth rate (AAGR) of 2.5%. Population growth has moderated over the past decade, with an AAGR of approximately 1.6%. Overall, this trend reflects continued but more gradual population growth in recent years.

Population projections¹ from PSU estimate an AAGR of 1.15% over the next 20 years. Based on these projections, Molalla will grow to 13,325 people by 2046. Table 3-1 also includes population estimates from the previous PSU forecast, which projected higher rates of population growth. Although some recent planning documents continue to cite these earlier projections, this SWMP uses the most recent PSU forecast, which reflects updated demographic trends and planning assumptions.

¹ Clackamas County Population Forecast 2024-2074; PSU Population Research Center.

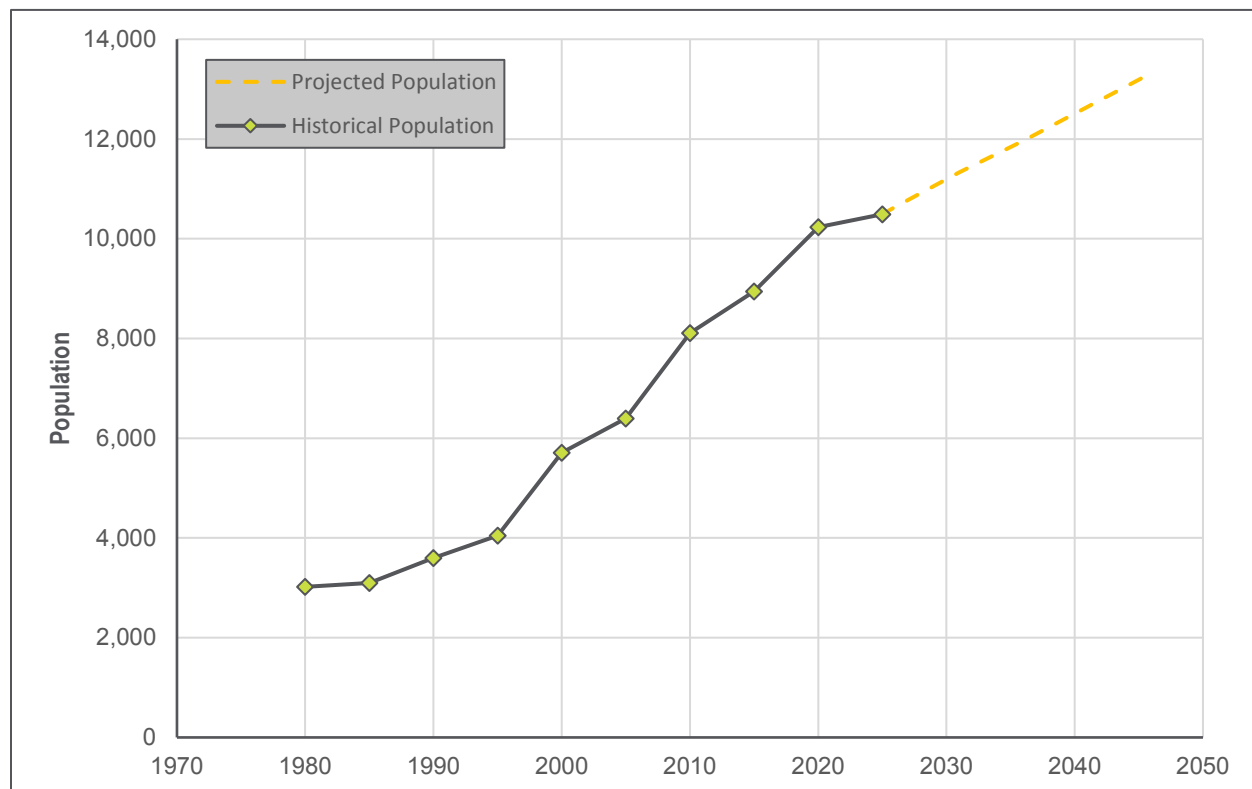


TABLE 3-1: POPULATION DATA

	Year	Population	AAGR (calculated)	Data Source & Comments
Historical	1980	3,020	-	PSU Population Research Center
	1990	3,600	1.8%	PSU Population Research Center
	2000	5,710	4.7%	PSU Population Research Center
	2010	8,110	3.6%	PSU Population Research Center
	2015	8,940	2.0%	PSU Population Research Center
	2020	10,231	2.7%	PSU Population Research Center
	2021	10,184	-0.5%	PSU Population Research Center
	2022	10,198	0.1%	PSU Population Research Center
	2023	10,219	0.2%	PSU Population Research Center
	2024	10,485	2.6%	PSU Population Research Center
	2025	10,491	0.1%	PSU Population Research Center
	25-Year AAGR		2.5%	
	10-Year AAGR		1.6%	
Projected ¹	2026	10,634	1.4%	Start of Planning Period
	2031	11,330	1.6%	5-year Planning Period
	2036	11,968	1.1%	10-year Planning Period
	2046	13,325	1.1%	20-year Planning Period
Prior Projections ²	2026	11,525	2.1%	Start of Planning Period
	2031	12,765	2.3%	5-year Planning Period
	2036	14,071	2.0%	10-year Planning Period
	2046	16,198	1.4%	20-year Planning Period
1) Based on Growth Rates from PSU Population Research Center's Forecast Report for Clackamas County, published in 2024				
2) PSU Population Research Center's Forecast Report for Clackamas County, published in 2020				



FIGURE 3-1: CITY OF MOLALLA POPULATION PROJECTIONS



3.1.2. EXISTING AND FUTURE LAND USE

Molalla's existing land use, shown in Figure 9 of Appendix B, is predominantly residential, consisting of low, medium, and medium-high density neighborhoods. Commercial development is concentrated along the established transportation corridors, including the downtown core, while a combination of light and heavy industrial uses is primarily located in the southern portion of the City. Agricultural and rural residential uses are found outside the City's Urban Growth Boundary (UGB). As the population continues to increase, the City anticipates gradual infill and development of currently vacant and underutilized parcels within the UGB.

Future land use patterns are guided by the City's Comprehensive Plan and zoning map, which emphasize preserving the residential character of established neighborhoods while supporting mixed-use infill and strategic expansion of commercial and industrial zones. The City is currently pursuing an expansion of the existing UGB to accommodate projected growth. Commercial and industrial development is expected primarily near the existing industrial areas, particularly along and south of Main Street.

3.2. REGULATORY FRAMEWORK

3.2.1. HISTORY AND ELIGIBILITY

Under the federal Clean Water Act (CWA), as amended in 1987, Congress directed the U.S. Environmental Protection Agency (EPA) to implement a phased approach to regulating stormwater discharges through the National Pollutant Discharge Elimination System (NPDES). EPA implemented the first phase of the municipal separate storm sewer system (MS4) program in 1990 (Phase I) and expanded the program in 1999 (Phase II), together forming the foundation of the modern federal stormwater regulatory framework.



Title 40 of the Code of Federal Regulations (C.F.R.) § 122.26 states, Phase I regulations apply primarily to large and medium MS4s, generally those serving populations of 100,000 or more. Phase II expanded the program to regulate small MS4s. Under 40 C.F.R. § 122.32, small MS4s are generally subject to permitting requirements if they are located fully or partially within a Census-defined urbanized area with a population of 50,000 or more, or if they are otherwise designated by the permitting authority.

Oregon implements the federal MS4 framework through its delegated NPDES program under OAR 340-045-0015(2), which requires permits for stormwater discharges subject to 40 C.F.R. §§ 122.26 and 122.33. Consistent with the federal Phase II regulations, the Oregon Department of Environmental Quality (DEQ) regulates small MS4s through the MS4 Phase II General Permit. DEQ's updated permit, effective July 1, 2026, clarifies that permit coverage applies to small MS4s located within Census-designated Urbanized Areas or Urban Areas identified in the 2000, 2010, or 2020 U.S. Census with populations greater than 50,000. The updated permit language also clarifies that areas previously identified as qualifying urbanized or urban areas remain subject to permit coverage unless DEQ grants a waiver pursuant to 40 C.F.R. § 122.32.

Municipal stormwater discharges may also be subject to water quality requirements independent of MS4 permit coverage. Under Section 303(d) of the Clean Water Act, states are required to identify water bodies that do not meet applicable water quality standards and to develop Total Maximum Daily Loads (TMDLs) for the pollutants causing impairment. A TMDL establishes the maximum amount of a pollutant that a water body can receive while still meeting water quality standards and allocates allowable pollutant loads among contributing sources. Because stormwater runoff is often identified as a contributing source of impairment, municipalities may be subject to TMDL-related implementation responsibilities even if they are not regulated under an MS4 permit.

3.2.2. REGULATORY REQUIREMENTS

Most Phase I MS4 communities are regulated through individual permits tailored to the specific conditions and needs of the jurisdiction, while Phase II communities are generally regulated through statewide or regional general permits developed for similarly situated dischargers. Both Phase I and Phase II permits address a common set of core stormwater management program elements, commonly referred to in the Phase II program as minimum control measures (MCMs), including: (1) public education and outreach; (2) public participation and involvement; (3) illicit discharge detection and elimination (IDDE); (4) construction site runoff control; (5) post-construction stormwater management; and (6) pollution prevention and good housekeeping practices. In addition, MS4 permits commonly include requirements related to stormwater system mapping and inventories, inspection and enforcement procedures, staff training, operation and maintenance activities, annual reporting, and implementation of water quality requirements associated with TMDLs.

Beyond MS4 permit requirements, municipalities may also be subject to obligations associated with approved TMDLs for receiving waters within their jurisdiction. In Oregon, TMDL implementation is supported through basin-specific planning and implementation frameworks that identify responsible parties and management measures needed to achieve pollutant reductions. Depending on the applicable TMDL, local governments may be expected to implement stormwater management practices, erosion and sediment control measures, riparian protection activities, public education programs, monitoring efforts, or other actions intended to improve water quality and support attainment of established load allocations.

3.2.3. CITY APPLICABILITY AND PLANNING CONSIDERATIONS

As of the 2020 Census, the Molalla Urbanized Area has a population of 10,258 and is not currently subject to mandatory Phase I or Phase II MS4 permit coverage under federal NPDES regulations. However, future growth and resulting changes in Census-defined Urbanized Area boundaries, or potential state-level designation by the permitting authority, could lead to future MS4 Phase II applicability. The City should continue developing stormwater management policies and programs consistent with Phase II permit expectations, including maintaining up-to-date stormwater mapping and inventories, evaluating stormwater design and maintenance standards, and incorporating water



quality considerations into future capital improvement planning and development review processes. Early development of these administrative, operational, and regulatory frameworks can help reduce future implementation challenges if MS4 permit coverage becomes required.

While the City is not currently regulated under an MS4 permit, it is a Designated Management Agency (DMA) for several applicable TMDLs. Molalla is located within the Molalla-Pudding subbasin, which is part of the larger Willamette River basin (see Figure 8 in Appendix B). This basin has established TMDLs for temperature, bacteria (*E. coli*), and mercury. Each pollutant includes specific load allocation that municipalities are required to help address. Stormwater runoff can transport bacteria, sediment-bound mercury, and other pollutants, as well as contribute to elevated temperatures in the Molalla and Pudding Rivers and their tributaries. As a result, it is critical for the City to implement stormwater management practices that effectively reduce these pollutants and support water quality restoration.

At this time, the City is not required to regulate stormwater quality, however, it is required to implement its TMDL implementation plan completed in September 2022. The City should also be aware that, at some future time, it may be required to develop a stormwater management plan to address and reduce pollutants in the stormwater system as a regulated NPDES Phase II MS4.

The City should continue coordinating with the Oregon DEQ, Oregon Water Resources Department (OWRD), and local watershed councils to support regional water quality objectives. Any modifications or expansions to the stormwater system should be consistent with applicable regulatory requirements and designed to protect downstream water resources.

3.2.4. CURRENT CITY POLICIES AND DESIGN STANDARDS

The City's policies and standards establish the framework for the design and construction of future storm drainage systems. The policies and design standards guide development and infrastructure improvements within the City limits and UGB. Ensuring that these documents are consistent with the City's goals and regulatory requirements is essential for effective stormwater management and for minimizing confusion during implementation.

Current City stormwater design standards, which directly impact the evaluation of the system in this study, are provided Table 3-2. The table also summarizes applicable design standards of nearby cities for comparison. A more detailed review of the City's design standards, along with recommended updates, is provided in Chapter 6.



TABLE 3-2: PLANNING CRITERIA SUMMARY

Planning Criteria	Molalla (Existing)	Molalla (Recommended)	Independence	Stayton	Salem
Runoff Model Approach	NRCS TR-55, SWMM, & Rational Method	NRCS TR-55, SWMM, & Rational Method	Rational method	Multiple	Rational Method, SBUH, SWMM, or NRCS TR-55
Storm Distribution	24-HOUR, NRCS 1A	24-HOUR, NRCS 1A	24-HOUR, NRCS 1A	Multiple	24-HOUR, NRCS 1A
Min. Tc	5 Minutes	5 Minutes	5 minutes	Multiple	5 minutes
24 hr Storm Precipitation	NRCS	NOAA	NRCS	Multiple	NOAA
PVC 'n' Value	Not Specified	0.013	Not Specified	0.013	Varies
Min. Pipe Diameter	12-inch	12-inch	10-inch	12-inch	12-inch
Minimum Freeboard in Open Channels (ft)	1.0	1.0	1.0	1.0	1.0
Minimum Freeboard in Detention Facility (ft)	1.0	1.0	1.0	1.0	1.0
Surcharging Allowed	None Allowed	None allowed	None allowed	To rim elevation	Not Specified
Water Quality Storm	0.36 inches in 4 hours	1/2 the 2-year depth or 1.25 inches in 24 hours	1.5 inches in 24 hours	1.61 inches in 36 hours	1.38 inches in 24 hours
Design Storm for Conveyance	25-Year	25-Year	25-Year	25-Year	50-years
Design Standards for Detention Facilities on New Developments	25-year with overflow to bypass 100-year	25-year with overflow to bypass 100-year	50-year with overflow to bypass 100-year	50-year	100-year
Detention Facility Peak Discharge	Post-development rates do not exceed predeveloped runoff rates for 2, 10, and 25 year 24-hour storms	Post-development rates do not exceed predeveloped runoff rates for 2, 10, and 25 year 24-hour storms	Post-development rates do not exceed predeveloped runoff rates for 1/2 the 2-year, 10, 25 and 50-year 24-hour storms	Equal pre-development for 2-, 5-, 10-, and 50-year storms. 25-year post-development equal to 10-year pre-development	Limit post-development flows to be equal to or less than the pre-development flows during 10-year event
Stormwater Quality Requirements	Required for new development. Sized for half the two year storm depth to treat 80% of annual rainfall and remove 70% of TSS.	Required for new development. Sized for half the two year storm depth to treat 80% of annual rainfall and remove 70% of TSS.	Designed to treat 80% of the average annual runoff and 70% of TSS.	Portland SWMM and PW Design Standards	Stormwater Source Controls (Administrative Rule Ch. 109 Division 012)

1) SBUH = Santa Barbara Unit Hydrograph, SWMM = S Stormwater Management Model



The recommended revisions to the City's policies and design standards have been developed to support the City's goal of preparing for future stormwater regulatory requirements while addressing its specific needs based on local geographic and hydrologic conditions. As shown in the table, neighboring communities use or accept multiple runoff calculation methodologies, although most rely on the NRCS Type 1A storm distribution.

3.2.5. EXISTING CITY CODE

The City's existing public works design standards, municipal code, and comprehensive plan were reviewed, with a summary of this review provided in Chapter 6.

3.2.6. CONVEYANCE STANDARDS

Molalla requires its stormwater conveyance system to safely contain peak runoff for a 25-year design storm. Overflow or gutter flow from a 25-year event may not exceed 4 inches in depth at the curb or extend more than 2 feet into the travel lane. In addition, surface water from a 100-year event is not permitted to flow through or flood existing buildings. Together, these standards promote effective drainage, infrastructure resilience, and efficient long-term maintenance.

Standard engineering practice and industry guidelines should be followed for minimum pipe slopes. In general, industry standards² recommend maintaining a minimum velocity of 3 feet per second (ft/s) for a full pipe (assuming a roughness of 0.013) to achieve adequate scour velocity. Molalla's Public Works Design Standards (2020) require pipe slopes sufficient to maintain at least 3 ft/s. Additionally, velocities exceeding 15 ft/s necessitate additional protective measures, such as ductile-iron pipe or drop manholes, to protect the system from erosion and shock. Table 3-3 summarizes reference minimum pipe slopes required to achieve the City of Molalla's minimum design velocity of 3 ft/s for various pipe materials and roughness assumptions. These values are provided for guidance only. Final pipe slopes should be determined using the roughness coefficient associated with the proposed pipe material to ensure compliance with the minimum velocity requirement.

Where feasible, a minimum pipe slope of 0.5% will be used in this planning study for new pipelines or replacement of existing pipelines. Constructing pipes at slopes less than 0.5% can present significant challenges, particularly when using non-rigid materials such as PVC, HDPE, and other plastic materials. Maintaining a 0.5% slope helps minimize sags and low points that can result from the installation and long-term performance of flexible pipe material at flatter slopes. Where a 0.5% slope cannot be achieved, the 3 ft/s requirement should be met.

² Ten State Standards; Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environment Managers, 2014



TABLE 3-3: MINIMUM RECOMMENDED PIPE SLOPES

Pipe Diameter (in)	Smooth Pipe (PVC, HDPE, Concrete; $n = 0.013$) ¹	Corrugated Metal Pipe (CMP; $n = 0.024$) ¹
10	0.55%	1.89%
12	0.44%	1.48%
15	0.32%	1.10%
18	0.25%	0.86%
21	0.21%	0.70%
24	0.17%	0.59%
27	0.15%	0.50%

1) Minimum slopes were calculated using Manning's equation for full-pipe flow with a minimum velocity of 3 ft/s.

3.2.7. STORAGE STANDARDS

The City's existing standards generally require detention facilities for new developments that add more than 5,000 square feet of impervious surface or for projects that exceed the allowable downstream capacity. Detention facilities are sized to prevent post-development peak flows from exceeding pre-development peak flows for the 2-, 10-, and 25-year, 24-hour return storm.

3.2.8. WATER QUALITY STANDARDS

Water quality facilities are designed to remove pollutants from stormwater runoff, such as sand, silt, metals, nutrients, oil, grease, and more. New development or redevelopment activities that create additional impervious surfaces, increase runoff, or result in pollution from a site are required to construct or fund permanent water quality facilities. Exceptions to this requirement may be granted by the Public Works Department if the facility is impractical or ineffective, when existing regional treatment facilities have sufficient available capacity, or when less than 5,000 square feet of impervious surface is created or redeveloped. Stormwater quality treatment methods should consider pre-treatment devices (i.e., water quality manholes or other filters), filtration (i.e., biofiltration swale or sand filter), ponds (i.e., wet or dry), constructed wetlands, or other infiltration facilities.

Stormwater quality facilities are designed to capture and treat 80% of the average annual runoff volume, with a target removal of 70% of total suspended solids (TSS). The water quality design storm is defined as one-half of the 2-year storm event which has a depth of 2.5 inches, resulting in a water quality event of 1.25 inches of rainfall over a 24-hour period as specified in Section 3.3.4 of the Molalla Design Standards.

3.2.9. DESIGN STORM

Design storms are used to evaluate the performance of the existing stormwater system, and to support the planning and design of future system improvements. Key characteristics that define a design storm include the recurrence intervals, cumulative depth of rainfall, and storm duration. The recurrence intervals represent the average time between storms of given magnitude and may also be described as an annual probability of occurrence. For example, a 50-year storm has a 2% chance of occurring in any given year. The total depth of rainfall varies depending on the recurrence interval and duration of the design storm for any specific location.



A 24-hour storm duration has been selected as the design storm duration for this master plan evaluation. A 24-hour storm duration is typical and the standard for design storms in the region. The specific recurrence intervals and corresponding total rainfall depth used in the evaluation of the stormwater system are shown in Table 3-3. The total rainfall depth for each recurrence interval and duration were obtained from the “Regional Precipitation-Frequency Analysis and Spatial Mapping of 24-hour Precipitation for Oregon” completed in 2008.

TABLE 3-4: DESIGN STORM DEPTHS (24-HOUR DURATION)

Storm event	Previous Master Plan (in)	Current Design Standard (in) ¹	ODOT Design Storms (in)
2-year	2.70	2.50	2.50
10-year	4.00	3.45	3.30
25-year	4.20	3.90	3.90
50-year	4.50	4.20	4.30
100-year	4.60	4.50	4.70
1) From 2020 Molalla Stormwater Design and Construction			

NOAA's 24-hour precipitation-frequency depths for Oregon are published only as static PDF maps. To make this data more practical for engineering design, ODOT extracted the underlying raster grids and released them as GIS layers. Using the GIS raster's allows designers to click directly on a project location and retrieve the depth, rather than visually interpolating contours on a crowded graphic. This approach provides more reproducible and site-specific rainfall inputs for hydrologic modeling.

The temporal distribution of the design storm was also considered. Temporal distribution describes how the given total precipitation depth is distributed over the duration of the storm. The Natural Resources Conservation Service (NRCS) has developed synthetic hyetographs for regions across the United States, based on historical precipitation data and statistical extrapolation, as shown in Figure 3-2. Molalla falls within the Type 1A theoretical rainfall distribution, as illustrated in Figure 3-3.

The hyetographs are appropriate for approximating the distribution of the design storm. However, because they represent an idealized pattern, an actual storm may not exhibit the same uniform progression to the maximum intensity shown in Figure 3-3.

FIGURE 3-2: GEOGRAPHICAL BOUNDARIES FOR NRCS (SCS) RAINFALL DISTRIBUTION

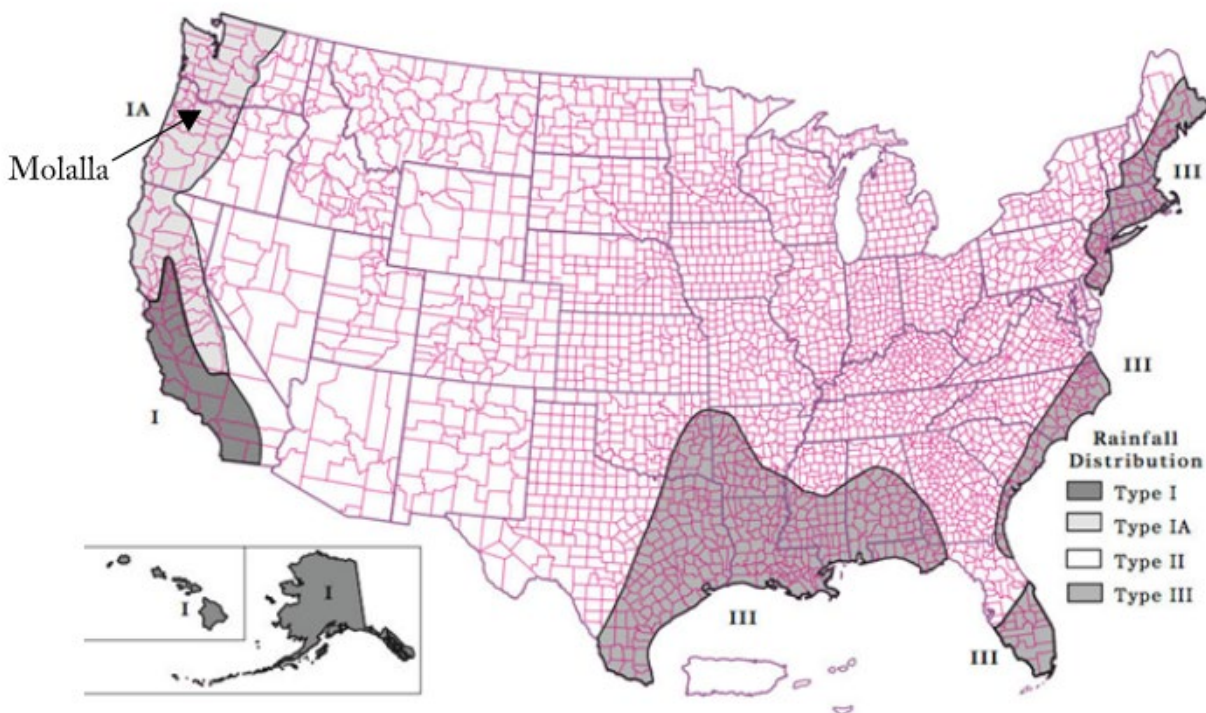
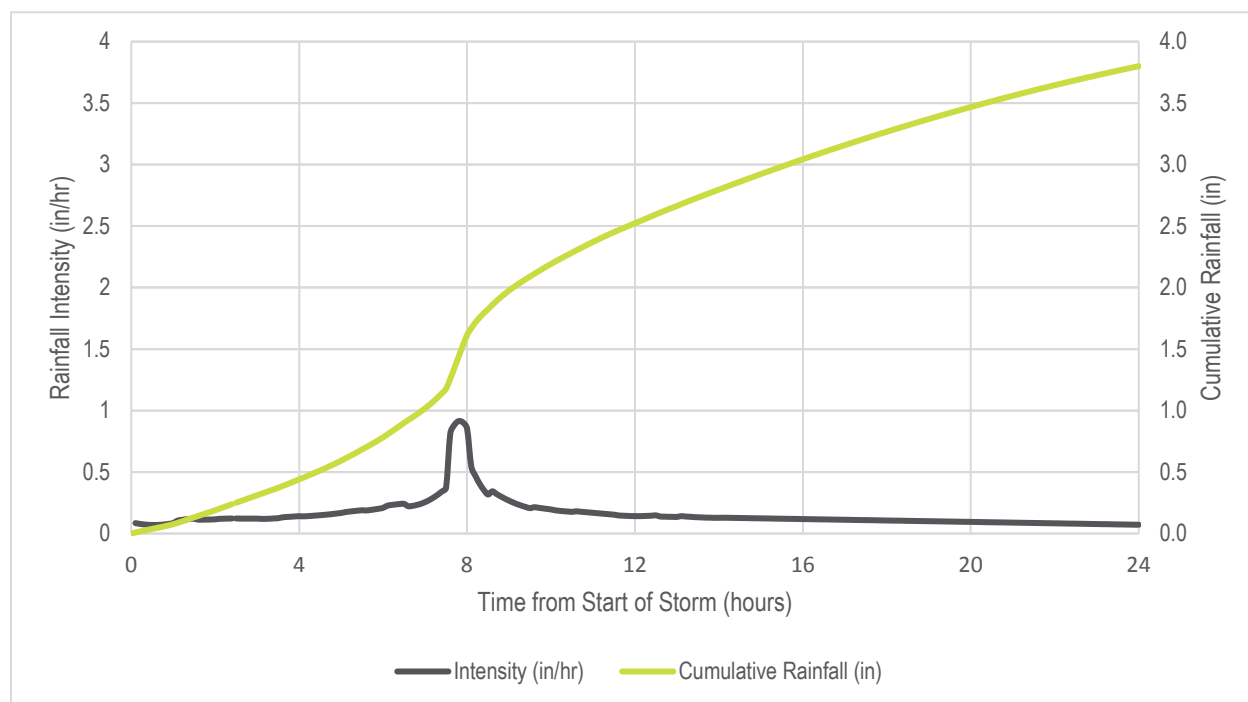


FIGURE 3-3: MOLALLA 25-YEAR STORM HYETOGRAPH



The design storm event characteristics are based on multiple sources of data, including historical observed storms and statistical analysis; however, they do not account for the potential impacts of



a changing climate. In the Pacific Northwest, anticipated effects of climate change generally include increased storm frequency and intensity. These changes could affect municipal stormwater infrastructure by increasing the frequency of system-loading events and potentially change peak runoff during storm events. Estimating the magnitude of these potential changes is outside the scope of the study. To address evolving rainfall patterns, the City may consider evaluating potential impacts during the pre-design phase of future individual stormwater infrastructure projects.

3.2.10. HYDROLOGY CALCULATION METHODOLOGY STANDARDS

The hydrologic component of the stormwater system describes how a given drainage area or “basin” will respond to a specific design storm event. Basins delineated for the City can be seen in Figure 5 – Drainage Boundaries of Appendix B. Hydrologic parameters are assigned to each basin to estimate the portion of rainfall that becomes runoff, the drainage paths the runoff follows, and the time required for runoff to travel to collection points such as inlets within the conveyance system or to an open channel, including ditches, creeks, or streams. The results of the hydrologic modeling are then used as input to the hydraulic or conveyance portion of the stormwater system.

Several hydrologic methods are available for defining basin characteristics, and no single methodology or procedure is universally accepted. The selection of an appropriate method depends on several factors, including geography, project area scale, and the overall purpose of the evaluation. Some of the most commonly applied methods in this region include the following:

- NRCS Urban Hydrograph Method (TR-55)
- Santa Barbara Urban Hydrograph Method (SBUH)
- Rational Method
- Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) Nonlinear Reservoir Runoff method

Each of these methods is applicable depending on the desired outcome and specific characteristics of the study. The TR-55 method remains widely used and is commonly referred to as the ‘Curve Number Method’. The SBUH method is similar to the NRCS approach but employs a different procedure for hydrograph development. The Rational Method is generally best suited for smaller urban watersheds, typically less than 200 acres in size. The EPA SWMM method, although developed several decades ago, continues to be widely accepted and used due to its relatively modest data requirements.

Additionally, the methods listed above are not entirely independent of one another. For example, the EPA SWMM methodology may utilize the same NRCS hyetographs employed in the NRCS TR-55 method to define rainfall distribution over the design storm event. For this master plan, the NRCS Urban Hydrograph Method was selected and applied.



CHAPTER 4 - SYSTEM EVALUATION

This chapter presents a discussion and information on the evaluation of the existing stormwater system using the hydraulic and hydrologic model updated as a part of this master plan. It also summarizes the model update process, flow monitoring results, and model calibration.

4.1. MODEL DEVELOPMENT

A stormwater model for the City was originally developed in 2003 as part a Stormwater Master Plan using the modeling software XPSWMM. That model was imported into PCSWMM and was used, as needed, in areas where no other data was available to support model development.

A stormwater model consists of two primary components: hydrology and hydraulics. The hydrologic components define how rainfall is converted to runoff, including the rate and volume of runoff entering the hydraulic system. The hydraulic components represent the physical conveyance system, including pipes, junctions (such as manholes or catch basins), open channel, storage systems, or other control structures convey runoff to an outfall.

An accurate computer model of the stormwater system serves as an important planning tool and provides the foundation for the evaluation presented in this study. The model offers insight into potential improvements to address existing deficiencies and support effective planning for future development within the study area, further discussed in Chapter 7. A stormwater model represents processes and manmade systems, such as open channels and piped systems. Because this model incorporates numerous variables with wide ranges of reasonable values, a coordinated and strategic data collection effort is essential. Where data cannot be feasibly obtained, practical assumptions and sound engineering judgement are applied, refer to Section 4.1.2 for additional discussion on hydraulic model development. Computational Hydraulics Institute's (CHI) Personal Computer Stormwater Management Model (PCSWMM) Version 7.7 was used for this analysis. PCSWMM is a fully dynamic modeling platform that allows for evaluation of complex hydraulic flow conditions and utilizes the Environmental Protection Agency (EPA) SWMM Version 5.2 engine.

4.1.1. HYDROLOGIC MODEL DEVELOPMENT

As established in Chapter 3, the SWMM non-linear reservoir runoff model was selected for use in this master plan. The primary hydrologic model inputs include subcatchment area, percent impervious, width, slope, routing type, and infiltration parameters. These components were developed from the ground up as a part of this master plan using multiple data sources and tools as described below. A summary of the hydrologic inputs for each subcatchment are provided in Appendix C.

Light Detection and Ranging (LiDAR) elevation data, aerial photos, and existing storm infrastructure were used to delineate subcatchments within the study area. Subcatchment boundaries were defined based on topography, locations of existing stormwater structures, curb and gutter systems, roadside ditches, and other physical features that influence runoff movement through the built environment. Each subcatchment was then assigned to a corresponding structure within the hydraulic system based on the anticipated drainage point, such as catch basin, open channel, storage pond, local low point, or directly to either Bear or Creamery Creeks. This process established a direct linkage between individual subcatchment and the hydraulic conveyance network.

Percent impervious was calculated using geographic information system (GIS) tools to quantify impervious surfaces area based on aerial imagery. The 2020 Oregon National Agricultural Imagery Program (NAIP) imagery was used as the primary basis for these calculations. This methodology provides an accurate representation of impervious surfaces within each subcatchment. Figure 4-1 illustrates an example from the northwest portion of Molalla and the resulting surface classifications.



FIGURE 4-1: RESULTING SURFACE CLASSIFICATION



Subcatchment slope and width were calculated by first determining a characteristic length for each subcatchment. The characteristic length represents the longest flow path within the subcatchment. The slope was calculated as the difference between the highest and the lowest elevation within the catchment divided by the characteristic length. The width was calculated as the subcatchment area divided by the characteristic length.

The infiltration model selected for this master plan was the Green-Ampt Method. Unlike the Curve Number and Horton method, which are primarily empirical methods, the Green-Ampt method is based on the physical properties of soils and provides a more mechanistic representation of the infiltration process. The soil input parameters required for this method include:

- the hydraulic conductivity,
- average capillary suction head,
- and the initial moisture deficit.

Soil data were obtained from the NRCS Web Soil Survey database and a weighted average for hydraulic conductivity and average capillary suction head were calculated for each subcatchment, as summarized in Table 4-1. Initial moisture deficit values were assigned to each subcatchment and subsequently adjusted, as necessary, during the model calibration process. Additional hydrologic inputs used in the SWMM runoff model are provided in Table 4-2.



TABLE 4-1: SOIL INPUT PROPERTIES

Soil Type	Soil	Suction (in)	Conductivity (in/hr)
Silt Loam	Aloha silt loam, 0 to 3 percent slopes	6.57	0.27
	Amity silt loam	6.57	0.27
	Clackamas silt loam	6.57	0.27
	Dayton silt loam	6.57	0.06
	Sawtell silt loam, 0 to 8 percent slopes	6.57	0.27
	Sawtell silt loam, 8 to 15 percent	6.57	0.27
	Huberly silt loam, 0 to 3 percent slopes	6.57	0.01
Silty Clay Loam	Wapato silty clay loam	10.75	0.20

TABLE 4-2: HYDROLOGIC INPUTS

Input	Value	Description
Area (acres)	Varies	Calculated based on area of subcatchment
Width (ft)	Varies	Equal to area divided by characteristic length
Slope (%)	Varies	Slope of characteristic length and basin elevations
% Impervious	Varies	Calculated based on aerial imagery
Impervious Manning N	0.015	Assigned based on typical value
Pervious Manning N	0.03	Assigned based on typical value
Impervious Storage (in)	0.08	Assigned based on typical value
Pervious Storage (in)	0.3	Assigned based on typical value
Percent no storage	50	Assigned based on typical value
Routing Method	Pervious	Assigned during model calibration
% Routed	24	Assigned during model calibration
Infiltration Model	Green-Ampt	Infiltration model selected
Hydraulic Conductivity (in/hr)	Varies	Weighted average for soils within subcatchment
Capillary Suction Head (in)	Varies	Weighted average for soils within subcatchment
Initial Moisture Deficit (%)	Varies	Assigned during model calibration

4.1.2. HYDRAULIC MODEL DEVELOPMENT

Development of a hydraulic model leverages GIS data representing the City's physical stormwater infrastructure. This GIS data can be imported or directly linked with the model, allowing updates to the GIS database to be reflected in the hydraulic model. The City recently updated its GIS files based on multiple field surveys conducted between the summer of 2024 and early 2026. This survey focused on collecting detailed information in critical areas with known deficiencies, as identified by the City and Keller. The City's GIS database includes information on stormwater infrastructure elements such as pipes, manholes, catch basins, storage locations, water quality features, and outfalls. The updated GIS files were imported into the modeling software and serve as the foundation of the hydraulic model.

In 2003, a hydraulic model was developed as a part of the City's SWMP efforts. Over the last twenty (20) years, the City has experienced growth that has resulted in the expansion of the stormwater infrastructure system. While the previous hydraulic model was reviewed and referenced, more recent data sources were considered more accurate and were therefore prioritized during development of the updated model.



The GIS data, including the recent survey data, did not include complete elevation data (such as pipeline inverts, junction inverts, and junction rim elevations) for the entire stormwater system. Because accurate elevation data are critical for developing a reliable hydraulic model, areas lacking elevation data but located within problem areas were supplemented using a combination of data from the previous model and LiDAR elevation data. Despite these efforts, several areas still lacked data and were not included in the model. If these unmodeled systems exhibit capacity deficiencies in the future and require evaluation, additional surveys will likely be necessary to support model development.

After all information including GIS data, LiDAR, record drawings, and the previous model, was reviewed and combined to establish the base model data, pipeline grades and overall system connectivity were evaluated. Adjustments were made as necessary, based on the project team's engineering judgment, to develop a functional model that reasonably represents the stormwater conveyance system. In addition, Bear and Creamery Creeks were incorporated into the model system using LiDAR-derived elevation data to inform cross section geometry.

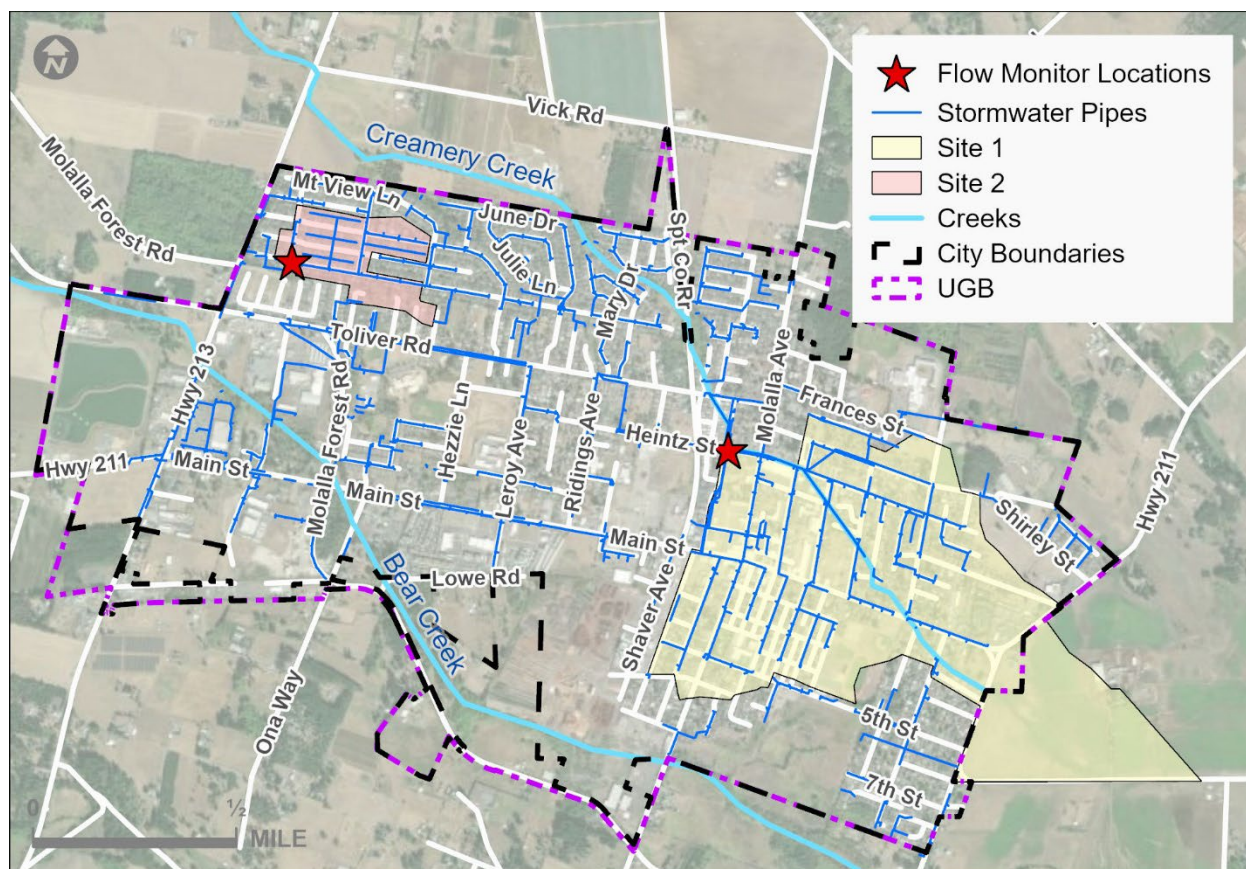
4.1.3. FLOW MONITORING

Flow monitoring sites for this study were installed for a period of approximately three months, from December 27, 2023, through March 20, 2024. Flow monitors were installed at two locations within the stormwater system, as shown in Figure 4-2. The flow monitoring plan and processed data are provided in Appendix D.

Rainfall data for the flow monitoring period were collected using a local rain gauge operated and maintained by NOAA. The gauge is located south of South Herman Road, approximately 1/3 mile east of the Adams Road and Herman Road intersection, and approximately 2.5 miles southeast of the City (Latitude 45.11429, Longitude-122.55266). Rainfall data were recorded at 10-minute time increments.



FIGURE 4-2: FLOW MONITOR BASINS



For the purpose of this study, flow monitoring refers to the temporary installation of a sensor within stormwater pipes to measure stormwater flows during storm events. The sensors measure water depth and velocity, which are used to calculate the flow rates based on the pipe size. The flow monitors were programmed to record data at 15-minute intervals to capture variations in system flows. Although, flow monitoring is an effective method for measuring stormwater flows, disruption or error in the data may occur. Common challenges include equipment malfunctions and debris accumulation on the sensor. To mitigate these issues, the flow data was reviewed regularly utilizing wireless technology allowing remote viewing of the collected data. Additionally, the monitoring equipment was inspected regularly to identify quality concerns and to perform field adjustments as needed.

The flow monitoring data were processed and reviewed for quality after the meters were removed. Scattergraphs were developed that plot velocity on the x-axis and depth on the y-axis. This approach is a standard industry practice used to evaluate data quality and identify potential inconsistencies. A theoretical Manning's Equation curve was plotted on each scattergraph to provide a reference for comparison with the observed data. Under the steady, uniform flow assumptions of Manning's Equation, which provides a useful approximation of expected stormwater conveyance conditions, observed velocity-depth pairs are generally expected to plot along or near the theoretical Manning curve. Data that generally follows this theoretical relationship is considered consistent with reliable meter performance and expected hydraulic behavior.

Deviations from the Manning curve do not necessarily indicate poor data quality. In stormwater systems, conditions such as downstream flow restrictions, surcharging, partial blockages, or other capacity limitations can violate the uniform flow assumptions underlying Manning's Equation. Under these conditions, flow depths may be higher and velocities lower than those predicted by Manning's



Equation, causing data points to plot above and left of the theoretical curve. Therefore, a limited number of deeper, slower data points may be expected at locations known to experience drainage constraints or backwater effects. Conversely, if the observed data does not generally follow the theoretical Manning curve and no reasonable hydraulic explanation exists for the deviation, the data warrant additional review to evaluate potential meter performance issues or other sources of measurement error.

Scattergraphs for both flow monitoring locations were developed and are provided in Appendix B. A summary of the flow monitoring results is provided below:

- Site 1 was located in the 36-inch pipe upstream of the manhole at the southeast corner of the intersection at West Heintz Street and Kennel Avenue (GIS MH-6). This location drains in an area of approximately 380 acres, including undeveloped, residential, commercial, industrial, and school areas. Flow data collected from January 3rd through February 14th were not usable because the sensor became covered with gravel and sediment; however, depth data continued to be recorded during this period. Some good-quality flow data were recorded beginning February 15th. During the largest calibration storm with usable flow data, peak flows at this location were approximately 6.1 cfs and occurred on March 12th.
- Site 2 was located at the intersection of Meadowlawn Place and Harvest Lane (GIS NW-203) and drains an area of approximately 40 acres consisting of newer residential homes with curb and gutter streets. The flow monitor was installed in a 12-inch diameter pipe. The monitoring data are considered to be of good quality, as most observed velocity-depth pairs are clustered along the Manning Curve. The scattergraph also shows a cluster of observations with greater depths and lower velocities than predicted by Manning's equation. This behavior is consistent with known downstream control conditions at the site, which can produce backwater effects during higher flows. During the largest calibration storm, peak flows at this location were approximately 3.9 cfs and occurred on February 29th.

4.1.4. MODEL CALIBRATION

The goal of model calibration is to adjust model parameters, so the simulated results closely reflect observed flows during storm events, with particular emphasis on peak flows. The quality and usefulness of flow monitoring data for stormwater model calibration are highly dependent on the magnitude and variability of rainfall events captured during the monitoring period provided below in Figure 4-4. Approximately 15 inches of rainfall occurred during the monitoring period; however, most of this rainfall resulted from long-duration, relatively low-intensity storms, and daily rainfall totals exceeded 1.0 inch during three storms events. All rainfall data collected during the flow monitoring period, from December 27 through March 20, were uploaded to PCSWMM and evaluated for model calibration at both sites. The storm event with the largest 24-hour rainfall depth occurred between February 28th and March 1st, a total of 1.89 inches. The second-largest event occurred during January 21st and January 25th, with a total rainfall depth of 1.50 inches. The third-largest storm, which produced 1.45 inches of rainfall on January 17th, was not included in the calibration processes because it consists of a mix of rain, sleet, and snow. As a result, runoff volume and response times associated with this event were not representative of a typical rainfall-only event. The two largest rainfall events were therefore selected for used in the calibration process, along with three smaller events that provided additional calibration reference points, as summarized in Table 4-3. Rainfall data referenced during the calibration process and used to identify representative design storms are shown in Figure 4-3.

Model-simulated flows were compared with observed flow monitoring data at both Site 1 and Site 2. As noted previously, flow measurements at Site 1 were inconsistent during some storm events and exhibited questionable data quality. For this reason, the model was primarily calibrated using data from Site 2. Site 1 was limited to events with good-quality flow data, and for events with unreliable flow measurement, observed depth data were used for comparison. During the calibration process, greater emphasis was placed on matching peak flows rather than total flow volumes, as the peak



flows are generally the governing criteria for the design and evaluation of stormwater conveyance structures.

During the calibration process, the primary hydrological parameters adjusted include routing type, percent routed, and depression storage. Routing type and percent routed represent the extent to which impervious surfaces are directly connected to the stormwater conveyance system versus draining over pervious areas prior to entering the system. For example, a developed commercial area with a high proportion of impervious surface typically has a greater degree of direct connected surfaces compared to an older residential area without curb and gutter infrastructure. The percent routed was set at approximately 24%, indicating that this portion of runoff is assumed to travel over pervious surfaces, allowing for infiltration, before entering the conveyance system. As shown in Table 4-3 below, this model calibrated well for Events 2, 3, and 4. The greatest weight was given to calibration of Event 4, as it represented the largest storm captured during the monitoring period. The large percent difference observed for Event 1 is attributed to a relatively short, high-intense period of the storm event during which model and observed data did not align. If this portion of the event were excluded, the resulting percent difference would be substantially reduced.

Figure 4-3 shows an example of the calibration process for Site 2, showing observed flows in black, pre-calibration model results in orange, and post-calibration results in blue. This comparison indicates the initial model produced approximately two-thirds the runoff observed in the metered peak flows. Model adjustments increased the simulated peak flow to better align with the metered data. Full calibration graphs and summary tables for each site are in Appendix D.

FIGURE 4-3: SITE 2 PRE- VS POST-CALIBRATION RESULTS

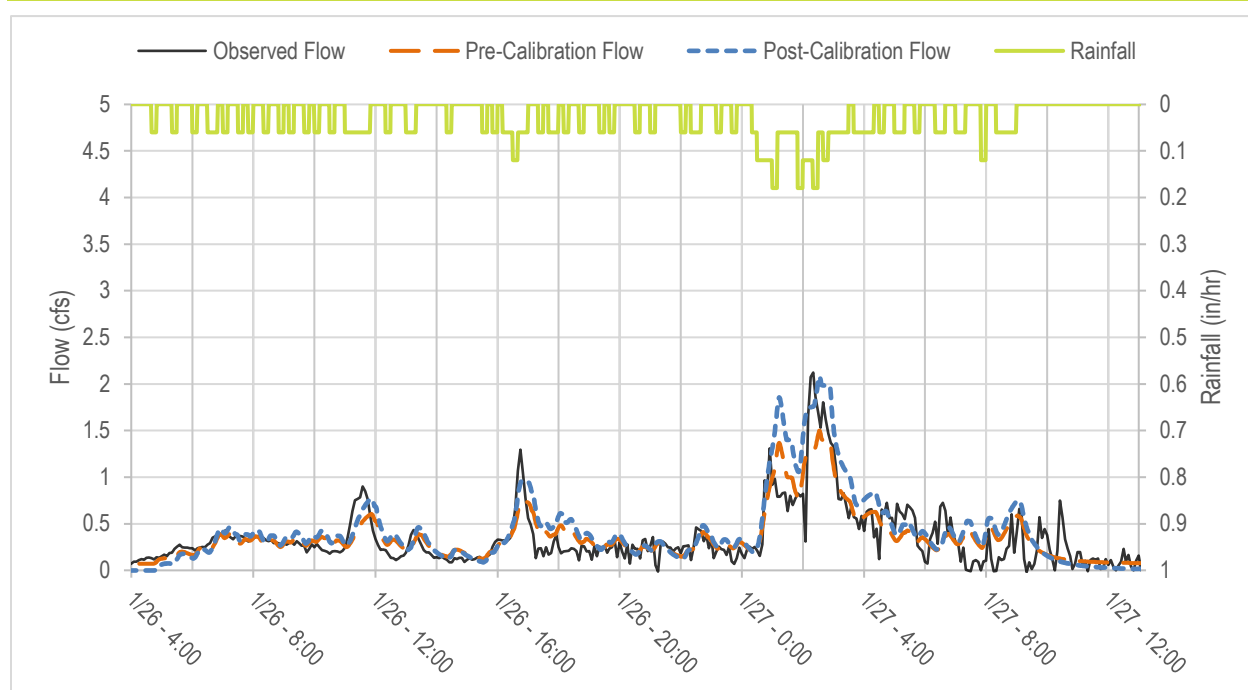
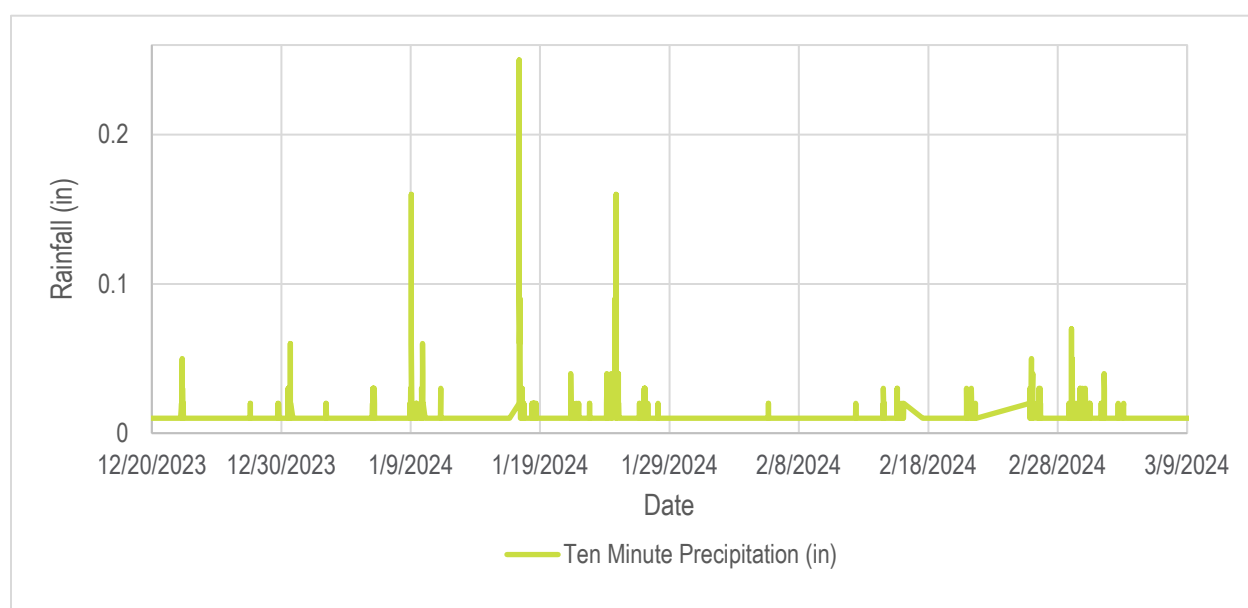




TABLE 4-3: MODEL CALIBRATION SUMMARY

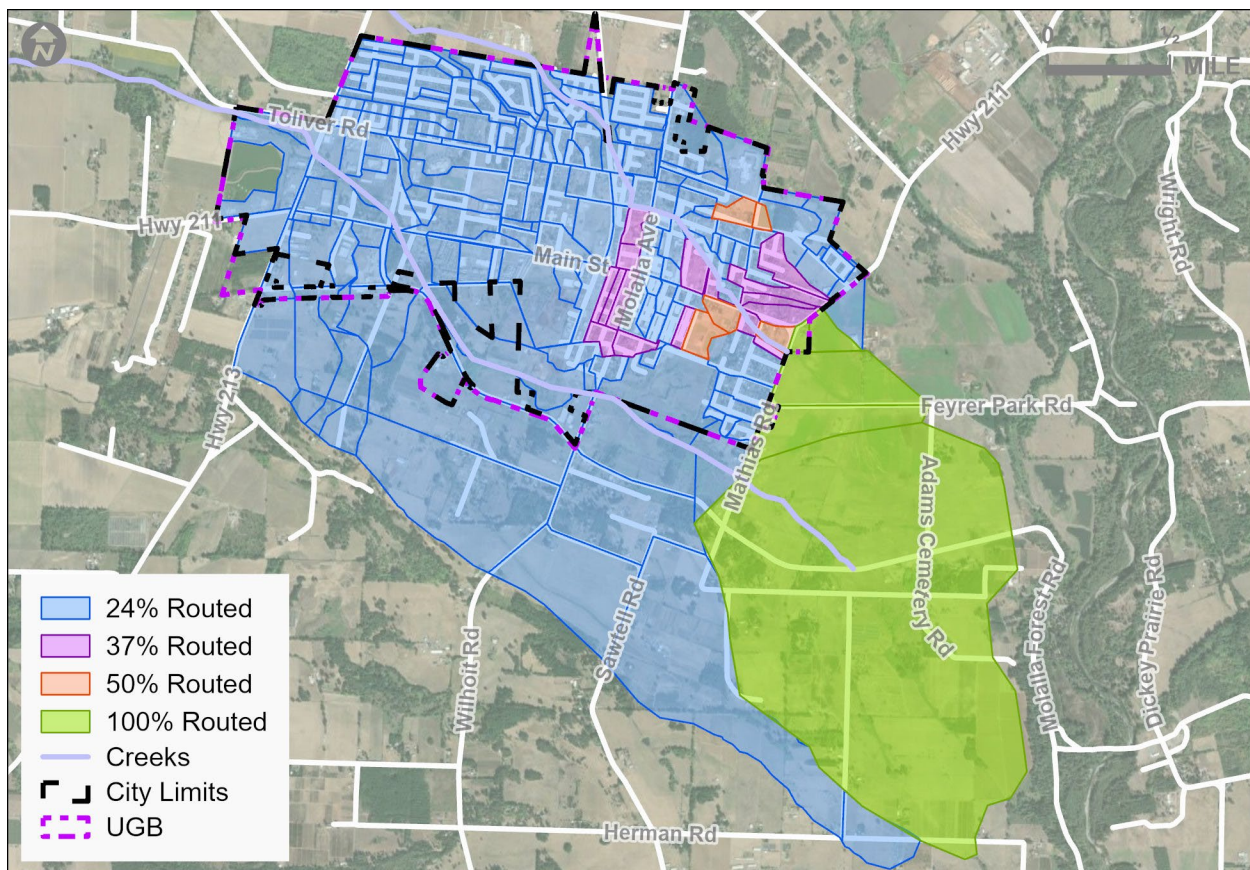
Event Number	Start of Event	End of Event	Rainfall Total (in)	Site 2 Observed Peak (cfs)	Site 2 Modeled Peak (cfs)	Percent Difference
Event 1	1/21/2024 0:00	1/25/2024 11:00	1.5	3.5	5.6	58%
Event 2	1/26/2024 4:00	1/27/2024 13:00	0.94	2.1	2.1	-2%
Event 3	2/15/2024 11:00	2/16/2024 8:00	0.51	1.6	1.6	0%
Event 4	2/28/2024 16:00	3/1/2024 17:00	1.89	3.9	3.8	-1%
Event 5	3/10/2024 18:00	3/13/2024 8:00	0.66	2.3	2.7	19%

FIGURE 4-4: RAINFALL DATA



Calibration of Site 1 was more challenging for several reasons. First, the quality and consistency of the flow monitoring data were lower than Site 2 because the sensor was buried by gravel during some of the events. Second, a flow split occurs upstream of the monitoring location, where runoff is divided between an approximately ~5-foot-wide by 3-foot-high squash pipe and the 36-inch pipe that conveys flow to the monitoring location. Because no control structures exist at this diversion, the actual flow split is unknown. Site photographs indicate that the pipe inverts have similar elevations, and the model was configured accordingly. During the calibration events, approximately 40% of flow was assumed to enter the 36-inch pipe leading to the flow monitor, with the remaining flow routed through the squash pipe, which bypasses the monitoring location. To better match observed flow and depth at Site 1, the percent routed parameter for contributing subcatchments were adjusted. The resulting percent routed values ranged from approximately 24% and 100%, depending on land use. All subcatchments were initially assigned a percent routed of 24%; then the percent routed was altered based on land use for the subcatchments that drain to the Site 1 flow monitor manhole to help with calibration, see Figure 4-2 that shows subcatchments draining to Site 1. Figure 4-5 shows the routed percent assigned to each of the subcatchments. Subcatchments with curb-and-gutter were assigned 24% routed, subcatchments where most homes were connected but curb-and-gutter was not continuous were assigned 37% routed; subcatchments that were approximately half developed and half undeveloped were assigned 50% routed; and fully undeveloped were assigned 100% routed.

FIGURE 4-5: PERCENT ROUTED BY SUBCATCHMENT



4.1.5. MODEL ASSUMPTIONS

Due to the inherent uncertainty associated with stormwater analysis, development of a stormwater master plan requires numerous assumptions and evaluations of various “what if” scenarios. The following sections summarize the key assumptions and boundary conditions applied in development of the stormwater model for Molalla.

- Bear Creek and Creamery Creek were included in the model, with upstream flows input based on their estimated upstream drainage boundary which was developed through a mixture of the USGS StreamStats watershed boundary tool and aerial imagery.
- Outfalls were modeled as free discharge (no backwater) as appropriate.
- All pipes are in good repair.
- All pipes and channels are free of debris.
- Manning’s n values for pipes are 0.013. Manning’s n values for open channels are 0.030.
- All channels have been maintained on a regular schedule and reflect the sizes documented in site surveys and photos.
- Natural channels have been mowed to remove excess vegetation, with only the plants intended to be used as water quality features remaining.



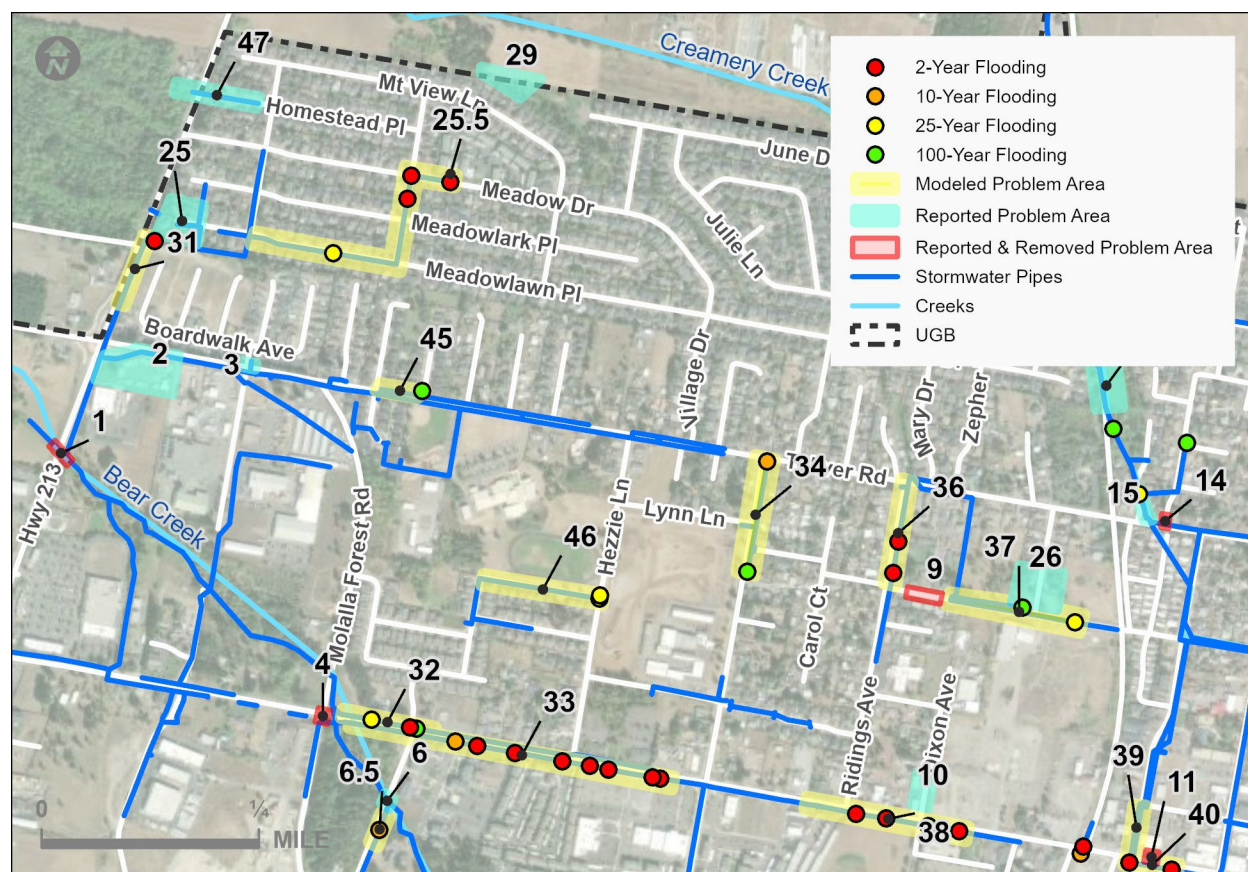
4.2. EXISTING SYSTEM EVALUATION

The calibrated model was used to evaluate the existing stormwater system for the 2-, 10-, 25-, and 100-year 24-hour Type IA design storms, as described in Chapter 3. The design storm depths and evaluation criteria are summarized below in Table 4-4 and discussed further in Chapter 3. Undersized infrastructure, defined as pipes surcharged and flooded manholes, under the design storm events and previously identified problem areas, are illustrated in Figures 4-6, 4-7, and 4-8. Each flooding or other problematic location is assigned a numerical problem area identifier and summarized following the figure. These identifiers are used only for reference and do not represent a priority ranking.

TABLE 4-4: DESIGN STORM DEPTHS (24-HOUR DURATION)

Storm event	ODOT Design Storms (Modeled) (in)
2-year	2.50
10-year	3.30
25-year	3.90
50-year	4.30
100-year	4.70

FIGURE 4-6: LOWER BEAR CREEK EXISTING EVALUATION

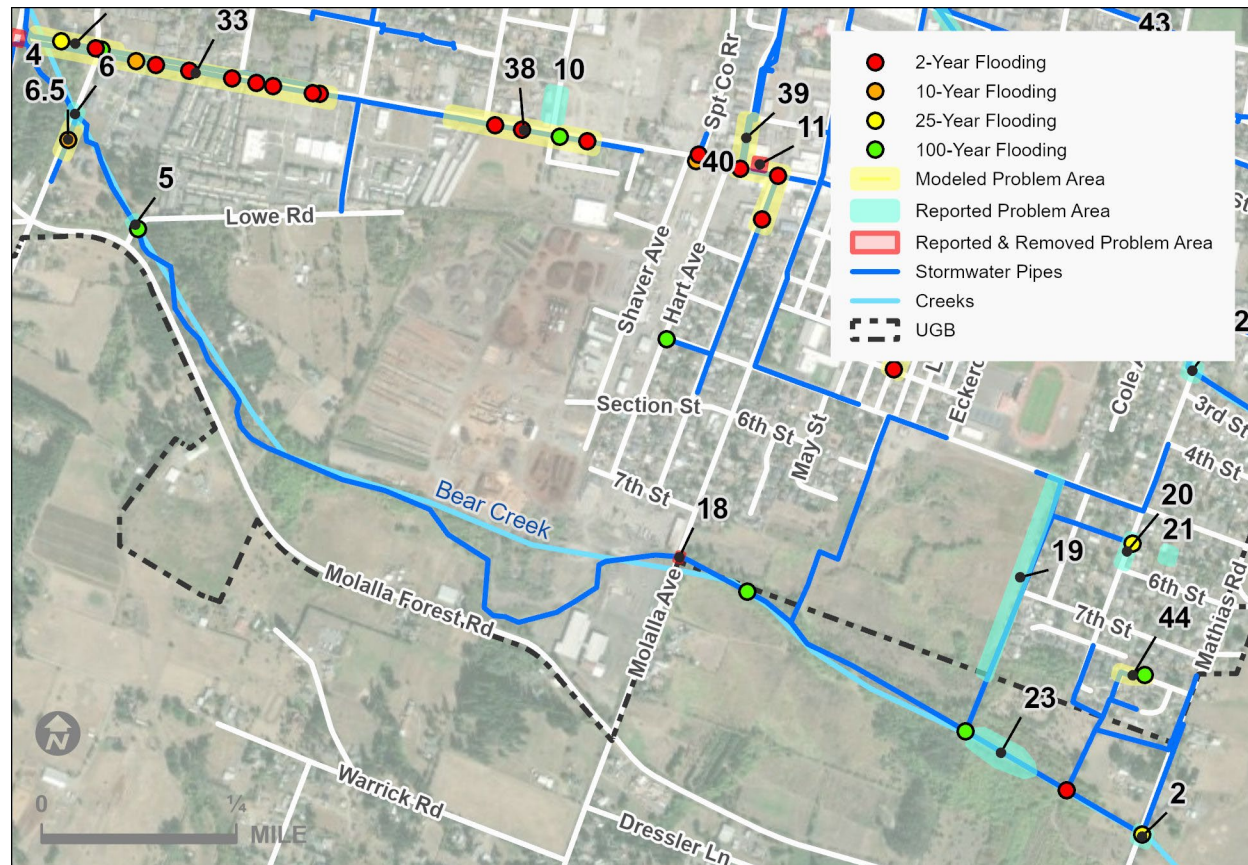


**Explanation of deficiencies:**

- Area 1 – This was identified as a problem in the 2003 Stormwater Master Plan as the arch culverts could not pass the 25-year storm. This has since been addressed by improvements to Highway 213.
- Area 2 – There is surface flooding within the bus barn south of Toliver Road. This is likely because of lack of surface inlets to drain the stormwater.
- Area 3 – Flooding on Industrial Way along Toliver Road was previously noted as a problem area because downstream infrastructure along Toliver Road needed work. However, recent improvements to the downstream infrastructure have removed this as a problem area.
- Area 4 – The Bear Creek crossing at Molalla Forest Road and Woodburn-Estacada Highway was previously noted by the City as a problem area. This location is under the jurisdiction of the Oregon Department of Transportation (ODOT) and the City no longer experiences flooding at this location.
- Area 6, 6.5 – The Bear Creek crossing at Ona Way experiences flooding due to blocked and undersized culverts, which can back up into Ona Way, starting at the 10-year storm.
- Area 9 – There was reported flooding on Heintz Street east of Ridings Avenue, identified in the 2003 Stormwater Master Plan but was noted by the City that it is no longer a problem area.
- Area 10 – Flooding has been reported at Dixon Avenue due to inadequate catch basin infrastructure.
- Area 25, 25.5, 31 – Meadowlawn Place experiences flooding starting at the 2-year storm due to a mixture of issues including insufficient catch basins, undersized pipelines, and blockage tendencies. Additionally, the model shows flooding at the ditch connection to Highway 213 starting at the 2-year storm.
- Area 26 – The stormwater facility at the end of the Pegasus Court cul-de-sac is failing due to its high elevation as compared to the nearby cul-de-sac and homes and its limited ability to drain water to the west as designed. The City reported that the detention facility frequently causes flooding the roads and driveways at the end of the cul-de-sac.
- Area 29 – The Mountain View Outfall at the northern end of the City is managed by the HOA and is noted to experience frequent flooding due to overgrowth in the downstream creek bed, and the low elevation of the incoming pipe as compared to the bottom of the creek.
- Area 32, 33, 34, 36, 38, 45, 46 – Existing stormwater pipes surcharge and flood as a result of flows exceeding the pipes' capacity.
- Area 37 – Detention pipes do not have sufficient volume to store the flow and smaller diameter pipes downstream do not release flows fast enough, therefore flooding is shown in the model starting in the 25-year storm.
- Area 47 – There is reported flooding due to insufficient capacity or blockages in a pipe that conveys water from Homestead Place underneath Highway 213 to outfall to the wetlands to the west. This structure was modeled following a survey of the infrastructure conducted by the City in May 2026. The model did not show flooding at this location during the design storms but remains a problem area since the City continues to report flooding at this location.



FIGURE 4-7: UPPER BEAR CREEK EXISTING EVALUATION



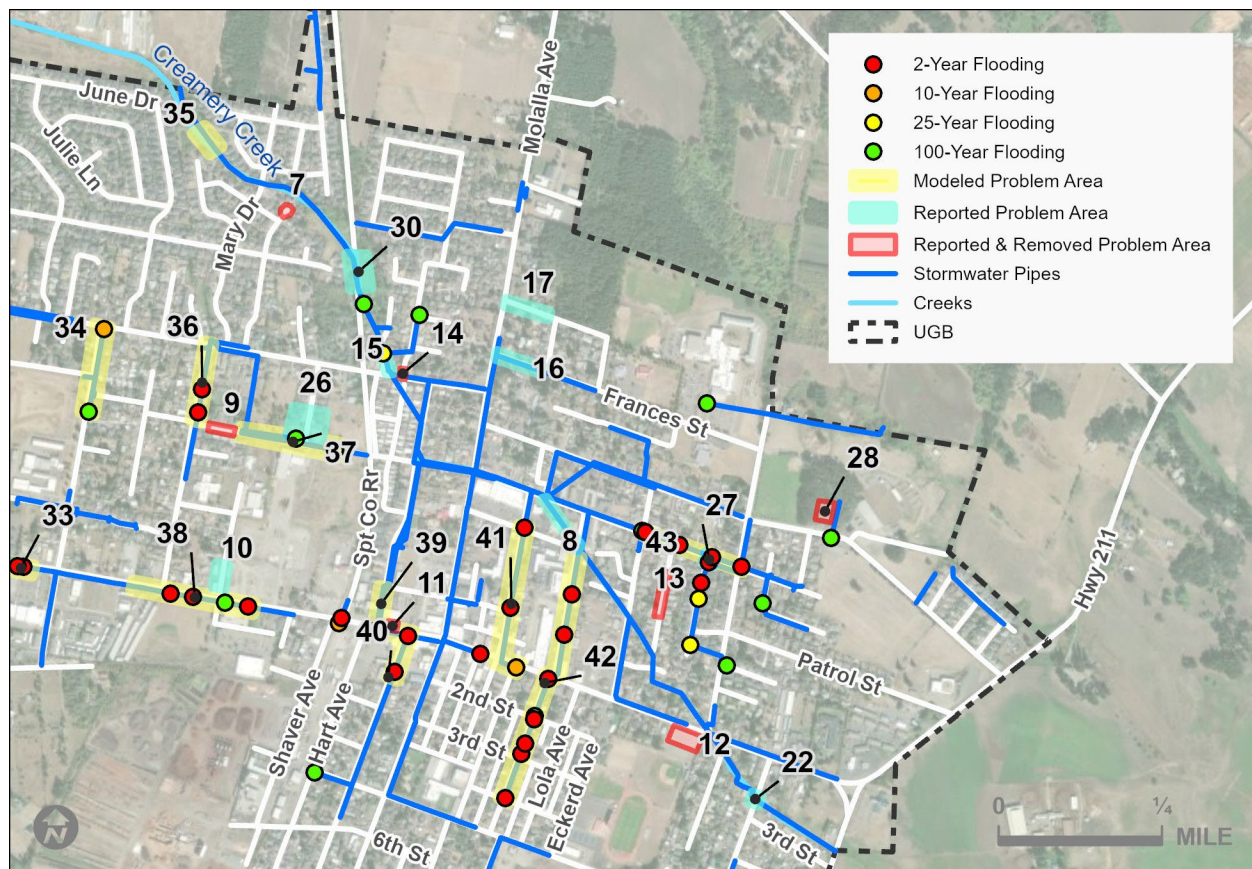
Explanation of Deficiencies:

- Area 5 – The Bear Creek crossing at Lowe Road consists of a circular culvert, which frequently experiences blockages from overgrowth and debris, which results in flooding during the 100-year storm.
- Area 18 – The Bear Creek crossing at Molalla Avenue has historically resulted in flooding into nearby areas, however, the County is in the process of completing a bridge culvert improvement project, which has been reflected in the model and shows that the crossing, once built, will no longer cause flooding.
- Area 19 – The Ivor Davies Park Ditch has reported flooding as it requires frequent maintenance, which is difficult to manage.
- Area 20, 21 – Both areas were noted as problem areas in the 2003 Stormwater Master Plan since flooding was reported, possibly due to old curbs and storm drains. The model also shows flooding during the 25-year storm due to pipe surcharging as a result of flows exceeding downstream pipes' capacity.
- Area 23 – Bear Creek is generally shallow in this location and frequently filled with overgrowth, resulting in flooding starting at the 2-year storm.



- Area 24 – The Bear Creek crossing at Mathias Road, under the County’s jurisdiction, has undersized culverts that are frequently blocked by overgrowth and debris, resulting in flooding starting at the 25-year storm.
- Area 44 – Existing stormwater pipes surcharge and flood as a result of flows exceeding the pipes’ capacity starting at the 100-year storm.

FIGURE 4-8: CREAMERY CREEK EXISTING EVALUATION

**Explanation of Deficiencies:**

- Area 7, 14, 15, 30, 35 – Creamery Creek experiences flooding in several locations starting at the 25-year storm due to its gradual slope through the City and regular blockages from overgrowth.
- Area 8, 39, 40, 41, 42, 43 – Existing stormwater pipes surcharge and flood as a result of flows exceeding the pipes’ capacity, including a portion of piped sections of Creamery Creek. Flooding occurs in these areas starting at the 2-year storm.
- Area 11 – This was reported as a problem area during the 2003 Stormwater Master Plan; piping replacements were recommended to improve the stormwater infrastructure.
- Area 12 – The field south of Main Street has reported flooding and was identified as a problem area in the 2003 Stormwater Master Plan. Flooding will likely be addressed by implementing a pond.



- Area 13, 22 – Creamery Creek passes through the City, through culverts, ditches, and pipes in the eastern portion of the City. This causes flooding at locations with undersized culverts and inherent risk as a portion of the piped creek passes underneath homes and government buildings.
- Area 16, 17 – Miller Street and northward along Molalla Avenue experience flooding issues due to a lack of functional stormwater infrastructure.
- Area 27 – The detention facility near the intersection of Finneys Avenue and Heintz Street is failing, resulting in flooding starting at the 2-year storm event.
- Area 28 – Clark Park has reported flooding, and the model shows flooding at the 100-year storm due to the park's inability to effectively drain the water during larger events. A project to address this problem area is currently in design and thus a capital improvement project for this area is not identified in Chapter 7 of this report.

Additional information on all problem areas identified prior to modeling, through modeling, and previous discussions with the City is provided in Appendix E.

The City's existing stormwater system exhibits significant capacity-related deficiencies beginning with the 2-year storm and extending through the 25-year design event. An evaluation of the future system analysis is provided in Chapter 5. In addition, alternatives to address prioritized problem areas, along with recommended Capital Improvement Plan (CIP) projects, are discussed in Chapter 7.



CHAPTER 5 - FUTURE STORMWATER INFRASTRUCTURE

A future conditions system model was developed based on current zoning maps, proposed future land use, and anticipated new development and redevelopment within the City. The future condition model assumes the City will be fully built out in accordance with the current land-use projections. The City's existing Public Works Design Standards (PWDS) require new development to limit post-development flows to pre-development flow rate for the 2, 10, and 25-year storm events. However, for this analysis, Keller modeled future conditions assuming that effective detention is not achieved with new development. Under this assumption, stormwater peak flows increase as a result of expanded impervious surface associated with new development and roadways improvements, including the installation of curb-and-gutter. This future condition scenario identifies portions of the existing stormwater infrastructure that are likely to require improvements if flow control measures are not adequately implemented as new development and redevelopment occur.

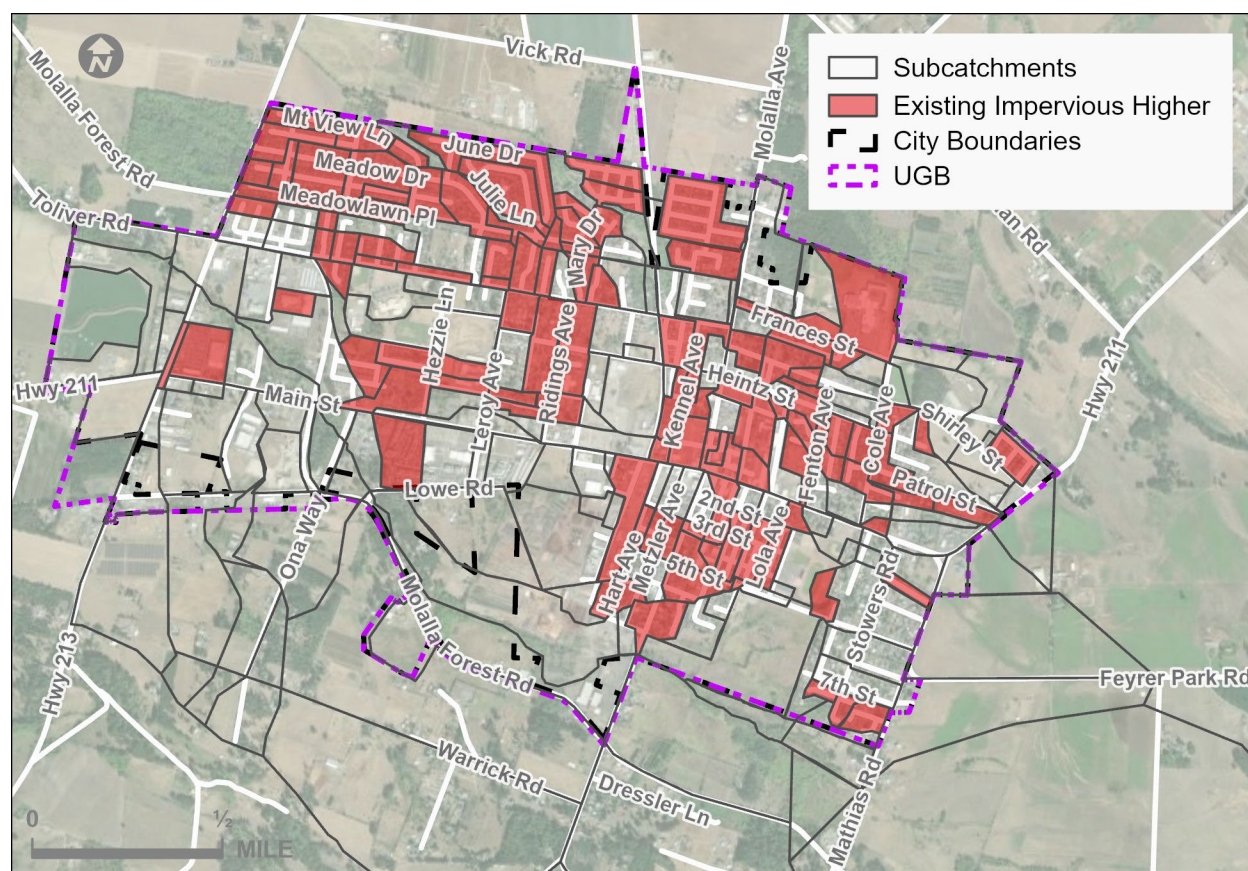
The City's current zoning map and future land use maps were used as the basis for updating future percent imperviousness for the City of Molalla. The future land use map, obtained from the 2025 City of Molalla Amended Comprehensive Plan is included in Appendix F. Table 5-1 summarizes the assumed percent imperviousness various for the various land uses categories, as defined by the City's PWDS.

TABLE 5-1: FUTURE LAND USE PERCENT IMPERVIOUS

Land Use	Percent (%) Impervious
Single-Family Residential	45%
Two- and Multi-Family Residential	55%
General and Central Commercial	80%
Light Industrial	80%
Heavy Industrial	90%
Public or Semi-Public	44%
Water	n/a

Each subcatchment's percent impervious value was updated by spatially intersecting future land use categories with existing subcatchment boundaries and computing an area-weighted average imperviousness. For example, if a subcatchment consists of 50% single-family residential land use and 50% two- and multi-family residential land use, the resulting impervious value would be 50%, representing the area-weighted average of the corresponding values provided in Table 5-1. In some instances, the existing percent imperviousness exceeded the value estimated under the future land-use scenario, primarily in single-family residential areas and at school sites. In these cases, the existing percent imperviousness was retained for the future model evaluation. Subcatchments where the existing imperviousness exceeds the future estimate are shown in red in Figure 5-1.

FIGURE 5-1: SUBCATCHMENTS WITH HIGHER EXISTING IMPERVIOUSNESS



The same suite of design storm events evaluated for the existing conditions model was applied to the future conditions model to identify potential infrastructure capacity deficiencies. All model parameters for the future scenario were kept consistent with the existing condition scenario, with the exception of the percent impervious. Locations where flooding or surcharging occurring during an earlier return-period storm than predicted in the existing conditions analysis are shown in Figure 5-2 and summarized in the bullets below.

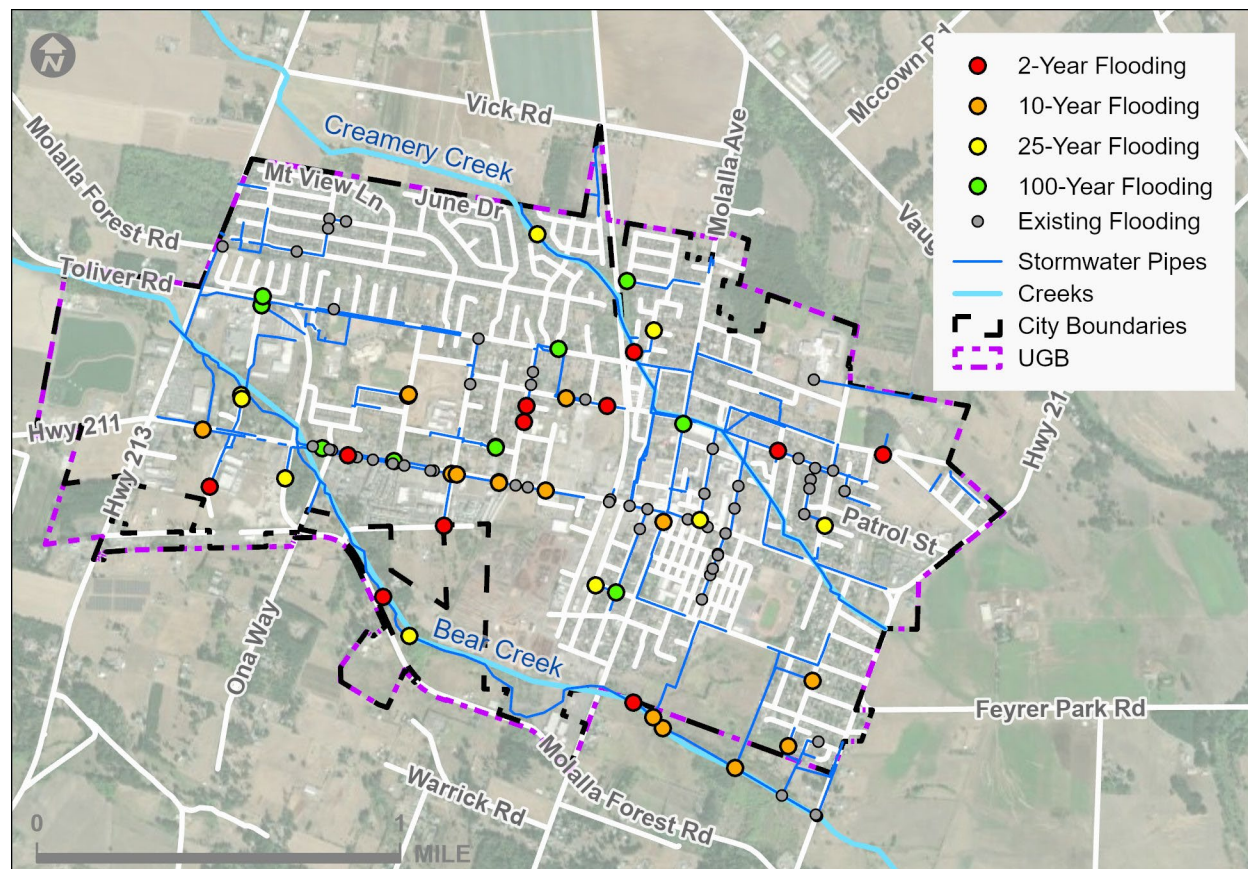
- Additional flooding along Bear Creek and Creamery Creek starting at the 2-year design storm.
- Additional flooding near Ridings Avenue starting at the 2-year design storm.
- Additional flooding along Woodburn-Estacada Highway starting at the 10-year design storm.
- Additional flooding in problem areas in east Molalla, including along Molalla Avenue.
- Flooding in the commercial areas near Lower Bear Creek starting at the 2-year design storm.
- Flooding along Toliver Road starting at the 25-year design storm.
- Flooding along N Valley Drive starting at the 10-year design storm.
- Flooding along West Lane starting at the 100-year design storm.

Although the future model results indicate additional capacity-related issues, it is not recommended that the City pursue improvements to address these at this time. The City's current PWDS requires detention for most new development. If these detention requirements are properly enforced, future capacity challenges are expected to be minimized and may not occur.



In addition, many of the capacity issues identified under future conditions may be partially addressed through projects recommended to correct existing system deficiencies. Refer to Chapter 7 for further information on these improvements.

FIGURE 5-2: FUTURE SYSTEM MODEL RESULTS





CHAPTER 6 - DESIGN STANDARDS AND O&M EVALUATION

The current city Public Works Design Standards (PWDS) and public facilities chapters of the Molalla Municipal Code were last updated in 2020. A review of each document, in addition to the Comprehensive Plan, TMDL implementation plan, and current operation and maintenance (O&M) program was completed to identify areas of potential improvement and provide recommendations for updates to maintain consistency and agreement between guiding documents.

The current PWDS were discussed at length with City staff after an initial review was completed. The intent of the discussion was to discuss the suggested updates and talk through potential challenges.

6.1. CITY CODE AND DESIGN STANDARDS

6.1.1. City Code Review

Molalla's Municipal Code, Chapter 13.13 Surface Water management, is relatively simple and provides guidance and direction at a high level; the PWDS provide greater detail regarding how stormwater will be managed within the city and what is required for new development and redevelopment.

The recommended changes to the city code are summarized below and documented in Appendix G via comments within the word document or with track changes.

- Storm pipe is regularly referred to as 'storm sewer' which is confusing language. It's suggested this be updated to reference storm pipe, stormwater, or storm infrastructure. The word 'sewer' should be removed from language referencing stormwater.
- Remove references to a stormwater NPDES permit. The City does not have a Phase II NPDES permit and is unlikely to be issued one within the timeframe that this SWMP will apply to.
- Many references throughout the Code suggest the language was borrowed from Chapter 13.08 Sanitary Sewers and not completely updated. A review and update of the entire stormwater section is needed to remove references to the sanitary system.
- Update illicit discharge language. Some example language has been provided. This also pertains to 13.13.700 and 13.13.710.

6.1.2. Public Works Design Standards

PWDS recommended changes are summarized below and documented in Appendix G. Proposed updates to the PWDS have been developed through multiple reviews and meetings with City staff.

- Adding definitions for existing, predeveloped, and future conditions
- Section 3.2.2: Update acceptable programs to use for hydraulic evaluation.
- Section 3.2.5 Review of Downstream System: Consider removing this from the design standards. The model developed for the stormwater master plan provides sufficient evaluation to determine where there are conveyance challenges.
- Section 3.3.4 Stormwater Quality Volume and Flow: Update the water quality rainfall depth to fall in line with industry standards.



- Section 3.4 Water Quantity Facility Design: Update section for clarity and separation of standard for quality and quantity facility design.
 - Decouple water quality facility design and conveyance from water quantity facility design.
 - Reconsider downstream deficiency trigger for detention/retention per suggestion that the downstream evaluation be removed.
- Section 3.4.5 Flood Management Design Standards: Remove from design standards and rely on the flood plain manager at the county.
- Section 3.5 Water Quality Facility Design:
 - Consider adopting a guidance document such as the Clean Water Services Low Impact Development Approaches Handbook, or something similar.
 - Update the water quality storm to be more in line with industry standards.
 - Clarify or standardize the impervious area trigger. Currently there are two numbers 5,000sf and 2,750sf.
- Section 3.8 Culvert Design Standards:
 - Consider utilizing ODOT standards that will be maintained and updated regularly.
 - Designing culverts for the 25-year flow is much lower than recommended. Consider referencing ODOT standards or increasing the standard to the 50- or 100-year flow.
- Section 3.10 Material Specifications: There may be a more appropriate location for specifications or reference specifications that will be regularly updated such as ODOT or CSI.
- Section 3.11 Construction Specifications: There may be a more appropriate location for specifications or reference specifications that will be regularly updated such as ODOT or CSI.
- Section 3.13 Warranties and Acceptance: Review this section for consistency with stormwater as much of the language appears to be taken from sanitary design standards.
- Section 9.2 Site Characterization: Consider revising or eliminating this section to not allow infiltration to be accounted for in facility design. Soils in Molalla are generally very poor for infiltration; removing the ability to account for infiltration will simplify the standards, design, and review.
- Section 10 Stormwater Quality Facility Design:
 - This section may cause confusion or conflict with Section 3.5. If both sections remain, they should be closely reviewed to eliminate any confusion or conflicts.
 - Consider adopting a guidance document such as the Clean Water Services Low Impact Development Approaches Handbook, or something similar.
 - This section was not thoroughly reviewed as it is assumed it will be replaced.
- Recommend removing language referring to downstream capacity and all associated guidance.
- Update the detention requirement to meet 5-year discharge rates for existing conditions not predeveloped conditions
- Update all language guidance to include retention in addition to detention



- Remove bio-swales from options for water quality treatment and allow for use of local facility design guidance from other agencies
- Recommend removing devices that utilize vortices or other radial flow to capture sediment and provide pretreatment. These devices, while appropriate for pretreatment will not meet desired treatment levels.

6.2. COMPREHENSIVE PLAN

The Molalla Comprehensive Plan includes community goals and policies on transportation, utilities, land use, recreation, growth, housing, and other subjects necessary to govern development in the community. The plan was developed in 2014 and last updated in 2025. Public facility master plans are technical support documents for municipal utilities and facilities (water, sewer, storm drainage, parks transportation and general government). The master plans, prepared by engineering and planning professionals, typically provide a detailed analysis of existing facilities, recommendations for improvements and a 20-year capital improvement plan. The public facility master plans provide guidance to city leaders on where limited public resources can be wisely invested for the benefit of local citizens. The comprehensive plan often references development codes, public works design standards and other studies and land use implementation measures.

A review of the comprehensive plan and associated documents was completed as a part of this effort. The Molalla Comprehensive Plan is divided into Parts I through V. Part I includes five volumes; Volume I includes the comprehensive plan direction while Volumes II and III provide the supporting documentation. Part IV: Public Facilities and Transportation addresses stormwater specifically. Parts I, II, III, and V address elements outside the scope of this plan. Public facility goals and policies are as follows:

- To plan and develop a timely, orderly, and efficient arrangement of public facilities and services to serve as a framework for urban and rural development.
- To ensure livable and complete neighborhood – with adequate sanitary sewer, water, storm drainage, transportation, park and school facilities.
- To ensure that development pays its fair share for the public facilities needed as called for in adopted plans.

Public facility policies that specifically speak to stormwater are included below.

- The City shall continue to construct, operate and maintain its water, sewer and storm facilities in conformance with Federal, State and Regional quality standards.
- Ensure that the City has an adequate storm detention systems to retain stormwater in town and effectively convey it to exit town through Bear or Creamery Creek or other appropriate outfall.
- Where feasible existing culvert or piped drainage ways will be “day lighted” (converted from underground to surface facilities). Open drainage ways may be used as open space requirements for development, provided that they meet the design requirements of the Planning Department.
- Conversion of existing swales or drainage ways to culvert, piped systems, or linear ditches shall be permitted only where the Director of Public Works or responsible City staff determine that there is no other reasonable site development option.
- Ensure adequate storm drainage.
- During development of a storm sewer master plan (see Public Facilities and Services element) the issue of water quality aspects of urban storm runoff shall be addressed.



- Maximize the use of the natural drainage system to allow for ground water infiltration and other benefits to community aesthetics as well as habitat enhancement. This does not mean that natural drainage ways will be left unimproved. The City must approve alterations of any kind.
- Regulations regarding the cleaning of private commercial and residential parking lots shall be addressed during development of the storm sewer master plan.
- This City shall require developers to utilize natural drainage ways in the storm drainage plan.
- The City shall require all future utilities to be placed underground, other than storm drainage facilities.

The comprehensive plan adequately addresses the need for stormwater infrastructure within the City limits and the Urban Grown Boundary. It is recommended that any reference to 'storm sewer' be replaced with 'stormwater' or 'storm', as appropriate, throughout the plan.

6.3. TMDL IMPLEMENTATION PLAN

Section 3.2.1 of this document provides a summary of the TMDL as it relates to stormwater management for the City of Molalla.

A review of the TMDL Implementation Plan completed in 2022, has outlined the TMDL Requirements and Parameters, Water Quality Efforts, Implementation Strategies, Monitoring, Reporting, Compliance and Funding, and TMDL Implementation Matrix.

Implementation strategies highlight how current policies are leveraged to meet TMDL needs and limit contaminate contribution to receiving waters.

The TMDL Implementation Matrix identifies specific efforts and implementation strategies to address temperature, bacteria, and Mercury. Highlights if the plan outcomes include improvement results like seven times more material removed from city streets via street sweeping and ten times more bags for pet waste cleanup than previous years.

An area for potential improvement includes the strategies for Mercury which have not been established and clear strategies remain undefined. The next update to the implementation plan should include clear strategies for Mercury reduction.

6.4. OPERATIONS AND MAINTENANCE EVALUATION

This section summarizes current city operating procedures with regard to operation and maintenance (O&M) of stormwater infrastructure and provides general recommended operations and maintenance activities for stormwater infrastructure. This section includes recommendations for conveyance, detention, and treatment facilities.

6.4.1. Pipelines

Current Operations:

The City currently does not have a regular or formal pipeline inspection or cleaning program, other than the preventative maintenance (PM) work order system. The PM system allows citizens to submit work order requests for failing or malfunctioning facilities. Funding for a program will be supplied by the stormwater utility rate which is in place to assist with pipeline maintenance and replacement.

**Proposed Operations:**

Regular CCTV inspection to document pipeline conditions is an important component of a proper stormwater maintenance program. Regular CCTV can identify damaged pipes, plugged pipes, illicit connections, root intrusion, and regular wear. It also provides confidence in the system connectivity and can be used to update system mapping.

Cleaning pipelines should also be completed on a regular basis as sediment build-up in the pipelines reduces their capacity and increases the potential for flooding. Sediment build-up can also result in higher pollutant concentrations flushed out during large storm events. A regular cleaning and CCTV program for the storm water pipelines will enable the City to identify and prioritize the pipelines in need of maintenance or replacement prior to failure. It is recommended that all the storm water pipelines be cleaned every 6 years, or more regularly if CCTV records justify a higher cleaning frequency (e.g. annual cleaning is recommended for lines with significant root intrusion). The recommended frequency for CCTV inspection is every 5-10 years initially, then more or less frequently, depending on the condition and volume of sediment in the pipelines.

It is recommended that Molalla continue to develop a pipe inspection program and use their CCTV equipment on a regular basis to conduct pipe inspections and identify pipes in need of repair or replacement. It is also recommended that the City works to more thoroughly implement the existing Stormwater Maintenance Agreement.

6.4.2. Manholes**Current Operations:**

The City currently does not have a formal manhole inspection or cleaning program. The City's preventative maintenance (PM) work order system enables citizens to submit work order requests for failing or malfunctioning facilities. A stormwater utility fee generates revenue for the general fund for stormwater improvements and maintenance, including manhole maintenance and replacement. Typically cleaning occurs when there is an identified drainage problem at a manhole after a large storm event.

Proposed Operations:

Manholes should be cleaned regularly to limit transport of sediment and contaminants downstream to an outfall or facility. Initial cleaning should be completed regularly, and it is suggested to be on a three-year cycle. Once an initial cleaning is completed tracking sedimentation levels will become easier and a cleaning cycle specific to sedimentation can be determined over time. A manhole's effectiveness, to capture and remove sediment and contaminants from traveling downstream, increases with more frequent cleanings. Manholes should be considered the second line of sediment and contaminant removal following the catch basins.

Manhole cleaning is typically achieved with a vactor mini truck and vactor trailer. The City owns a vactor truck and trailer, but stormwater employees have noted that the vactor truck needs to be replaced. It is recommended that the vactor trailer is replaced to improve efficiencies during manhole maintenance. The vactor trailer was recently purchased by the City. It is also recommended that the City works to more thoroughly implement the existing Stormwater Maintenance Agreements.

6.4.3. Catch Basins**Current Operations:**

The City currently does not have a formal catch basin inspection or cleaning program. other than The City's PM work order system enables citizens to submit work order requests for failing or malfunctioning facilities. A stormwater utility fee generates revenue for the general fund for stormwater improvements and maintenance, including catch basin maintenance and replacement. Typically cleaning occurs when there is an identified drainage problem at a catch basin after a large storm event.

**Proposed Operations:**

At a minimum, catch basins need to be cleaned when sediment or debris blocks more than 1/3 of the pipe. An EPA study titled Evaluation of Catch Basin Performance for Urban Stormwater Pollution Control (Aronson et al, 1983, EPA-600/2-83-043) recommends that all catch basins be cleaned at least annually; annual cleaning may be required by a future NPDES permit. A catch basin's effectiveness, to capture and remove sediment and contaminants from traveling downstream, increases with more frequent cleanings. Servicing all the catch basins every year may not be realistic for the City so cleaning every three years is recommended.

Catch basin cleaning is typically achieved with a vactor mini truck and vactor trailer. The City owns a vactor truck and trailer, but stormwater employees have noted that the vactor truck needs to be replaced. It is recommended that the vactor truck is replaced to improve efficiency during catch basin maintenance. The vactor trailer was recently purchased by the City. It is also recommended that the City works to more thoroughly implement the existing Stormwater Maintenance Agreement.

6.4.4. Public Detention Facilities, Open Channels, and Water Quality Facilities**Current Operations:**

The City currently does not have a formal facility inspection or cleaning program. The Cities PM work order system enables citizens to submit work order requests for failing or malfunctioning facilities. A stormwater utility generates revenue for the general fund to fund stormwater improvements and maintenance, including detention facility, open channel, and water quality facility maintenance and replacement. An operations and maintenance plan should be provided as part of the final design package for future water quality facilities. Currently, an inspection and cleaning or maintenance occurs when there is an identified problem, which occurs frequently after large storm events.

Proposed Operations:

Operations and maintenance of public water quality and flow control facilities should be completed annually to ensure the facilities retain their intended function. Each facility should be inspected each year once or twice to identify potential maintenance items. Inspections should include vegetation health and invasive or undesirable species, structural such as the inlet and outlet structure and flow control structures as appropriate, security, surrounding area and slope stability, access, and any other element identified. Identified maintenance items should be documented and addressed each year during the summer-dry season. All inspections and maintenance activities should be documented and tracked, with the city's current software iWorQs or a similar program, to document completion and maintain a record. Inspection and maintenance should be increased or decreased based on the documented need over time. A few examples of regular maintenance that are needed in most facilities are listed below.

- Grates on inlet and outlet pipes (where applicable) should be cleaned regularly
- The control structures should be inspected and cleaned
- The areas around the detention facilities should be maintained for weeds.
- Open detention facilities should be cleared of any trash or debris on a regular basis
- Open channels should be cleared of any trash or debris on a regular basis, additionally the channel's stability should be inspected
- The facility should be cleared of sedimentation before sediment accumulation exceeds the elevation of the outfall pipe which may interfere with proper functioning of the facility



6.4.5. Private Detention Facilities, Open Channels, and Water Quality Facilities

Current Operations:

Private stormwater facilities are expected to be operated and maintained by the owner to retain the effectiveness for the life of the facility. An operations and maintenance plan should be provided, executed, and recorded with the City. The plan will be recorded and maintained through different ownership of the property by inclusion with the deed of sale. The City is working to finalize its Stormwater Maintenance Program which will require that privately owned facilities submit an annual report on all operations and maintenance. Requirements for these actions are outlined in Molalla Municipal Code Sections 13.13.400/410 and in the Public Works Standards Section 3.6. Additional guidance and forms have been developed including a Facility Inspection Maintenance Report form, a Guide to Maintenance and Access Easement, Stormwater Maintenance Brochure, and a Stormwater Operations and Maintenance Guide. These four documents are provided in Appendix H – Private Facility Maintenance.

Proposed Operations:

Operations and maintenance of private water quality and flow control facilities should be completed annually or as needed to ensure the facilities retain their intended function. Inspections should include vegetation health and invasive or undesirable species, structural such as the inlet and outlet structure and flow control structures as appropriate, security, surrounding area and slope stability, access, and any other element identified as outlined in the City maintenance guide. Identified maintenance items should be documented and addressed each year during the summer-dry season. All inspections and maintenance activities should be documented and tracked to document completion and maintain a record. Inspection and maintenance should be increased or decreased based on the documented need over time. A few examples of regular maintenance that are needed in most facilities are listed below.

- Grates on inlet and outlet pipes (where applicable) should be cleaned regularly
- The control structures should be inspected and cleaned
- The areas around the detention facilities should be maintained for weeds.
- Open detention facilities should be cleared of any trash or debris on a regular basis
- Open channels should be cleared of any trash or debris on a regular basis, additionally the channel's stability should be inspected
- The facility should be cleared of sedimentation before sediment accumulation exceeds the elevation of the outfall pipe which may interfere with proper functioning of the facility

6.4.6. Street Sweeping

Street sweeping is one of the most functional O&M practices to prevent contaminants from entering the stormwater system. Street sweeping should take place on streets, parking lots, and paved surfaces that have curb and gutter to collect contaminants. Non curb and gutter streets, parking lots and paved surfaces should be lower priority as the contaminants will drain off into the adjacent spaces and typically not enter the stormwater system.

Current Operations:

The City owns a street sweeper, which aids in preventing contaminants from entering the stormwater system. The City sweeps their streets regularly, sweeping all streets approximately every 1.5 weeks or 35 times per year.

**Proposed Operations:**

Municipality street sweeping programs vary greatly depending on the level of funding for this important water quality best management practice (BMP). Larger municipalities have programs that sweep up to 12 times per year and others complete sweeping as funding allows. As current City operations perform street sweeping approximately 35 times per year, it is recommended that the current practices continue.

It is also recommended that the downtown core of the City, which experiences more traffic than the rest of the City is swept more frequently than other residential side streets, especially during leaf season.

6.4.7. Summary of Recommended O&M Activities

A summary of the recommended O&M activities for Molalla are provided below while Table 6-1 provides a bit more detail regarding the suggested O&M activities, frequency, and number to complete per year.

- Clean and inspect manholes and cleanouts on a 3-year cycle (approximately 1/3 system annually)
- Clean and inspect catch basins on a 3-year cycle (approximately 1/3 system annually)
- Clean storm lines by hydro-jetting and CCTV inspect on a 6-year cycle (approximately 1/6 of the system annually). This schedule should be adjusted to increase or decrease O&M cleaning as needed.
- Clean and inspect conveyance ditches annually or as needed
- Maintain detention facilities annually
- Continue performing street sweeping frequency, especially in high traffic areas
- Maintain staff and equipment to complete emergency repairs in a timely manner
- Maintain staff and equipment to address problematic areas as needed



TABLE 6-1: RECOMMENDED O&M ACTIVITIES

Activity		Description	Frequency	Quantity to Perform
Manholes	Manhole Inspection	• Check frame and lid for cracks and wear • Inspect manhole and surrounding areas for pollutants • Inspect pavement around manhole	Inspect 100% of manholes on 3-year cycle	175 Manholes/Year
	Manhole cleaning	• Clean manholes when there is a blockage of the stormwater channel or as deemed necessary during inspection	Clean 100% of manholes on 3-year cycle	175 Manholes/Year
	Water Quality Manholes and Drywells	• Inspect and clear orifice, weir, or other hydraulic controls • Clean debris and pollutants with vac truck	Once per Year	0 Structures Year
Catch Basins	Inspect catch basins	• Inspect structure, note sediment build up or debris, ensure frame sitting flush on slab, ensure frame securely attached, note vegetation growth	Inspect 100% of catch basins on 3-year cycle	345 Catch basins/Year
	Clean catch basins	• Clean catch basins and curb inlets • Remove sediment, trash/debris, vegetation with vac truck	Clean 100% of catch basins on 3-year cycle	345 Catch basins/Year
Pipes	Clean storm lines	• Cleaning storm lines with jet truck • Prioritize based on sediment observations during manhole inspection, develop system to monitor and routinely clean storm lines	Clean 100% of storm lines on a 6-year cycle	30,000 Feet/Year
	CCTV inspect storm lines	• CCTV inspection of the storm lines should be conducted as soon as possible after cleaning. This will provide a more accurate image of the pipeline structure and reduce risk of camera getting stuck	CCTV inspect 100% of storm lines on a 6-year cycle	30,000 Feet/Year
	Root Removal	• Remove root intrusion discovered during inspection	as needed	
Ditches	Clean and Clear Open Channels	• Clear open ditches and manage vegetation so water can flow freely. • Clear and inspect inlets and outlets.	Clean 100% of open ditches Once per year	20,800 Feet/Year
Detention Facilities	Maintain Detention Facilities	• Vegetation control, inspect and clean inlets and outlets	Once per year	18 Facilities/Year
Streets	Street sweeping	• Continue existing street sweeping frequency and quantity	Annually, downtown core with more frequency	35 Weeks/Year
	Loading Street Sweeping Debris	• Continue assisting in loading street sweeping debris	Loading dump truck	10 Weeks/Year
Repairs	Emergency Repairs	• Continue existing emergency repairs	---	4 Weeks/Year
	Address Problematic Areas	• Continue addressing problematic areas as needed	As needed	80 Hours/Year



6.5. STAFFING EVALUATION

The following section summarizes existing stormwater staffing levels, identifies deficiencies in existing staffing levels, and provides staffing recommendations for the City of Molalla.

6.5.1. GENERAL

The City Public works (PW) Operations staff are responsible for the operations and maintenance (O&M) of the stormwater system in Molalla. On October 17, 2023, PW Operations staff were interviewed by Keller Associates to assess existing levels of stormwater staffing and annual O&M activities, identify deficiencies in staffing and equipment, and provide recommendations to assist the City in meeting level of service (LOS) goals for the local stormwater system. To summarize, the PW Operations staff currently provide support for many City activities that are now directly related to public utility O&M (i.e., water, sewer, street and parks maintenance, stormwater, etc.). The sections below provide more detail regarding existing stormwater system staffing and recommendations based on the findings from the PW Operations staff interviews.

6.5.2. EXISTING STORMWATER STAFFING

During staff interviews, the general roles and responsibilities of PW Operations for the stormwater system O&M were reviewed. A list of O&M activities and approximate time, frequency, and size of crew was developed to determine the approximate annual labor hours spent on stormwater O&M. The primary O&M activities include responding to areas with frequent and historical flooding during large rain events, cleaning facilities, maintaining ditched and detention facilities, in-house storm line replacement or extensions, street sweeping, responding to reported problems, and construction permitting and inspections. The City estimates that their 8-person staff spend 10% of their time on stormwater tasks. This means the City has approximately 0.8 full-time employees (FTE) to spend annually on stormwater infrastructure O&M activities.

The current budgeted FTE for stormwater collection systems O&M is reported to be:

- 1.0 FTE, which includes 0.2 FTE from the engineering department for construction, inspection, permitting support, and in-house replacement and extension project support. Additional discussions with the PW Operations and engineering staff made clear the fact that they are requested to complete significant tasks and projects outside of utility O&M. Some of these tasks include, but are not limited to, water and sewer system maintenance; building maintenance; park projects and maintenance; and groundwork for City projects. It is estimated that the PW Operations staff spend 80%-90% or more of their time completing work that is not directly related to utility O&M. these additional tasks pull the PW staff away from utility maintenance activities and prevent them from spending the allocated FTE on utility O&M. Existing maintenance practices on the stormwater system tend to be reactive because of the additional non stormwater projects PW operations staff is asked to complete, and as a result, the time they can spend on utility O&M is minimized.

6.5.3. RECOMMENDED STORMWATER O&M AND STAFFING

LOS goals were discussed with PW Operations staff for the stormwater system. The desired LOS goals are summarized Below.

- No excessive flooding in stormwater system
- No property damage from stormwater
- Address reported problems in a timely manner to prevent interruptions to service
- Complete regular maintenance, repairs, and replacements to minimize interruptions and failures (perform proactive O&M in lieu of reactive O&M)



A summary of recommended O&M activities to achieve these LOS goals and follow industry good practices are listed below.

- Clean and CCTV storm lines per Table 6-1
- Repair or replace defects as identified
- Clean catch basins and manholes per Table 6-1
- Clean and inspect 100% of ditches and inlet/outlet grates annually
- Sweep all roadways approximately twice per year
- Perform detention and water quality facility maintenance per Table 6-1
- Respond to problems as they are identified or reported
- Install minor in-house storm line replacements and extensions (similar to existing practice)
- Facilitate public education and outreach
- Complete construction inspection and permitting
- Comply with new Mercury TMDL implementation plan and complete annual reporting

Using similar expected labor hours for activities as the existing staffing evaluation, it is estimated that approximately 2.6 FTE are needed to meet the O&M and LOS goals described above.

As budgeted, the existing stormwater FTE staff appears to be inadequate. Additionally, the non-utility work and work the PW Operations staff are currently requested to complete, significantly decreases the budgeted FTE that can be spent on stormwater O&M. The recommendation would be that either additional FTE be budgeted for the PW Operations staff to complete the existing workload requested, or the responsibilities of the PW Operations staff be reduced to focus solely on utility O&M. The staffing evaluation for this report is a high-level estimate. The City would benefit from tracking the number of hours the PW Operations staff spend on various activities and utilities throughout the year to assess how best to budget and allocate resources in order to provide recommended O&M on utilities. It is also recommended that staffing needs be reevaluated every two to three years.

In addition to annual O&M discussed above, an annual replacement program should be maintained. Stormwater infrastructure replacement and rehabilitation needs will increase as the system ages, so it would be beneficial for CCTV inspection reports to be reviewed to prioritize rehabilitation and replacement efforts completed when needed. An annual replacement program is an important part of proactively maintaining the stormwater system. Staffing FTE and construction costs for an annual replacement program were not included in the staffing evaluation, but construction costs are discussed and estimated in Section 7. If the PW Operations staff are asked to be responsible for and complete some of the rehabilitation of replacement work, the budgeted FTE for the PW Operation staff would increase.



The City currently has 8 full time equivalent (FTE) public works employees of which little time is currently committed to O&M of the stormwater system, refer Table 6-2, below, for details. Based on the recommended stormwater O&M activities described above, a general estimate of FTE required to meet the activities is provided in Table 6-3 below.

- If the City targets completing the recommended O&M activities an additional 2 FTE (rounding up based on 0.25 increments) will be needed. This is based on the total estimated FTE hours outlined in Table 6-3 which equals 4,700 hours.
- With an assumed FTE working approximately 1,800 hours per year once vacation, sick, holidays and training time is accounted for, the need is 2.75 FTE (rounding up based on 0.25 increments) and the City currently has 0.8 FTE allocated for stormwater maintenance. Additional staff will likely only be partially committed to the stormwater system and would be able to assist with the sanitary sewer and potable water system O&M.

TABLE 6-2: CURRENT CITY STAFFING

Position	# of Employees	% FTE (Storm) ¹	% FTE (Other)	Total FTE
Utility Lead	1	0.10	0.90	1.00
Utility Worker III	2	0.20	1.80	2.00
Utility Worker II	1	0.10	0.90	1.00
Utility Worker I	4	0.40	3.60	4.00
Total	8	0.80	7.20	8.00
1) Includes time spent on stormwater system, street sweeping, and right-of-way maintenance.				



TABLE 6-3: O&M FTE ESTIMATE

	Activity	Production Rate	Crew Size	Quantity to Perform	FTE Hours
Junctions	Manhole and cleanout Inspection	16 Manholes/Day	2	175 Junctions/Year	175
	Manhole and cleanout cleaning	8 Manholes/Day	2	175 Junctions/Year	350
Catch Basins	Inspect catch basins	16 Catch basins/Day	2	345 Catch basins/Year	345
	Clean catch basins	8 Catch basins/Day	2	345 Catch basins/Year	690
Closed Conduit	Clean storm lines - Jetter Truck	1,800 Feet/day	2	36,000 Feet/Year	320
	CCTV inspect storm lines	1,200 Feet/day	2	30,000 Feet/Year	400
	Root Removal	1,000 Feet/Day	2	0 Feet/Year	0
Ditches	Clean Open Conveyance Ditches	2,500 Feet/day	4	20,800 Feet/Year	266
Detention Facilities	Maintain Detention Facilities	4 Facilities/day	4	18 Instances/Year	144
In-House Construction	In-House Rehabilitation and Replacement of Facilities	40 hours/week	8	1 Projects/Year	320
Streets	Street sweeping	Existing Quantity	2	66 Days/Year	528
	Loading Street Sweeping Debris	Existing Quantity ---	4	10 Days/Year	80
Repairs	Emergency Repairs	40 hours/week	6	2 Weeks/Year	480
	Address Problematic Areas	40 hours/week	6	1 Weeks/Year	240
Other	Supporting Contractors	40 hours/week	2	4 Weeks/Year	320
Total Hours					4,700



6.6. CONCLUSION

As budgeted, the existing stormwater FTE staff appears to be less than adequate. The additional projects and work that the PW Operations staff are currently requested to complete significantly decreases the budgeted FTE that can be spent on stormwater O&M. It is recommended additional FTE be budgeted for the PW Operations staff to complete the estimated maintenance per Table 6-1, or the responsibilities of the PW Operations maintenance staff be reduced to focus solely on utility O&M. The City would benefit from tracking the number of hours the PW Operations staff spend on various activities and utilities throughout the year to assess how best to budget and allocate resources in order to provide recommended O&M on utilities. It is also recommended that staffing needs be reevaluated every two to three years.



CHAPTER 7 - RECOMMENDED PROJECTS AND PROGRAMS

This chapter provides a summary of the recommended projects and programs resulting from the master planning process. It includes capital improvement projects, annual replacement budgets, O&M activities, water quality program guidance, and staffing recommendations.

7.1. CAPITAL IMPROVEMENT PLAN

The capital improvement plan (CIP) contains a list of projects to improve and expand the existing stormwater system and guide future improvements as development within the city occurs. The identified projects are included below. Project sheets describing each project in detail are provided in Appendix I. Detailed cost estimates are provided in Appendix J.

- 1: Underground Creamery Creek Realignment
 - This project realigns and replaces aging, high-risk underground stormwater infrastructure associated with Creamery Creek to reduce failure risk, address localized flooding, and improve long-term system capacity. The work is phased to maintain drainage during construction while appropriately abandoning problematic pipes beneath existing structures.
- 2: McLeod's Ditch and Cascade Highway
 - This project pipes and backfills McLeod's Ditch to eliminate frequent blockages, improve hydraulic performance, and preserve City access for maintenance as adjacent properties are developed. Pipe upsizing along Highway 213 is included to remove downstream capacity constraints.
- 3: Finney's Avenue and E Heintz Street
 - This project addresses recurring flooding caused by undersized pipes and a failing detention facility by abandoning the detention system and improving upstream stormwater conveyance. Improvements should be coordinated with the Creamery Creek Realignment project as the project extents overlap.
- 4: Creamery Creek Railroad Culvert
 - This project replaces an undersized and frequently blocked railroad culvert that causes upstream flooding in Creamery Creek. Coordination with the culvert owner will be required.
- 5: Meadowlark and Meadowlawn West Cul-de-sacs
 - This project reduces frequent cul-de-sac flooding by adding catch basins and constructing new pipes to connect to the existing system along Harvest Lane.
- 6: Bear Creek at Ona Way Culvert
 - This project replaces an aging culvert with a bridge crossing designed to improve hydraulic capacity, reduce maintenance, and meet fish passage requirements. Associated roadway reconstruction and stream restoration are included.
- 7: Creamery Creek Lane Culvert
 - This project replaces undersized culverts beneath Creamery Creek Lane with higher-capacity box culverts to alleviate upstream flooding impacting nearby residences.



- 8: N Molalla Avenue, Frances to Church Street
 - This project addresses flooding along Molalla Avenue through targeted CCTV inspections, surface drainage improvements, and construction of new storm pipe to create a continuous, documented conveyance system. The project resolves both capacity and unknown connectivity issues in the existing infrastructure.
- 9: Bear Creek at Lowe Road
 - This project replaces an undersized culvert with a bridge crossing to improve hydraulic performance, reduce flooding risk, and provide fish passage. Roadway reconstruction and ecological enhancements are included as part of the work.
- 10: Homestead Place Line
 - This project mitigates cul-de-sac flooding by adding catch basins and short storm pipe connections to improve surface water capture.
- 11: Bear Creek at Mathias Road
 - This project replaces frequently blocked culverts with a bridge crossing or box culvert to improve conveyance, eliminate ongoing maintenance issues, and meet fish passage requirements. The crossing is owned and maintained by Clackamas County; however, it is included in the Master Plan because its hydraulic capacity affects drainage conditions within the City.
- 12: Bohlander Field and Clark Park
 - This project will construct new stormwater detention facilities near Bohlander Field and Clark Park to reduce flooding impacts on adjacent private properties, including Buckaroo Grounds and nearby residences. At the time of this master plan, the City is conducting a separate feasibility study and developing preliminary designs for the project. A fact sheet and cost estimate have not been developed for this project and not included in Appendix I.

The projects are prioritized into three categories based on criteria described in Table 7-1.

TABLE 7-1: PRIORITIZATION CRITERIA

Priority	Criteria
1	Address current flooding or high maintenance locations Address flooding that potentially restricts emergency response or isolates residents Replace/repair existing infrastructure due to lack of capacity Replace/repair existing infrastructure due to poor condition
2	Connect existing stormwater system to identified development areas Address areas that lack adequate storm infrastructure
3	New infrastructure to improve drainage and provide trunkline for future development Additional studies recommended within the next 10-20 years

A summary of the prioritized projects and their estimated costs is provided in Table 7-2 and illustrated in Figure 7-1.

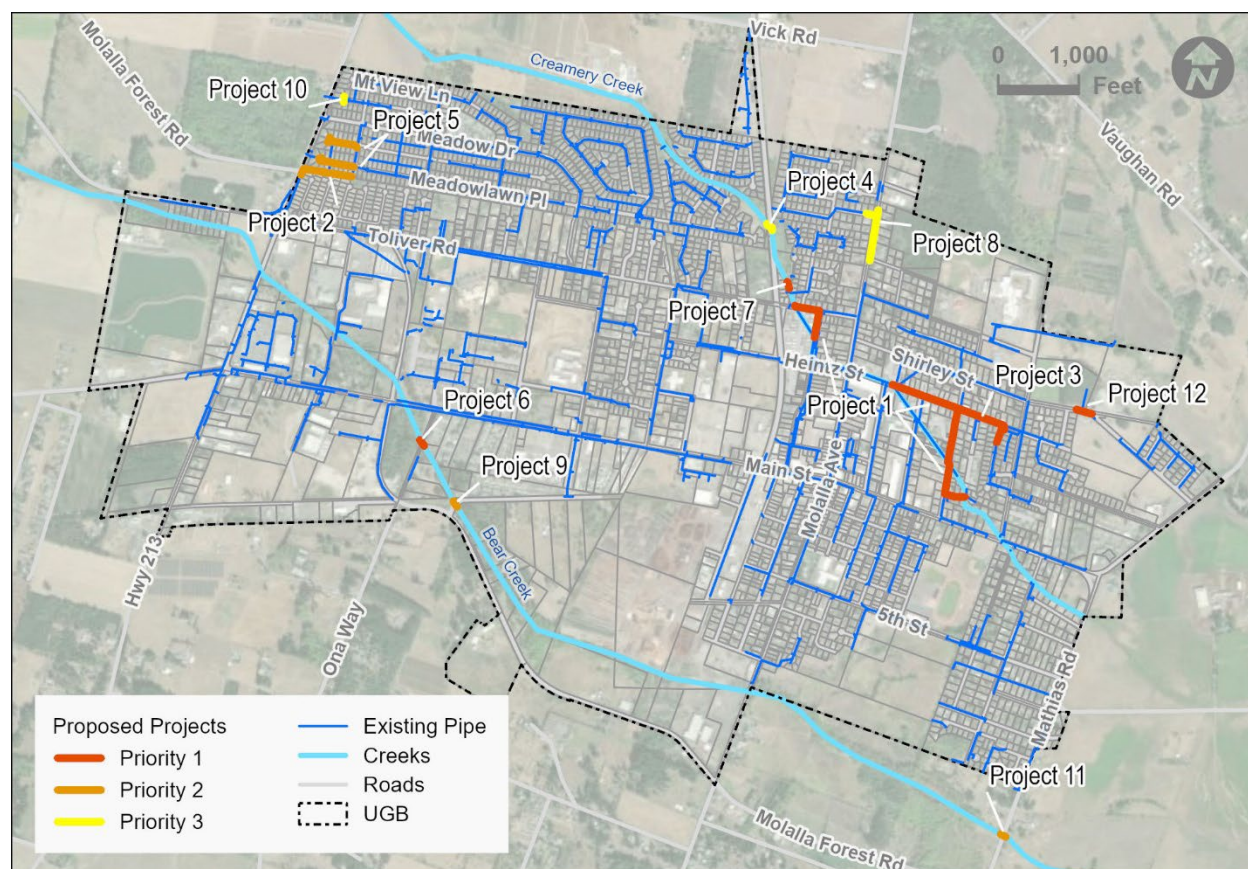


TABLE 7-2: CAPITAL IMPROVEMENT PLAN

Project ID	Project Name	Project Goal	Total Estimated Cost (2025 Dollars)
Priority 1 Improvements			
1	Underground Creamery Creek Realignment	Reduce risk, increase system capacity	\$6,252,700
3	Finney's Avenue and E Heintz Street	Increase system capacity	\$1,701,200
6	Bear Creek at Ona Way Culvert	Replace inadequate culvert	\$2,068,600
7	Creamery Creek Lane Culvert	Replace inadequate culvert	\$585,000
12	Bohlander Field and Clark Park	Mitigate flooding	NA
Priority 1 Improvement Costs			\$10,607,500
Priority 2 Improvements			
2	McLeod's Ditch and Cascade Highway	Increase system capacity	\$888,000
5	Meadowlark and Meadowlawn Cul-de-sacs	Add stormwater infrastructure	\$1,152,500
9	Bear Creek at Lowe Road	Replace inadequate culvert	\$1,081,100
11	Bear Creek at Mathias Road	Replace inadequate culvert	\$981,900
Priority 2 Improvement Costs			\$4,103,500
Priority 3 Improvements			
4	Creamery Creek Railroad Culvert	Address inadequate culvert	\$366,100
8	N Molalla Avenue, Frances to Church Street	Add stormwater infrastructure	\$955,600
10	Homestead Place Line	Add stormwater infrastructure	\$86,300
Priority 3 Improvement Costs			\$1,408,000
TOTAL SYSTEM IMPROVEMENT COSTS (rounded)			\$16,119,000



FIGURE 7-1: CAPITAL IMPROVEMENT PLAN



7.2. RECOMMENDED PROGRAMS

Formal programs to maintain, gather information, address aging infrastructure, and comply with regulatory requirements are recommended to be initiated and maintained. These programs include the following:

- Manhole/Catch Basin Cleaning
- CCTV and Pipe Cleaning
- Street Sweeping
- Water Quality and Flow Control Maintenance
- Repair and Replacement (R and R)

The degree to which each program is developed and implemented will vary as needed based on existing programs. This summary is intended to provide a framework to inform the needed programs and develop the necessary funding and staffing to support each program. Table 7-3 summarizes the dollar amount (and FTE hours where applicable) for each of the recommended programs. Additional details regarding the programs are provided in the following sections.



TABLE 7-3: PROGRAMS SUMMARY TABLE

Annual Programs Summary	Annual Cost (\$/year)
Manhole/Catch Basin Cleaning	\$128,000
CCTV and Pipe Cleaning	\$180,000
Street Sweeping	\$30,400 or 604 FTE
Water Quality and Flow Control Maintenance	\$19,700 or 410 FTE
Repair and Replacement	\$1,103,000
Total Annual Program Budget	\$1,460,000

7.2.1. Manhole and Catch Basin Cleaning

As discussed in Chapter 6, regular cleaning of manholes and catch basins improves effectiveness at capturing sediment and contaminants from moving downstream and minimizing re-entrainment. The City owns a vactor truck and trailer, a common method for cleaning manholes and catch basins; but it has been noted by City staff that the vactor trailer is in need of replacement. Manholes and catch basins are recommended to be cleaned on a 3-year cycle. It is estimated to cost approximately \$128,000 to clean one third of the manholes and catch basins within the system each year.

7.2.2. CCTV and Pipe Cleaning

Closed-camera television (CCTV) is an important aspect of managing a stormwater collection system. Regular CCTV will identify damaged, blocked, or other important information for the pipes and therefore reduce the risk of flooding streets, infrastructure, and structures. Cleaning the stormwater pipes also reduces sediment buildout and pollutant discharge during large storm events. The City owns both CCTV equipment and a jet truck for pipe cleaning. Pipelines are recommended to be cleaned and inspected through CCTV every 6 years. Assuming a cost of \$5 per foot for cleaning and CCTV, the cost per year would be approximately \$180,000.

7.2.3. Street Sweeping

A street sweeping program is an effective practice to prevent sediment and contaminants from entering the stormwater system. As discussed in Chapter 6, the City owns a street sweeper and sweeps each street approximately every 1 and half weeks. Chapter 6 provides an estimate of approximately 604 hours per year. Assuming a fully loaded rate for an operator at a pay grade of \$100,000/year, this equates to approximately \$30,400 or 604 FTE hours.

7.2.4. Water Quality and Flow Control Facility Maintenance

The City has numerous stormwater detention facilities, vegetated water quality facilities, and other flow control facilities. Maintaining these facilities is critical to their proper operation and long-term viability. Annual maintenance will vary depending on the type of facility, but it is recommended these facilities be inspected and maintained a minimum of once per year.

Inspections and maintenance activities should be documented and tracked with a GIS or asset management system. The costs for maintenance of the stormwater facilities will likely be included within the staffing costs for the Public Works Department but may need to be clearly earmarked to provide sufficient funding.

7.2.5. Repair and Replacement Program

As the existing stormwater system ages, an annual replacement program should be implemented to replace infrastructure that has reached the end of its useful life. An annual replacement program should be developed to provide a starting point for the City to begin a replacement program and is summarized in Table 7-4. Values in Table 7.4 are based on total length of pipe and number of structures as provided in Tables 2-2 and 2-3.



Fully funding the annual replacement program may not be practical at this time and the budgets proposed in the table are a general guideline for the costs needed to replace the infrastructure completely based on their typical useful life. In practice, the City's annual replacement program will likely be implemented as capital improvement projects as failed pipes are identified by the CCTV program or by responding to problem areas. The City should also consider completing stormwater projects in coordination with other roadway, sanitary sewer, or potable water projects to reduce the costs.

TABLE 7-4: ANNUAL REPLACEMENT PROGRAM

Replacement Program	Useful Life (years)	Replacement Budget (\$/year) ¹
Pipelines ²	100	\$878,000
Manholes ³	50	\$107,000
Catch Basins ⁴	50	\$118,000
Total Annual Replacement		\$1,103,000
1) Provided in 2026 dollars. Based on the existing GIS database. 2) Assumes replacement of 1% of the system each year (~1,600 LF). Replacement costs include pipe material, road repair, mobilization, contingency, and engineering costs which results in an average cost of \$545/LF. 3) Assumes replacement of ten manholes per year and a replacement cost of \$10,300 per manhole. 4) Assumes replacement of twenty-one catch basins per year and a replacement cost of \$5,700 per catch basin.		

7.3. FUNDING SOURCES AND RECOMMENDATIONS

Funding the improvements described above in Section 7.1 may come from a variety of sources. Some of the potential sources to be considered are provided below.

7.3.1. System Development Charges (SDCs)

System development charges (SDCs) are a fee imposed on new development or redevelopment to provide funding for public infrastructure impacted by the development. SDCs are regulated by Oregon Revised Statute (ORS) 223.297-314. The ORS statute states that SDCs are a one-time fee to help pay for capital improvements needed to serve the new growth. Molalla currently has an SDC program for stormwater that is summarized in Table 7-5.

TABLE 7-5: 2026 SYSTEM DEVELOPMENT CHARGE SUMMARY

	SDC Component			Total SDC
	Improvement	Reimbursement	Administrative	
Cost per Equivalent Dwelling Unit ¹ (EDU)	\$924	\$41	\$19	\$984
1) Single family homes count as one EDU. Otherwise, EDU is calculated by dividing the total impervious area (ft ²) by 2,640.				

SDC eligibility for each of the CIP projects was estimated based on the percent of developable area within the upstream drainage area that contribute to the respective project. These areas are shown in Figure 11 in Appendix B. The estimated SDC eligibility is summarized in Table 7-6.



TABLE 7-6: SDC ELIGIBILITY FOR CIP PROJECTS

Project ID	Project Name	Total Estimated Cost (2025 Dollars)	SDC Allocation		City Estimated Portion
			% Growth Allocation	SDC Eligibility	
Priority 1 Improvements					
1	Underground Creamery Creek Realignment	\$6,252,400	2.1%	\$128,000	\$6,124,400
3	Finney's Avenue and E Heintz Street	\$1,701,200	0.4%	\$7,000	\$1,694,200
6	Bear Creek at Ona Way Culvert	\$2,068,600	0.2%	\$4,000	\$2,064,600
7	Creamery Creek Lane Culvert	\$585,000	2.0%	\$12,000	\$573,000
12	Bohlander Field and Clark Park	-	-	-	-
Priority 1 Improvement Costs		\$10,607,000	1.42%	\$151,000	\$10,456,200
Priority 2 Improvements					
2	McLeod's Ditch and Cascade Highway	\$888,000	6.0%	\$54,000	\$834,000
5	Meadowlark and Meadowlawn Cul-de-sacs	\$1,173,000	3.3%	\$38,000	\$1,135,000
9	Bear Creek at Lowe Road	\$1,081,100	0.2%	\$2,000	\$1,079,000
11	Bear Creek at Mathias Road	\$981,900	0%	\$0	\$982,000
Priority 2 Improvement Costs		\$4,124,000	2.28%	\$94,000	\$4,030,000
Priority 3 Improvements					
4	Creamery Creek Railroad Culvert	\$366,100	1.9%	\$7,000	\$359,000
8	N Molalla Avenue, Frances to Church Street	\$955,600	26.9%	\$257,000	\$699,000
10	Homestead Place Line	\$91,500	0%	\$0	\$91,500
Priority 3 Improvement Costs		\$1,413,000	18.68%	\$264,000	\$1,149,500
TOTAL SYSTEM IMPROVEMENT COSTS		\$16,144,400	3.15%	\$509,000	\$15,635,400

7.3.2. Stormwater Utility Rate

A stormwater utility rate is an important source of revenue to fund stormwater infrastructure needs and operations and maintenance. Molalla currently charges \$5.06 per EDU per month for stormwater service, with the rate automatically adjusting for inflation. Single-family dwellings are billed as 1 EDU; for other properties, EDUs are calculated by dividing total impervious area (ft²) by 2,980.

7.3.3. Local, State, and Federal Funding Programs

Additional sources of funding for stormwater improvements could come from State and federal funding programs such as the Clean Water State Revolving Fund, USDA Rural Development, or Community Development Block Grants. These programs offer grants and low-interest loans to communities for infrastructure projects and could assist with project funding.



7.4. PLANNING RECOMMENDATIONS

The planning elements used as the basis for the recommendations and CIP projects in this plan may evolve over time and it is recommended that the City continue to maintain current models of the system and review each improvement in more detail a year or two ahead of implementing individual capital improvements. By reviewing upcoming improvements ahead of time, it will provide the City with an opportunity to refine project scopes and budget. A more comprehensive update of the master plan is recommended every 10 years to allow for the City to re-assess needs, priorities, and properly allocate budgets to address system deficiencies. The GIS mapping and hydraulic model should continuously be updated and improved to reflect new development and improvements to the stormwater system that occur over time.

APPENDIX A

Public Engagement





City of Molalla

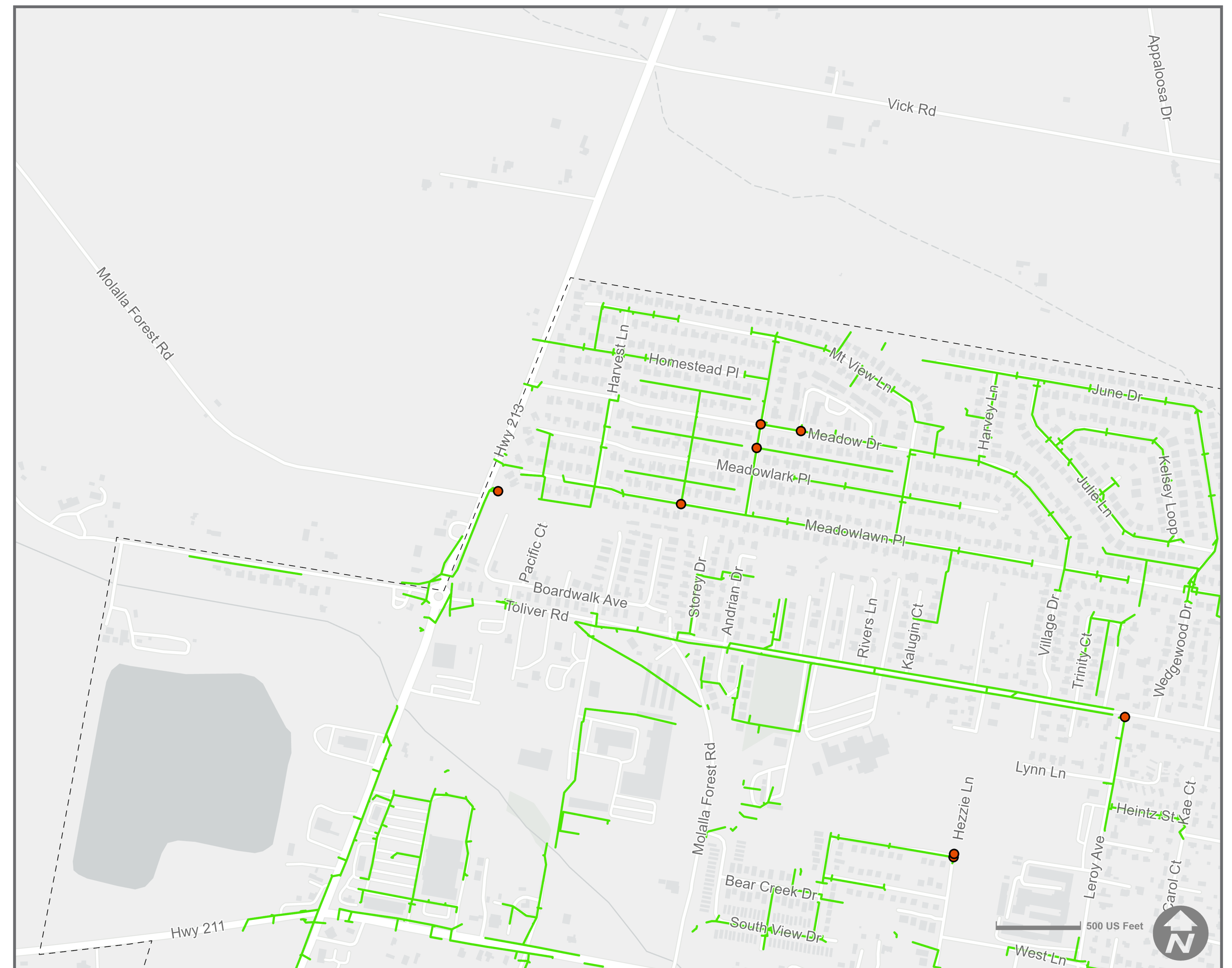
Stormwater Master Plan

Why are we pursuing this master plan?

This Stormwater Master Plan is being completed to provide the City with a plan or framework to guide maintenance, capital projects, and management of the stormwater infrastructure now and into the future.

- 1** Place a push pin on areas where you have experienced flooding
- 2** Take a sticky note and describe the nature of the flooding
- 3** Place the sticky note in the comment section below

Place comments here:



Legend Breakdown

- A red dot represents flooded manholes
- A green line represents storm infrastructure
- A dashed black line represents urban growth boundary



City of Molalla

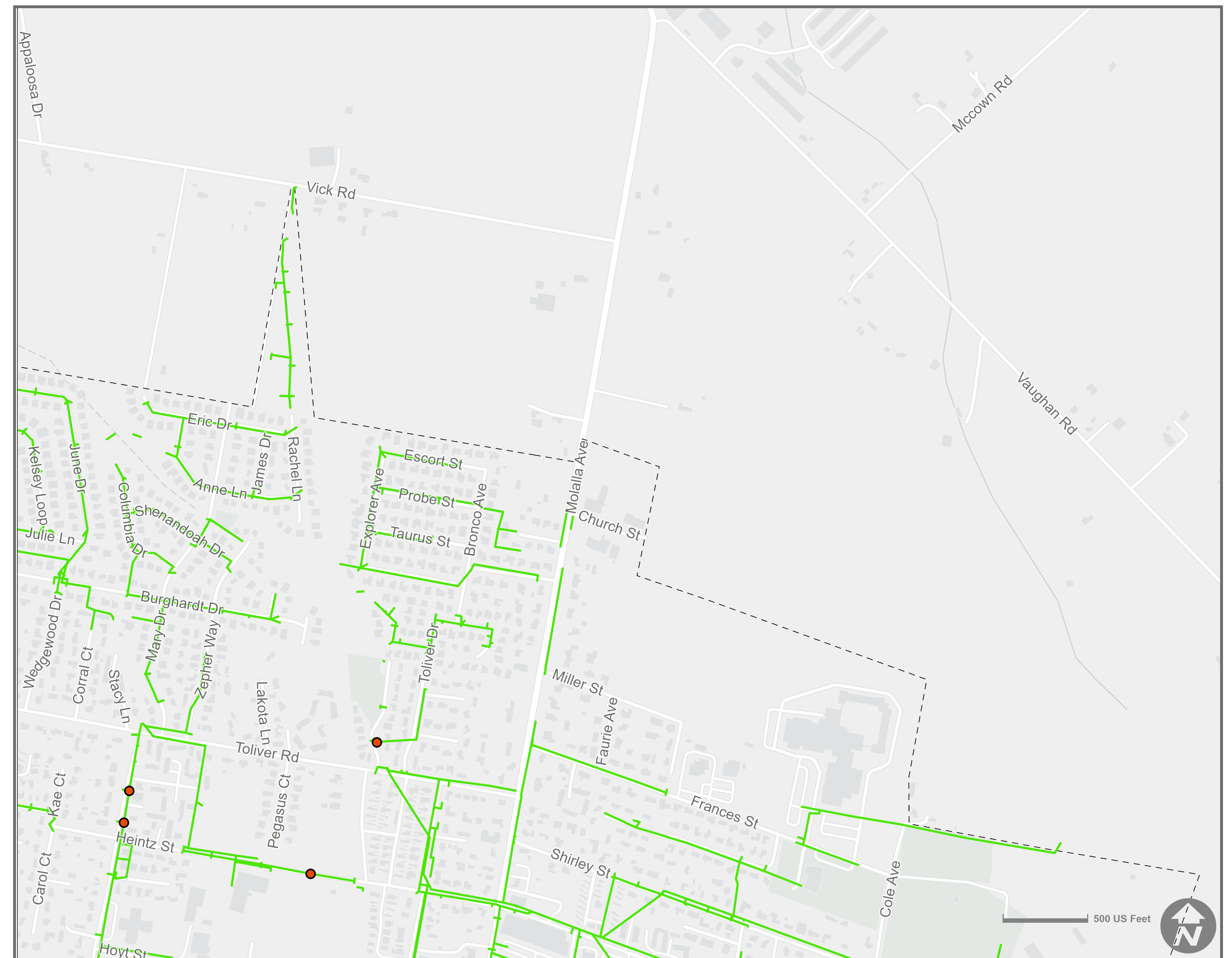
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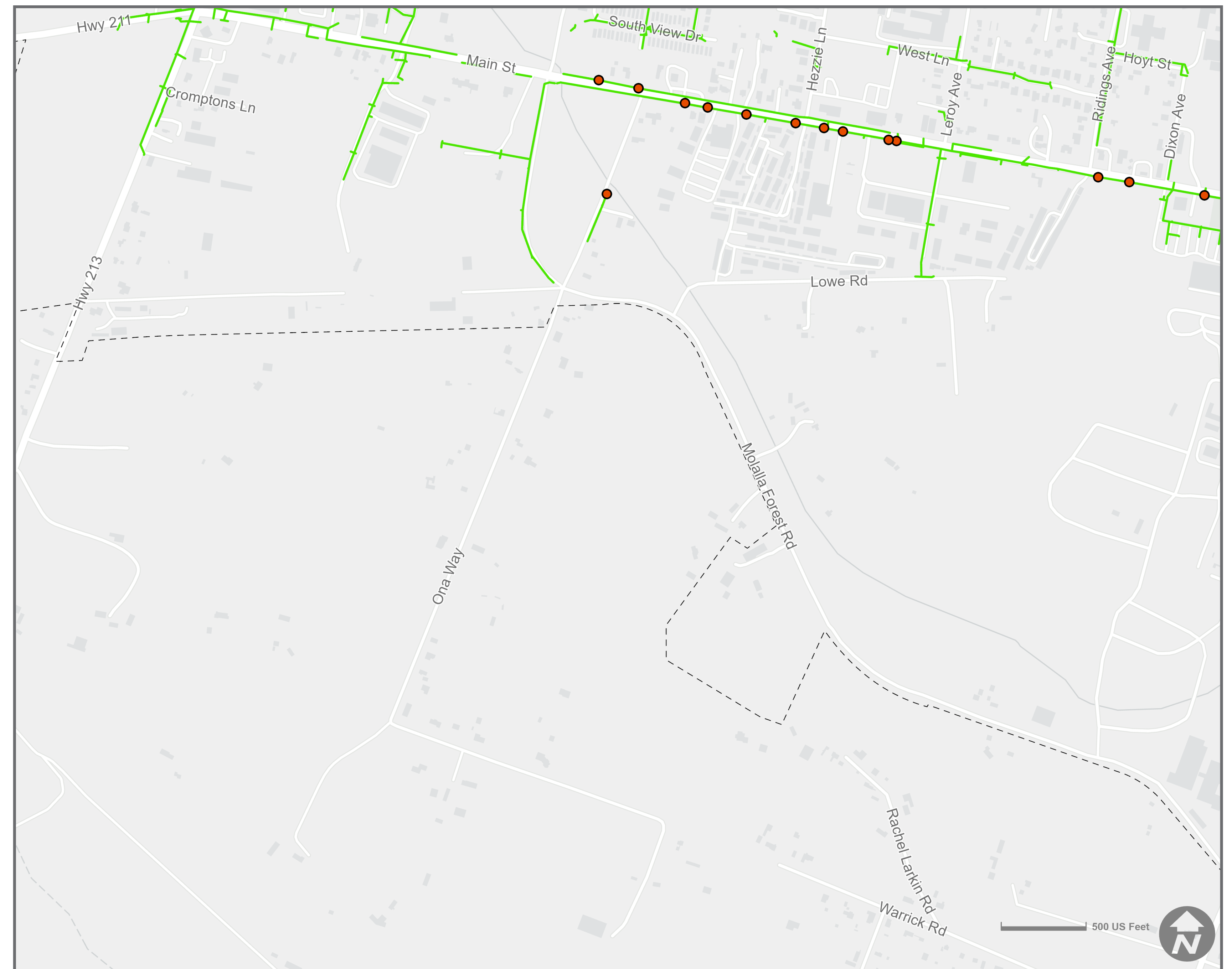
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City of Molalla

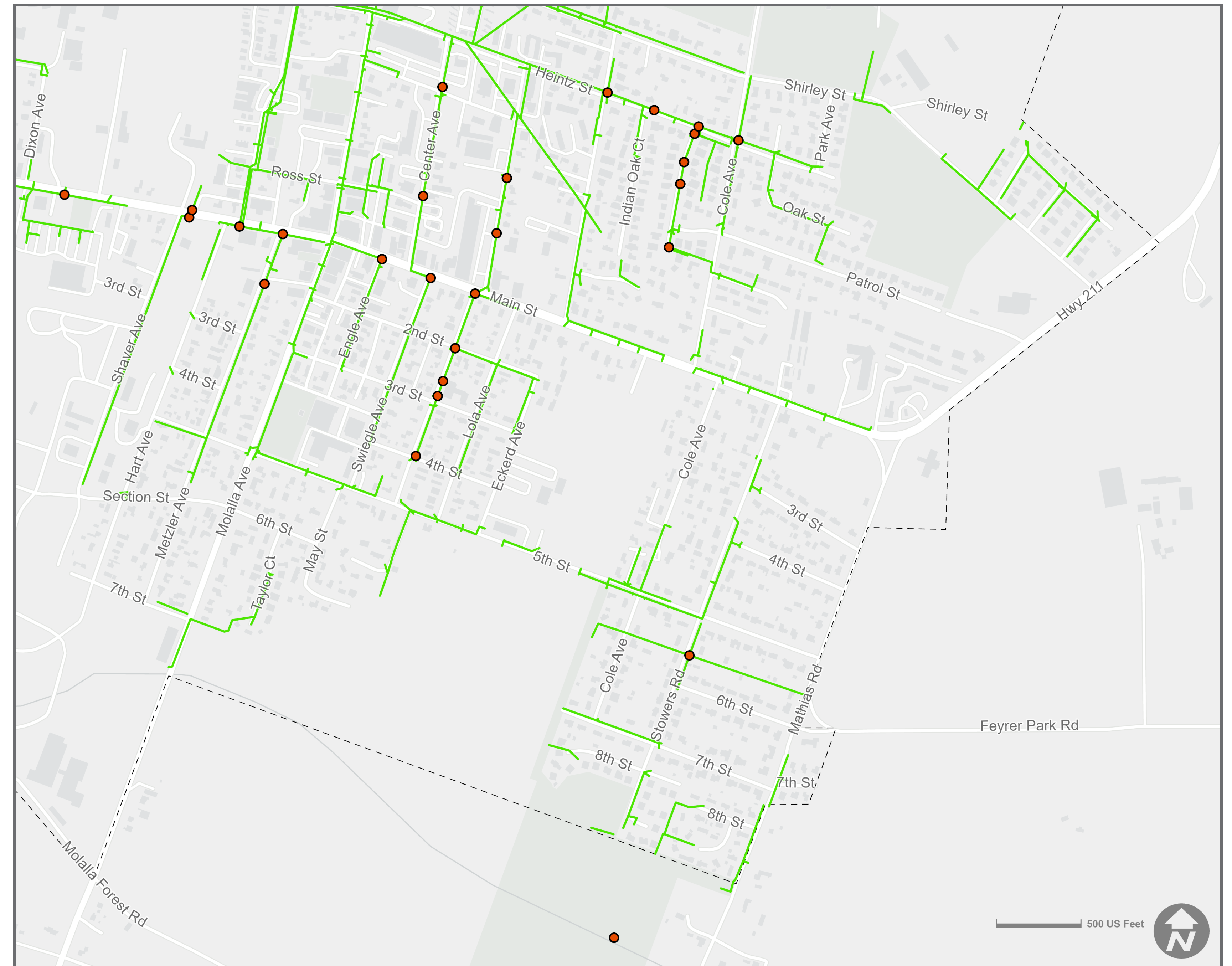
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A green line represents storm infrastructure



A dashed black line represents urban growth boundary



Stormwater Master Plan

City of Molalla
May 19, 2026



Growing Possibilities.

AGENDA



STORMWATER MASTER PLAN



- Goals and Objectives
- Plan (SWMP) Need
- Planning Process
- System Evaluation
- Problem Areas
- Capital Improvement Plan
- Project Status/Next Steps

Growing Possibilities.



GOALS AND OBJECTIVES



STORMWATER MASTER PLAN

- Share status of SWMP
- Provide transparency
- Receive feedback/input
- Integrate feedback/input



PLAN (SWMP) NEED



STORMWATER MASTER PLAN



- City growth
- Private development pressure
- Asset management
- Plan for future
- Funding
- Increasing regulatory requirements

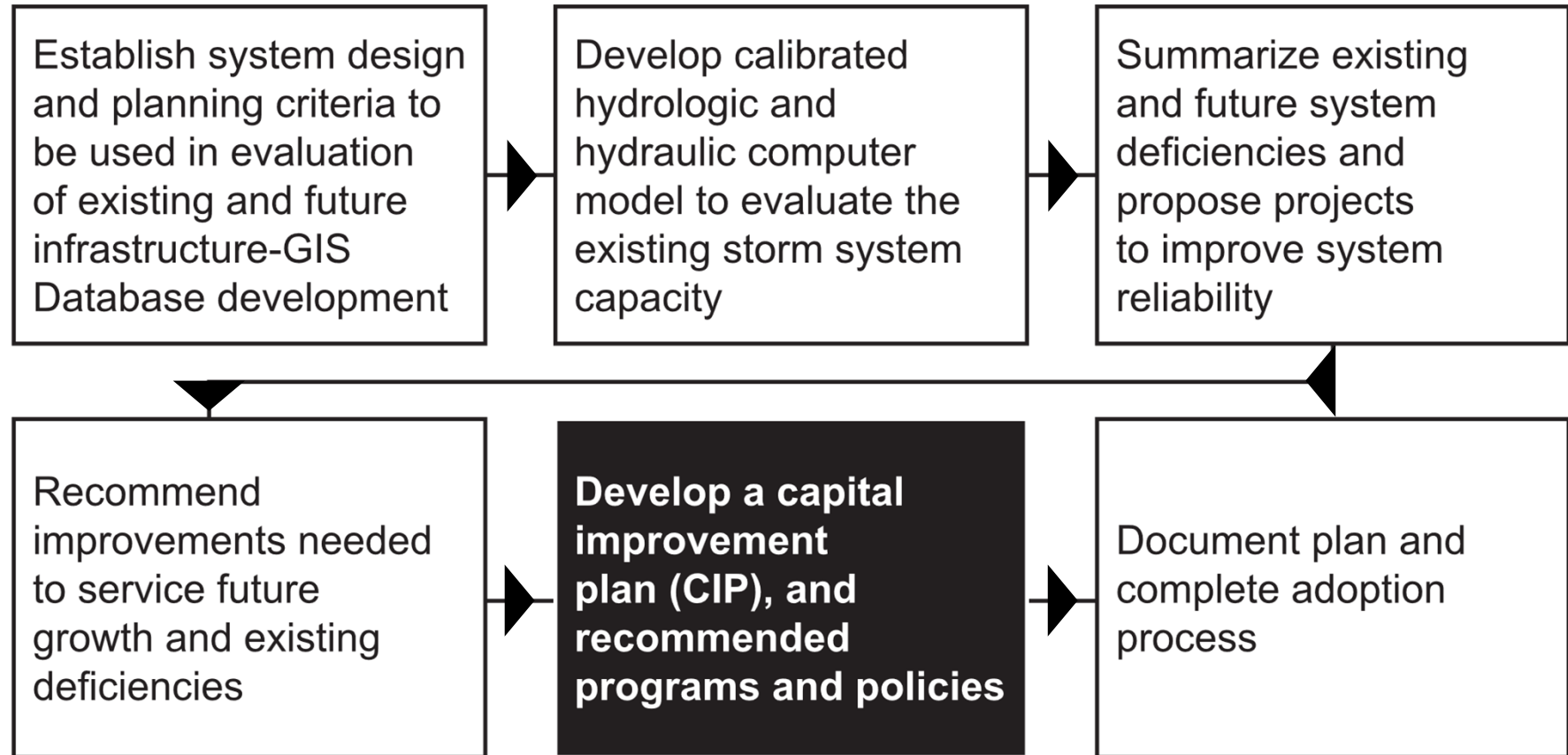
Growing Possibilities.



PLANNING PROCESS



STORMWATER MASTER PLAN



WE ARE HERE

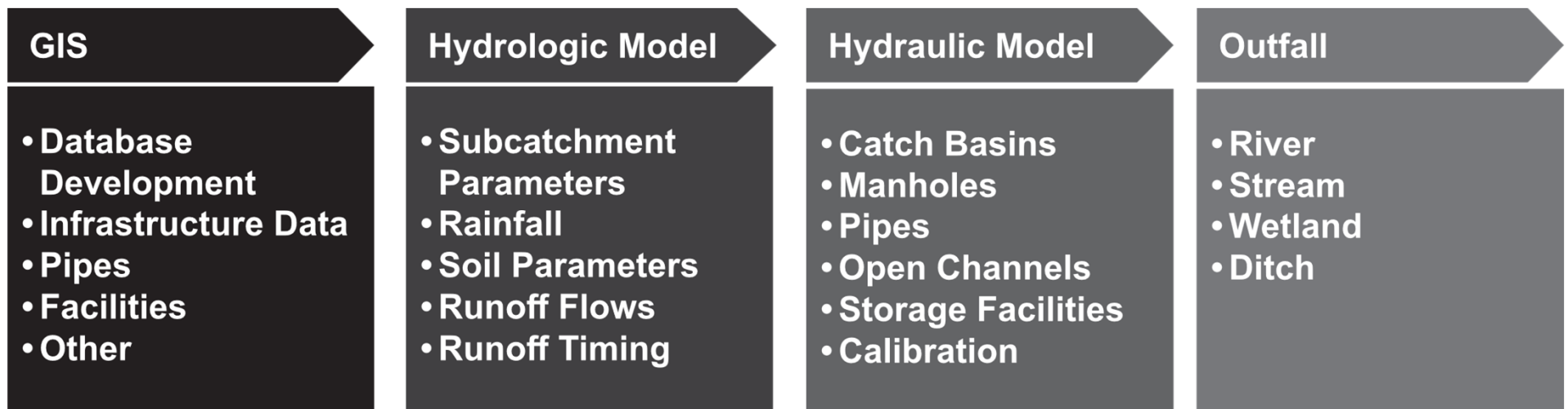
Growing Possibilities.



SYSTEM EVALUATION



STORMWATER MASTER PLAN



Growing Possibilities.



PROBLEM AREAS



STORMWATER MASTER PLAN



SUMMARY OF CHALLENGES

- Old pipes/infrastructure
- Undersized infrastructure
- Underserved areas
- Limited flow control
- Limited water quality treatment
- Continued growth
- Limited resources

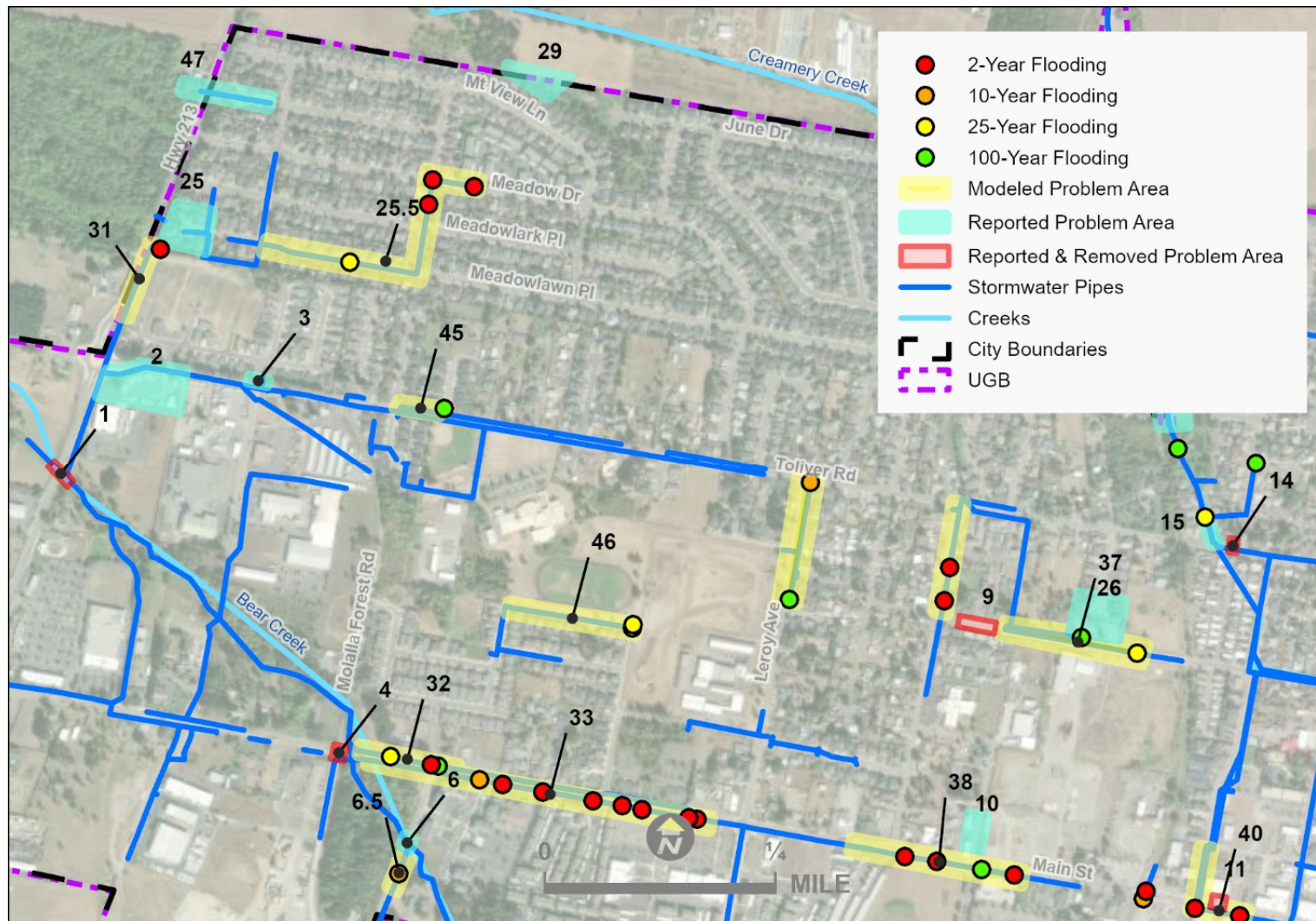
Growing Possibilities. _____



PROBLEM AREAS - NW



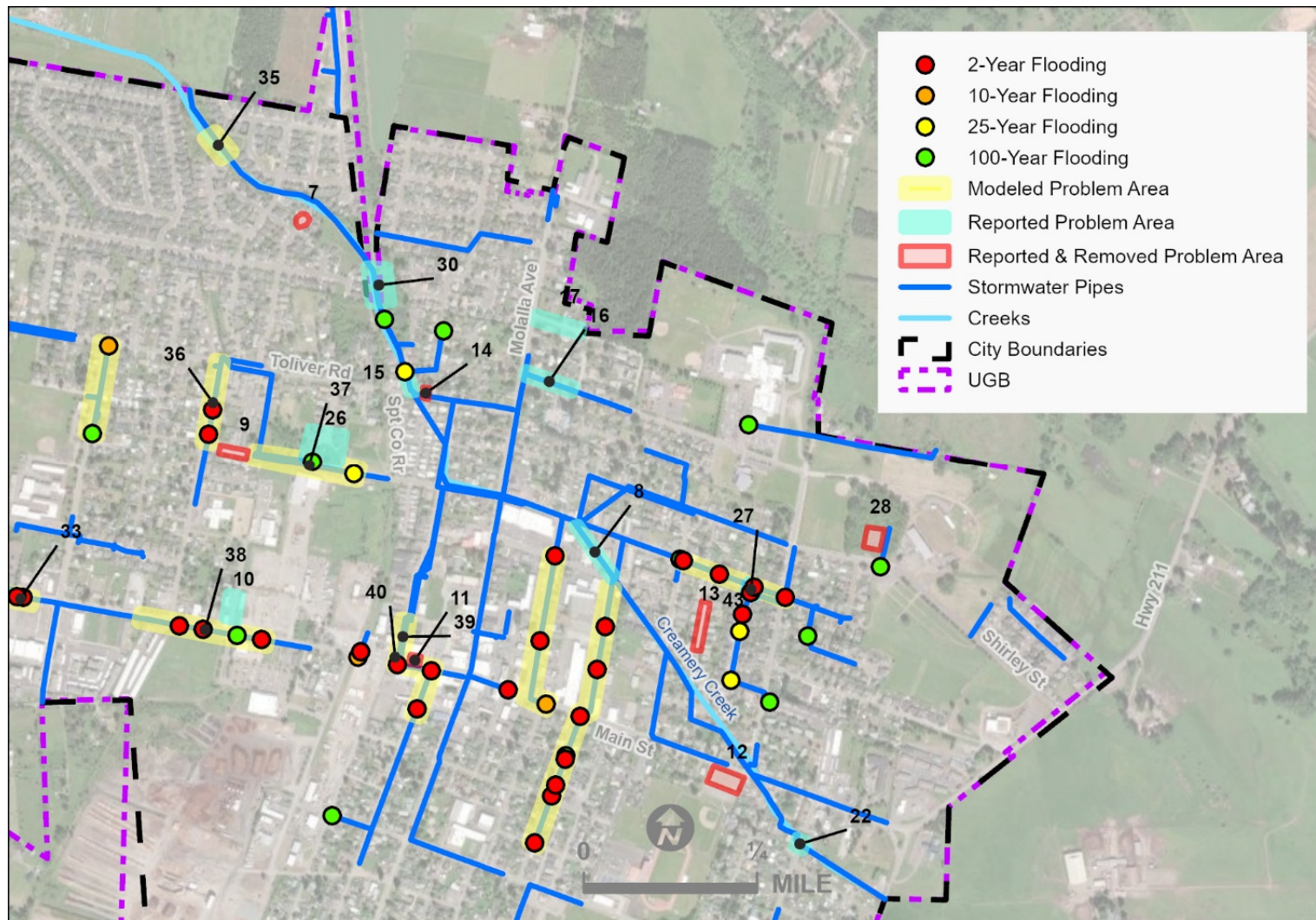
STORMWATER MASTER PLAN



PROBLEM AREAS - NE



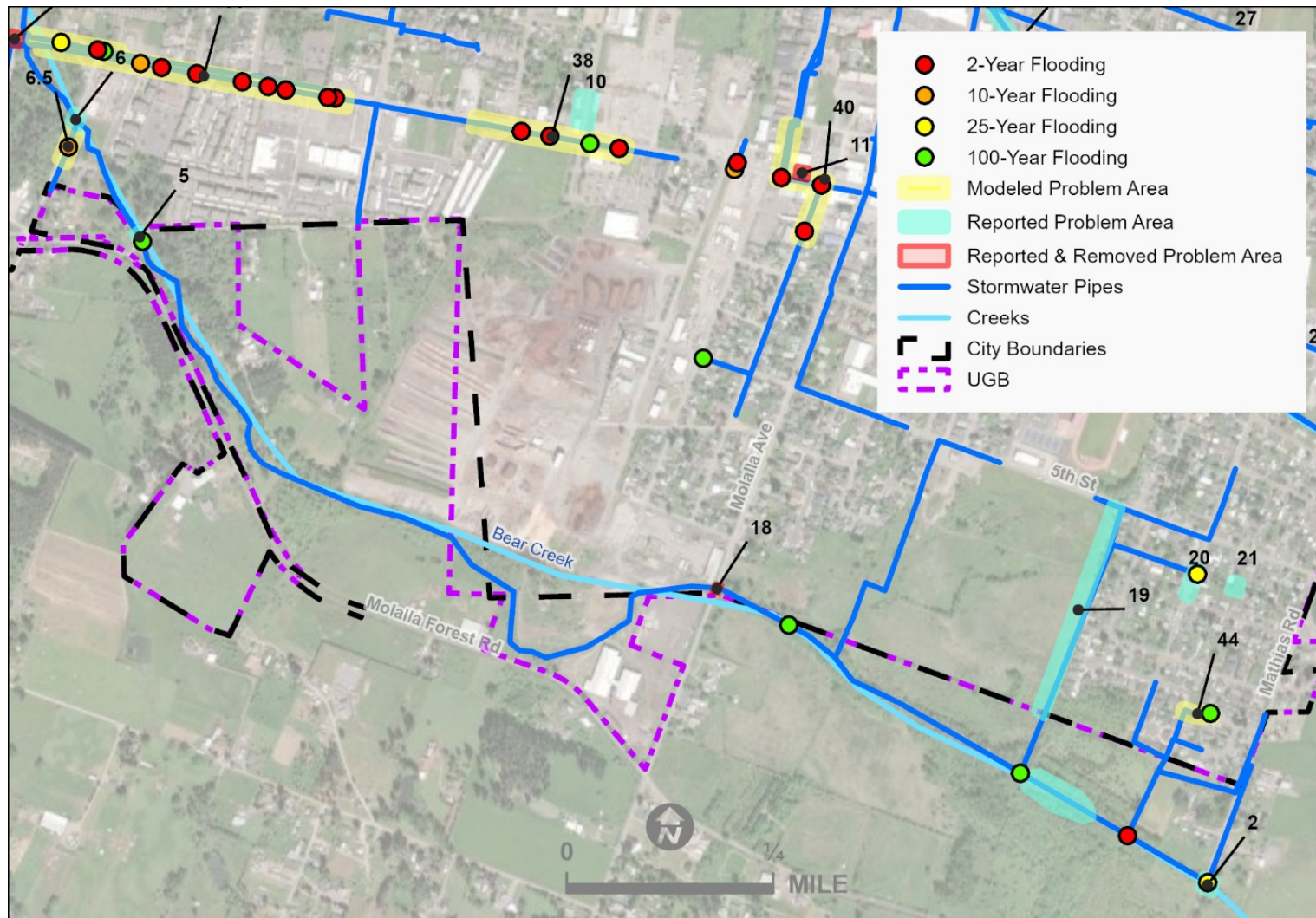
STORMWATER MASTER PLAN



PROBLEM AREAS - SOUTH



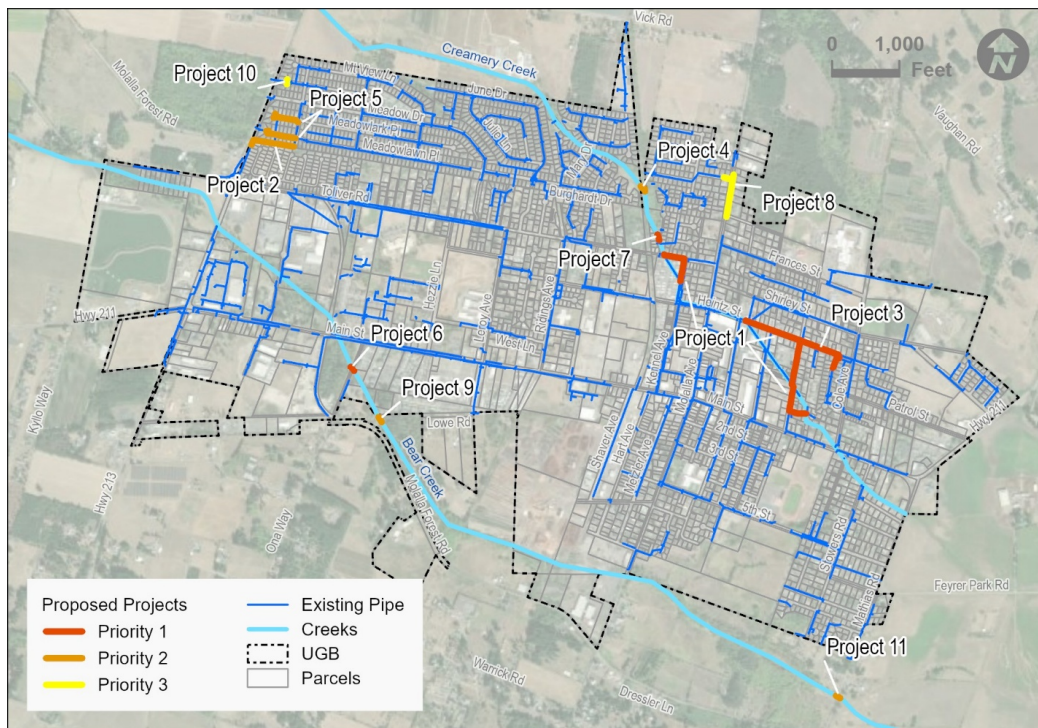
STORMWATER MASTER PLAN



CAPITAL IMPROVEMENT PROJECTS



STORMWATER MASTER PLAN



- P1 – Creamery Creek
- P2 – McLeod's Ditch
- P3 – Finney's Ave/Heitz Street
- P4 – Creamery Creek RR
- P5 – Meadowlark/Meadowlawn
- P6 – Ona Way at Bear Creek
- P7 – Creamy Creek Lane
- P8 – N Molalla Ave
- P9 – Lowe Road at Bear Creek
- P10 – Homestead Place
- P11 – Mathias Road at Bear Creek

Growing Possibilities.



CAPITAL IMPROVEMENT PLAN



STORMWATER MASTER PLAN



PROGRAMS

- Manhole/Catch Basin Cleaning
- CCTV and Pipe Cleaning
- Street Sweeping
- Facility Maintenance
- Repair and Replacement

Growing Possibilities.



PROJECT STATUS/NEXT STEPS



STORMWATER MASTER PLAN



- We want your input
- Project/program refinement
- Project fact sheets
- Council and planning Commission meetings
- Final reporting

Growing Possibilities.



QUESTIONS?

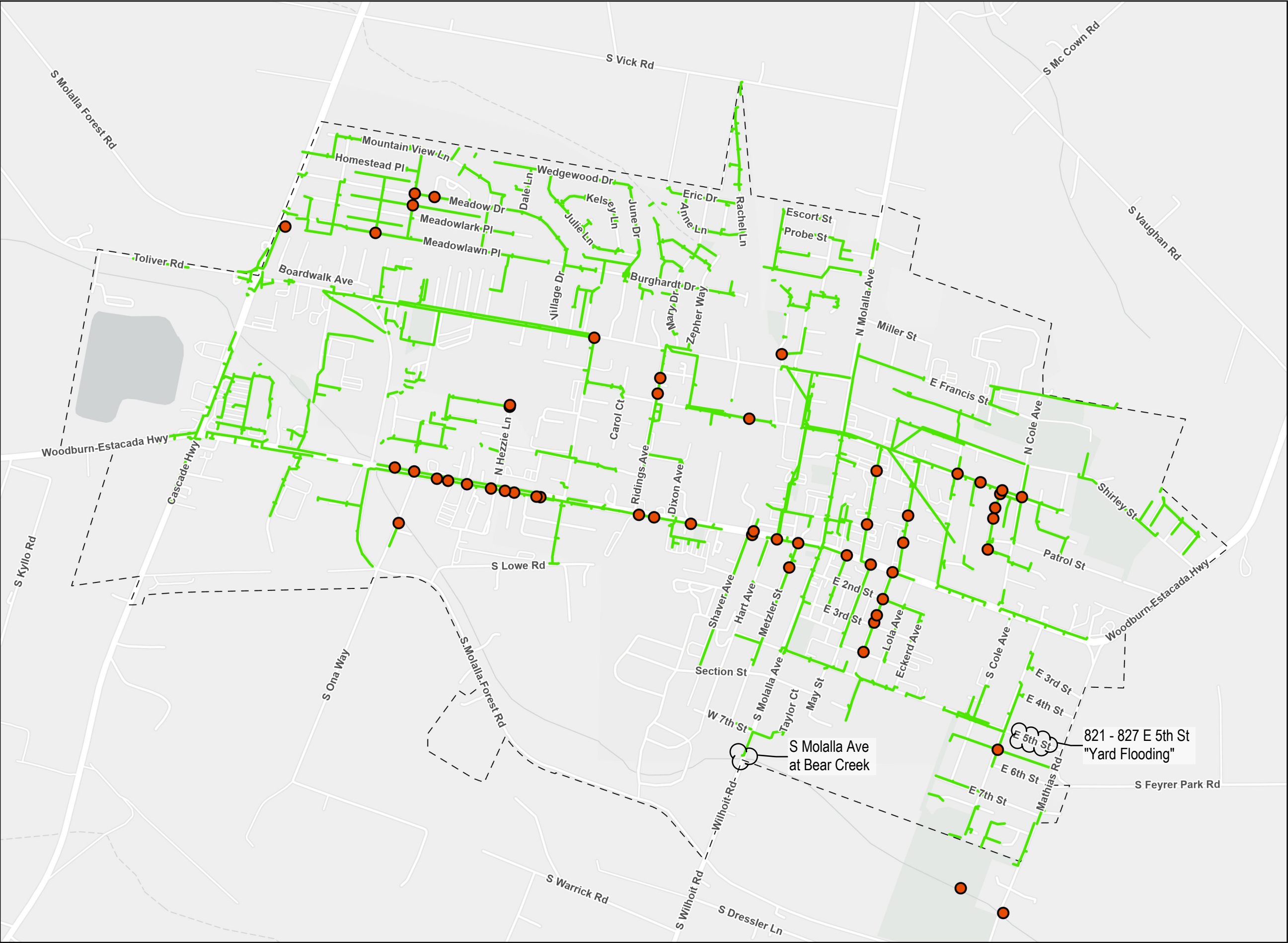
STORMWATER MASTER PLAN



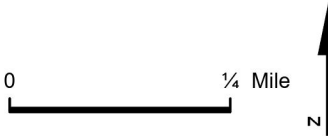
Growing Possibilities.



Open House Comments
Stormwater Master Plan
Molalla, OR



- Modeled Flooding at Manholes or Catch Basins
- Stormwater Pipes
- - - UGB





Stormwater Master Plan Summary

City of Molalla
June 15, 2026



Growing Possibilities.

AGENDA



STORMWATER MASTER PLAN



- Goals and Objectives
- Plan (SWMP) Need
- Planning Process
- System Evaluation
- Problem Areas
- Capital Improvement Plan
- Project Status/Next Steps

Growing Possibilities.



GOALS AND OBJECTIVES



STORMWATER MASTER PLAN

- Share status of SWMP
- Provide transparency
- Receive feedback/input
- Integrate feedback/input



PLAN (SWMP) NEED



STORMWATER MASTER PLAN



- City growth
- Private development pressure
- Asset management
- Plan for future
- Funding
- Increasing regulatory requirements

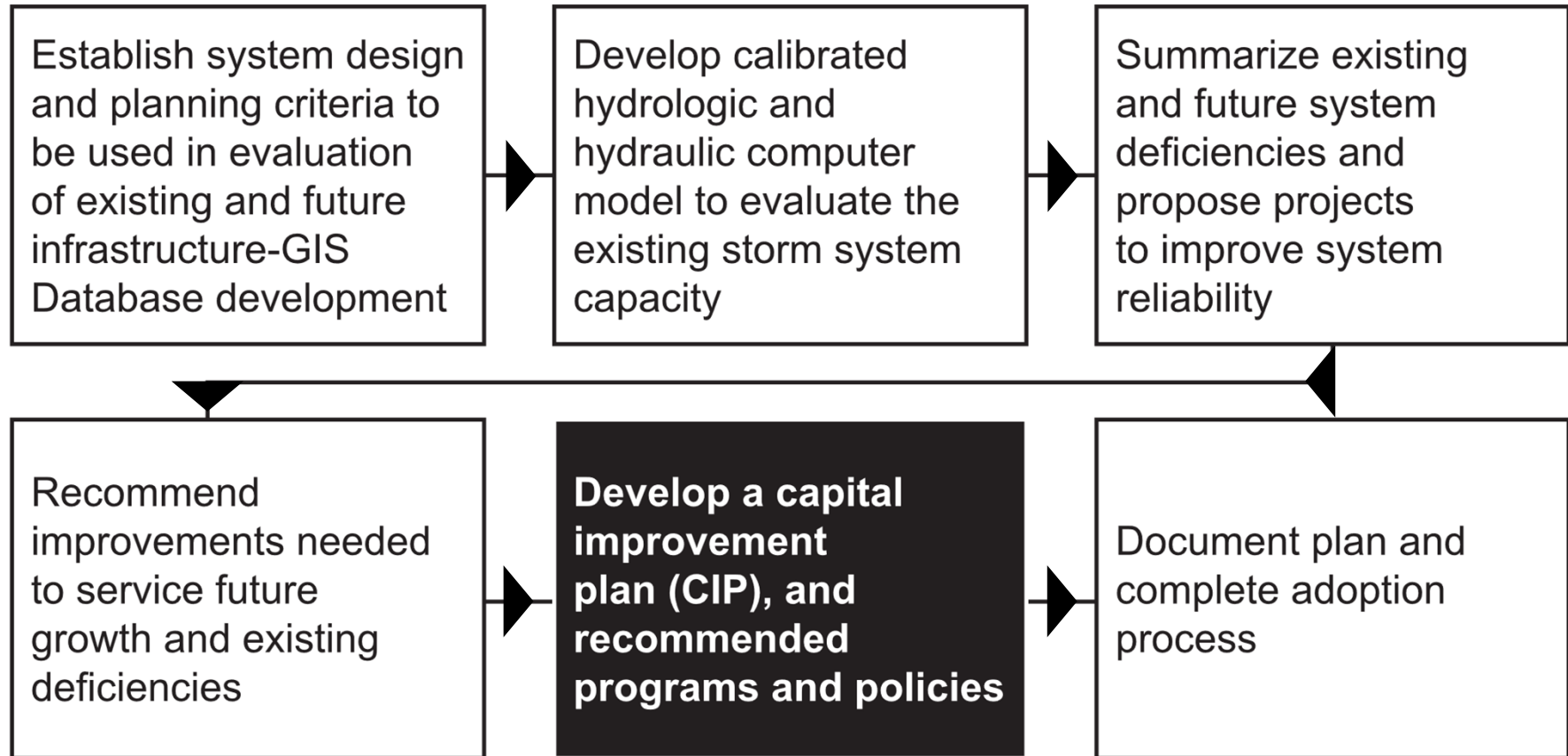
Growing Possibilities.



PLANNING PROCESS



STORMWATER MASTER PLAN



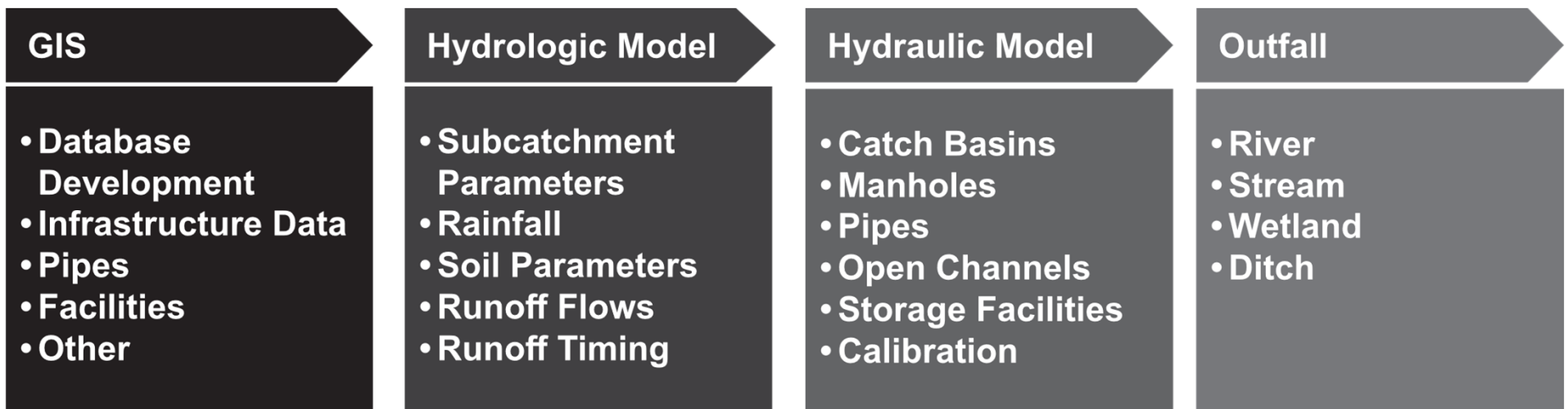
WE ARE HERE



SYSTEM EVALUATION



STORMWATER MASTER PLAN



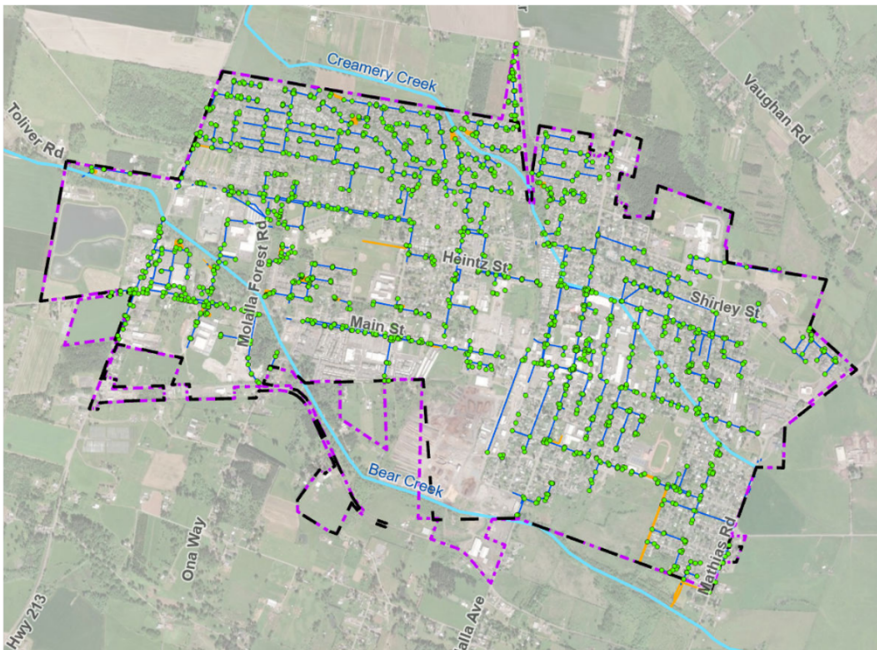
Growing Possibilities.



MODELING



STORMWATER MASTER PLAN



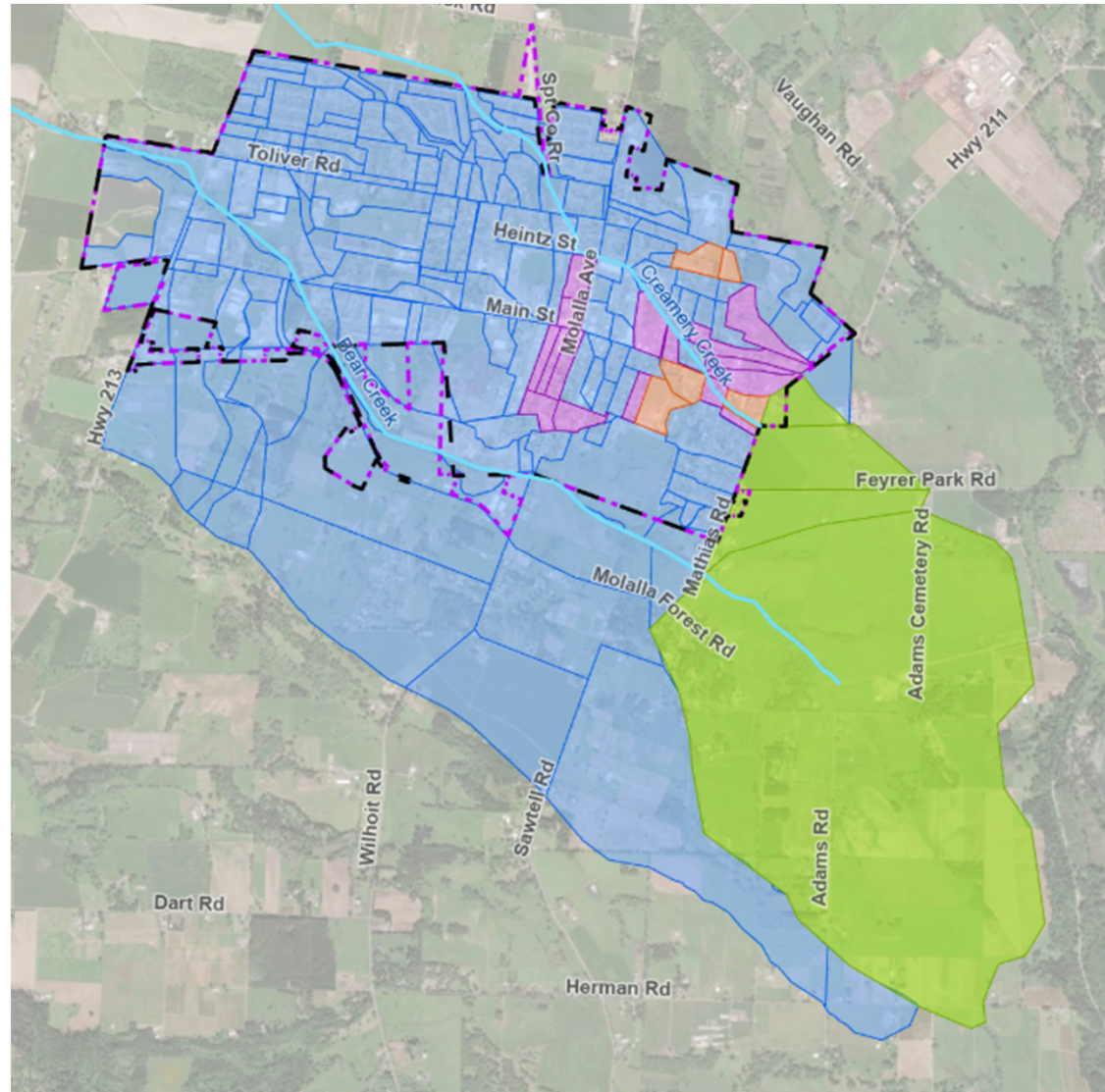
MODELING METHODS

- PCSWMM
- EPA SWMM Runoff Method
- Pipe < 12" not modeled
- Creeks modeled for conveyance
- Facilities not modeled
- Flow monitoring/Calibration

MODELING



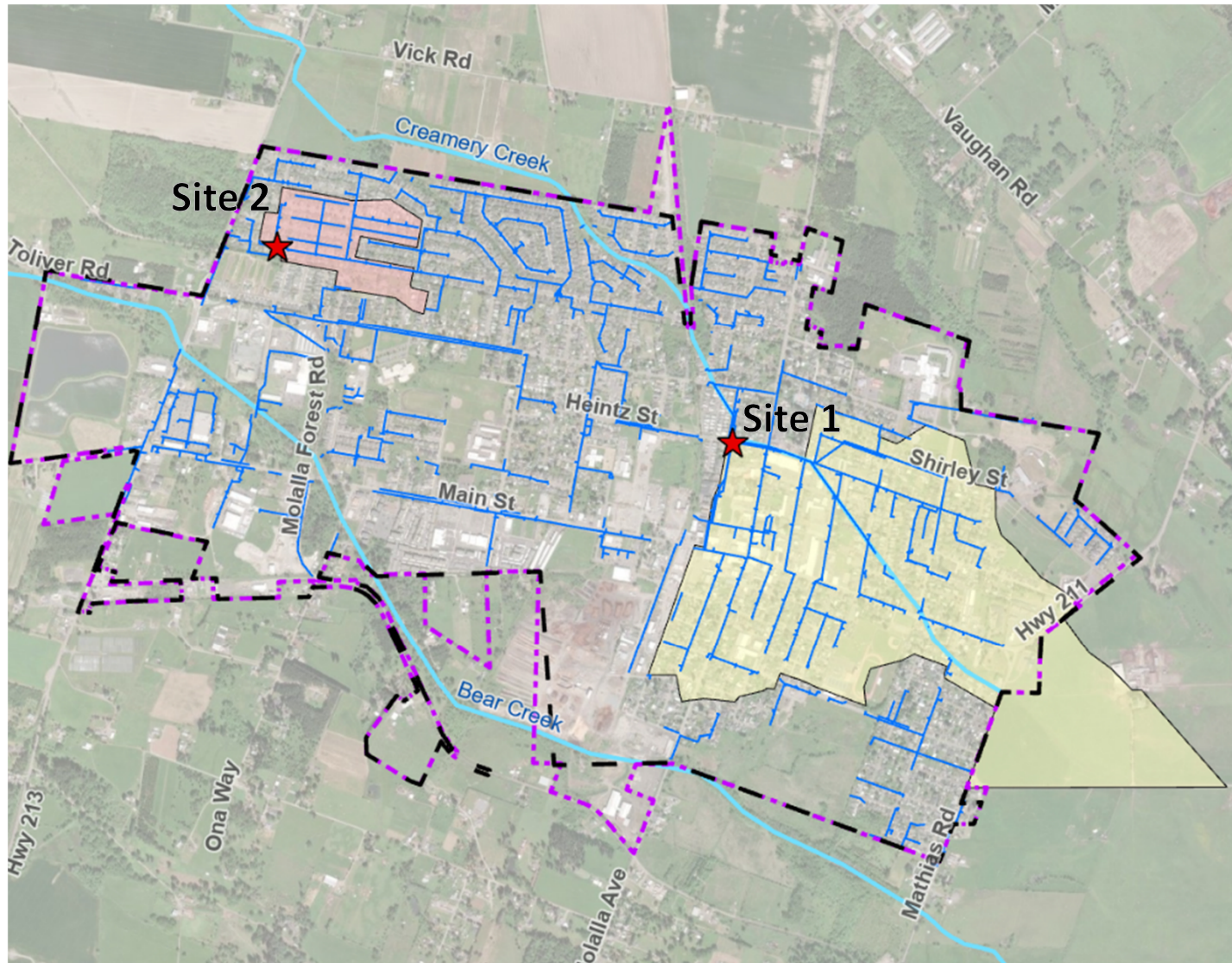
STORMWATER MASTER PLAN



MODELING (flow monitoring)



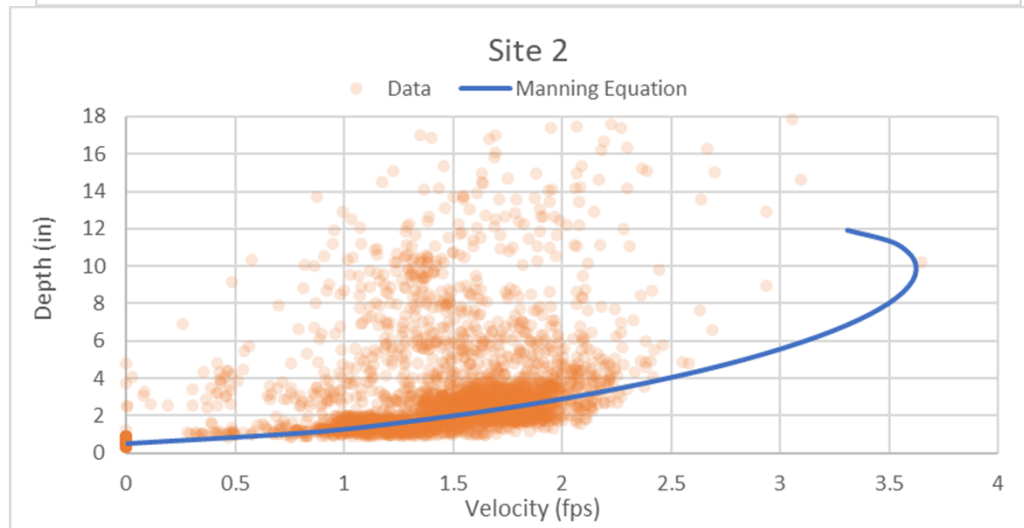
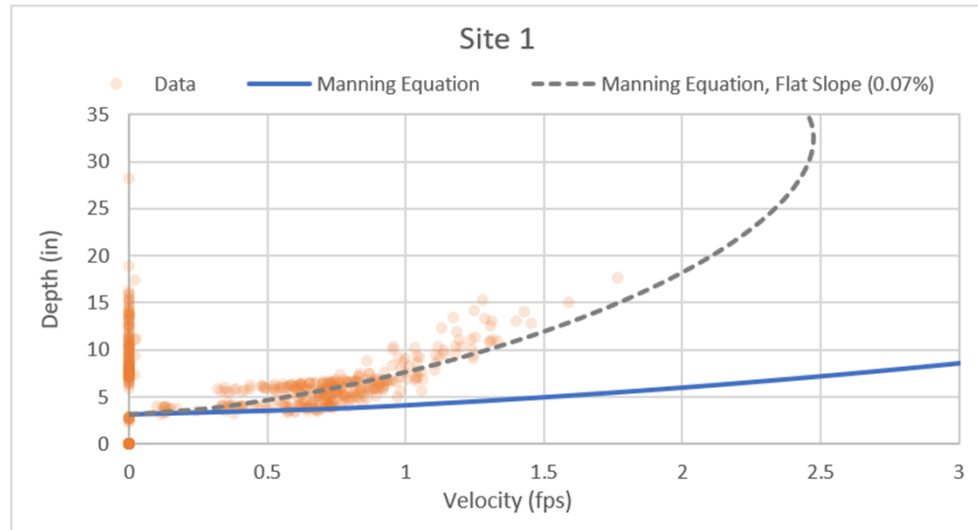
STORMWATER MASTER PLAN



MODELING (flow monitoring)



STORMWATER MASTER PLAN



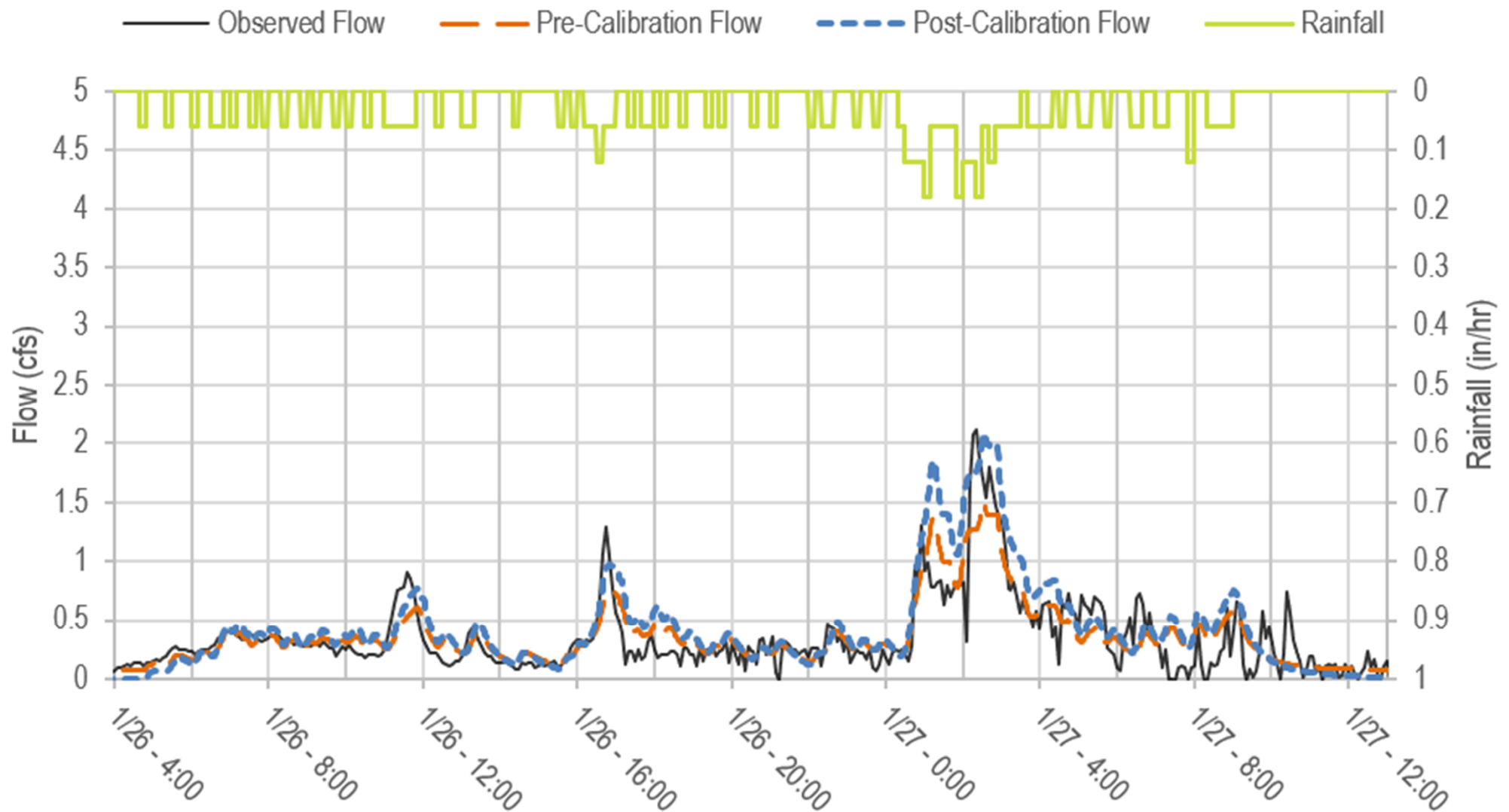
Growing Possibilities.



MODELING (calibration)



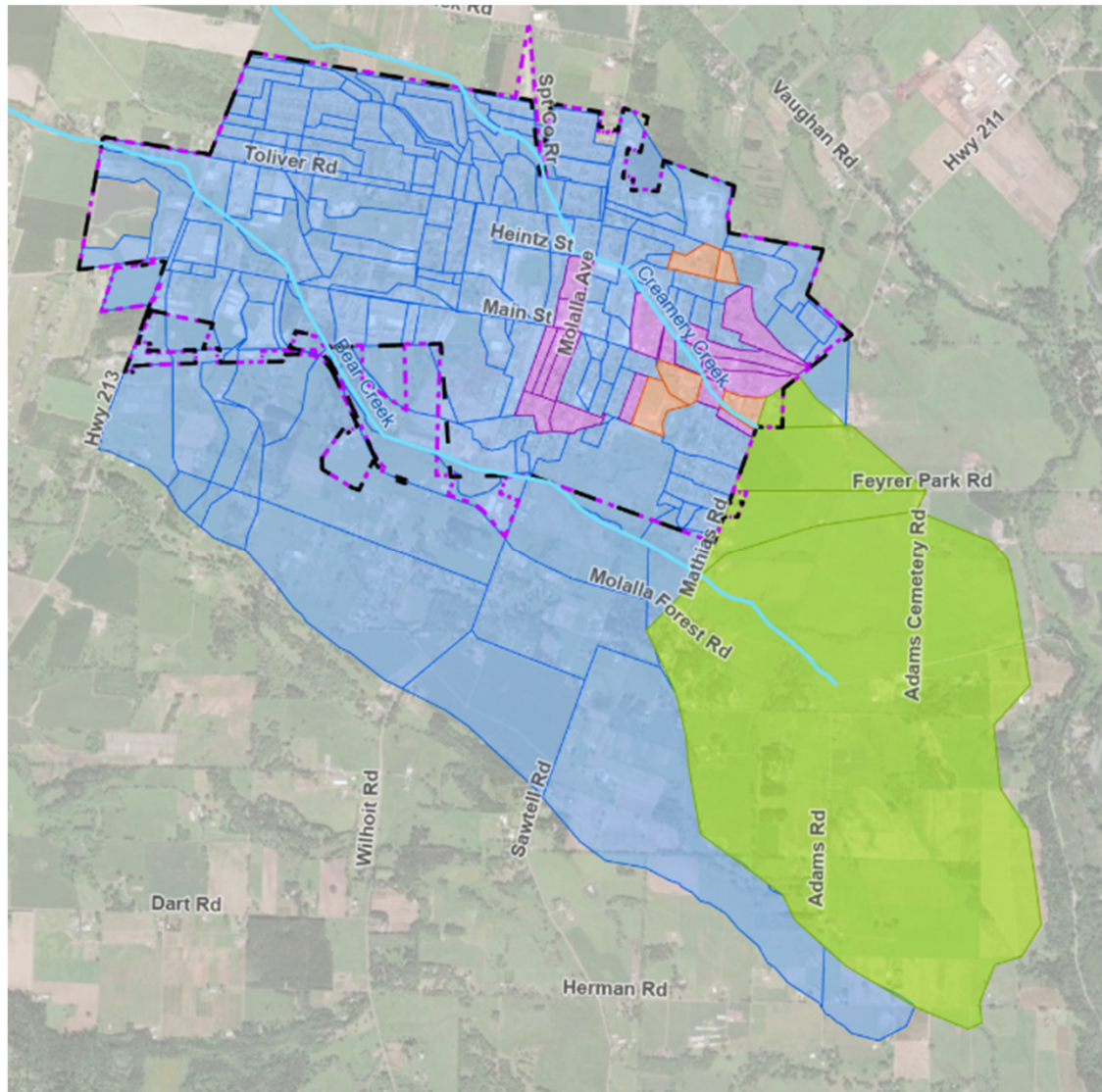
STORMWATER MASTER PLAN



MODELING (calibration)



STORMWATER MASTER PLAN



- 24% Routed
- 37% Routed
- 50% Routed
- 100% Routed

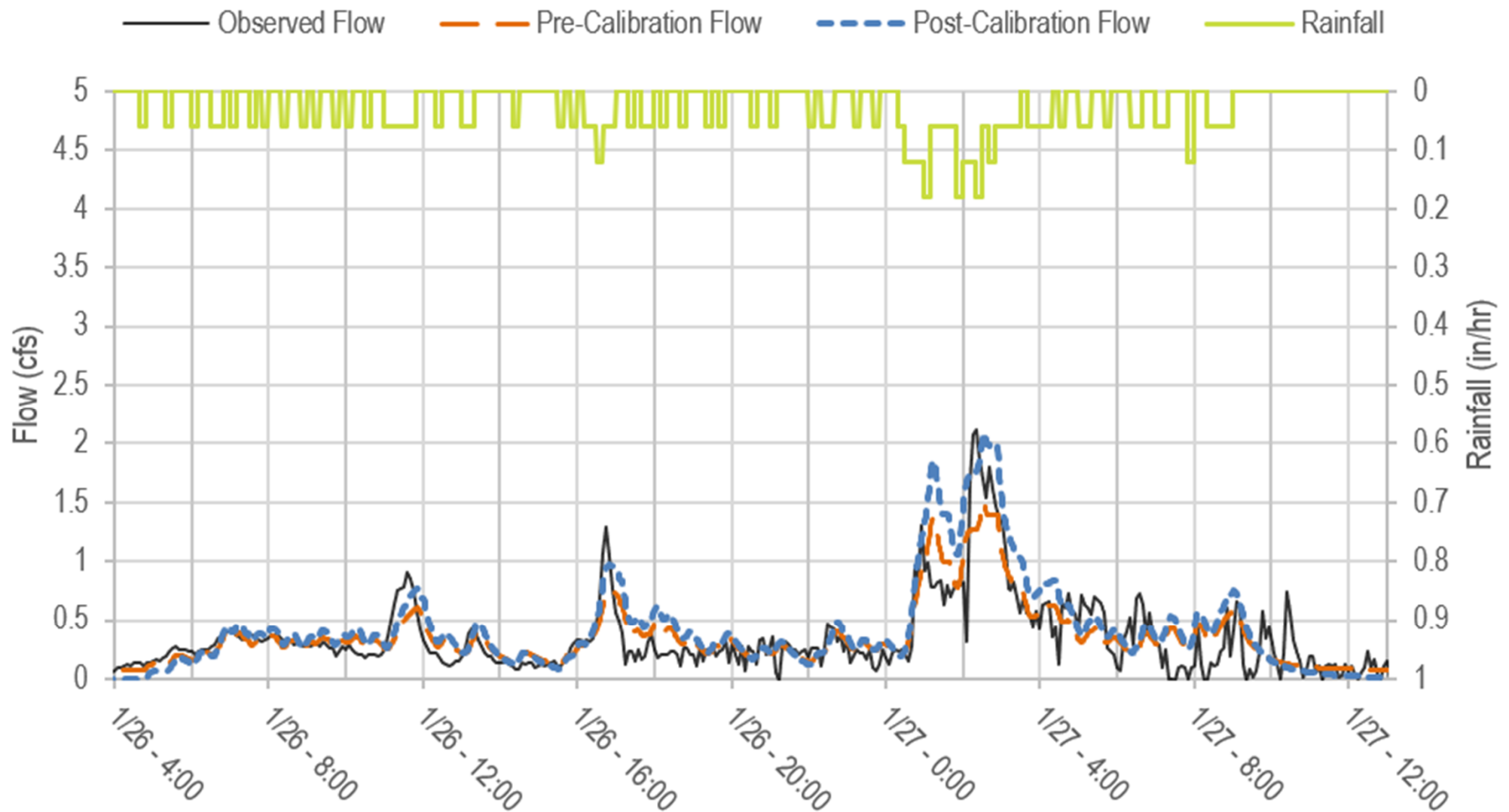
- Creeks
- City Boundaries
- UGB



MODELING (calibration)



STORMWATER MASTER PLAN



PROBLEM AREAS



STORMWATER MASTER PLAN



SUMMARY OF CHALLENGES

- Old pipes/infrastructure
- Undersized infrastructure
- Underserved areas
- Limited flow control
- Limited water quality treatment
- Continued growth
- Limited resources

Growing Possibilities. _____



PROBLEM AREAS



STORMWATER MASTER PLAN



SUMMARY OF SOURCES

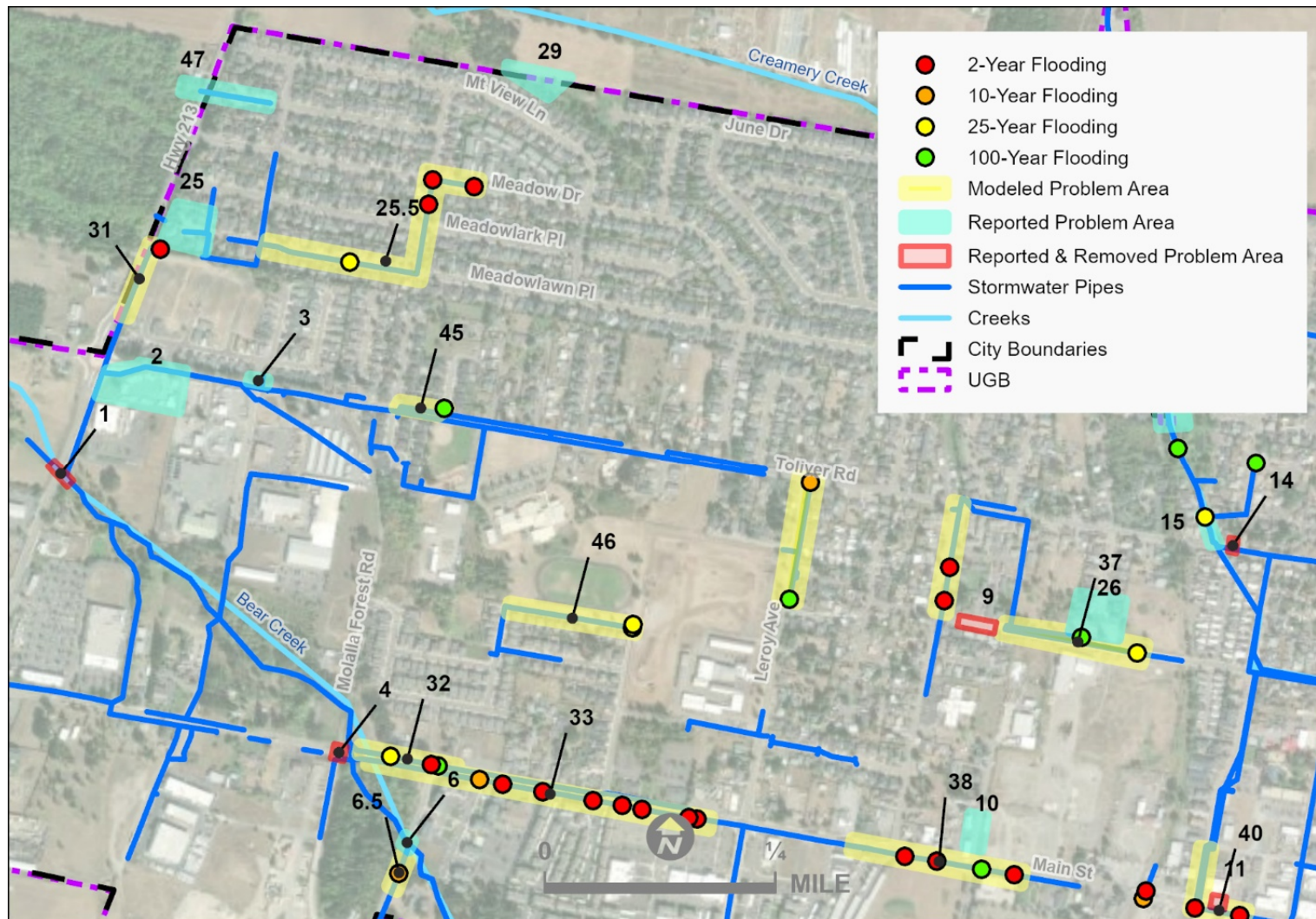
- Previous Master Plans
- Operations Staff
- Engineering Staff
- Site Visit Observations
- Modeling Results



PROBLEM AREAS - NW



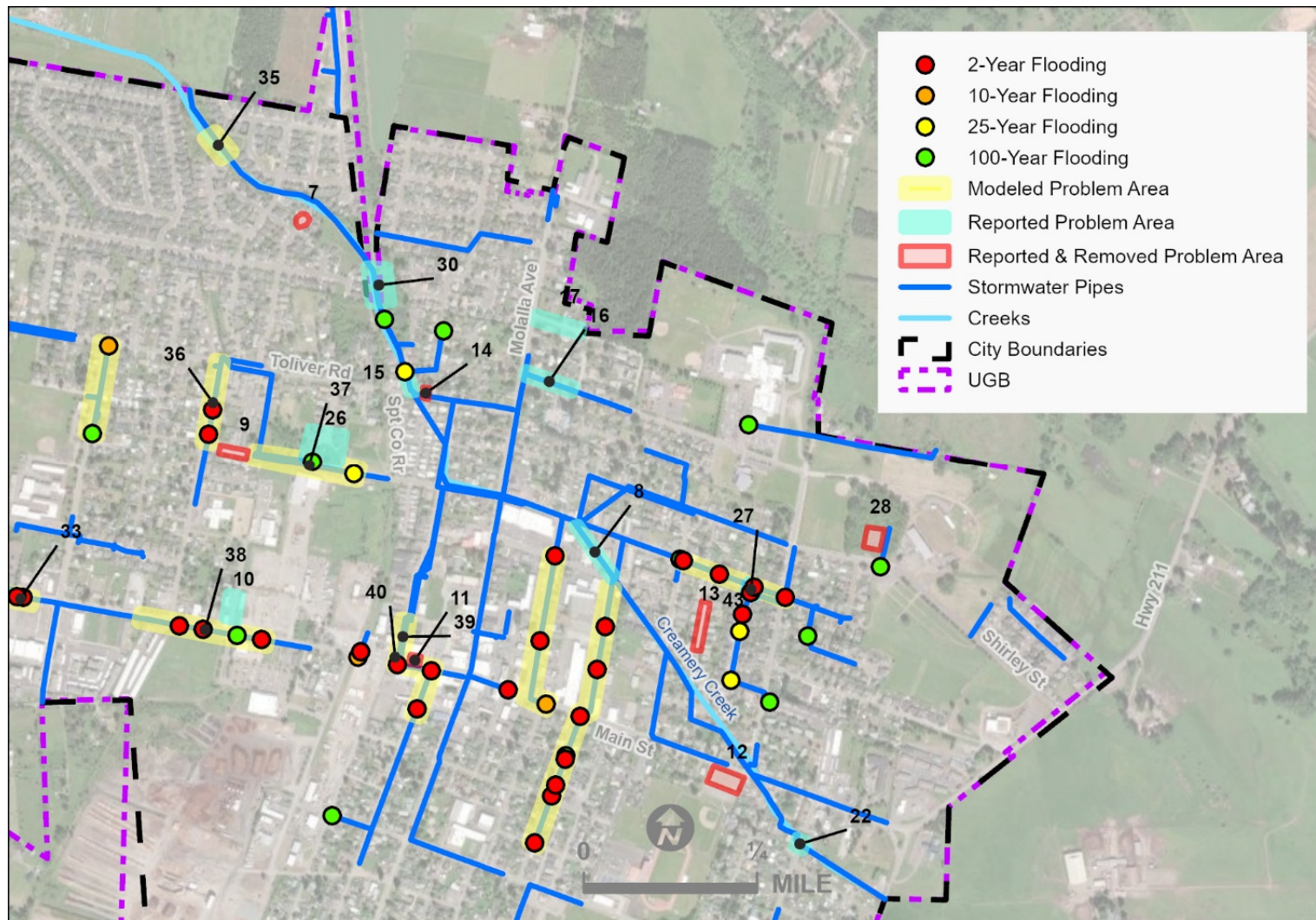
STORMWATER MASTER PLAN



PROBLEM AREAS - NE



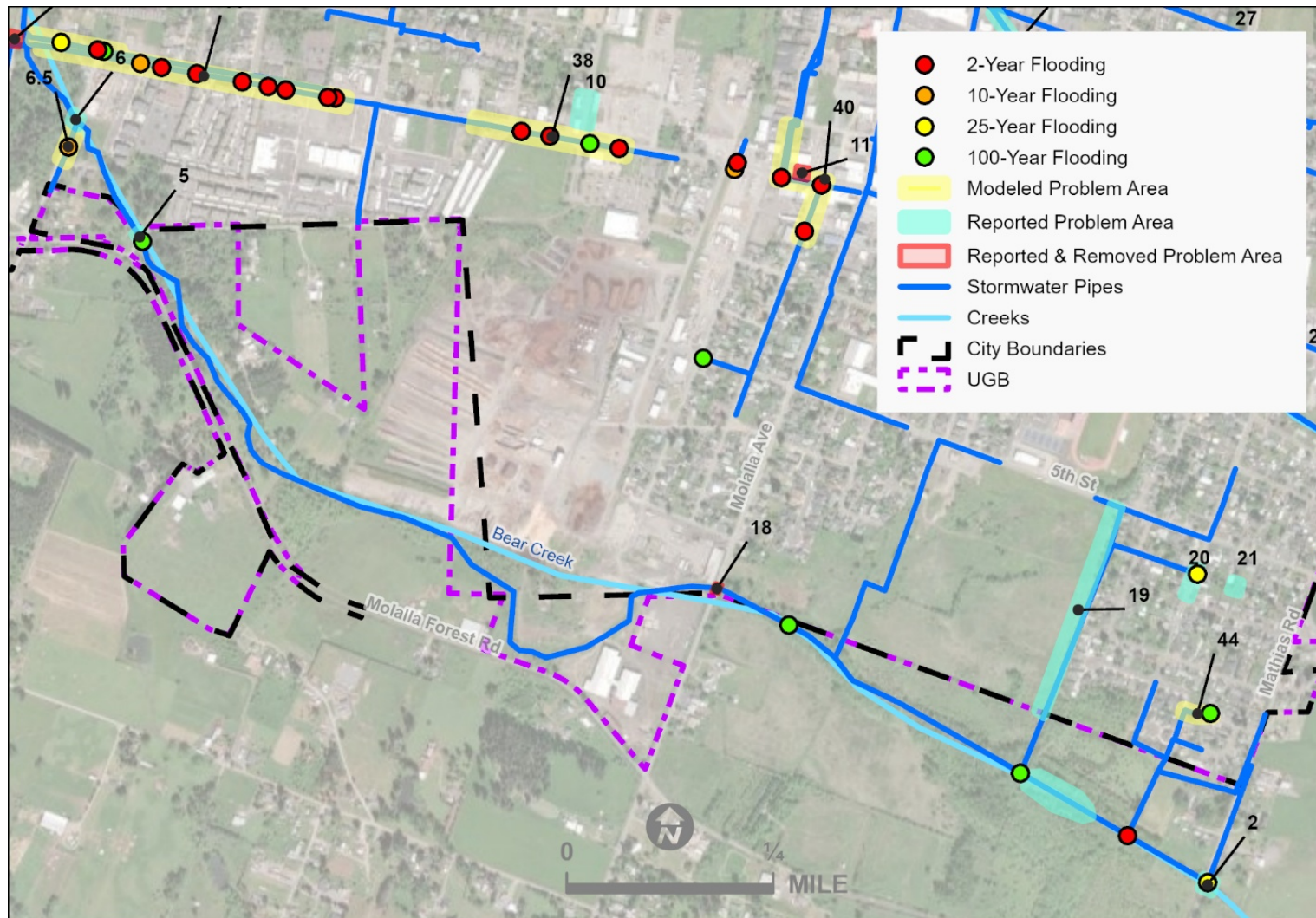
STORMWATER MASTER PLAN



PROBLEM AREAS - SOUTH



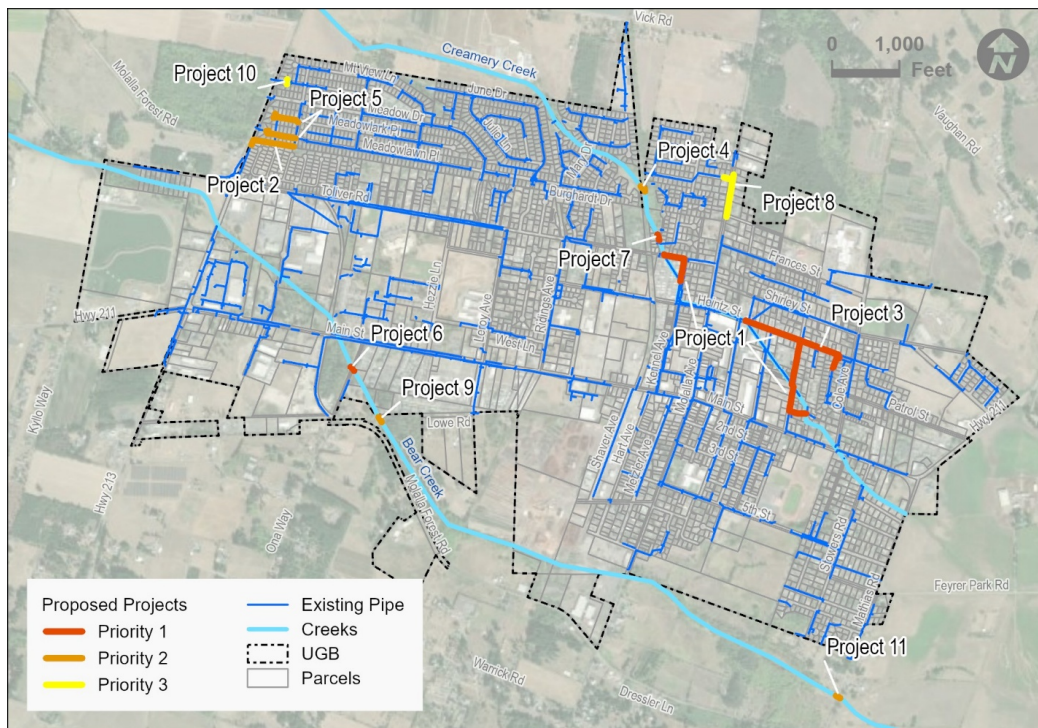
STORMWATER MASTER PLAN



CAPITAL IMPROVEMENT PROJECTS



STORMWATER MASTER PLAN



- P1 – Creamery Creek
- P2 – McLeod's Ditch
- P3 – Finney's Ave/Heitz Street
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- P7 – Creamy Creek Lane
- P8 – N Molalla Ave
- P9 – Lowe Road at Bear Creek
- P10 – Homestead Place
- P11 – Mathias Road at Bear Creek

(Transition to project fact sheets as needed)

Growing Possibilities.



CAPITAL IMPROVEMENT PLAN



STORMWATER MASTER PLAN



PROGRAMS

- Manhole/Catch Basin Cleaning
- CCTV and Pipe Cleaning
- Street Sweeping
- Facility Maintenance
- Repair and Replacement



PROJECT STATUS/NEXT STEPS



STORMWATER MASTER PLAN



- We want your input
- Project/program refinement
- Project fact sheets
- Council and planning Commission meetings
- Final reporting

Growing Possibilities.



QUESTIONS?

STORMWATER MASTER PLAN



Growing Possibilities. _____



APPENDIX B

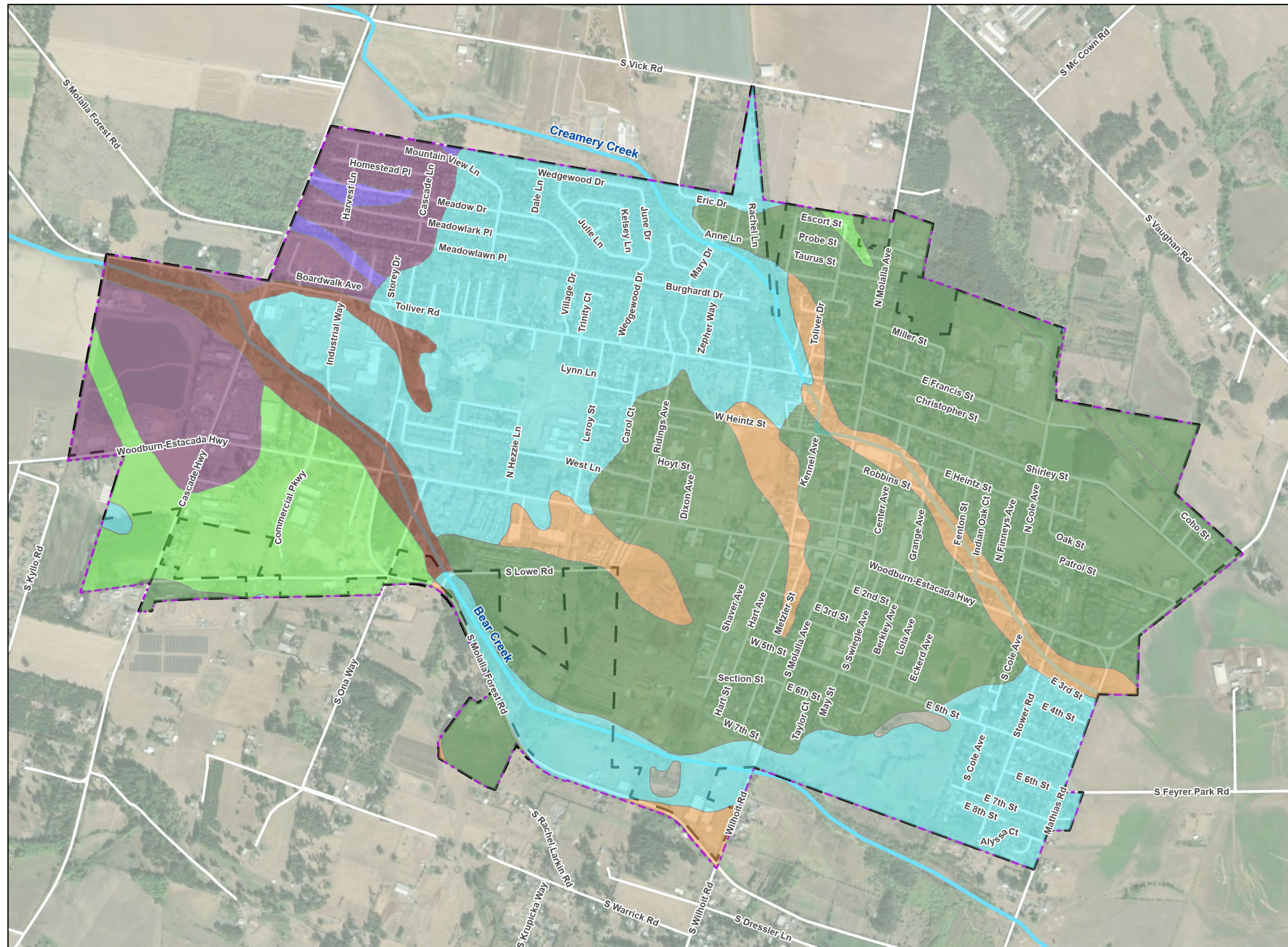
Figures



FIGURE 4

Soils

Stormwater Master Plan
Molalla, OR



-  Aloha silt loam
-  Amity silt loam
-  Clackamas silt loam
-  Dayton silt loam
-  Huberly silt loam
-  Sawtell silt loam
-  Wapato silty clay loam
-  Creeks
-  City Limits
-  UGB

0 1,000 Feet





FIGURE 8
Willamette River Subbasins
Stormwater Master Plan
Molalla, OR

- Willamette River
- Willamette River Subbasins
- Molalla UGB

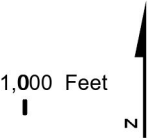
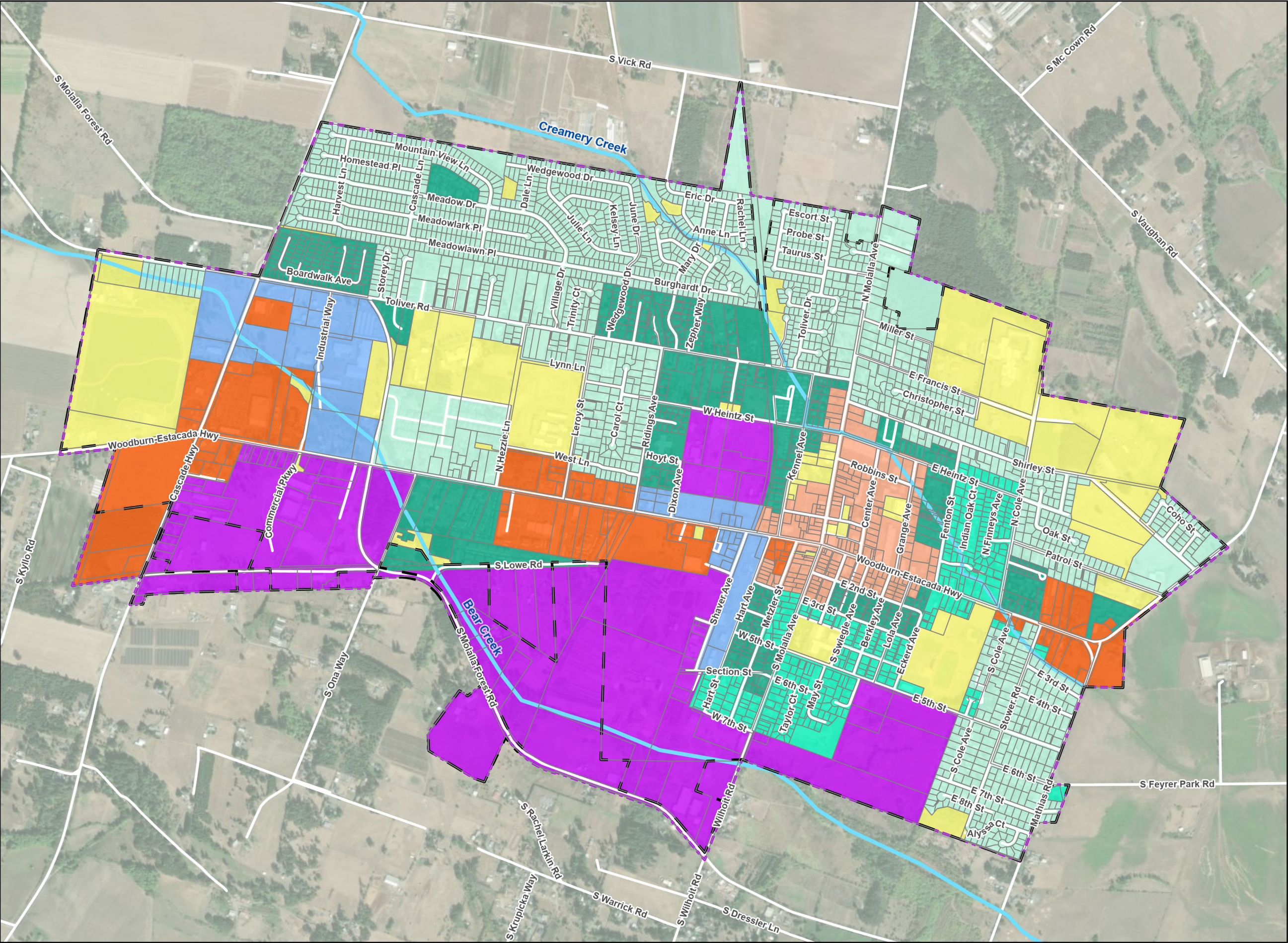


FIGURE 9
Zoning Districts
 Stormwater Master Plan
 Molalla, OR



- Parcels
- City Limits
- UGB
- Creeks
- Central Commercial (C-1)
- General Commercial (C-2)
- Light Industrial (M-1)
- Heavy Industrial (M-2)
- Public and Semi Public (PSP)
- Low Density Residential (R-1)
- Medium Density Residential (R-2)
- Medium-High Density Residential (R-3)

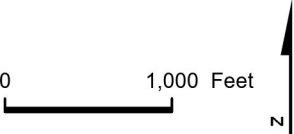
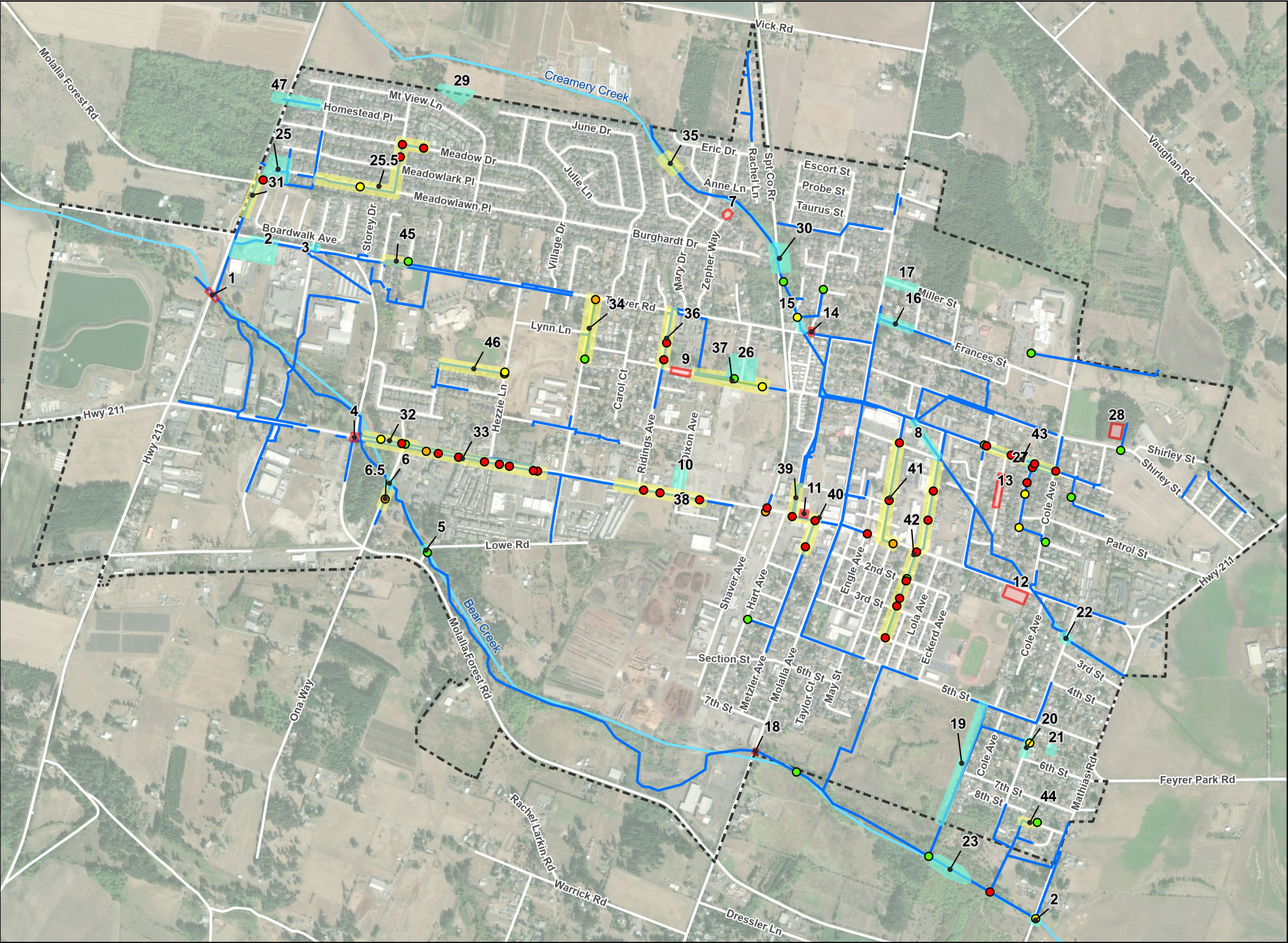
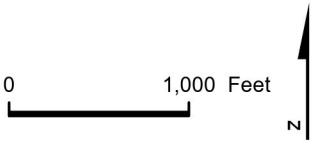


FIGURE 10
Modeled Flooding
Stormwater Master Plan
Molalla, OR



- 2-Year Flooding
- 10-Year Flooding
- 25-Year Flooding
- 100-Year Flooding
- Modeled Problem Area
- Reported Problem Area
- Reported & Removed Problem Area
- Stormwater Pipes
- Creeks
- - - UGB



APPENDIX C

Subcatchment Model Inputs



Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122



Model Subcatchment Inputs

Appendix C

Basin Name	Modeled?	Outlet	Area (ac)	Width (ft)	Slope (%)	Impervious (%)	Manning N (Imp)	Manning N (Per)	Dstore (Imp, in.)	Dstore (Per, in.)	Zero Imp (%)	Routing Method	% Routed
B-0	Yes	J-0135	12.2	770	2.1	82.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-1	Yes	J-0135	2.0	96	1.8	86.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-2	Yes	CB-158	1.7	197	1.4	54.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-3	Yes	O-35	2.0	236	1.9	32.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-4	Yes	B-4_OF	10.8	473	1.2	66.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-5	Yes	J-0004	4.1	305	0.9	89.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-6	Yes	O-50	7.2	737	2.2	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-7	Yes	CB-262	3.5	264	0.9	90.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-8	Yes	CB-268	3.5	288	1.5	70.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-9	Yes	B-9_OF	3.1	178	1.2	5.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-10	Yes	B-10_OF	8.0	411	1.5	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-11	Yes	B-11_OF	3.4	383	1.8	67.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-12	Yes	B-12_OF	23.4	480	0.8	38.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-13	Yes	MH-53	1.6	233	0.8	58.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-14	Yes	CB-288	2.0	161	0.7	64.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-15	Yes	J-0020	3.4	154	0.8	63.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-16	Yes	B-12_OF	26.0	544	1.0	23.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-17	Yes	MH-416	10.5	297	1.3	61.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-18	Yes	J-0144	20.1	411	0.9	46.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-19	Yes	J-0071	13.8	558	1.5	79.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-20	Yes	B-105	1.4	402	0.9	77.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-21	Yes	J-0063	8.3	162	0.9	62.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-22	Yes	CB-216	5.6	270	1.0	57.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-23	Yes	OF-03	8.9	453	1.2	43.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-24	Yes	CB-213	5.8	413	0.8	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-25	Yes	CB-217	2.5	189	1.4	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-26	Yes	J-0050	13.2	910	4.0	18.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-27	Yes	CB-137	9.7	418	1.6	79.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-28	Yes	J-0003	16.4	441	1.1	87.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-29	Yes	B-106	6.1	337	1.0	59.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-30	Yes	B-155	3.3	239	1.3	69.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-31	Yes	B-155	5.8	499	1.2	69.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-32	Yes	J-0044	4.2	452	1.7	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-33	Yes	CB-230	11.4	429	0.6	49.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-34	Yes	CB-236	0.7	148	1.0	46.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-35	Yes	B-35_OF	15.6	476	1.1	72.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-36	Yes	CB-227	17.8	514	1.2	69.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-37	Yes	CB-209	24.9	1135	1.1	36.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-38	Yes	MH-278	21.0	744	1.0	59.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-39	Yes	J-0034	6.6	676	1.9	78.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-40	Yes	MH-197	19.4	746	1.6	64.4	0.015	0.030	0.076	0.3	50	Pervious	24.2

Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122



Model Subcatchment Inputs

Appendix C

Basin Name	Modeled?	Outlet	Area (ac)	Width (ft)	Slope (%)	Impervious (%)	Manning N (Imp)	Manning N (Per)	Dstore (Imp, in.)	Dstore (Per, in.)	Zero Imp (%)	Routing Method	% Routed
B-41	Yes	J-0117	9.4	413	2.2	59.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-42	Yes	CB-51	10.0	619	3.3	38.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-43	Yes	J-0022	8.3	564	2.2	58.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-44	Yes	MH-6	7.8	489	0.9	61.0	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-45	Yes	MH-386	3.7	270	1.0	107.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-46	Yes	B-46_OF	7.9	224	0.6	79.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-47	Yes	MH-68	5.8	399	1.5	87.4	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-48	Yes	MH-166	3.7	259	2.4	31.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-49	Yes	J-0042	6.3	189	1.4	54.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-50	Yes	CB-37	7.4	556	2.6	49.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-51	Yes	MH-109	7.9	458	2.7	47.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-52	Yes	J-0035	7.5	443	2.7	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-53	Yes	MH-111	7.3	396	1.4	72.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-54	Yes	MH-80	8.9	393	2.3	36.8	0.015	0.030	0.076	0.3	50	Pervious	50.0
B-55	Yes	CB-21	3.9	460	3.6	28.8	0.015	0.030	0.076	0.3	50	Pervious	50.0
B-56	Yes	MH-348	4.2	338	1.9	64.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-57	Yes	MH-100	7.4	269	1.9	52.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-58	Yes	MH-100	3.3	293	3.4	58.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-59	Yes	CB-12	16.0	389	2.1	41.4	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-60	Yes	MH-87	12.4	308	2.1	66.7	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-61	Yes	MH-88	6.4	169	2.1	48.3	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-62	Yes	MH-387	4.4	361	1.1	65.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-63	Yes	MH-125	9.2	363	1.3	87.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-64	Yes	MH-391	7.0	404	1.5	96.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-65	Yes	MH-126	4.4	289	1.8	97.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-66	Yes	MH-73	11.9	437	1.6	59.8	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-67	Yes	J-0024	3.7	165	1.5	43.7	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-68	Yes	J-0059	5.4	427	2.8	38.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-69	Yes	CB-106	9.0	408	1.3	32.2	0.015	0.030	0.076	0.3	50	Pervious	50.0
B-70	Yes	CB-105	12.1	723	1.0	42.6	0.015	0.030	0.076	0.3	50	Pervious	50.0
B-71	Yes	J-0057	4.6	497	2.1	41.4	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-72	Yes	MH-28	28.5	920	1.1	47.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-73	Yes	J-0052	7.7	418	1.2	39.1	0.015	0.030	0.076	0.3	50	Pervious	50.0
B-74	Yes	B-71	2.8	165	0.6	58.7	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-75	Yes	O-22	10.3	399	1.0	50.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-76	Yes	CB-66	13.3	482	0.9	50.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-78	Yes	MH-48	7.2	373	2.4	54.1	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-79	Yes	MH-47	8.2	310	1.2	64.4	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-80	Yes	MH-449	8.1	711	3.1	62.1	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-81	Yes	CB-94	9.9	306	1.4	67.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-82	Yes	MH-44	2.9	236	2.5	93.2	0.015	0.030	0.076	0.3	50	Pervious	24.2

Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122



Appendix C

Model Subcatchment Inputs

Basin Name	Modeled?	Outlet	Area (ac)	Width (ft)	Slope (%)	Impervious (%)	Manning N (Imp)	Manning N (Per)	Dstore (Imp, in.)	Dstore (Per, in.)	Zero Imp (%)	Routing Method	% Routed
B-83	Yes	MH-44	5.2	255	1.2	70.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-84	Yes	MH-127	5.4	420	2.3	63.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-85	Yes	CB-107	4.0	318	2.3	58.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-86	Yes	MH-102	6.1	407	1.3	75.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-87	Yes	MH-37	2.9	325	1.8	42.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-88	Yes	MH-104	5.5	292	1.4	64.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-89	Yes	MH-105	5.0	254	0.6	57.5	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-90	Yes	J-0081	5.4	304	1.7	34.5	0.015	0.030	0.076	0.3	50	Pervious	100.0
B-91	Yes	B-90	14.2	570	3.8	2.3	0.015	0.030	0.076	0.3	50	Pervious	100.0
B-92	Yes	B-92_OF	23.5	669	3.4	20.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-93	Yes	MH-49	6.3	345	3.7	70.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-94	Yes	B-94_OF	13.5	533	2.7	3.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-95	Yes	MH-263	24.9	1163	3.8	59.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-96	Yes	MH-79	12.0	531	3.0	17.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-97	Yes	CB-20	21.2	778	2.5	25.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-98	Yes	CB-54	1.0	112	1.0	28.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-99	Yes	B-99_OF	38.4	715	1.6	23.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-100	Yes	B-104	11.2	439	1.0	43.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-101	Yes	O-11	5.1	281	1.9	18.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-102	Yes	J-0121	6.4	264	1.0	75.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-103	Yes	B-166	15.0	511	0.7	42.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-104	Yes	J-0051	6.7	350	1.3	65.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-105	Yes	B-106	4.8	492	1.6	66.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-106	Yes	B-106_OF	3.3	276	2.6	64.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-107	Yes	B-175	9.3	333	1.3	70.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-108	Yes	B-188	2.9	244	1.1	61.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-109	Yes	MH-310	10.9	656	1.2	62.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-110	Yes	B-173	6.4	266	0.8	39.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-111	Yes	MH-329	3.7	528	2.3	65.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-112	Yes	B-169	4.9	219	0.9	65.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-113	Yes	J-0111	26.9	600	1.4	33.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-114	Yes	J-0135	21.4	440	1.2	18.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-115	Yes	J-0080	26.3	476	1.1	27.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-116	Yes	B-138	42.1	983	3.6	10.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-117	Yes	J-0089	11.9	333	1.9	15.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-118	Yes	MH-359	50.6	1005	1.7	44.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-119	Yes	B-119_OF	11.2	472	0.9	1.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-120	Yes	J-0080	30.0	760	2.1	23.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-121	Yes	B-1	17.5	976	1.9	9.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-122	Yes	CB-83	7.4	396	1.0	63.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-123	Yes	J-0122	8.8	479	3.3	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2

Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122



Appendix C

Model Subcatchment Inputs

Basin Name	Modeled?	Outlet	Area (ac)	Width (ft)	Slope (%)	Impervious (%)	Manning N (Imp)	Manning N (Per)	Dstore (Imp, in.)	Dstore (Per, in.)	Zero Imp (%)	Routing Method	% Routed
B-124	Yes	J-0095	74.6	1957	1.4	11.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-125	Yes	J-0131	59.1	715	1.4	46.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-126	Yes	B-140	256.1	1726	1.7	2.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-127	Yes	J-0092	17.6	597	3.6	4.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-128	Yes	B-130	48.8	965	3.4	2.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-129	Yes	MH-262	5.9	251	2.6	0.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-130	Yes	B-1	16.5	424	1.5	23.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-131	Yes	J-0011	14.1	520	2.9	42.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-132	Yes	MH-376	3.7	140	2.1	64.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-133	Yes	B-186	41.4	826	3.7	9.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-134	Yes	B-135	107.6	1520	1.4	3.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-135	Yes	B-137	176.4	2613	1.3	4.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-136	Yes	J-0104	43.8	423	1.1	29.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-137	Yes	B-136	165.1	1473	1.8	5.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-138	Yes	J-0089	13.7	427	1.7	13.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-139	Yes	J-0097	75.1	1331	1.6	3.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-140	Yes	B-139	107.4	1551	2.5	10.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-141	Yes	B-183	16.8	714	1.0	5.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-142	Yes	B-144	5.7	309	1.3	0.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-143	Yes	B-133	7.5	481	1.6	0.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-144	Yes	B-133	17.3	488	3.5	4.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-145	Yes	B-126	35.6	998	2.2	4.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-146	Yes	O-22	1.9	216	1.0	67.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-147	Yes	MH-89	12.7	247	2.0	62.1	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-148	Yes	MH-108	2.1	193	1.0	57.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-149	Yes	MH-113	6.4	375	1.7	42.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-150	Yes	CB-38	3.8	274	1.6	55.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-151	Yes	MH-396	1.6	171	1.4	66.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-152	Yes	J-0013	35.2	686	1.4	21.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-153	Yes	J-0013	3.8	232	1.6	5.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-154	Yes	B-154_OF	3.8	400	1.8	49.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-155	Yes	B-155_OF	1.8	265	2.5	52.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-156	Yes	B-104	4.3	302	1.3	69.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-157	Yes	J-0121	5.4	260	1.3	65.6	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-158	Yes	J-0091	18.7	634	1.2	8.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-159	Yes	MH-36	0.5	167	1.5	80.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-160	Yes	J-0003	12.4	613	2.0	74.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-161	Yes	CB-139	0.8	267	2.4	79.4	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-162	Yes	J-0005	7.1	523	1.2	38.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-163	Yes	J-0118	4.9	264	2.1	13.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-164	Yes	OF-04	5.9	262	1.1	18.4	0.015	0.030	0.076	0.3	50	Pervious	24.2

Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122



Model Subcatchment Inputs

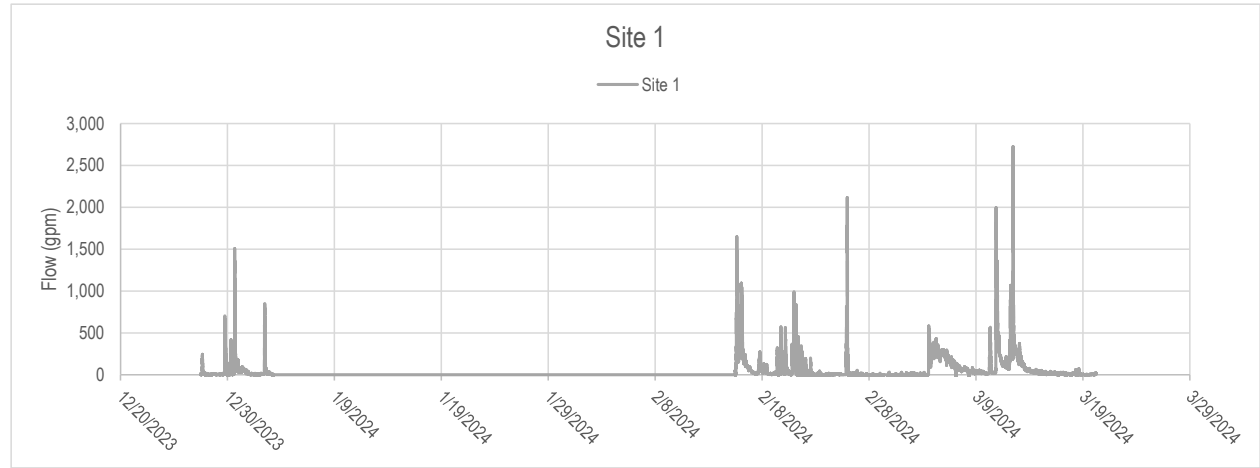
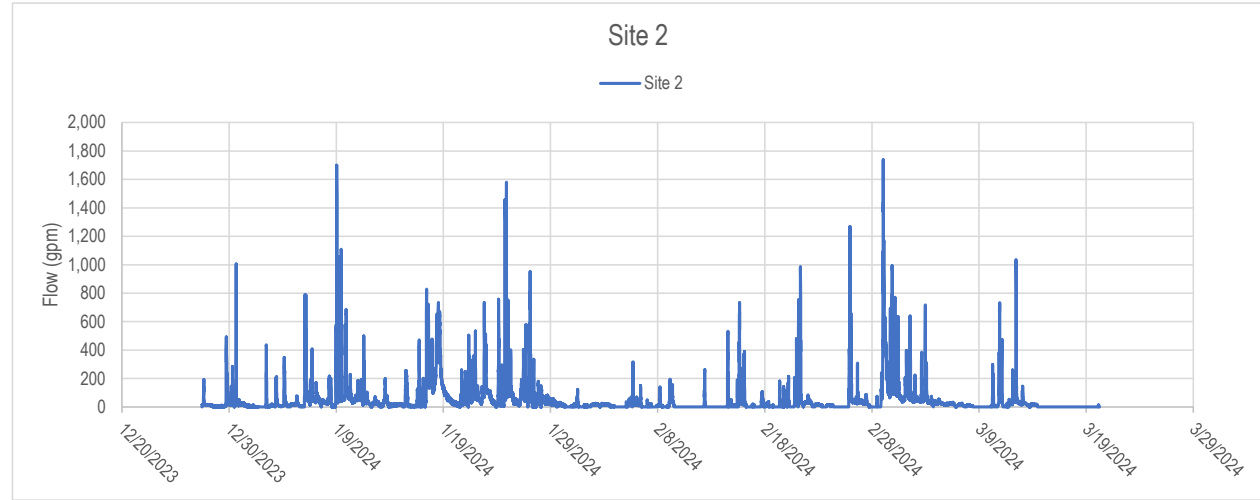
Appendix C

Basin Name	Modeled?	Outlet	Area (ac)	Width (ft)	Slope (%)	Impervious (%)	Manning N (Imp)	Manning N (Per)	Dstore (Imp, in.)	Dstore (Per, in.)	Zero Imp (%)	Routing Method	% Routed
B-165	Yes	B-166	2.6	279	1.3	61.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-166	Yes	B-188	7.9	457	2.3	66.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-167	Yes	B-167_OF	10.6	512	1.2	63.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-168	Yes	B-188_OF	6.3	534	1.0	66.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-169	Yes	B-169_OF	8.3	318	1.0	62.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-170	Yes	MH-323	14.8	863	1.6	58.7	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-171	Yes	MH-331	3.0	520	2.1	57.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-172	Yes	CB-261	3.2	215	1.3	49.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-173	Yes	MH-324	5.5	201	0.8	54.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-174	Yes	B-188	5.5	371	2.0	57.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-175	Yes	B-187	14.5	526	1.9	67.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-176	Yes	CB-288	4.7	254	0.8	51.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-177	Yes	CB-203	3.3	314	0.9	52.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-178	Yes	CB-200	2.6	278	1.2	70.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-179	Yes	CB-268	6.4	498	1.6	71.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-180	Yes	CB-270	6.2	954	2.8	77.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-181	Yes	MH-376	11.1	601	2.9	59.8	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-182	Yes	CB-134	6.9	666	4.6	24.2	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-183	Yes	B-144	8.8	290	1.4	11.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-184	Yes	B-133	10.1	411	3.1	16.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-185	Yes	J-0037	7.5	203	1.4	63.3	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-186	Yes	B-3	31.2	807	1.7	16.1	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-187	Yes	B-187_OF	1.8	62	1.6	34.5	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-188	Yes	B-188_OF	3.3	141	1.2	21.9	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-189	Yes	J-0122	2.9	195	3.7	84.0	0.015	0.030	0.076	0.3	50	Pervious	24.2
B-190	Yes	J-0081	70.4	1049	5.0	2.3	0.015	0.030	0.076	0.3	50	Pervious	100.0
B-77_1	Yes	MH-85	4.8	352	1.4	78.2	0.015	0.030	0.076	0.3	50	Pervious	37.0
B-77_2	Yes	MH-86	5.2	352	1.4	78.2	0.015	0.030	0.076	0.3	50	Pervious	37.0
SUB001	Yes	J-0046	1053.4	500	0.5	5.0	0.015	0.030	0.076	0.3	50	Outlet	100.0
SUB002	Yes	J-0017	60.0	6002	0.5	5.0	0.015	0.030	0.076	0.3	50	Pervious	100.0

APPENDIX D

Flow Monitoring Data





Client: City of Molalla
Project: SWMP
Project No.: 223122



Model Calibration Results

Event Number	Start of Event	End of Event	Rainfall Total (in)	Site 1 Observed Peak (cfs)	Site 1 Modeled Peak (cfs)	Percent Difference	Site 2 Observed Peak (cfs)	Site 2 Modeled Peak (cfs)	Percent Difference
Event 1	1/21/2024 0:00	1/25/2024 11:00	1.50	n/a	20.6	-	3.5	5.6	58%
Event 2	1/26/2024 4:00	1/27/2024 13:00	0.94	n/a	8.2	-	2.1	2.1	-2%
Event 3	2/15/2024 11:00	2/16/2024 8:00	0.51	3.7	6.4	73%	1.6	1.6	0%
Event 4	2/28/2024 16:00	3/1/2024 17:00	1.89	n/a	15.1	-	3.9	3.8	-1%
Event 5	3/10/2024 18:00	3/13/2024 8:00	0.66	6.1	10.5	73%	2.3	2.7	19%

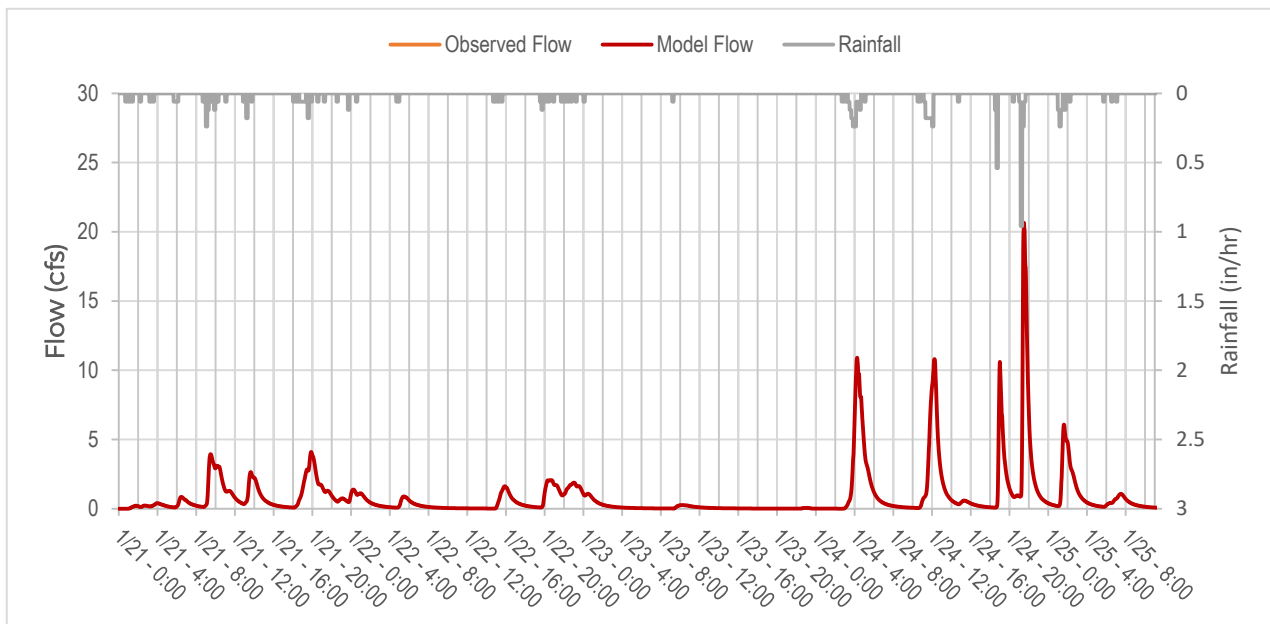
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 1
 Event Number: 1
 Event Start: 1/21/24 0:00
 Event End: 1/25/24 11:00
 Total Duration (hr): 107.0
 Cumulative Rainfall (in): 1.50

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	No Flow Data Available	
Model Data	335,700	20.6
Difference	-	-



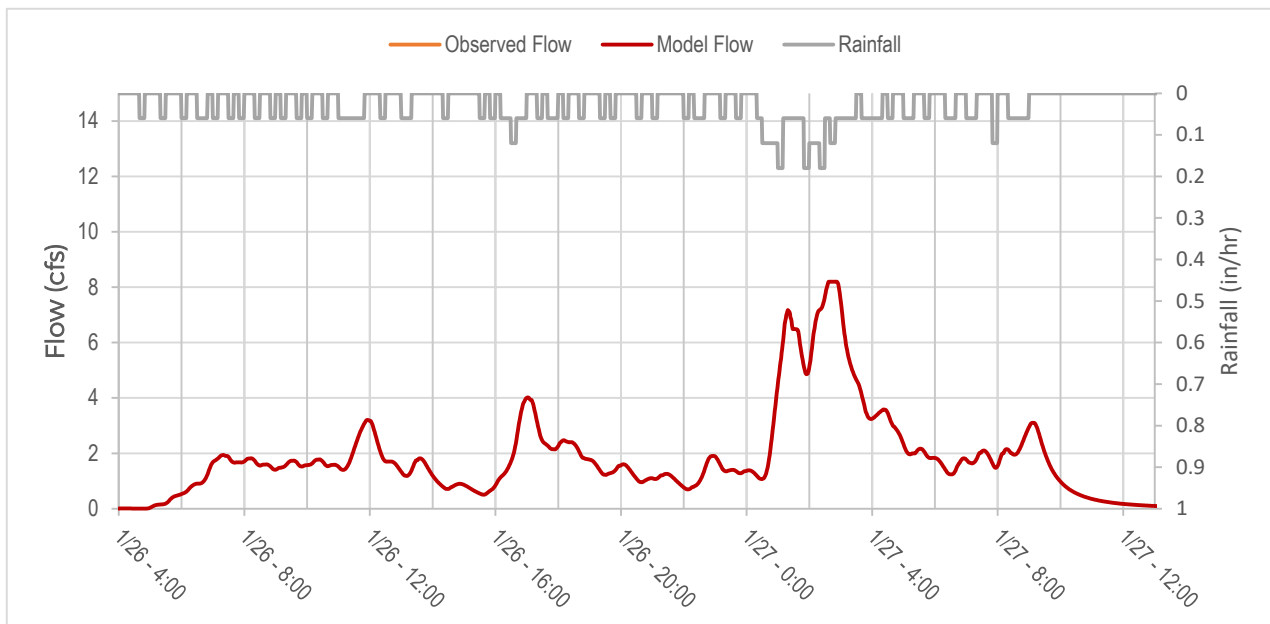
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 1
 Event Number: 2
 Event Start: 1/26/24 4:00
 Event End: 1/27/24 13:00
 Total Duration (hr): 33.0
 Cumulative Rainfall (in): 0.94

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	No Flow Data Available	
Model Data	224,100	8.2
Difference	-	-



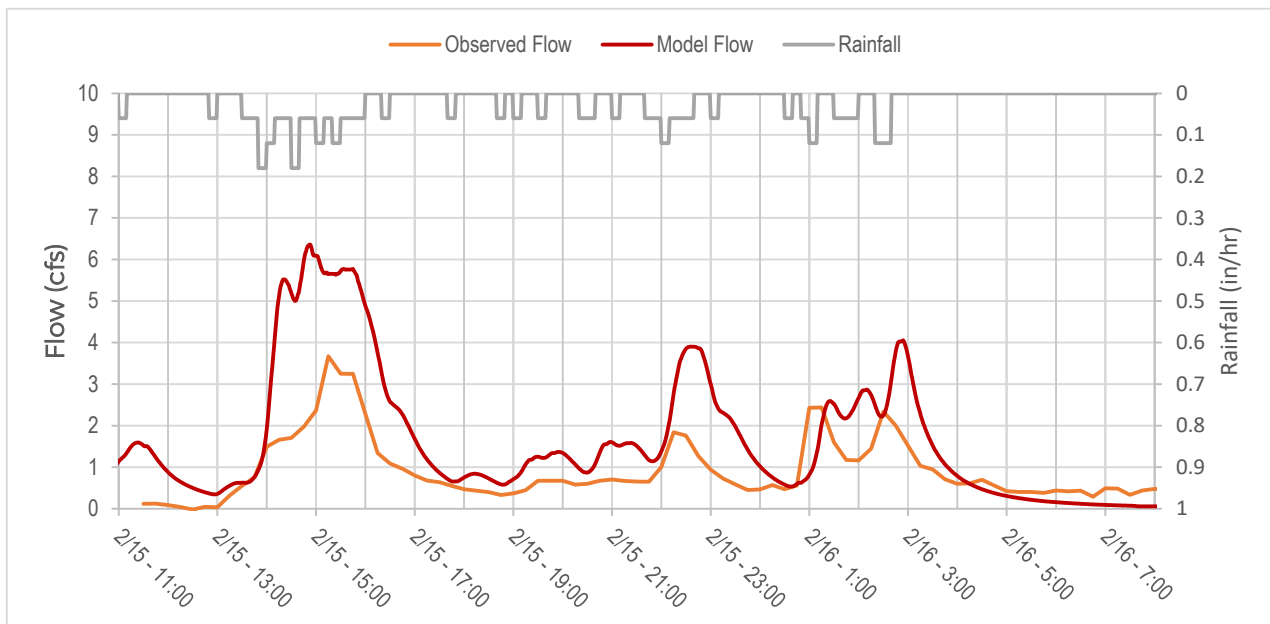
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 1
 Event Number: 3
 Event Start: 2/15/24 11:00
 Event End: 2/16/24 8:00
 Total Duration (hr): 21.0
 Cumulative Rainfall (in): 0.51

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	67,100	3.7
Model Data	127,200	6.4
Difference	89.6%	73.2%



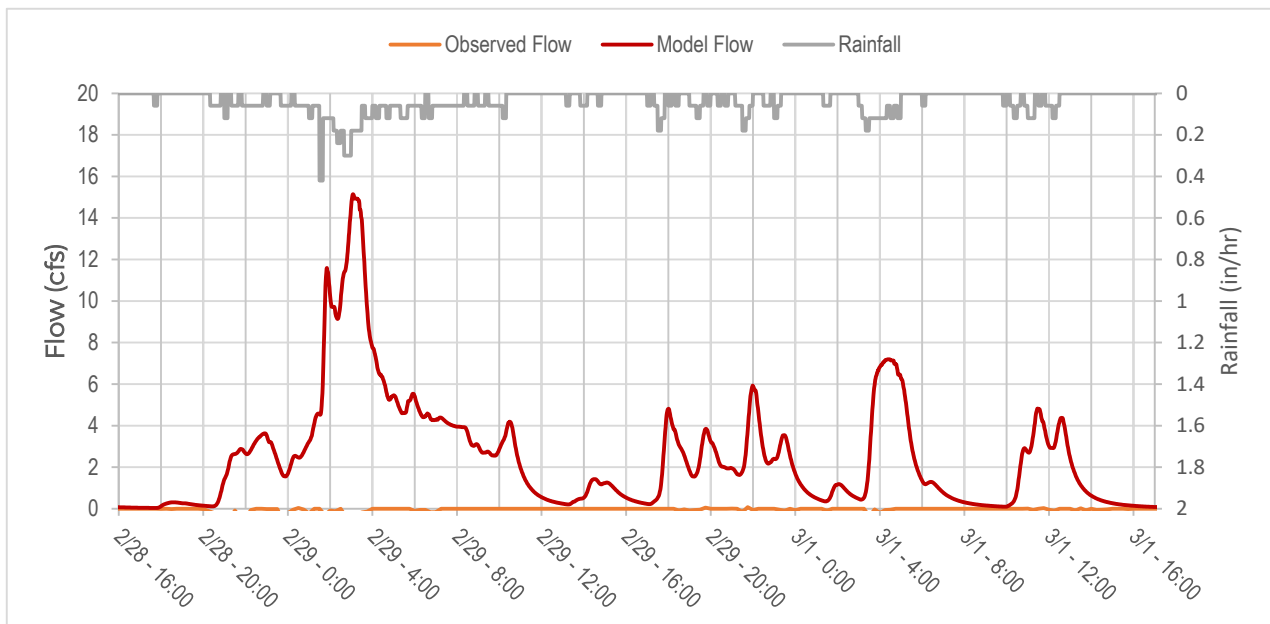
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 1
 Event Number: 4
 Event Start: 2/28/24 16:00
 Event End: 3/1/24 17:00
 Total Duration (hr): 49.0
 Cumulative Rainfall (in): 1.89

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	No Flow Data Available	
Model Data	438,400	15.1
Difference	-	-



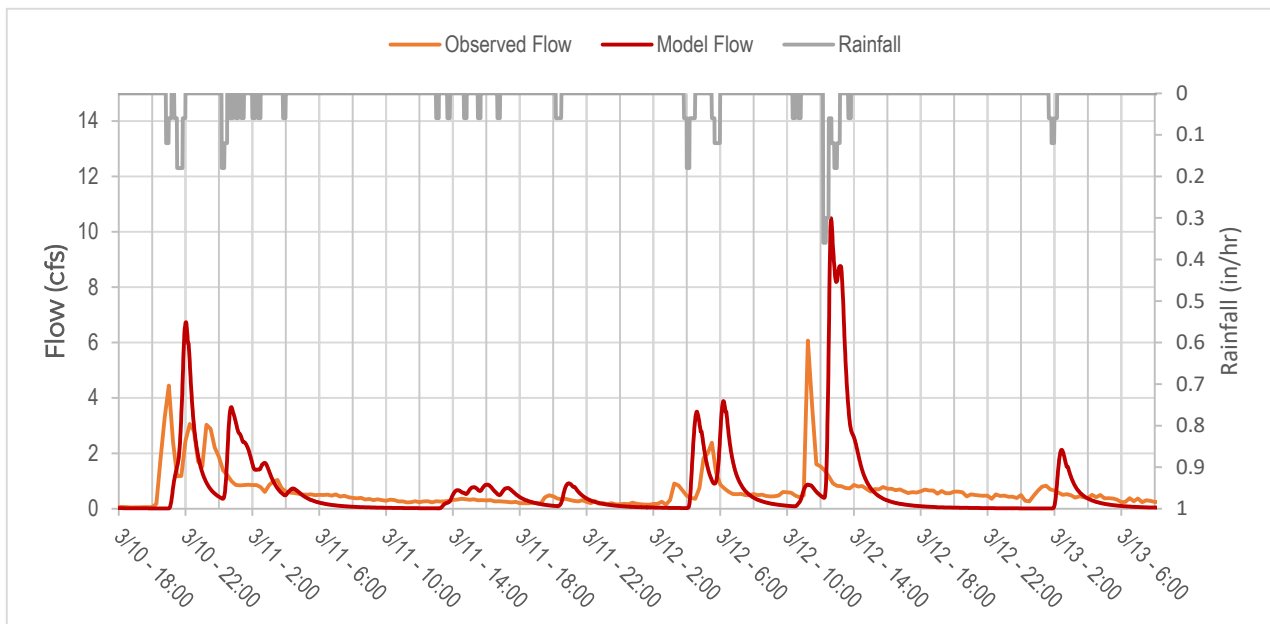
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 1
 Event Number: 5
 Event Start: 3/10/24 18:00
 Event End: 3/13/24 8:00
 Total Duration (hr): 62.0
 Cumulative Rainfall (in): 0.66

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	143,900	6.1
Model Data	157,300	10.5
Difference	9.3%	72.7%



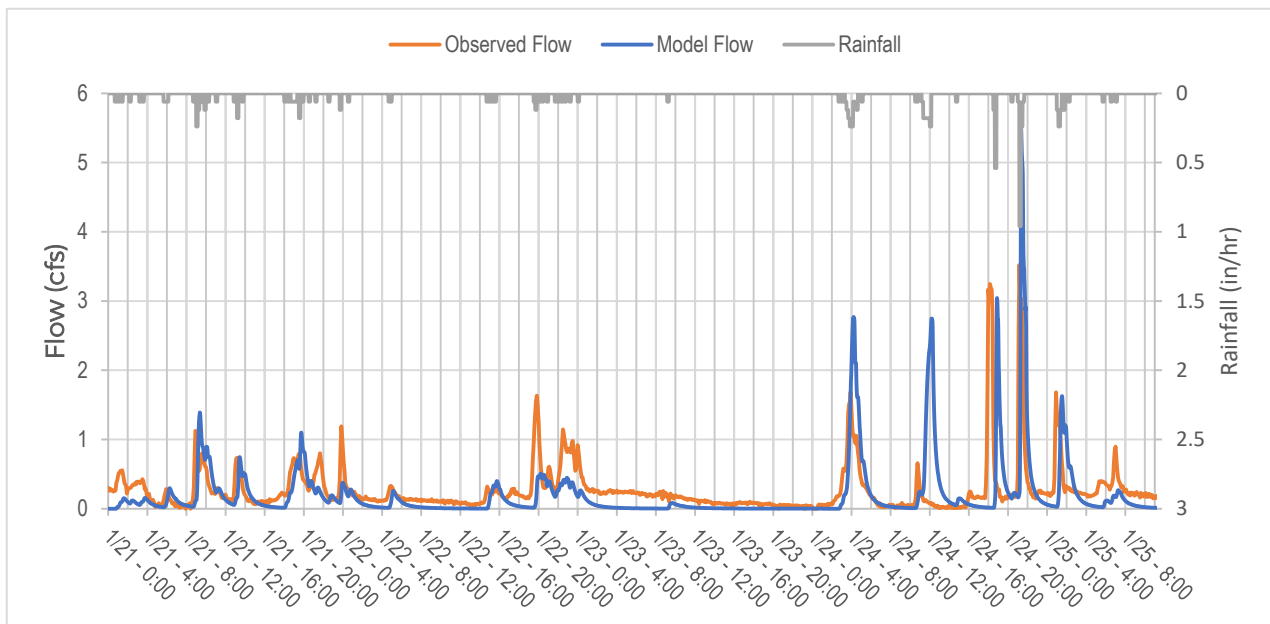
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 2
 Event Number: 1
 Event Start: 1/21/24 0:00
 Event End: 1/25/24 11:00
 Total Duration (hr): 107.0
 Cumulative Rainfall (in): 1.50

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	314,800	3.5
Model Data	78,200	5.6
Difference	-75.2%	58.0%



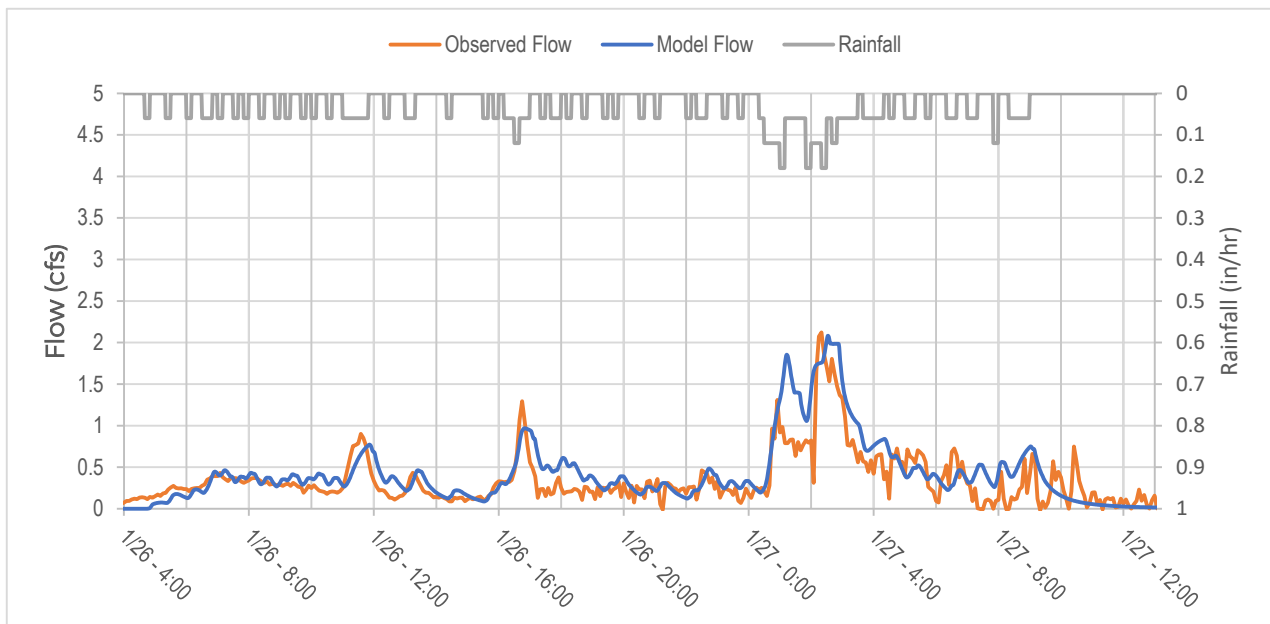
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 2
 Event Number: 2
 Event Start: 1/26/24 4:00
 Event End: 1/27/24 13:00
 Total Duration (hr): 33.0
 Cumulative Rainfall (in): 0.94

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	123,600	2.1
Model Data	50,800	2.1
Difference	-58.9%	-1.8%



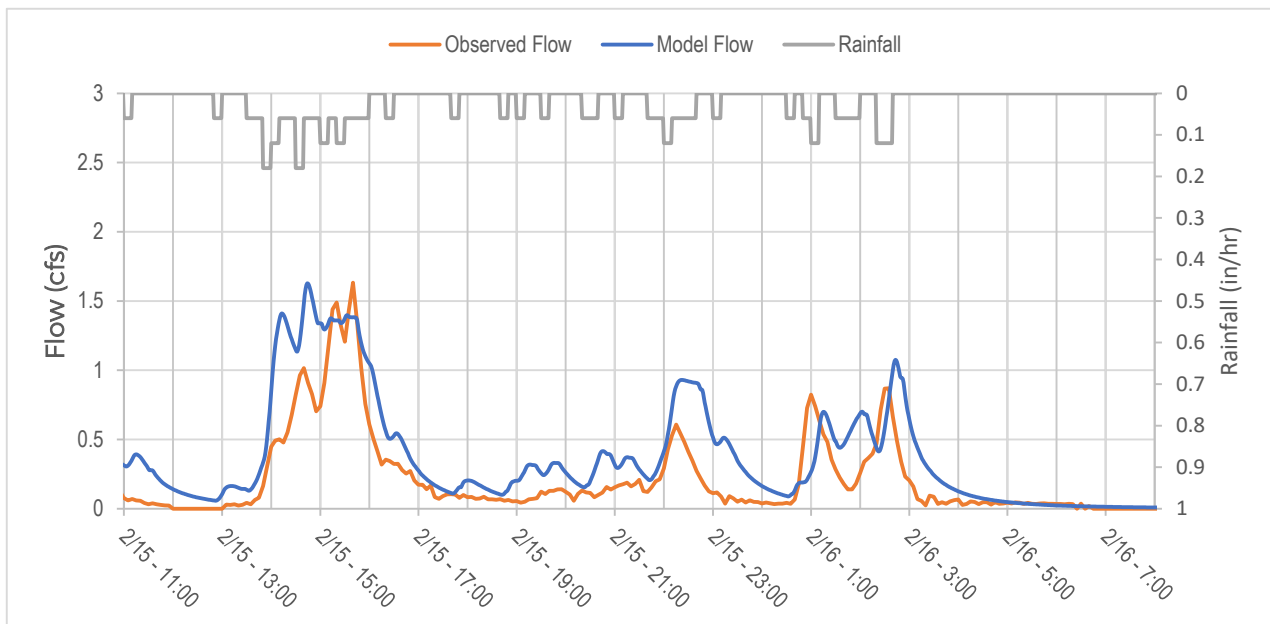
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 2
 Event Number: 3
 Event Start: 2/15/24 11:00
 Event End: 2/16/24 8:00
 Total Duration (hr): 21.0
 Cumulative Rainfall (in): 0.51

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	49,500	1.6
Model Data	28,700	1.6
Difference	-42.0%	-0.3%



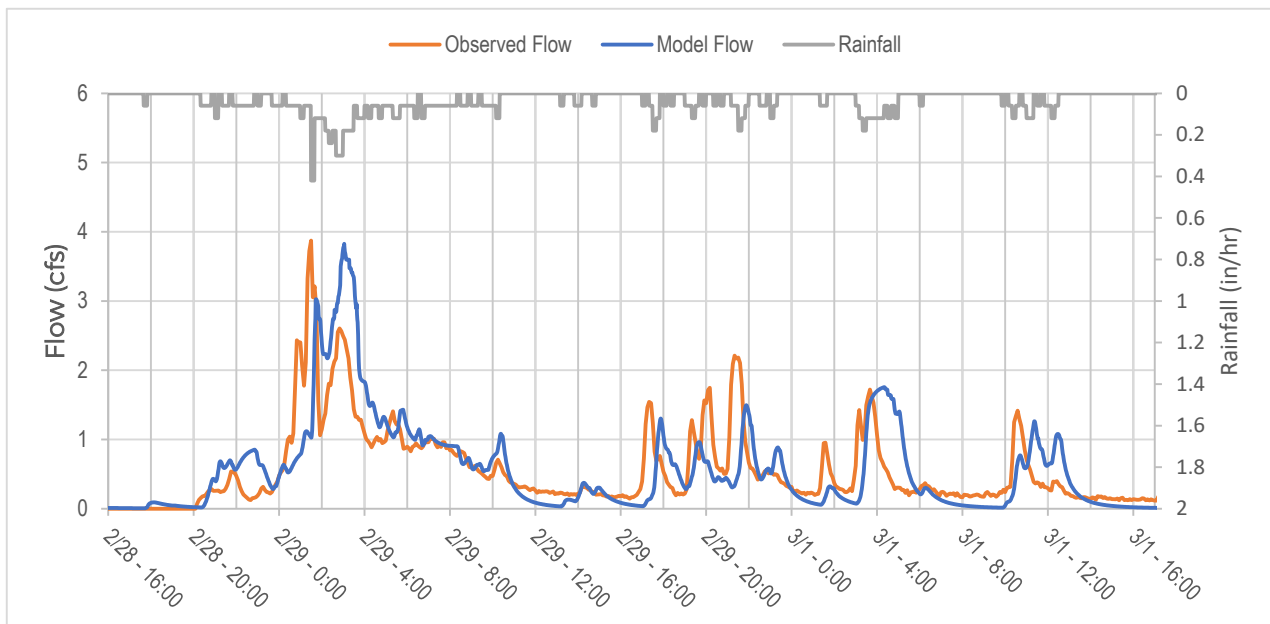
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



Model Calibration Results

Site Number: 2
 Event Number: 4
 Event Start: 2/28/24 16:00
 Event End: 3/1/24 17:00
 Total Duration (hr): 49.0
 Cumulative Rainfall (in): 1.89

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	297,200	3.9
Model Data	102,000	3.8
Difference	-65.7%	-1.2%



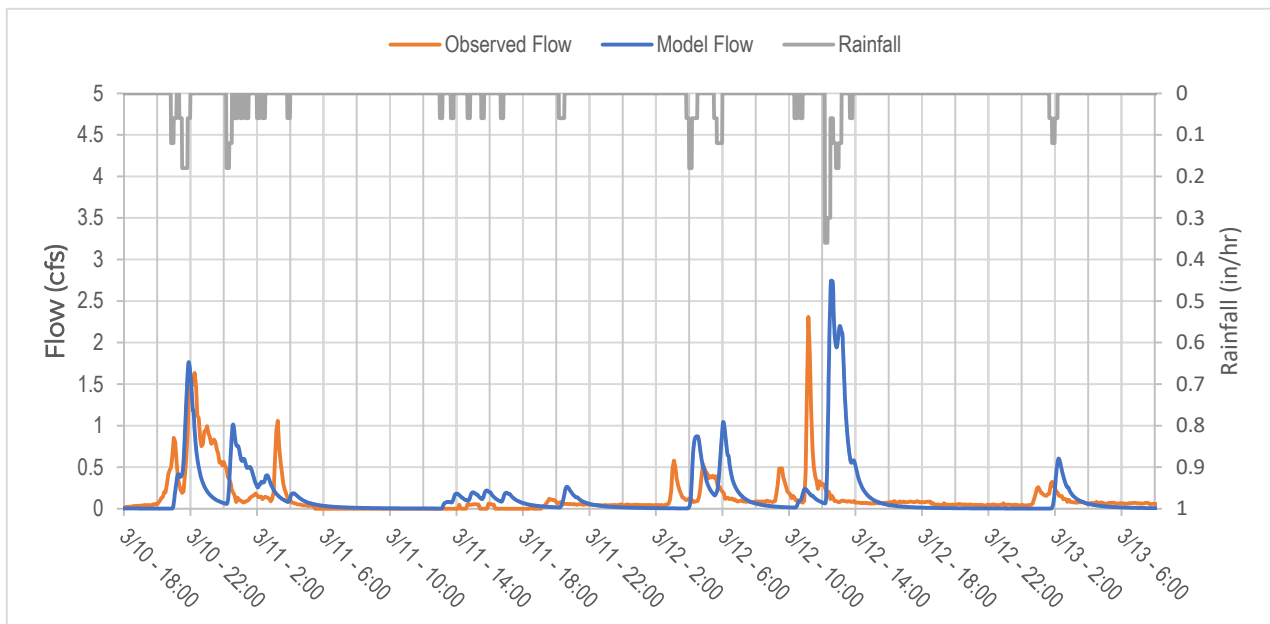
Client: City of Molalla
 Project: SWMP
 Project No.: 223122



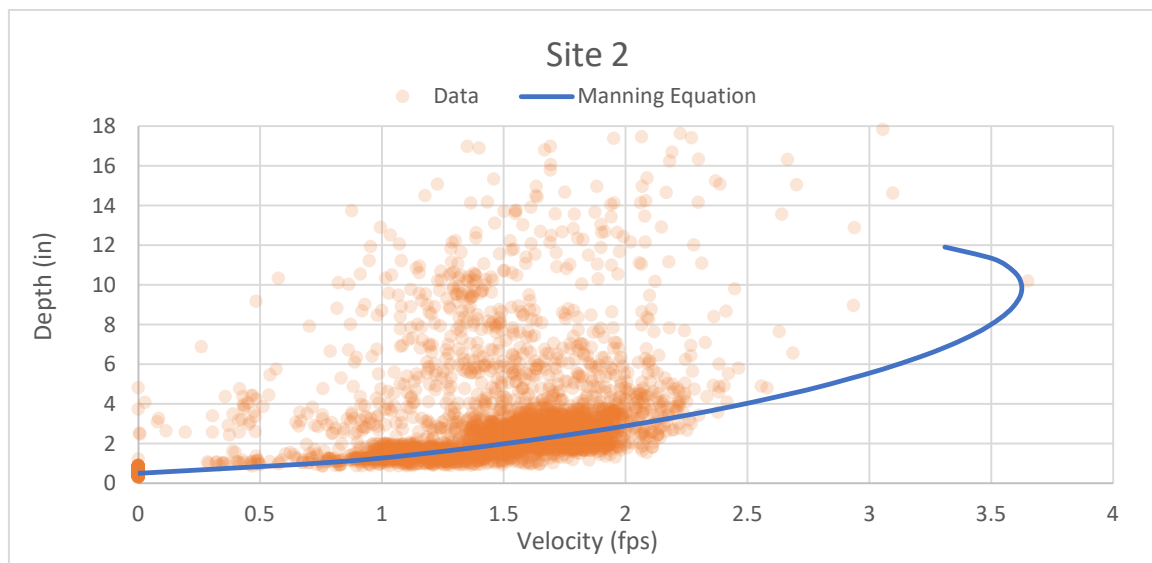
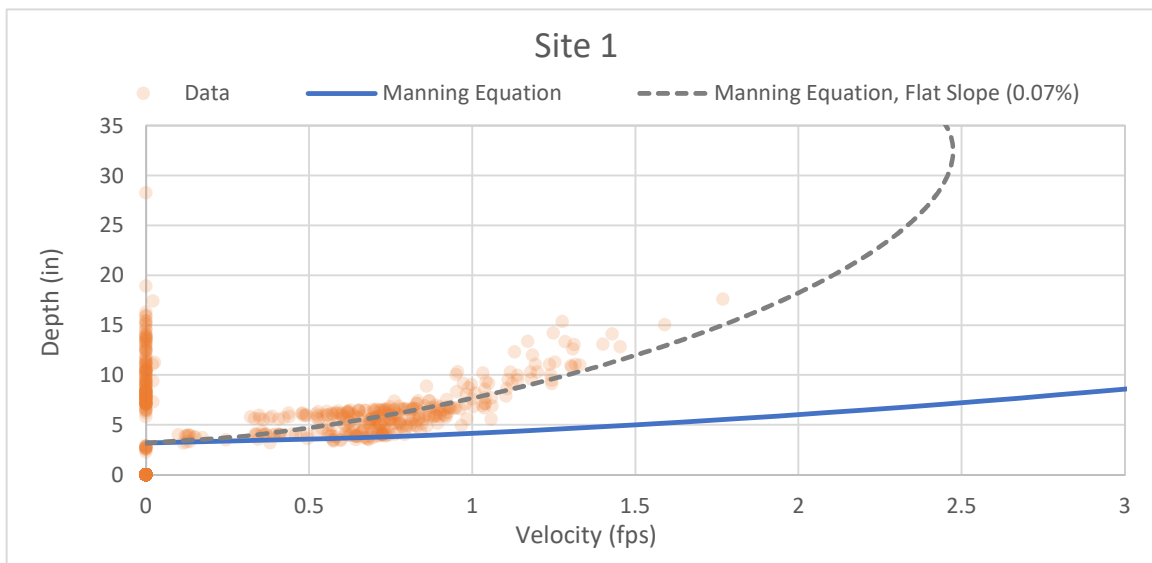
Model Calibration Results

Site Number: 2
 Event Number: 5
 Event Start: 3/10/24 18:00
 Event End: 3/13/24 8:00
 Total Duration (hr): 62.0
 Cumulative Rainfall (in): 0.66

Parameter	Total Flow (CF)	Peak Flow (cfs)
Observed Data	90,800	2.3
Model Data	35,600	2.7
Difference	-60.8%	18.9%



City of Molalla SWMP
Flow Monitoring Scattergraphs



APPENDIX E

Problem Areas



Storm Problem Areas November 2025

Updated Ranking October 2025	Priority Rank (city Sept 2025)	Project #	Problem Area	Notes from meeting with city October 16	Notes from meeting with city Sept 2025	Y/N to Project	notes from primary problem area matrix - site visit
	-	-	CCTV AND SYSTEM MAPPING PROGRAM, NEED TO KNOW WHAT EXISTS AND THE QUALITY OF THE PIPES	N/A	N/A	N/A	
Maintenance Program	2	15	Creamery Creek North of Toliver Rd	This is an area with an undersized culvert and lots of vegetation. The railroad culvert downstream should be addressed first.	Digout west of Creamery Creek culvert, allow water to flow through wetland. Replace railroad culvert. Curenly backed-up.	YES	☐ Flooding occurs here ☐ Wetland ☐ Even in summer water is 1-2 ft deep
Maintenance Program	3	26	Pegasus Detention Pond	This is a failing detention pond that impacts access to homes at the end of the cul-de-sac. When the detention pond fills up, water cannot infiltrate or escape in the ditch to the southwest fast enough. The wetlands don't have as much capacity for water as it was believed when the facility was designed. The elevations at this location make it difficult to address. Keller can identify this, with other similar projects, as a "facility maintenance" CIP item.	Elevations possibly need to be adjusted from outfall of catchbasin to outfall of pond. Culdesac floods with heavy rains.	DISCUSS FURTHER WITH CITY	☐ Major Issue ☐ Stormwater facility at end of cul-de-sac is failing ☐ Can possibly connect to stormwater infrastructure south of facility
Maintenance Program	6	22	Creamery Creek @ Stowers	Culvert that pulls conveys Creamery Creek under Stowers Road is too small. There are easement issues with Creamery Creek in this area since it runs trhough backyards and such. Keller to update the model to show the box culvert and re-run the model. THIS HAS BEEN COMPLETED AND THERE ARE NO ISSUES WITH THE NEW BOX CULVERT, THINK THAT IT'S A MAINTENANCE ISSUE.	Head waters of Creamery Creek cause flooding at Stowers. Undersized culvert with no access to maintain ditch line.	DISCUSS FURTHER WITH CITY	☐ Flooding occurs downstream of this location ☐ Downstream channel has major maintenance issues ☐ Potential flooding and compromising of nearby structures/private property

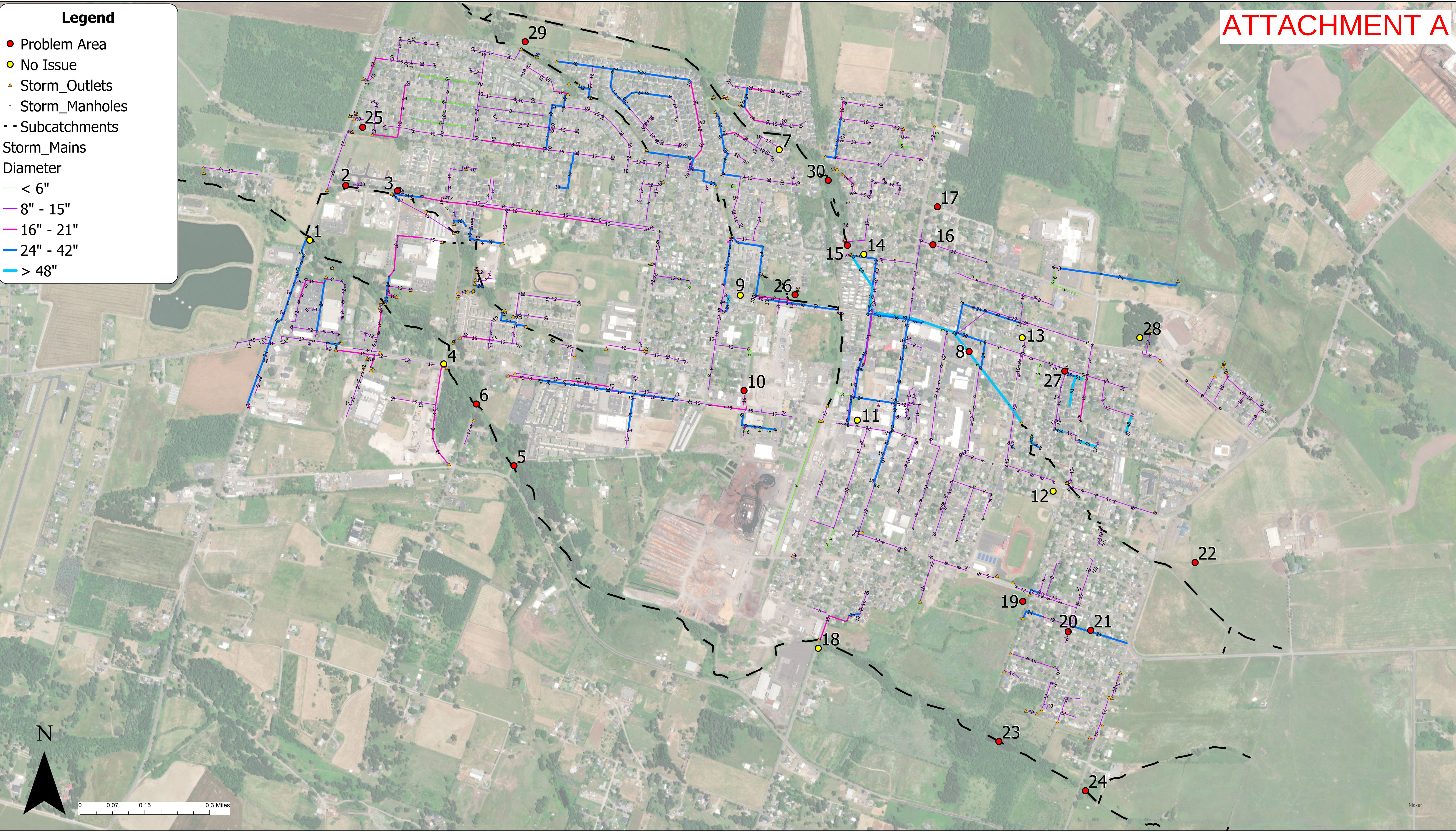
9	12	6	Bear Creek at Ona Way Culvert	N/A - not discussed in the meeting and the information sent after doesn't provide clarity.	Overgrowth from Ona Way to highway contributes to flooding and clogging of culvert.	DISCUSS FURTHER WITH CITY	☐ Major problem area ☐ Undersized ☐ Culvert to the south is completely covered in brush and likely full of gravel ☐ Age unknown; likely 50 - 100 years ☐ Old SWMP calls to replace with box culvert ☐ Flooding over the road has been more frequent in past years ☐ Flooded during big rain in June 2022
Maintenance Program	13	35	Creamery Creek Southwest of Anne Lane	The model didn't show significant issues here , it appears that it is more of a maintenance issue. The City should communicate with the HOA to address this problem. Flag as maintenance unless further investigation reveals it should not be.	Creek is overgrown from north of City limits to Project 15. Believe this overgrowth will contribute to flooding throughout the creek line. Many portions of this are HOA owned.	DISCUSS FURTHER WITH CITY	
Maintenance Program	15	23	Ivor Davies Pond	There are also brush issues upstream and downstream this location, some mention of clearing the entirety of Bear Creek as a CIP project. This could be part of a program that clears the creeks.	North dike wall is breeched, has lost several feet of holding capacity. Repair dike, remove sediment from pond. Possibly remove overgrowth to west of pond for better flow. Possibly add valving to control levels and create holding space for large rain events.	YES	☐ Look into potential of combining improvements with park project ☐ Near the source of Bear creek and very dry in the summer
8	16	24	Bear Creek at Mathias Rd	The City provided information on the culverts that flow into the area, the other information is provided in the other columns, no additional discussion.	Outfall of culvert backs up due to debris catching on fence causing major flooding over Mathias. (Currently outside City limits)	YES	☐ Can flood during big storms ☐ Source of Bear Creek ☐ May be keeping downstream areas from flooding.

1	9	8	Underground Portion of Creamery Creek	The underground portion of Creamery Creek is an issue because there are some pipes under buildings and some other sections of the creek that are inaccessible to the City due to lack of easements. Some of the buildings include homes and the post office. Keller recommends relocating sections of the creek to be within the ROW so that it's easier to maintain and allows the City to be more aware of the condition of the system. This is likely something that would be split into multiple projects. The risk of failure should bring this to a higher priority on the list of projects, the City and Keller agree on this.	Pipe runs under Post Office, condition of pipe believed to be poor condition	YES	☐ Potential to split flow between Wolf Creek and Creamery Creek ☐ Pipeline very shallow; 1 foot in locations ☐ Pipe under post office not in good shape; other portions of pipeline appear to be in good shape(i.e. Grange Avenue and Kennel Avenue
2	1	31	Cascade Highway inlet south of Meadowlawn Pl. (McLeod's Ditch)	With developments, the City will lose all access to the open ditch. The line that goes into the ditch has a lot of roots and they have to vac truck it out. The water backs up into the neighborhood to the north. There is some root intrusion in the pipe between the ditch and Meadowlawn Pl. The City hasn't seen the upstream flooding in the pipes as shown in the model. The City would like to pipe the ditch and pave it over so they can easily access it when the area is developed.	Maintenance Access will be lost with development of homes. Fill and pipe ditch line with maintenance road access. Root issues in pipe form Meadow Drive to Ditch	YES	
3	5	27	Finney's and E Heintz	Heintz and Finney's Ave flood. There is a 50-inch detention failing facility that runs through the backyards of the homes between Finney's Ave and Cole Ave. Keller suggests that the City bypasses the detention facility and sends all water downstream.	Detention facility failing. Possible design / construction issues. Intersection floods with most rain events. (HOA owned detention)	YES	☐ Major Issue ☐ Detention facility not working properly; Similar to Contech pipe detention system ☐ Flooding occurs regularly
4	14	30	Creamery Creek Railroad Culvert	The City would like this as a CIP item because it causes issues in the rest of the system and it could be a tool to develop projects to address the infrastructure problems here.	Area overgrown. Possible replacement of culvert.	DISCUSS FURTHER WITH CITY	☐ Made of railway ties ☐ Backs water up to piped Creamery Creek and neighborhoods east of bottleneck
5	7	25	Meadowlark / Meadowlawn / Harvest (West Culdesacs)	Meadowlark backs up because there is a single catch basin, Harvest Ln also has issues due to minimal catch basins and the slopes push additional water to Meadowlark. It might be worthwhile to connect the 12-inch and 18-inch systems that flow into the ditch.	Addition of catchbasin on north side of road.	YES	☐ Major Issue ☐ Flooding occurs in surrounding neighborhoods ☐ Likely not enough inlets ☐ Ditch south of subdivision is not easy to maintain and piping would be preferred

6	10	41	Center and E Heintz	Pooling around catch basins and manholes. Keller's modeling shows flooding here as well, it appears to be due to undersized pipes.	Some pooling around manhole and catchbasin just east of intersection	YES	
7	8	17/16	East side of N Molalla from Frances to Church St.	Stormline from Frances has a line that goes to the north by the church and outfalls but Frances and Shirley don't have much infrastructure. There is an abandoned storm system that the City discovered in the last few years. Possibly put together a CIP item that first adds infrastructure to address drainage and then adds infrastructure to Miller and Frances. Miller St experiences flooding problems, Keller would like to investigate the topography of this area further.	Storm line from Frances running north to outfall in ditch at Church. Line not mapped, found catchbasin at 815 N Molalla buried under sidewalk. Water flowed when tested with tanker. Flooding issues have subsided after removing large quantities of roots from line south of Francis. (no functioning storm north of Frances)	DISCUSS FURTHER WITH CITY	☐ Flooding occasionally ☐ Likely from lack of infrastructure and/or grading
No Project	4	29	Mountain View Outfall	Outfall from the neighborhood, owned by the HOA, was poorly designed to effectively convey water to the creek. The outfall pipe sits about 1-ft below the creek bed so any water in the creek results in water being pushed back up the pipe. The City doesn't have easements to easily access this area so the City has to access it through Big Meadow Park. This area will sometimes back up to Big Meadow Park and the City has to bog out the creek all the way to the Oak Trees to the north. Keller suggests that this issue could be addressed with updating the standards and codes - this sounds like an issue with the HOA.	Outfall from Mt. View blocked annually by plant growth and debris. Needs dugout downstream to culvert and beyond. Upstream, the entire creek bed needs cleared upto and including the city owned detention pond.	DISCUSS FURTHER WITH CITY	☐ Managed by the HOA, City ponds drains into the HOA infrastructure. Address through maintenance.
No Project	11	10	Dixon	This problem might be addressed with a development project in the area.	Catch basin on SE end runs north. Line is leaking and causing infiltration in sanitary sewer system. Possibly being addressed with property development.	DISCUSS FURTHER WITH CITY	☐ Catch basin that the City doesn't know where it flows ☐ New City development just to the east of catch basin will be rerouting storm water to the catch basins on the North
No Project	17		Homestead Pl Line	N/A sent after the meeting	System that pipes under the highway is inadequate and results in flooding in the upstream neighborhood (boo)	N/A	

Legend

- Problem Area
- No Issue
- ▲ Storm_Outlets
- Storm_Manholes
- - Subcatchments
- Storm_Mains
- Diameter
- < 6"
- 8" - 15"
- 16" - 21"
- 24" - 42"
- > 48"



City of Molalla Problem Areas



Figure 2
City of Molalla



CLIENT NAME: CITY OF Molalla

PROJECT: Molalla SWMP

KA PROJECT

ENGINEER
DATE: October

Project #	Problem Area	Pre-Site Visit Notes	Notes from Site Visit	Source
2	Toliver by Bus Barn, Flooding (Site may be 'flooding' from no infrastructure. Sites 6-8 feet above drainage)	Replace existing pipe with a larger pipe connecting to the drainage system in the area.	☐ New roundabout on highway 213 has improved flooding conditions ☐ Current Bus barn flooding likely from maintenance issue ☐ Bus barn has no internal drainage which could also be contributing to issues - No need to investigate with the model.	RFP Problem Location
3	Industrial Way along Toliver rd	Not recommended improvements at this time due to some improvements have been made on the Toliver rd project. If flooding still occurs, then the existing 36" pipe is replaced with a 48" pipe. Flooding does not show as a risk at the moment.	☐ Flooding likely occurring due to ditch ☐ Open ditch very deep (approx. 6-8 ft) Maintenance issue and is difficult to clean. Ideal would be to pipe ditch and due to road widening from TSP, likely will be pipe in the future. ☐ Can flood if it gets backed up ☐ Recent Bus Barn improvements may have improved issues	2003 MP Problem Location
5	Culvert Below Forest Road	The existing 36" CMP below Forest Road East of Ona Way is undersized for the flow expected from the upstream basin. Recommend leaving this culvert in place at this time due to there not being any habitat structures upstream and the area upstream provides temporary detention.	☐ Culvert under road ☐ Culvert not sized for truck traffic ☐ More of a structural issue than a flooding issue ☐ Not sure size/material ☐ County property	2003 MP Problem Location
6	Bear Creek at Ona Way, Flooding	Replace existing culverts with a bottomless culvert. A bridge or an arch will be needed with a natural creek bottom.	☐ Major problem area ☐ Under sized ☐ Culvert to the south is completely covered in brush and likely full of gravel ☐ Age unknown; likely 50 - 100 years ☐ Old SWMP calls to replace with box culvert ☐ Flooding over the road has been more frequent in past years ☐ Flooded during big rain in June 2022	RFP Problem Location
8	Underground portion of Creamery Creek (60" pipe)	Replace with a new 60" pipe due to the existing 60" being in bad shape.	☐ Potential to split flow between wolf creek and creamery creek ☐ Pipeline very shallow; 1 ft in locations ☐ Pipe under post office not in good shape; other portions of pipeline appear to be in good shape (i.e. Grange Ave and Kennel Ave)	RFP Problem Location
10	Dixon Avenue drainage improvements	Reported flooding in this area, and should be monitored to see if the improvements on along Hoyt st solved the flooding. This drainage system could be developed as a long term plan.	☐ Catch basin that the city doesn't know where it flows ☐ New City development just to the east of catch basin will be rerouting storm water to the catchbasins on the North	2003 MP CIP Location
15	Creamery Creek east of Toliver, Flooding	Replace existing culvert with a bottomless culvert.	☐ Flooding occurs here ☐ Wetland ☐ Even in summer water is 1-2 ft deep	RFP Problem Location
16	Francis at N Molalla, Flooding	Replacing existing storm water pipes with a larger pipe.	☐ Flooding occasionally ☐ Likely from lack of infrastructure and/or grading	RFP Problem Location
17	Miller at N Molalla	Miller Street Drainage Improvements (2003 CIP)	☐ Flooding an issue ☐ Likely from lack of infrastructure and/or grading	RFP Problem Location
19	Ivor Davies Park Ditch	Reported Flooding	☐ Flooding when maintenance is not kept up	RFP Problem Location
20	2003 MP Problem Location	Reported Flooding	☐ Old curbs (low), storm drains ☐ Recent City improvements may have solved issue; City to monitor over the next year	2003 MP Problem Location

21	2003 MP Problem Location	Reported Flooding	☐ Old curbs (low), storm drains ☐ Recent City improvements may have solved issue; City to monitor over the next year	2003 MP Problem Location
22	Detention Pond at Mathias Ave & Creamery Creek	A detention pond to store storm water upstream of Mathias Ave could reduce or eliminate flooding downstream along Creamery Creek. The downstream benefits would be significant by reducing the current storm flow in the system, theoretically reducing any chance of flooding.	☐ Flooding occurs downstream of this location ☐ Downstream channel has major maintenance issues ☐ Potential flooding and compromising of nearby structures/private property	RFP Problem Location
23	Ivor Davies Pond	Making larger or making a new pond as a detention area? Could reduce flooding in downstream sections.	☐ Look into potential of combining improvements with park project ☐ Near the source of Bear creek and very dry in the summer	2003 MP Problem Location
24	Bear Creek at Mathias Rd	The existing culverts can not past the 25-yr storm flow, and is recommended to replace the 36" corrugated metal pipe culvert with a bottomless culvert that can pass a 100-yr design storm. The new culvert recommendation is a 12 ft span bridge or arch span with a natural creek bottom.	☐ Can flood during big storms ☐ Source of Bear Creek ☐ May be keeping downstream areas from flooding.	RFP Problem Location
25	Meadows Lark	New Problem Area from Site Visit 10/17/23	☐ Major Issue ☐ Flooding occurs in surrounding neighborhoods ☐ Likely not enough inlets ☐ Ditch south of subdivision is not easy to maintain and piping would be preferred	
26	Pegasus	New Problem Area from Site Visit 10/17/23	☐ Major Issue ☐ Stormwater facility at end of cul-de-sac is failing ☐ Can possibly connect to stormwater infrastructure south of facility	
27	Finney and Heintz	New Problem Area from Site Visit 10/17/23	☐ Major Issue ☐ Detention facility not working properly; Simialar to Contech pipe detention ☐ Flooding occurs regularly	
29	Mountain View Outfall	New Problem Area from Site Visit 10/17/23	☐ managed by the HOA, City ponds drains into the HOA infrastructure. Address through maintenance.	
30	Railway Culvert	New Problem Area from Site Visit 10/17/24	☐ Made of railway ties ☐ Backs water up to piped creamery creek and neighborhoods east of bottleneck	

Projects Removed from List				
Project #	Problem Area	Description	Notes from Site Visit	Source
1	Bear Creek at Highway 213	There are two arch CMPs culverts as the existing system that fails to pass a 25-yr storm flow. It is recommended that it is replaced with a bottomless culvert. The new culvert will have a 18 ft span bridge with a natural creek bottom.	☐ There is a history of fish migration although in recent years none have been spotted likely due to low flows ☐ Pipe buried with creek bed on top ☐ Likely built to SLOPE standards ☐ Cost approx. 2.2 million	2003 MP Problem Location
4	Molalla Forest Rd & Woodburn-Estacada Highway		☐ ODOT. No issue	RFP Problem Location
7	Big Meadow east cul de sacs, Flooding	Replace existing pipe with larger pipe connecting to a catch basin.	☐ No issue	RFP Problem Location
9	2003 MP Problem Location	Reported flooding on Heintz St east of Ridings	☐ No issue	2003 MP Problem Location
11	2nd Street/Kennel Ave Storm System	Alternative 2: Recommended if the railroad alignment is not available or its use is cost -prohibitive. Replacing pipe in existing sections and installing new pipe in add on section	☐ No issue	2003 MP Problem Location
12	Sunrise Acres Drainage Improvements	Implementing a pond?	☐ No issue	2003 MP Problem Location
13	Heintz st Collector Replacement Project	Replacing the existing Creamery Creek pipe (60" CMP pipe). Due failures in the past years, a new system is to intercept Creamery Creek at the South end of Indian Oak Court and divert the creek don to Heintz St.	☐ No issue	2003 MP CIP Location
	Shirley Street discharge Improvements	Allow drainage on Shirley st to discharge to the proposed Heintz st system. This task could eliminate the need to follow through with a CIP projects.	☐ No issue	RFP Problem Location
14	Heintz st Outfall Project	If the old railroad is not obtainable, the storm system downstream of Kennel Ave and Heintz St intersection will need to be upgraded. This new system will be required to run to Toliver rd with 48" pipe and a 48" pipe along Toliver rd as well.	☐ No issue	RFP Problem Location
18	Bear Creek at Molalla Avenue	There are two existing CMP arch culverts that can not pass the 25-yr storm flow. The recommendation is to replace the culverts with a bottomless culvert that can pass a 100-yr design storm. There will be a 14 ft span bridge or arch span with a natural creek bottom.	☐ County Project	RFP Problem Location
28	Clark Park / Buckaroo	New Problem Area from Site Visit 10/17/23	☐ Buckaroo has complained about flooding after park improvements made ☐ Not an issue	

APPENDIX F

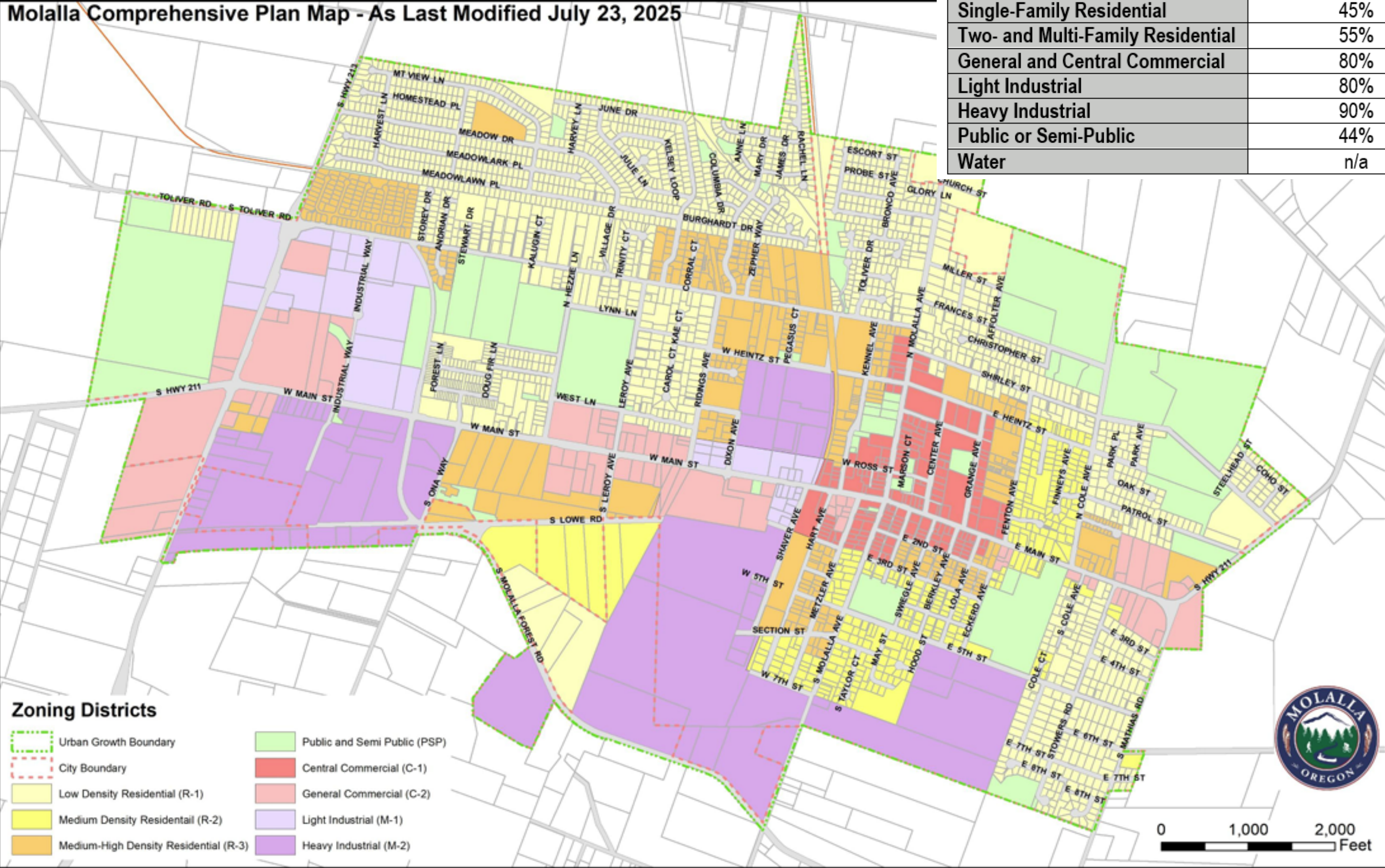
Land Use Figures



Molalla Comprehensive Plan Map - As Last Modified July 23, 2025

Land Use	Percent (%) Impervious
Single-Family Residential	45%
Two- and Multi-Family Residential	55%
General and Central Commercial	80%
Light Industrial	80%
Heavy Industrial	90%
Public or Semi-Public	44%
Water	n/a

Molalla
Comprehensive
Plan



- Commercial (C-1)
- Commercial (C-2)
- Industrial (M-1)
- Industrial (M-2)
- Family Residential (R-1)
- Family Residential (R-2)
- Family Residential (R-3)
- Industrial Semi Public (PSP)
- Industrial (RI)
- Residential Farm Forest 5 Acre (RRFF5)
- Residential Farm Use (EFU)

Urban Growth Boundary



The City of Molalla presents administrative boundary information for Clackamas County Information Services. It is presented "as is," as of April, and may be subject to change. The City of Molalla and Clackamas County Information Services assume no liability for any errors, omissions, or inaccuracies in the information presented. There are no warranties which extend beyond the document. The City of Molalla and Clackamas County Information Services assume no liability for decisions made or action taken (or not taken) based upon any of the furnished information or data.

APPENDIX G

City Code and Design Standards



CHAPTER 13.13
SURFACE WATER MANAGEMENT

§ 13.13.010. Definitions.

Unless the context specifically indicates otherwise, the meaning of terms used in this chapter shall be as set forth as follows:

"Auxiliary water supply" means any water supply on or available to the premises, other than the City's approved public potable water supply. These auxiliary waters may include water from another provider's public potable water supply, or any natural source(s) such as a well, spring, river, stream, harbor, etc., or "used waters" or "industrial fluids." These waters may be polluted or contaminated, or they may be objectionable and constitute an unacceptable water source over which the City does not have sanitary control.

"Backflow" means the flow of water or other liquids, mixtures or substances under pressure into the distributing pipes of a potable water supply from any source or sources other than its intended source.

"Backflow preventer" means a device or means designed to prevent backflow or back-siphonage.

"Back-siphonage" means the flow of water or other liquids, mixtures or substances into the distributing pipes of a potable water supply system, from any source other than its intended source, caused by the sudden reduction of pressure in the potable water supply system.

"Building drain" means that part of the lowest horizontal piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building, and conveys it to the building storm sewers, beginning five feet outside the inner face of the building walls.

"Building sewer" means that part of the horizontal piping of a drainage system which extends from the end of the building drain and which receives the discharge of the building drain and conveys it to a public sewer at the public right-of-way or easement, private sewer, individual sewage disposal system, or other point of disposal.

"Business day" or "working day" means Monday through Friday from 8:00 a.m. to 5:00 p.m., excluding any City-recognized holidays.

"Commercial business" means a business establishment which furnishes goods or services to either the general public or other commercial operations.

"Controlled cross-connections" means a connection between a potable water system and a non-potable water system, with an approved backflow-prevention device properly installed that will continuously afford the protection commensurate with the degree of hazard.

"Cross-connection" means any physical connection or arrangement of piping or fixtures between two otherwise separate piping systems, one of which contains potable water and the other non-potable water or industrial fluids of questionable safety, through which, or

because of which, backflow or back-siphonage may occur into the potable water system. Other types of cross-connections include but are not limited to connectors such as swing connections, removable sections, four-way plug valves, spools, dummy sections of pipe, swivel or changeover devices, sliding multiport tube, and solid connections.

"Customer." See "User."

"DEQ" means the Oregon Department of Environmental Quality.

"Developed" means any property which has been altered by grading, filling of the ground surface, or by construction of any improvement or impervious surface area, which could affect the hydraulic or hydrologic properties of the property.

"Developer" means any person, company or corporation who purchases or holds an interest in real property with the intent to increase the value thereof by the installation of utilities, construction of a building or buildings, grading, ditching, improving or enhancing the ground or structures for the purpose of resale.

"Domestic stormwater" means surface or subsurface drainage of the type commonly introduced into a drainageway or storm sewer system by residential users.

"Double-check valve assembly" means an assembly of two independently operating approved check valves with tightly closing shutoff valves on each side of the check valves, plus properly located test cocks for the testing of each check valve. The entire assembly shall meet the design and performance specifications and approval of a recognized and City-approved testing agency for backflow-prevention devices. To be approved, these devices must be readily accessible for the in-line maintenance and testing.

"Dwelling unit" means any of the following:

- A. A single-family dwelling;
- B. An accessory dwelling unit;
- C. A habitable unit of multifamily dwelling(s), including an apartment;
- D. A condominium; or
- E. A manufactured home.

"Equivalent development unit (EDU)" means a unit of measurement of impervious surface. One EDU is equal to the estimated amount of impervious surface that would contribute the same amount of runoff to the City's storm and surface water drainage system as the impervious surface on the average single-family residential use in the City of Molalla. One EDU is therefore equal to square feet of impervious surface area or any portion thereof.

"Erosion prevention and sediment control (ESC)" means any temporary or permanent measures taken to reduce erosion, control siltation and sedimentation, and ensure that sediment laden water does not leave a site.

"Erosion prevention and sediment control plan (ESC plan)" means plan approved by the Oregon Department of Environmental Quality through a 1200-C permit or other state

agency permit for construction activities within the City of Molalla.

"Impervious surface" means a developed hard surface area which prevents or retards the entry of water into the soil mantle and/or causes water to run off the surface in greater quantities or at an increased rate of flow than would occur under natural or undeveloped conditions. "Impervious surface" includes, but is not limited to, rooftops, concrete or asphalt paving, compacted gravel, walkways, patios, driveways, parking lots or storage areas, and oiled, macadam or other surfaces which similarly impede the natural infiltration or runoff of surface water.

"Industrial facility" means an establishment primarily engaged in manufacturing, processing or fabrication of goods.

"Industrial user" means any user engaged in the introduction of pollutants into a Publicly Owned Treatment Works (POTW) from any non-domestic source regulated under Section 307(b), (c) or (d) of the Federal Water Pollution Control Act, Title 33 U.S.C. 1251.

"Industrial wastes" means the liquid wastes from any industrial user. A user in the divisions listed in industrial user may be excluded if it is determined that it will introduce primarily segregated domestic wastes or wastes from sanitary conveniences.

"Mains" means collection pipelines that are part of the City stormwater system.

"Maintenance" means preservation of functional integrity and efficiency of equipment and structures.

This includes preventive maintenance, corrective maintenance and replacement of equipment as needed.

"Multi-user" means a customer supplied with water service to more than one dwelling unit, commercial business or industrial facility, or combination thereof, from one water service connection.

"Natural outlet" means any outlet into a watercourse, pond, ditch, lake or other body of surface water or groundwater.

"Non-potable water" means water that is not safe for human consumption, or which is of questionable potability.

"NPDES" means National Pollutant Discharge Elimination System.

"Operation" means control of the unit processes and equipment which make up the treatment works. This includes financial and personnel management, records, laboratory control, process control, safety and emergency operation planning.

"Operation and maintenance" means activities required to assure the dependable and economical function of the treatment works.

"Person" means any individual, firm, company, association, society, group or corporation.

"pH" means the logarithm of the reciprocal of the weight of hydrogen ions in grams per liter of solution.

"Premises" means the integral property or area, including improvements thereon, to

which water service is or will be provided.

"Private sewer" means a privately owned and maintained lateral sewer system normally six or eight inches in diameter, installed to serve multi-unit structures on single-ownership properties, which cannot legally be further divided, such as apartments, mobile home parks, schools and condominiums.

"Property owner" means the owner of the premises who is also the ultimate responsible party for all customer charges and fees. The property owner may also be the customer for any given premises.

"Publicly owned treatment works" or "POTW" means a treatment plant or system, owned and operated by the City of Molalla, for the treatment of waters collected in a sewer collection system.

"Public sewer" means a sewer in which all owners of abutting properties have equal rights, and which is controlled by public authority.

"Replacement" means expenditures for obtaining and installing equipment, accessories or appurtenances which are necessary during the useful life of the treatment works to maintain the capacity and performance for which such works were designed and constructed. The term "operation and maintenance" includes replacement.

"Service connection" means a water connection or sewer connection as the context indicates.

"Service connection charge" means the fee levied to pay for the cost of labor, materials and any inspection required during the construction of a utility service line from the water or sewer main to the property that is to be served, with the charges to be itemized on a standard City billing form.

"Sewage" means a combination of the water-carried wastes from residences, business buildings, institutions, and industrial establishments, together with such groundwater, surface water, and stormwater as may be present.

"Sewer" means a pipe or conduit for carrying sewage.

"Sewer connection" means a public sewer that has been constructed to the property line or right-of-way line from a public main for the sole purpose of providing a connection for the building sewer.

"Shall" is mandatory; "may" is permissive.

"Single-family residential" means any service location which is improved with a dwelling unit for occupancy by a single family or a similar group of persons.

"Slug" means any discharge of water, sewage or industrial waste which, in concentration of any given constituent or in quantity of flow, exceeds for any period of duration longer than 15 minutes, more than five times the average 24-hour concentration of flows during normal operation.

"Storm drain" (sometimes termed "storm sewer") means a sewer designed to carry stormwater and surface water and drainage, but excludes sewage and industrial wastes, other than unpolluted cooling water.

"Stormwater" means surface runoff and street wash waters, and drainage.

"Surface water" means all naturally occurring water whose surface is exposed to the atmosphere, including natural drainage ways, stream corridors, rivers, ponds, wetlands, and impoundments.

"Surface water management system" means all facilities, both natural and constructed, used by the City to regulate the quantity and quality of surface water, including drainage easements, culverts, storm drains, catch basins, stream corridors, rivers, ponds, wetlands and impoundments.

"Suspended solids" means solids that either float on the surface of, or are in suspension in water, sewage, or other liquids, and which are removable by laboratory filtering.

"System development charge" means the fee or charge assessed to each commercial business, industry or dwelling unit for the right to connect to the City's sewer or water system, and which is used for expansion of those systems.

"Temporary service" means service of limited duration.

"TSS (total suspended solids)" means the total suspended matter that floats on the surface of, or is suspended in, water, wastewater, or other liquid, and that is removable by laboratory filtering. (EPA Standard Methods 2540(D) shall be used for any tests for TSS.)

"Undeveloped" means any location which has not been altered by grading or filling of the ground surface, or by construction of any improvements or other impervious area, which could affect the hydraulic or hydrologic properties of the property.

"Untreated stormwater" means any runoff from a site or property, whether by storm, washdown, or any other form, that either violates the basin approved Molalla-Pudding River Subbasin TMDL standards for Temperature, Bacteria, Pesticides, Nitrate, Metals, the conditions of any NPDES permit that applies, or that in the opinion of the Public Works Director constitutes a harmful discharge to the ecology or use of the receiving body within the City.

"Useful life" means the period during which a treatment works is planned and designed to be operated.

"User" means the owner, agent, tenant or other authorized representative responsible for occupancy of the premises that is served by a City utility system. A person, corporation, association or agency which rents, or leases premises shall be considered an agent of the property owner.

"User service charge" means a charge levied on customers that may be a combination of a base fee, a usage fee and a fixed fee as set by resolution and/or ordinance.

"Utility" or "utility system" means sewer, water and stormwater management services provided by the City of Molalla.

"Utility rate" is the rate established by City Council to cover the cost of providing utility system services.

"Utility service" means services provided for water, sewer, and stormwater.

"Wastewater" means a combination of the water-carried wastes from residences, business buildings, institutions and industrial establishments, together with such incidental groundwater, surface water and stormwater as may be present.

"Water connection" means the pipe, valves, fittings and meter by means of which the City conducts water from its main to and through a meter(s), but not including piping from the meter to the premises served.

"Watercourse" means a channel in which a flow of water occurs, either continuously or intermittently.

"Water main" means water pipe and all necessary valves, fittings, hydrant connections and other appurtenances used for the distribution of water.

"Water system" means all municipally owned facilities of the City used to supply, process and distribute drinking-quality water to each customer service connection or temporary service.

(Ord. 2020-05 §1)

§ 13.13.020. Fees, rates and charges—Council authority.

All fees, rates and charges stated within the utility code may be changed at any time by resolution of the City Council.

(Ord. 2020-05 §1)

§ 13.13.030. Fees, rates and charges set by resolution.

The City Council will establish the fees, rates and charges for the City's utilities by resolution in an amount reasonable and necessary to fund the administration, debt, planning, design, construction, operation, maintenance and repair of the City's utility systems. Rates shall be based on generally accepted rate-making principles, including the City's true costs in upgrading the system to accommodate regulatory requirements and to provide adequate collection and treatment capacity for system users.

(Ord. 2020-05 §1)

§ 13.13.040. Application for service.

The following criteria must be met regarding application for utility service:

- A. Application for storm sewer service shall be made in writing by the owner of the premises to be served, or the owner's agent duly authorized in writing on regular application forms furnished by the City. No service will be rendered until such application has been completed and the required payments made. All applications shall include signature of applicant, locations of premises for which service is requested, address to which all bills shall be sent, and such additional data as the Council from time to time may require.
- B. Applications for service shall be considered merely as a request for service, and they shall not bind the City or Council to provide service.
- C. Two or more parties who join together to make or who jointly make application for

service are jointly and individually liable and will be sent a single billing.

- D. Any person 18 years of age or older who receives utility services at a premises is liable for the services provided.
- E. Contracts, other than applications, may be required prior to service where, in the opinion of the City, special circumstances exist.
- F. If a service is connected to the City utility system without application, the City will disconnect the premises. Before a new connection is made, the applicant must pay double the rate of the estimated charges for the unpaid services during the period of non-City-approved connection.
- G. In no case will utility service be allowed until the customer has complied with the terms of this section and all appropriate fees and charges have been paid.
- H. In no case will utility service be allowed for properties that are not in compliance with any other section of the Municipal Code.

(Ord. 2020-05 §1)

§ 13.13.050. Deposit requirements.

Each storm sewer service customer shall pay a deposit to secure the payment of sewer/utility bills, unless exempted under the provisions of subsection (A)(3) of this section. The amount of the deposit shall be established by the City Council by resolution. After payment of all amounts due for storm sewer service, the deposit shall be refunded, within 90 calendar days, to the customer upon termination of service or upon the customer's qualification for an exemption from the deposit requirement.

- A. Storm sewer service customers shall be exempt from the requirement to maintain a deposit if:
 - 1. The customer has maintained a storm sewer service account with the City for a continuous period of one year without any delinquencies in payment; or
 - 2. The customer previously had a storm sewer service account with the City of Molalla for a period of at least one year, and there were no delinquencies in payment on that account.
 - 3. Notwithstanding the provisions of this section, the City Manager may waive a customer's deposit requirement, extend the period during which a deposit is required, or reinstate a customer's deposit requirement for good cause.

(Ord. 2020-05 §1)

§ 13.13.060. Rates—Generally.

All users of the City's stormwater system shall pay to the City the rates for storm sewer service as provided by this chapter. A surface water utility user charge, which shall be set by the City Council by resolution, is established. The rate shall be in an amount reasonable and necessary to fund the administration, planning, design, construction,

operation, maintenance and repair of the surface water management system.

The surface water utility user charge shall be based upon the amount of developed impervious surface used by a customer. Owners or occupants of undeveloped property shall not be charged. Each customer using a location for one single-family residential use shall be charged a uniform rate based upon one equivalent development unit (EDU). For multifamily residential uses, the charge shall be one EDU per each residential unit. The charge for all other uses shall be based upon the total amount of measured impervious surface used, divided by one EDU and rounded to the nearest whole number. The actual service charge shall be computed by multiplying the total amount of EDUs measured for each use by the rate established for each EDU.

(Ord. 2020-05 §1)

§ 13.13.070. Service connection charges—Generally.

- A. A connection charge levied and imposed upon the owner of any property connecting to the storm sewer system of the City of Molalla, which shall be paid prior to such connection. The charge shall be established by the City Council by resolution.
- B. The connection charge is levied upon a property based upon the existing or intended use of the property at the time of application for connection. If the property is improved, expanded, subdivided or otherwise modified so as to increase the connection charge due from that property, a connection charge shall be levied for the modified portion of the property based upon connection charges in effect at the time of the modification.

(Ord. 2020-05 §1)

§ 13.13.080. Rates—Outside-City.

No services will be provided outside of City limits.

(Ord. 2020-05 §1)

§ 13.13.090. Charges for restoration of service.

The City will charge a fee to a customer for restoration of utility service when service has been discontinued under the provisions of the utility code. This charge does not apply to newly installed service connections unless the applicant has outstanding charges on another account. The City may require a deposit, or require a larger deposit, before it will restore utility service based on prior payment history.

(Ord. 2020-05 §1)

§ 13.13.100. Computation and collection of charges.

The Finance Department will collect all user service charges. User service charges are computed and payable as provided in the utility code.

(Ord. 2020-05 §1)

§ 13.13.110. Revenues—Deposit and use.

The Finance Department will deposit in the appropriate fund all the gross revenues received from charges, rates and penalties collected for the use of the utility systems. The revenues deposited in the appropriate fund must be used exclusively for administration, planning, design, construction, improvements, operation, maintenance, debt payments and repair of the City's storm sewer utility system.

(Ord. 2020-05 §1)

§ 13.13.120. Billing—Mailing address.

The City will mail bills for user service charges to the mailing address specified on the application for services, unless a different owner or customer has requested to the Finance Department that services be placed in their name and has agreed in writing to be responsible for the user service charges. When requested, the City will submit bills through its online billing program.

(Ord. 2020-05 §1)

§ 13.13.130. Billing—Payment responsibility.

- A. The property owner of record is ultimately responsible for payment of all charges prescribed in the utility code, regardless of any agreement the property owner may have with a third party and regardless of whether the customer's bills were in a tenant's name.
- B. A customer who is a tenant continues to be responsible for delinquent utility charges until paid regardless of relocation to premises different from the premises at which the tenant accrued delinquent charges. The City may refuse to provide service to such tenant at any new address, and/or may terminate utility service until the delinquent bill is paid. The City may also pursue any action available under the laws of the City or State of Oregon to recover payment.

- C. Multi-metered accounts must be in the property owner's name.

(Ord. 2020-05 §1)

§ 13.13.140. (Reserved)**§ 13.13.150. Adjustment of accounts—No service provided.**

If a customer pays for utility services not actually received as a result of the City's error, the City will refund the amount paid for services not received. Refunded amount may not exceed a period of one year from the date the customer notified the City. To be designated as property not receiving service, the property must be undeveloped.

(Ord. 2020-05 §1)

§ 13.13.160. (Reserved)

§ 13.13.170. Liens for delinquent utility account.

Utility service charges become a lien against the premises served from and after the date of billing and entry on City records pertaining to the utility system. Such records are accessible for inspection by anyone interested to ascertain the amount of such charges against the property. Whenever a bill for utility service remains unpaid for 90 calendar days after billing, the lien thereby created may be foreclosed in a manner provided for in Oregon Revised Statutes, or in any other manner provided for by law or by City ordinance.

(Ord. 2020-05 §1)

§ 13.13.180. Exclusive control of system and services by City.

The surface water management system within the City limits, including all connections and contributions to the system, shall be under the exclusive control of the City. No person shall install any service, connect to any part of the system, discharge storm sewer or surface water into the system, or otherwise interfere with any part of the system without authorization of the City.

(Ord. 2020-05 §1)

§ 13.13.190. Service discontinuance at customer request.

- A. A customer may have utility service discontinued by notifying the City at least five business days in advance of the desired date of discontinuance.
- B. If the customer does not give notice, the customer must pay for utility service until the date the City has learned the customer has vacated the premises or a new customer has requested service.

(Ord. 2020-05 §1)

§ 13.13.200. Abandoned and non-revenue-producing services.

- A. The City may remove a utility service connection to a premises that has been abandoned or not used for a period of one year or longer.
- B. The City will only begin new utility service when the City receives a new customer application and payment for the new connection.

(Ord. 2020-05 §1)

§ 13.13.210. Disconnection from storm sewer system—Destroyed or removed structures.

- A. When any structure connected to the storm sewer system is destroyed by an act of God, is removed, or is torn down, and/or no longer usable, it shall be required to disconnect from the storm sewer system and remove all impervious surfaces from site. The owner must advise the City of the destruction, stating the date of destruction or removal of the structure, and pay all user service charges to the date of destruction or removal, and thereafter no storm sewer user service charge will be made to the property until new improvements, if any, are placed on the property.

- B. When the property is relieved from user service charges and then reconnected to the utility system, the City will determine whether the property had paid into the appropriate utility fund the amount required while the property was using City utilities. If the property had paid user service charges equal to the amount required under the utility rates that were in effect at the time of the disconnection from the utility system, the City will not levy any additional charges.
- C. In addition, when a building with storm sewer service is destroyed or is relocated to a different property and thereafter replaced by a new building within three years after the date of destruction or removal, the City shall not levy a system development charge for the new building, unless the new building constitutes an increase in use under the system development charge schedule currently in effect. If the replacement building requires a greater system development charge than compared to the destroyed or relocated building previously on the same site, then a credit will be given on the replacement building's system development charge equal to that of the previous building fee, and when the above provisions of this section and Section 13.13.220 are met.
- D. The current system development charge schedule shall be used for all comparisons and credit determinations under Chapter 13.14. When a destroyed or relocated building is not replaced by a new building within three years of the date of destruction or an update to the storm sewer master plan is completed, then the owner of any replacement building must pay the full system development charge in effect at the time of application for storm sewer service.

(Ord. 2020-05 §1)

§ 13.13.220. Disconnection from storm sewer system—Reuse of old facilities.

- A. Before the City will issue a moving or demolition permit, City personnel must verify disconnection and capping of the building storm sewer service at the right-of-way cleanout. If a cleanout does not exist, property owner must install a cleanout and cap at the right-of-way meeting City requirements.
- B. In addition, when a building with storm sewer service is destroyed or relocated to a different property and is not replaced by a new building within three years from the date of destruction or removal, the Director of Public Works or director's designee may inspect the storm sewer service to determine whether it is in usable condition and is to be reused. If the storm sewer service is found unusable, the property owner is required to pay all costs for replacement of the storm sewer service connection.

(Ord. 2020-05 §1)

§ 13.13.230. Disconnection and reconnection procedures.

- A. When any structure connected to the storm sewer system is destroyed by an act of God, is removed or is torn down, and/or no longer usable, it shall be required to disconnect from the storm sewer. The owner shall advise the City, stating the date of destruction or removal of the structure, and pay all user service charges to the date of destruction or removal, and thereafter no user service charge shall be made

to the property until new improvements, if any, are placed on the property.

- B. When the property is relieved from user charges and then reconnected to the storm sewer, the City shall determine whether the property had paid into the storm sewer fund the amount required while the property was using the storm sewer. If the property had paid user service charges equal to the amount required under storm sewer rates that were in effect at the time of disconnecting from the storm sewer, no additional charges will be levied.
- C. In addition, when a building with storm sewer service is destroyed, or relocated to a different property and thereafter replaced by a new building within three years from the date of destruction or removal, the City shall not levy a system development charge for the new building unless the new building constitutes an increase in use under the system development charge schedule currently in effect. If the replacement building requires a greater system development charge when compared to the destroyed or relocated building previously on the same site, then a credit will be given on the replacement building system development charge equal to that of the previous building fee, and when the above provisions of this section are met.
- D. The current system development charge schedule will be used for all comparisons and credit determinations under this section.
- E. When a destroyed or relocated building is not replaced by a new building within three years of the date of destruction or an update to the storm sewer master plan is completed, then any replacement building shall pay the system development charges in effect at the time of application for storm sewer service.

(Ord. 2020-05 §1)

§ 13.13.240. Unsanitary deposit of waste.

It is unlawful for any person to place, deposit, or permit to be deposited in any unsanitary manner on public or private property within the City, or in any area under the jurisdiction of the City, any human or animal excrement, garbage, or other unsanitary waste that can drain into or impact a storm sewer or drainageway. This includes ranging livestock, poultry, or pet-runs near or within storm facilities such as bioswales.

(Ord. 2020-05 §1)

§ 13.13.250. Treatment of storm sewer required.

It is unlawful to discharge to any natural outlet within the City, or in any area under the jurisdiction of the City, any untreated stormwater or other polluted substances. All discharges shall comply with the Molalla Public Works Standards and its NPDES permit issued by the DEQ. Stormwater shall be protected from soap, wax or other pollution runoff from vehicle wash facilities.

(Ord. 2020-05 §1)

§ 13.13.260. Unlawful sewage disposal facilities.

Except as provided in this chapter, it is unlawful to construct or maintain any privy, privy vault, septic tank, cesspool, or other facility intended or used for the disposal of sewage that may have an effect on groundwater or surface water within the City limits.

(Ord. 2020-05 §1)

§ 13.13.270. Storm sewer connections required.

The owner of all houses, buildings, or properties used for human occupancy, employment, recreation, or other purposes, situated within the City and abutting on any street, alley, or right-of-way in which there is now located or may in the future be located a public storm sewer of the City, is required at the owner's expense to install storm facilities therein, and to connect such facilities directly with the proper public storm sewer in accordance with the provisions of this chapter, within 90 calendar days after date of official notice to do so, provided that the public storm sewer is within 100 feet of the property line.

(Ord. 2020-05 §1)

§ 13.13.280. Private storm sewer disposal—When permitted.

- A. Where a public storm sewer is not available the building storm sewer shall be connected to a private storm system that meets all federal and state rules, and does not negatively impact groundwater, drainageways, or downstream properties.
- B. The provisions of this section shall be in addition to and not in lieu of the requirements of other applicable laws, rules and regulations.

(Ord. 2020-05 §1)

§ 13.13.290. Private storm sewer disposal—Operation and maintenance.

The owner of property with a private storm sewer disposal system shall always operate and maintain the system in a sanitary manner, at no expense to the City.

(Ord. 2020-05 §1)

§ 13.13.300. Upon availability of public storm sewer—Abandonment of private systems.

At such times as a public storm sewer becomes available to a property served by a private sewage disposal system, as provided in Section 13.13.280, and upon notification to the property owner from the City, a direct connection shall be made to the public storm sewer in compliance with this chapter, and any drywell and similar private storm sewer disposal facilities shall be decommissioned, abandoned and filled with suitable material. All costs associated with decommissioning, abandonment and connection shall be the responsibility of the property owner.

(Ord. 2020-05 §1)

§ 13.13.310. Unauthorized connections and disturbances.

No unauthorized person shall uncover, make any connections with or opening into, use, alter, or disturb any public storm sewer or appurtenance thereof without first obtaining a written permit from the Director of Public Works.

(Ord. 2020-05 §1)

§ 13.13.320. Costs of building storm sewer borne by owner.

All costs and expense incident to the installation and connection of the building storm sewer shall be borne by the owner. The owner shall indemnify the City from any loss or damage that may directly or indirectly be occasioned by the installation of the building storm sewer.

(Ord. 2020-05 §1)

§ 13.13.330. Building storm sewer for each lot or parcel.

- A. Every single-ownership property which cannot legally be further subdivided must have a separate storm sewer connection. These properties include, but are not limited to, multiple-family apartments, condominiums, mobile home parks and commercial or industrial establishments. Only one storm sewer lateral shall be provided to a residential property.
- B. Multi-users with more than one unit located in common ownership on a single parcel of property shall also comply with the Oregon State Plumbing Specialty Code.
- C. Any property which is located so as to require the storm sewer lateral to cross any other property or parcel shall provide evidence of a duly recorded perpetual easement for such lateral, appurtenant to the property to which such lateral will provide service, before any storm sewer connection is made.
- D. Property other than residential shall utilize a common storm sewer main to provide services to individual building. Exceptions to this requirement must be in the interest of the public as determined and approved by the Director of Public Works.

(Ord. 2020-05 §1)

§ 13.13.340. Materials and connections—Private side.

The size, slope, alignment, materials of construction of a building storm sewer, and the methods to be used in connecting, excavating, placing of the pipe, jointing, testing, and backfilling the trench, shall all conform to the requirements of the uniform building and plumbing code and all other applicable rules and regulations. In the absence of code provisions or in amplification thereof, the materials and procedures set forth in appropriate specifications of the A.S.T.M. and W.P.C.F. Manual of Practice No. 9 shall apply, or the most current version thereof. All connections shall be made gastight and watertight. Any deviation from the prescribed procedures and materials must be approved by the Director of Public Works before installation.

Storm sewer laterals on private property that are not part of the public system or within a public right-of-way or public storm sewer easement, the size, slope, alignment, materials of construction of a building storm sewer, and the methods to be used in connecting, excavating, placing of the pipe, jointing, testing, and backfilling the trench, shall all conform to the requirements of the uniform building and plumbing code and all other applicable rules and regulations.

(Ord. 2020-05 §1)

§ 13.13.350. Elevation.

Whenever possible, the building storm sewer shall be brought to the building at an elevation to drain directly to the street through a weep hole in the curb. In all buildings in which any building drain is too low to permit gravity flow to the public storm sewer, storm sewer carried by a building drain shall be lifted by an approved means and discharged to the public storm sewer at the property owner's expense.

(Ord. 2020-05 §1)

§ 13.13.360. Connection of sources of surface runoff.

- A. No person shall make connection of roof downspouts, exterior foundation drains, areaway drains, or other sources of surface runoff or groundwater to a building sanitary sewer or building drain which in turn is connected directly or indirectly to a public sanitary sewer.
- B. Where the City finds that any private service lateral piping is leaking or not legally connected, the property owner will be notified in writing by the City to make necessary repairs. The notification shall include the type of repairs to be made and the date, no less than 30 calendar days from the date of the notice, by which the repairs shall be completed.
- C. The property owner shall notify the Director of Public Works when repairs have been made, but before any piping is buried, and the City shall inspect and retest the private service lateral for leaks. The lateral will be considered repaired when it passes the retest by the City.

(Ord. 2020-05 §1)

§ 13.13.370. Inspection—Connection to public storm sewer.

The applicant for the building storm sewer permit shall notify the Director of Public Works or appropriate City official when the building storm sewer is ready for inspection and connection to the public storm sewer. The connection shall be made under the supervision of the Director of Public Works or representative.

(Ord. 2020-05 §1)

§ 13.13.380. Protection of excavations—Restoration of public property.

All excavations for building storm sewer installation shall be adequately guarded with barricades and lights to protect the public from hazard. Streets, sidewalks, parkways, and other public property disturbed in the course of the work shall be restored in a manner

satisfactory to the City.
(Ord. 2020-05 §1)

§ 13.13.390. Unlawful discharge of storm and other waters.

No person shall discharge or cause to be discharged any stormwater, surface water, groundwater, roof runoff, subsurface drainage, uncontaminated cooling water, or unpolluted industrial process waters to any sanitary sewer.
(Ord. 2020-05 §1)

§ 13.13.400. Regular utility service—Rules and regulations.

- A. The City may furnish and install a utility service connection of such size and location as a customer requests; provided, that the request is reasonable and is in compliance with provisions of the Oregon State Plumbing Specialty Code, the City's design standards, and the utility code. The customer is responsible for all costs, including administration, for installation of utility service.
- B. The City will install the storm sewer service from the main to right-of-way/property line of the premises, if the main is in the street, or to a point in a City right-of-way or easement unless storm access through a weep hole in the curb is a viable option.
- C. The customer or property owner must furnish, install and keep in good and safe condition equipment that may be required for receiving, controlling, applying and utilizing any city utility, and the customer or property owner must do so at their own risk and expense.
- D. The City is not responsible for loss or damage caused by the improper installation of the equipment used for receiving a City utility service by customer or customer's agent, or the negligence, want of proper care, or wrongful act in installing, maintaining, using, operating or interfering with the equipment by the customer or customer's agent.
- E. The City is not responsible for damage to property caused by City's regular cleaning and maintenance of storm sewer main lines.
- F. A customer making any material change in the size, character or extent of the equipment or operation utilizing storm sewer service, or whose change in operations results in a large increase in the use of water, shall immediately give the City written notice of the nature of the change and, if requested, amend the customer's application.
- G. Any utility service connection, whether located on public or private property, is the property of the City, and the City reserves the right to repair, maintain and/or replace it.
(Ord. 2020-05 §1)

§ 13.13.410. Inspection and maintenance—Responsibility.

The owner of all houses, buildings or properties used for human occupancy,

employment, recreation or other purposes, situated within the City, wherein such facilities are connected to the proper public storm sewer in accordance with this chapter, are responsible for the maintenance and cost of maintaining the private service lateral and private site systems.

(Ord. 2020-05 §1)

§ 13.13.420. Inspection and maintenance—Testing, cleanouts, and right of entry.

- A. The Director of Public Works and other duly authorized employees of the City bearing proper credentials and identification shall be permitted to enter all properties, upon prior written notice, to make tests of private service lateral piping to determine whether such piping is adequately watertight.
- B. The property owner shall be responsible to supply cleanout at or adjacent to the house or buildings upon 10 business days' written notice by the City. Such cleanout shall be the same size as the service lateral piping and shall conform to the City of Molalla standard specifications for service lateral cleanout.
- C. The City may elect at its cost to construct a service lateral cleanout on public right-of-way for use in testing and/or repairing of service lateral piping. The cleanout shall conform to City standards.

(Ord. 2020-05 §1)

§ 13.13.430. Inspection and maintenance—Grease traps and interceptors.

Where no polluted waters are allowed to discharge to the storm system, groundwater, or drainageway, no grease traps or interceptors shall be connected to the storm system or any other facility carrying stormwater.

(Ord. 2020-05 §1)

§ 13.13.440. Improper connection and notice to repair.

- A. Where the City finds that any private service lateral piping is leaking or not legally connected, the property owner will be notified in writing by the City to make necessary repairs. The notification shall include the type of repairs to be made and the date, no less than 30 calendar days from the date of the notice, by which the repairs shall be completed.
- B. The property owner may elect to have the City repair or replace private service laterals by notifying the Director of Public Works in writing. The property owner may then contract with the City for such repairs.
- C. The City shall contract out the work and charge for any in-house labor and materials so furnished.
- D. Upon completion of repairs, the City shall provide a written accounting to the property owner prepared by the Director of Public Works.
- E. The property owner shall pay the City for the repairs by paying no less than one-twelfth the cost of the improvements as a surcharge on the storm sewer bill until the

outstanding amount has been paid in full. The City shall charge no interest on the unpaid balance.

- F. The City does not assume any obligation for reasonably necessary damage to landscaping, vegetation and walkways caused by repair work, and the property owner shall be solely responsible for repairing or replacing such damages.

(Ord. 2020-05 §1)

§ 13.13.450. Nonconformance—Notice.

- A. Any property owner who fails to comply with the provisions of Sections 13.13.410 through 13.13.440 shall be deemed to possess a private service lateral not in conformance.
- B. The Director of Public Works shall notify by mail each property owner he or she determines is in violation at the address of such owner as listed on the latest tax rolls of the Tax Assessor for Clackamas County, Oregon. The notice shall set forth the basis for such alleged violations along with an explanation of the consequences of having a service lateral not in conformance. The notice shall include notification of the right to a hearing as described in this section.
- C. Within 10 business days of the mailing of the notice described in subsection B of this section, the property owner may request a hearing before the City Manager. At such hearing the City Manager shall determine whether or not the property is in violation as alleged. Unless such request for a hearing is filed within the time provided by this section, the property owner shall be deemed to possess a service lateral not in conformance. If the property owner is found to be in violation at the hearing by the City Manager, then the property owner's service lateral shall be deemed not in conformance. The property owner may appeal the decision of the City Manager within 10 business days of such decision by filing a written notice of appeal with the City Manager. Appeals shall be heard by the City Council.

(Ord. 2020-05 §1)

§ 13.13.460. Nonconformance—Charges.

Any property owner who maintains a private service lateral not in conformance with the maintenance requirements of this article shall be assessed a monthly storm sewer charge triple the normal rate until the private service lateral is brought into conformance with the requirements of this chapter.

(Ord. 2020-05 §1)

§ 13.13.470. City may assume cost of repairs.

At such times that the City Council shall determine by resolution that it is in the public interest to repair a service lateral or group of service laterals without delay the City may repair such lateral at the City's expense without prior testing of such lateral and with the consent of the property owner without notice as provided in Sections 13.13.410 through 13.13.440.

(Ord. 2020-05 §1)

§ 13.13.480. Damage to sewage works prohibited.

No unauthorized person shall maliciously, willfully, or negligently break, damage, destroy, uncover, deface, or tamper with any structure, appurtenance, or equipment which is a part of the storm system.

(Ord. 2020-05 §1)

§ 13.13.490. Entry on property.

The Director of Public Works and other duly authorized employees of the City bearing proper credentials and identification shall be permitted to enter all properties, upon prior written notice, for the purposes of inspection, observation, measurement, sampling, and testing in accordance with the provisions of this chapter. The Director of Public Works or representative shall also have the authority to inquire into any processes including metallurgical, chemical, oil, refining, ceramic, paper, or other industries beyond that point having a direct bearing on the kind and source of discharge to the storm sewers or waterways or facilities for wastes treatment.

(Ord. 2020-05 §1)

§ 13.13.500. Observance of safety rules—Liability of City.

While performing the necessary work on private properties referred to in Section 13.13.490, the Director of Public Works or duly authorized employees of the City shall observe all safety rules applicable to the premises established by the company and the company shall be held harmless for injury or death to the City employees and the City shall indemnify the company against loss or damage to its property by City employees and against liability claims and demands for personal injury or property damage asserted against the company and growing out of the gauging and sampling operation, except as such may be caused by negligence or failure of the company to maintain safe conditions.

(Ord. 2020-05 §1)

§ 13.13.510. Entry and work on easements.

The Director of Public Works and other duly authorized employees of the City bearing proper credentials and identification shall be permitted to enter all private properties through which the City holds a duly negotiated easement for the purposes of, but not limited to, inspection, observation, measurement, sampling, repair, and maintenance of any portion of the sewage works lying within the easement. All entry and subsequent work, if any, on the easement shall be done in full accordance with the terms of the duly negotiated easement pertaining to the private property involved.

(Ord. 2020-05 §1)

§ 13.13.520. Certain discharges subject to approval.

No person shall discharge or cause to be discharged the following described substances, materials, waters, or wastes if it appears likely in the opinion of the Director of Public Works that such wastes can harm the storm sewer system or public drainageways. The substances prohibited are including but not limited to the following:

- A. Any untreated stormwater as defined in Section 13.13.010;
 - B. Stormwater discharges a temperature higher than 150°F (65°C);
 - C. Stormwater discharges containing fats, gas, grease, or oils, whether emulsified or not;
 - D. Stormwater discharges containing acid, plating solutions whether neutralized or not;
 - E. Stormwater discharges containing iron, chromium, copper, zinc, and similar objectionable or toxic substances, or chlorine;
 - F. Stormwater discharges containing phenols or other taste or odor producing substances;
 - G. Stormwater discharges containing any radioactive wastes or isotopes;
 - H. Stormwater discharges containing having a pH in excess of 8.0 or less than 6.0;
 - I. Stormwater discharges containing unusual concentrations of inert suspended solids or discoloration;
 - J. Stormwater discharges containing paint, stains, or other coatings;
 - K. Stormwater discharges containing substances which are not amenable to treatment or reduction by the water quality facilities;
 - L. Stormwater discharges or runoff containing fluids or materials from a defective or improperly maintained septic system.
- (Ord. 2020-05 §1)

§ 13.13.530. Decision of Director of Public Works regarding harmful wastes.

If any waters or wastes are discharged, or are proposed to be discharged to the public storm sewers, which waters contain the substances, or possess the characteristics enumerated in Section 13.13.520 and which, in the judgment of the Director of Public Works, may have a deleterious effect upon the sewage works, processes, equipment, or receiving waters, nuisance, the Director of Public Works shall require pretreatment prior to discharge to water quality or detention facilities to an acceptable condition for discharge to the public storm sewers. Stormwater pretreatment shall be permitted and monitored through the DEQ.

(Ord. 2020-05 §1)

§ 13.13.540. Notification of spills.

- A. As soon as any person in charge of a facility or responsible for emergency response for a facility becomes aware of any suspected, confirmed, or unconfirmed release of material, pollutants, or waste creating a risk of discharge to the public stormwater system, such persons shall:

1. Begin containment procedures;
 2. Notify proper emergency personnel in case of an emergency;
 3. Notify appropriate City and/or State officials regarding the nature of the spill; and
 4. Follow-up with the City regarding compliance and modified practices to minimize future spills, as appropriate.
- B. The notification requirements of this section are in addition to any other notification requirements set forth in local, State, or Federal regulations and laws. The notification requirements do not relieve the person of necessary remediation.
- (Ord. 2020-05 §1)

§ 13.13.550. Illicit discharges and connections.

- A. The Public Works Director may require by written notice that any user who makes an illicit connection to the public stormwater system complies with the requirements of this chapter to eliminate the illicit connection or secure approval for the connection by a specified date.
- B. If, subsequent to eliminating a connection found to be in violation of this chapter, the responsible party can demonstrate that an illicit discharge will no longer occur, that user may request approval to reconnect. The reconnection or reinstallation of the connection shall be at the user's expense.
- C. Whenever the City finds that a discharge of pollutants is taking place or has taken place which will result in or has resulted in pollution of stormwater, stormwater system, and therefore the receiving water body, the Public Works Director may require by written notice to the responsible party that the pollution is remediated and the affected property restored, to the requirements of this chapter.
- D. Whenever the Public Works Director determines that any person engaged in any activity which may cause or contribute to stormwater pollution or illicit discharges to the stormwater system, the Public Works Director may, by written notice, order that the responsible party undertake such monitoring activities and/or analyses and furnish such reports as the Public Works Director may deem necessary to demonstrate compliance with this chapter. The written notice shall be served either by personal delivery or by certified or registered mail, return receipt requested, and shall set forth the basis for such order and shall particularly describe the monitoring activities and/or analyses and reports required including but not limited to, that which may be undertaken by a third party independent monitor, sampler and/or tester. The recipient of such order shall undertake and provide the monitoring, analyses and reports within the time frames set forth in the order. If the City cannot locate the responsible party and the responsible party is a person other than the owner of the property, the City will notify the owner of the property in writing via personal delivery or certified mail requiring the owner to monitor the property and furnish such reports as the Public Works Director may deem necessary to

demonstrate compliance with this chapter.
(Ord. 2020-05 §1)

§ 13.13.560. Reporting of harmful discharges.

Businesses are required to accurately report any chemical discharges to the storm sewer system to the Director of Public Works and the DEQ.
(Ord. 2020-05 §1)

Discharge Regulations

No person shall discharge, or cause to be discharged, any substance into the public stormwater system if the discharge poses a threat to health, safety, public welfare, or the environment, or is otherwise prohibited by law. The City Manager may withdraw approval to discharge if the City Manager determines that a discharge poses a threat to health, safety, public welfare, or the environment, or is otherwise prohibited by law.

No person shall allow an illicit discharge from their property to flow out, on or into a stormwater management system, whether public or private.

No person shall place or cause to be placed, a substance which is harmful to or tends to clog any public stormwater system or permit such substance in the control of such person to enter the public stormwater system.

No person shall allow stormwater to flow out on or under a public way in a manner that creates a hazard for those lawfully using the public way or that creates a hazard within the public stormwater system.

No person shall cause or suffer visible and measurable erosion or sediment which enters or is likely to enter the public storm drainage system, waterways, drainage courses, wetlands, or waters of state or United States.

Discharge in Violation of NPDES Permit.

Any discharge that would result in or contribute to a violation of an existing or future NPDES MS4 Permit and any amendments, revisions, or reissuance thereof, either separately considered or when combined with other discharges, is a violation of this Chapter and is prohibited. Liability for any such discharge shall be the responsibility of the persons causing or responsible for the discharge, and such persons shall defend, indemnify, and hold harmless the City in any administrative or judicial enforcement action against the permit holder relating to such discharge.

Compliance with Other Permits and Regulations; Conflicts

Any industrial discharger, discharger associated with a construction activity, or other discharger subject to any NPDES or Water Pollution Control Facility permit issued by the Oregon DEQ, from which pollutants may enter the public or private stormwater system, shall obtain, and comply with all provisions of such permits, including notification to and cooperation with local entities as required by state and federal regulations. Proof of compliance with said permits may be required in a form acceptable to the City Manager prior to issuance of any grading, building, or occupancy permits or business license. At the City Manager request, the discharger shall submit a copy of Discharge Monitoring Reports required by NPDES or Water Pollution Control Facility permits to the City.

All users of the public stormwater system and any person or entity whose actions may affect the system shall comply with all applicable federal, state, and local laws. Compliance with the requirements of this Chapter shall in no way substitute for or eliminate the necessity for compliance with applicable federal, state, and local laws.

Any provisions or limitations of this Chapter and any Codes adopted pursuant hereto are superseded and supplemented by any applicable federal, state, or local requirements existing or adopted subsequent hereto, which are more stringent than the provisions and limitations contained herein. Any provision of this Chapter and Codes adopted pursuant hereto which are more stringent than any such applicable federal, state, or local requirement shall prevail and shall be the standard for compliance by the connectors to and the discharges to the public stormwater system.

Prohibition of Illicit Discharges

The construction, use, maintenance, or continued existence of illicit connections to the public stormwater system, groundwater and waterways is prohibited. This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.

Requirement to Report Illicit Discharges

Any person owning, engaging in any activity on, or occupying real property shall report the discharge of any pollutant from that property to the City Public Works Department if the discharge has introduced, or is likely to introduce, a pollutant into the public stormwater system, a private stormwater system, or receiving waterway or wetland. The report shall be made at the earliest possible time, but in no case later than 24 hours after discovery of the discharge. Reporting pursuant to this Chapter is in addition to, and not in lieu of, any other reporting requirements imposed by federal, state, or local laws. A failure to report a discharge under this Chapter is a violation.

Requirement to Remediate

Whenever the City Manager finds that a discharge of pollutants is taking place or has taken place which will result in or has resulted in pollution of stormwater or the public stormwater system or which will result in or has resulted in a violation of the NPDES MS4 General Permit, the City Manager may require by written notice to the responsible person that the pollution be remediated and the affected property restored, to the standards established by the City Manager, within a specified time, at the responsible person's expense.

The City Manager may require dischargers to make structural or operational modifications to their facilities, equipment, or drainage systems or to take other measures to protect the public stormwater system, private stormwater system or receiving water. Such structures and site modifications must be reviewed and approved by the City Manager to determine sufficiency.

If, subsequent to eliminating a discharge or connection found to be in violation of this Chapter, the responsible person can demonstrate that an illicit discharge will no longer occur, that person may request approval to reconnect. The reconnection or reinstallation of the connection shall be at the responsible person's expense.

Dischargers must eliminate or control direct or indirect spills or discharges into the public stormwater system, private stormwater system or receiving water by the deadline set forth in notifications made by the City Manager.

Requirement to Monitor and Analyze

The City Manager may require by written notice to the property owner that any person engaged in any activity and/or owning or operating any facility which may cause or contribute to stormwater pollution, illicit discharges, releases or spills to the public stormwater system, private stormwater system or receiving water to undertake at the owner's expense any monitoring and analyses and furnish any reports to the City Manager as deemed necessary to determine compliance with this Code.

§ 13.13.570. Construction—Public works design standards.

Storm sewers shall be designed in compliance with Chapter 12.12 for all public improvements and the Oregon Plumbing Specialty Code for all private plumbing services.

(Ord. 2020-05 §1)

§ 13.13.580. Construction—Construction specifications.

Storm sewers shall be constructed in compliance Chapter 12.12 for all public improvements. All building storm sewers shall be constructed in compliance with the Oregon Plumbing Specialty Code, except where higher standards apply within the utility code.

(Ord. 2020-05 §1)

§ 13.13.590. Construction—Permit required for storm sewer work.

No unauthorized person shall uncover, make any connections with or opening into, use, alter or disturb any public storm sewer or appurtenance thereof without first obtaining a written permit from the Director of Public Works.

(Ord. 2020-05 §1)

§ 13.13.600. Construction—Erosion prevention and sediment control.

- A. Purpose. These regulations contained herein, together with the current version of the Molalla Public Works Standards will be referred to herein as "these Standards." The purpose of these Standards is to establish uniform requirements for land development and construction-related activities in order to control the occurrence of erosion and to prevent the creation, migration and/or transport of erosion at the source during construction and land development.
- B. Standards. These Standards shall be administered and enforced by the Public Works Director or designee. The Public Works Director shall have the authority to develop and implement procedures, forms, policies, and interpretations for administering the provisions of these Standards.
- C. ESC Permit Required. An ESC applicant must obtain an ESC permit from the DEQ and a City of Molalla Public Works permit before commencing any ground disturbing activity affecting 500 square feet or greater, cumulatively, throughout the duration of development, redevelopment, or other construction related activity of a parcel or parcels. A copy of the approved DEQ 1200-C permit shall be

submitted to the Public Works Director before issuance of any Public Works permit and before any clearing or grading shall be allowed to proceed.

- D. ESC Plan Required. The ESC applicant shall submit a copy of the approved DEQ ESC plan with and incorporate into all construction plans.
- E. ESC Implementation. An approved ESC permit shall be implemented and maintained in accordance with DEQ requirements and as follows:
 - 1. It shall be the duty of the ESC applicant to inspect the property in conformance with the permit issued to ensure ESC measures are effective.
 - 2. The ESC Applicant is responsible to ensure that no visible and measurable erosion and sediment leaves the permitted site.
 - 3. The ESC Applicant shall keep a record of inspections with a brief explanation as to any signs of erosion or sediment release and measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site. Records must be made available to the City and DEQ upon request and must be submitted to the City upon final completion of work if requested by the City.
 - 4. During periods of wet weather, disturbed areas of the site and/or stockpiled soil shall be covered by the ESC applicant by tarps or straws at the end of each day's operations; all disturbed, unworked areas of the site shall be protected from erosion.
 - 5. The ESC applicant shall remove ESC measures, establish permanent groundcover on all exposed soils; clean and remove trash, construction waste and sediment deposits before receiving a final ESC inspection approval.
- F. Ineffective Measures and ESC Plan Amendment. If the facilities and techniques in the approved ESC Plan are not effective or sufficient to meet the purposes of this chapter, based on an on-site inspection, the Public Works Director or designee may require the ESC applicant to revise the ESC Plan. Such requirement shall be in writing and shall explain the problem. The written requirement shall be presented to the ESC applicant and any other related parties.
 - 1. The revised ESC Plan shall be submitted by the ESC applicant not later than three business days of when written notification by the Public Works Director is received. Receipt of such notice shall be deemed complete three days after simultaneous regular mail and certified mail is deposited in the mail or completed the same day as personal delivery.
 - 2. The ESC applicant shall implement fully the revised ESC Plan not later than three business days after mailing the revised ESC Plan to the City, or within such other time frame as the Public Works Director may specify.
 - 3. In cases where significant erosion is occurring, the Public Works Director or designee may require the ESC Applicant to immediately install interim control

measures before submittal of a revised ESC Plan.

4. If there is a confirmed or imminent threat of significant off-site erosion, the Public Works Director or designee shall issue a stop work order, upon issuance of which all work on the development site shall halt. The stop work order shall not be lifted until mitigation measures are implemented that comply with the City of Molalla and DEQ's performance standards for ESC and are approved by the Public Works Director or designee.

G. Duty of ESC Responsibilities are With Applicant. It is the duty of the ESC applicant to maintain ESC measures and to comply with the requirements of the DEQ 1200-C permit. The City of Molalla is not responsible for ensuring ESC applicants compliance with DEQ's permit.

(Ord. 2020-05 §1)

§ 13.13.610. Construction—Cost of installation and connection.

All costs and expenses incident to the installation and connection of the building storm sewer shall be borne by the owner. It shall be the responsibility of the owner, lessee or occupant of a building to maintain the building storm sewer or private collection system in a free-flowing and watertight condition, from the structure served to the public storm sewer. All existing private storm sewers shall be maintained in a safe and sanitary condition.

(Ord. 2020-05 §1)

§ 13.13.620. Construction—Cleanout specifications.

At the connection with the public storm sewer and the building storm sewer, there shall be a cleanout of the same material as the public storm sewer connection pipe furnished by the owner. The cleanout shall extend vertically to within six inches of the finished ground surface and shall be sealed with an approved cap or plug. This riser shall be used for inserting a test plug for water or air testing the building storm sewer, and as an auxiliary cleanout. Backfilling around the riser shall be done in such a manner as not to damage the pipe.

(Ord. 2020-05 §1)

§ 13.13.630. Construction—Separate storm sewers for each building.

Every building storm sewer shall be separate and independent of any other building, whether connecting to a public or private storm sewer.

(Ord. 2020-05 §1)

§ 13.13.640. Construction—Private storm sewer restrictions.

Private storm sewer lines shall only be allowed where the building or buildings affected are located on a single parcel of land. Private storm sewer connections to public storm sewer shall be subject to the same design and construction standards as public storm sewers of the City and shall be subject to complete review and approval by the Director of Public Works.

(Ord. 2020-05 §1)

§ 13.13.650. Construction—Leaks and extraneous discharges—Monitoring procedures.

A. New and existing private storm sewers, building drains and building storm sewers will be monitored for leaks or discharges of extraneous water. This monitoring may take the form of, but is not limited to:

1. Direct visual observation;
2. Indirect measurement;
3. Tele-inspection; or
4. Air or water pressure tests, smoke tests, or exfiltration tests.

B. If, in the opinion of the Director of Public Works, such monitoring shows a storm sewer to be defective, no further proof is needed for the Director to require the storm sewer to be repaired to current standards.

(Ord. 2020-05 §1)

§ 13.13.660. Construction—Capping and inspection prior to abandonment.

A. Before a moving or demolition permit is allowed to be issued, evidence must be presented showing the storm sewer has been properly capped and inspected. No exceptions will be allowed. All building storm sewer shall be capped at the public main in an approved manner by the applicant or the applicant's contractor and inspected by City forces prior to closure of the excavation.

B. Exception. If adequate proof can be given showing a storm sewer service is in usable condition and is to be reused, the inspector may allow the service to be capped at the property line. It is the applicant's responsibility to ensure that no other structure is connected to the storm sewer service being abandoned. If the line abandoned is serving more than one structure, a service connection for the structure(s) still using the service must be provided. If the Director of Public Works determines that capping at the main will cause undue hazard to the public, or if a street has been recently resurfaced, a variance to this section may be granted to require that the storm sewer be capped as close to the main as practical.

(Ord. 2020-05 §1)

§ 13.13.670. Construction—Public works inspection fees.

A. The construction inspection services and fee is mandatory and not subject to request by the property owner. All construction costs must be verified from actual invoices and receipts when the City is not responsible for contract administration.

B. The City Council will establish the fees, rates and charges for the City's inspection services by resolution.

(Ord. 2020-05 §1)

§ 13.13.680. Construction—Bonding and insurance.

Bonding and insurance for utility construction will be as provided in the Molalla Municipal Code or the Public Works design standards adopted in Chapter 12.12.
(Ord. 2020-05 §1)

§ 13.13.690. Construction—Storm sewer main extensions.

Whenever a public improvement is to construct or extend a storm sewer main, the following shall apply:

- A. Extension of all lines will be to the farthest edge of the property requesting service, unless otherwise authorized by the Director of Public Works.
- B. Minimum pipe sizes shall be in compliance with the Public Works Standards unless otherwise approved by the Director of Public Works.
- C. When required by the City, the City will share in the cost of storm sewer lines larger than the minimum size provided in Section 13.13.690(B) by paying the difference in cost between a minimum size pipe and the larger size, except:
 - 1. When a new development requires a larger line to provide adequate service, as determined by the Director of Public Works;
 - 2. Only pipe and fitting materials will be paid by the City unless the line size is greater than 10 inches in diameter.
- D. The property owner requesting the extension must pay the cost for extending new storm sewer lines. If a property owner requests service from a portion of the storm sewer line provided by the original developer, then the City shall collect a proportionate share of the storm sewer line cost, and reimburse the original developer or assignee that amount, less administrative costs. This reimbursement policy shall continue for 10 years from the date of line construction, and then end.

(Ord. 2020-05 §1)

§ 13.13.700. Violation—Notice.

Unless otherwise stated in section of this chapter, any person found to be violating any provision of this chapter shall be served by the City with written notice stating the nature of the violation and providing a 14-day time limit for the satisfactory correction thereof.
(Ord. 2020-05 §1)

§ 13.13.710. Violation—Penalty.

Any person who continues any violation beyond the time limit provided for in Section 13.13.700 shall be guilty of a violation and, on conviction thereof, shall be fined in the amount set by Council resolution or subject to fines established per code Section 1.04.010, general provisions for each violation. Each day in which any such violation continues shall be deemed a separate offense. Failure to comply with a written directive or timeline of the City Manager made under the authority of this chapter is a punishable

§ 13.13.710

§ 13.13.720

offense and may result in a temporary loss of City water and storm sewer services.
(Ord. 2020-05 §1)

§ 13.13.720. Violators liable to City.

Any person violating any of the provisions of this chapter shall become liable to the City for any expense, loss, or damage occasioned by the City of Molalla by reason of such violation.
(Ord. 2020-05 §1)

SECTION 3 – STORMWATER DESIGN & CONSTRUCTION STANDARDS

3.1 ENGINEERING

3.1.1 Introduction

This section outlines design and construction requirements for stormwater and surface water management. The provisions and technical specifications herein set forth the requirements of the City of Molalla for constructing stormwater and surface water improvements.

Interpretations of such provisions and their application in specific circumstances shall be made by the Public Works Department authorized representative. Refer to Section 1 of these standards for general provisions and requirements.

Design guidelines established here are consistent with the City of Molalla Stormwater Master Plan. These provisions are intended to prevent or reduce adverse impacts to the drainage system and water resources of the Willamette River Basin. In combination with other federal, state, and local laws and ordinances, these requirements are intended to protect the beneficial uses of waters in the Willamette River Basin and inside the Molalla city limits.

3.1.2 General Design Requirements

In developing a drainage plan for stormwater management, the design engineer is encouraged to provide, to the extent feasible, on-site stormwater management through the use of Low Impact Development (LID) principles. The primary Stormwater management objective for LID is to match pre-development hydrologic condition over the full range of rainfall intensities and durations. LID principles include, but are not limited to, the following:

1. Integrate Stormwater management into site planning activities.
2. Use natural hydrologic functions as the integrating framework.
3. Minimize site disturbance.
4. Focus on prevention rather than mitigation.
5. Emphasize simple, nonstructural, low-tech, and low-cost methods.
6. Manage stormwater as close to the source as possible.
7. Distribute small-scale LID techniques throughout the landscape.
8. Create a multifunctional landscape.

If approved by the Public Works Department authorized representative, alternative storm water design standards may be substituted for the standards specified herein. While LID principals provide for the consideration of alternative standards that may conflict with the City's adopted Fire Prevention Code, it is understood that alternative standards will be considered and applied on a case-by-case basis.

3.1.3 Alternative Design and Construction Standards

Public storm storm systems shall be extended to the most distant upstream parcel boundary or boundaries to accommodate current and future storm flows entering the property, unless otherwise approved by the Public Works Department authorized representative. Except as otherwise provided, the extension or upsizing of the public stormwater systems to serve any parcel or tract of land shall be done by, and at the expense of, the property owner or permit applicant. The Public Works Department authorized representative may require a storm pipeline that serves or may serve more than one property to be a public system.

3.1.4 Extension of Public Storm Storm Systems

Public storm storm systems shall be extended to the most distant upstream parcel boundary or boundaries to accommodate current and future storm flows entering the property, unless otherwise approved by the Public Works Department authorized representative. Except as

otherwise provided, the extension or upsizing of the public stormwater systems to serve any parcel or tract of land shall be done by, and at the expense of, the property owner or permit applicant. The Public Works Department authorized representative may require a storm pipeline that serves or may serve more than one property to be a public system.

3.1.5 Drainage Plans

- a. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines in these standards.
- b. All elevation on design plans and record drawings shall be based on the applicable NAVD datum specified in Subsection 1.16.6, "Surveying and Land Monuments."
- c. All engineering drainage plans shall be stamped by a Professional Engineer registered in the State of Oregon. The drainage plan shall contain the following:
 1. At least one sheet showing a plan view of the entire project site. If the project site is sufficiently large that detailed drainage plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.
 2. A topographic map showing existing conditions for the site, including:
 - (a) Existing topography for the site.
 - (b) Adjacent streets, including street names.
 - (c) Existing utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert elevations.
 - (d) Existing sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).
 3. Plans for proposed drainage improvements shall include the following:
 - (a) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations.
 - (b) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscaped areas, etc.
 - (c) Proposed utilities, showing exact line and grade of all proposed utilities at crossings with the proposed drainage system.
 - (d) Applicable detail drawings.
 - (e) Existing and proposed easements.
 - (f) Setbacks from environmentally sensitive areas or protected resource areas.
 - (g) Proposed drainage structures, including pipes, open channels, culverts, ponds, vaults, biofiltration swales, infiltration facilities, outfalls, riprap treatment, energy dissipaters, etc.
 - (h) Plan and profile of drainage conveyance facilities, including the following information: pipe sizes, pipe types and materials, lengths, slopes, type of structure (e.g. Type CG-30 catch basin), location of structures, invert elevations in/out of structures, and top elevations of structures. Notes shall be included for referencing details, cross-sections, profiles, etc.
 - (i) Any proposed phasing of construction. (Note: water quality and quantity facilities must be constructed before completion of any phased construction)
 4. A detailed grading plan shall be provided for all open stormwater quantity or quality control facilities. The plan shall include the following:

- (a) Existing ground contours (shaded) and proposed ground contours at a minimum 2-foot contour interval. Slopes steeper than 6H:1V shall be identified.
- (b) Location of top and toe of slope.
- (c) Limits of embankment designed to impound water.
- (d) Location of all drainage structures as well as any other piped utilities in vicinity (0.1-foot detail).
- (e) Flow route of the secondary/emergency overflow system (0.1-foot detail).
- (f) Maintenance access, as applicable (see Subsection 3.4.4, "Access Road Design").
- 5. A detailed landscape plan shall be provided for open stormwater quantity or quality control facilities. The plan shall include the following:
 - (a) Final ground contours at a minimum 1-foot contour interval.
 - (b) Location of top and toe of slope.
 - (c) Maximum water surface elevations.
 - (d) Location of all drainage structures as well as any other piped utilities in vicinity (screened) (0.1-foot detail).
 - (e) Limits of areas to receive amended topsoil.
 - (f) Irrigation plan to achieve the required plant survival rate.
 - (g) Planting species, locations and densities in accordance with the landscape requirements in Section 8, "Landscape Requirements: Stormwater Quality and Quantity Facilities".
- 6. Cross-sections shall be provided for at least the following:
 - (a) Detention/retention ponds (including parking lot ponds and other multiuse facilities), wet ponds, and sediment ponds. Cross-sections shall graphically illustrate the following:
 - (1) Design maximum water surface for the 2-year, 10-year, and 25-year design storms.
 - (2) Proposed dead storage water surface (as applicable).
 - (3) Pavement section or amended soil section, as applicable.
 - (b) Proposed ditches and swales, including vegetated swales.

3.1.6 Storm Systems and Fish Passage

For pipe systems that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. All culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria*, or latest edition, unless exempted by ODFW and the City.

3.1.7 Surveying

- a. The design engineer shall be responsible for establishing the location of the storm using reference stakes offset along the storm. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.
- b. Stakes shall locate all public tees, cleanouts, manholes, catch basins, area drains, water quality stations, and pump stations. Maximum spacing for reference stakes is 50 feet. Stakes shall reference cuts or fills to all invert elevations and rim grades. The design engineer shall also be responsible for identifying easements during construction.

3.1.8 Hydrologic Analysis

The hydrologic analysis shall be consistent with Subsection 3.3, "Hydrology and Hydraulics." The design engineer may use various computer models or formulas for the hydrograph analysis, but the Public Works Department authorized representative may verify the design flows and volumes based on the SBUH methodology or as alternatively identified in Subsection 3.2.2, "Hydraulic Design."

3.2 HYDRAULIC ANALYSIS

3.2.1 General

The method of hydraulic calculations shall be subject to approval from the Public Works Department authorized representative and shall be consistent with Subsection 3.3, "Hydrology and Hydraulics."

3.2.2 Hydraulic Design

- a. Detention/retention design shall be assessed by dynamic flow routing through the basin. Documentation of the proposed design shall be included in the drainage report. Acceptable analysis programs include:
 - 1.
 2. SWMM – U.S. Environmental Protection Agency
 3. HYDRA – Pizer Incorporated
 4. HYDROCAD – HydroCAD Software Solutions
 5. PCSWMM – Computational Hydraulics Inc.
 6. InfoDrainage, InfoWorks ICM - Innovyze
 7. Others, as approved
- b. Peak runoff rates shall not exceed predevelopment rates for the specific range of storms. Exemptions to the on-site detention requirements may be considered for situations in which properties discharge directly to the Molalla River or to open bodies of water that have no capacity limitations, hydromodification challenges, or areas where detention in downstream reaches could increase peak stormwater flow rates, and other areas or unique circumstances as identified by the Public Works Director.
- c. A pond overflow system shall provide for discharge of the design storm event without overtopping the pond embankment or exceeding the capacity of the emergency spillway. Vortex valve discharge control shall be considered to optimize effective pond volume.
- d. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.

3.2.3 Design Criteria

- a. The facility can be a combined water quality/quantity facility, provided that it meets all relevant criteria.
- b. Interior side slopes up to the maximum water surface = 4H:1V.
- c. Maximum exterior side slopes = 2H:1V, unless analyzed for stability by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
- d. If slopes need to be mowed, maximum side slope = 4H:1V
- e. Walls in Water Quality/Quantity Facilities
 1. Retaining walls may serve as pond walls if the design is prepared and stamped by a Professional Engineer registered in the State of Oregon and a 4-foot tall fence is

provided along the top of the wall. At least 25% of the pond perimeter will be vegetated to a maximum side slope of 3:1.

2. Walls that are 4 feet or higher must meet all of the following criteria:
 - (a) Be approved by a Professional Engineer registered in the State of Oregon whose area of expertise is structural or geotechnical engineering.
 - (b) The City shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the water quantity tract or easement shall be clearly documented in the City's Stormwater Maintenance Covenant and Access Easement.
- f. Over excavate by a minimum of 20% to allow for sediment deposition.
- g. Minimum freeboard =1 foot from 25-year design water surface elevation.
- h. Maximum water storage depth in water quality/quantity facilities for the 100-year storm event shall not exceed 4 feet in depth, unless otherwise approved by the Public Works Department authorized representative. Where design depth exceeds 4 feet, the facility shall be constructed in conformance with public safety considerations (see Section 3.3.9 "Detention/Retention Facility Protection").
- i. Provide approved outlet structure(s) for all flows up to the 100-year storm event.

3.2.4 System Design Criteria

Site development improvement projects shall address on-site and off-site drainage concerns, both upstream and downstream of a project, including but not limited to the following:

- a. Modifications to the existing on-site storm drainage facilities shall not restrict flows creating backwater onto off-site property to levels greater than the existing situation, unless approved by the impacted off-site property owners and the Public Works Department authorized representative. The off-site property owner(s) shall agree to and sign a permanent easement legally describing the location of the backwater storage and authorizing the use of their property for stormwater drainage and detention/retention purposes. The easement shall be in a form approved by the City.
- b. Storm drainage facilities shall be designed and constructed to accommodate all future full build out flows generated by the proposed development or improvement and all upstream property based on the most recent approved comprehensive land-use plan.
- c. The design of storm drainage facilities shall analyze the impact of restrictions downstream of the project site, in accordance with Subsection 3.2.5, "Review of Downstream System." Downstream restrictions that create on-site backwater may be required to be removed by the applicant, at the discretion of the Public Works Department authorized representative, or the on-site backwater shall be addressed in the design of the development's storm system. The removal of downstream obstructions shall not be allowed if removal would create downstream capacity problems.
- d. If the projected increase in the surface water runoff from a proposed development will cause or contribute to damage from flooding to existing buildings or dwellings, the downstream stormwater system shall be enlarged to relieve the identified flooding condition before development, or the applicant shall construct an on-site detention/retention facility.

3.2.5 Conveyance System Hydraulic Standards

- a. The conveyance system shall be designed to convey and contain at least the peak runoff for the 25-year design storm.
- b. Structures for proposed pipe systems must be demonstrated to provide a minimum of 1 foot of freeboard between the hydraulic grade line and the top of the structure or finish grade above pipe for the 25-year post-development peak rate of runoff.
- c. Design surcharge in new pipe systems shall not be allowed if it will cause flooding in a

- habitable structure, including below-floor crawl spaces.
- d. The 25-year design shall be supplemented with an overland conveyance component demonstrating how a 100-year event will be accommodated. The overland component shall not be allowed to flow through or inundate an existing building.
 - e. Flows in streets during the 25-year event shall not run deeper than 4 inches against the curb or extend more than 2 feet into the travel lane.
 - f. Open channel systems shall be designed for minimum 1-foot freeboard from bank full, provided that no structures are impacted by the design water surface elevation.

3.2.6 Catch Basin System Standards

Design of catch basins and drain inlets shall follow the specifications provided in Subsection 3.9.7, "Drain Inlet Design Standards."

- a. **Standard Catch Basin System:** All catch basins shall be sumped. The main storm line shall not pass through any catch basins or sumped manholes unless approved by the Public Works Department authorized representative. No more than three catch basins may be connected in a series before connecting to the main storm line. A ditch inlet or field inlet may be connected directly to the end of the main storm line.
- b. **Series Catch Basin System:** Unsumped catch basins are allowed, provided that a sumped manhole is constructed below the unsumped catch basins before the flow enters the main storm line. No more than three unsumped catch basins may be constructed above a water quality or stormwater pretreatment manhole. The main storm line may not pass through the catch basins or sumped manholes. No ditch inlet or field inlet may be part of a series of unsumped catch basins.
- c. **Flow-through Catch Basin System:** This system is allowed within an arterial or collector road, provided that the mainline storm pipe has a design velocity of at least 3 feet per second. Unsumped catch basins, ditch inlets, and field inlets are allowed to connect directly

- to the main storm line. An adequately sized water quality manhole is required at the downstream end of the flow-through system prior to connecting to the mainline.
- d. Grates shall be identified with a pavement marking, as indicated by the MUTCD, Part 9, or latest edition. Drainage grate inlets shall be bicycle-safe (as required by ORS 810.150) and hydraulically efficient.

3.3 HYDROLOGY & HYDRAULICS

3.3.1 Hydrologic Analysis

This section describes acceptable methods of estimating the quantity and characteristics of surface water runoff, as well as the assumptions and data required as input to the methods. These methods shall be used to analyze existing and to design proposed drainage systems and related facilities.

3.3.2 Rational Method

The rational method for analyzing small drainage basins is allowed, with the following limitations:

- a. Use it only in predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.
- b. The rational method cannot be used to determine LID or detention requirements, sizing of facilities, or other surface water management other than conveyance capacity calculations.
- c. Drainage sub-basin area cannot exceed 25 acres for a single calculation without approval from the Public Works Department authorized representative.
- d. The time of concentration shall be five minutes when computed to be less than five minutes.
- e. Rainfall intensities shall be from **Table 3.1**, or an alternative approved by the Public Works Department authorized representative.
- f. Rational formula:

$$Q = C \cdot I \cdot A$$

Where: Q = Flow in cubic feet per second.

C = Runoff coefficient (0.9 for paved surfaces).

I = Intensity.

A = Area in acres

Table 3.1. RAINFALL INTENSITY

Time of Concentration (minutes)	Storm Event (year and probability)					
	2 (50%)	5 (20%)	10 (10%)	25 (4%)	50 (2%)	100 (1%)
0	1.90	2.50	3.00	3.40	4.00	4.50
5	1.90	2.50	3.00	3.40	4.00	4.50
10	1.30	1.70	2.20	2.50	3.00	3.50
15	1.10	1.40	1.80	2.10	2.50	2.90
20	0.90	1.20	1.50	1.80	2.10	2.40
30	0.75	0.95	1.20	1.40	1.65	1.90
40	0.60	0.75	1.00	1.15	1.30	1.60
50	0.55	0.70	0.85	1.00	1.15	1.35
70	0.45	0.55	0.70	0.82	0.95	1.10

100	0.40	0.45	0.55	0.67	0.75	0.90
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180 or more	0.35	0.40	0.50	0.60	0.70	0.85
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1. Data for east Washington County; data from Clean Water Services.

3.3.3 Unit Hydrograph Method

- a. **Hydrograph Analysis:** To obtain a realistic and consistent hydrologic analysis for each development site, all developments shall use the hydrograph analysis method for drainage planning and design unless otherwise approved in advance by the Public Works Department authorized representative. The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume, and duration of the runoff hydrograph. The Santa Barbara Urban Hydrograph (SBUH) will be the primary acceptable unit hydrograph method.
- b. **Design Storm:** Return frequency and duration specify the design storm event. The design storms shall be based on two parameters:
 1. Total rainfall (depth in inches).
 2. Rainfall distribution (dimensionless).
- c. **Design Storm Distribution:** The total depth of rainfall for storms of 24-hour duration is shown in **Table 3.2** The rainfall distribution to be used in the City is the design storm of 24-hour duration based on the standard National Resource Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), type 1A rainfall distribution using **Table 3.3**.

Table 3.2. RAINFALL DEPTH

Recurrence Interval (years)	Total Precipitation Depth (inches)
2	2.50
5	3.10
10	3.45
25	3.90
50	4.20
100	4.50

Table 3.3. DESIGN STORM DISTRIBUTION CHART¹

Hour	Percent Rainfall		Rainfall Depth (inches)					
			2-Year Storm	5-Year Storm	10-Year Storm	25-Year Storm	50-Year Storm	100-Year Storm
	Incremental	Cumulative	2.50	3.10	3.45	3.90	4.20	4.50
1	2.40	2.40	0.06	0.07	0.08	0.09	0.10	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.08	0.10	0.11	0.12	0.13	0.14
4	3.80	12.00	0.10	0.12	0.13	0.15	0.16	0.17
5	4.44	16.44	0.11	0.14	0.15	0.17	0.19	0.20
6	5.18	21.62	0.13	0.16	0.18	0.20	0.22	0.23
7	6.48	28.10	0.16	0.20	0.22	0.25	0.27	0.29
8	16.44	44.54	0.41	0.51	0.57	0.64	0.69	0.74
9	7.58	52.12	0.19	0.23	0.26	0.30	0.32	0.34
10	5.28	57.40	0.13	0.16	0.18	0.21	0.22	0.24
11	4.96	62.36	0.12	0.15	0.17	0.19	0.21	0.22
12	4.32	66.68	0.11	0.13	0.15	0.17	0.18	0.19
13	4.02	70.70	0.10	0.12	0.14	0.16	0.17	0.18
14	3.42	74.12	0.09	0.11	0.12	0.13	0.14	0.15
15	3.28	77.40	0.08	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.09	0.10	0.12	0.13	0.14
17	2.80	83.20	0.07	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.07	0.08	0.09	0.10	0.11
19	2.40	88.00	0.06	0.07	0.08	0.09	0.10	0.11
20	2.40	90.40	0.06	0.07	0.08	0.09	0.10	0.11
21	2.40	92.80	0.06	0.07	0.08	0.09	0.40	0.11
22	2.40	95.20	0.06	0.07	0.08	0.09	0.10	0.11
23	2.40	97.60	0.06	0.07	0.08	0.09	0.10	0.11
24	2.40	100.00	0.06	0.07	0.08	0.09	0.10	0.11

1. Source: *Sub-basin Hydrologic Modeling Criteria*, Kramer, Chin, & Mayo, Inc. 1991.

- d. **Runoff Parameters:** The physical drainage basin characteristics listed below shall be used to develop the runoff hydrograph.

1. Area

- (a) To obtain the highest degree of accuracy in hydrograph analysis requires the proper selection of homogeneous basin areas. Significant differences in land use in a given basin must be addressed by dividing the basin area into sub-basin areas of similar land use or runoff characteristics. Hydrographs shall be computed for each sub-basin area and superimposed to form the total runoff hydrograph for the basin.

- (b) All pervious and impervious areas within a given basin or sub-basin shall be analyzed separately. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately, the cumulative errors associated with averaging these areas are avoided, and the true shape of the runoff hydrograph is better approximated.

2. Selection of Curve Number

- (a) The NRCS has developed CN values based on soil type and land use. The combination of these two factors is called the “soil-cover complex.”
- (b) Soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. Soil hydrologic groups may be found in Table 14, *Soil Survey of Clackamas County, Oregon* (SCS, November 1985) or Table 13, *Soil Survey of Washington County, Oregon* (SCS July 1982).
 - (1) Many factors can affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.
 - (2) CN values can be area-weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas shall not be combined with low CN areas (unless the low CN areas are less than 15% of the sub-basin).
 - (3) Antecedent soil moisture values shall be considered. Soil shall be considered to be saturated before the start of a precipitation event.

3. NRCS Curve Number Equations:

- (a) The rainfall-runoff equations of the NRCS curve number method relate a land area’s runoff depth (precipitation excess) to the precipitation it receives and to its natural storage capacity, as follows:

$$Q_d = (P_R - 0.2S)^2 / (P_R + 0.8S), \text{ for } P_R > 0.2S$$

and

$$Q_d = 0, \text{ for } P_R < 0.2S$$

Where: Q_d = runoff depth in inches over the area.

P_R = precipitation depth in inches over the area.

S = potential maximum natural detention/retention, in inches over the area, due to infiltration, storage, etc.

The area’s potential maximum detention/retention, S , is related to its curve number, CN:

$$S = (1000/CN) - 10$$

The computed runoff represents inches over the tributary area. Therefore, the total volume of runoff is found by multiplying Q_d by the area (with necessary conversions):

$$\text{Total runoff volume (cf)} = Q_d (\text{in}) \times A (\text{ac}) \times 3,630 (\text{ft}^3/(\text{ac-in}))$$

- (b) **Time of Concentration:** Time of concentration (T_c) is the time for runoff to travel from the hydraulically most distant point of the watershed to the point where the hydrograph is to be calculated. Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of T_c . T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. T_c influences the shape and peak of the runoff hydrograph.

- (1) **Sheet Flow:** Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. For sheet flow up to 300 feet, use the kinematics solution below to directly compute T_t :

$$T_t = (0.93L^{0.6} \times n^{0.3}) / (I^{0.4} \times S^{0.3})$$

Where: T_t = travel time (minutes).

n = Manning's effective roughness coefficient for sheet flow.

L = flow length (feet).

I = rainfall intensity (inches per hour).

S = slope of hydraulic grade line (feet per foot [ft./ft.])

Sheet flow shall not be used for distances over 300 feet.

- (2) **Shallow Concentrated Flow:** For slopes less than 0.005 ft./ft. (0.5%), the following equations can be used:

(a) For unpaved surfaces: $V = 16.1345 (S)^{0.5}$

(b) For paved surfaces: $V = 20.3282 (S)^{0.5}$

Where: V = velocity (feet per second).

S = slope (ft./ft.).

- (3) **Channel Flow:** A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

$$V = (1.486 / n) \times R^{0.6} \times S^{0.5}$$

Where: V = velocity (ft./s).

n = Manning's roughness coefficient.

S = slope of flow path (ft./ft.).

R = area/perimeter.

3.3.4 Water Quality Volume and Flow

The water quality storm is the storm required by regulations to be treated. The total runoff and total volume can be calculated based on one half the 2-year event (2.5 inches) which is 1.25 inches.

3.3.5 Hydraulics

Catch Basins and inlets collect water from an adjacent ditch, gutter line, or pavement and convey the water to a storm storm or culvert. The inlet systems are to be designed in accordance with the following criteria:

- a. Subsection 3.9.7, "Drain Inlet Design Standards."
- b. The following sources shall be used to locate catch basins and inlets:
 1. ODOT's "Hydraulics Manual."
 2. Hydraulic Engineering Circular 12 (Federal Highway Administration, FHWA-84-202), "Drainage of Highway Pavements."

3.3.6 Area Drains

The maximum acceptable intake flow rate for Type II area drains and ditch inlets is shown in **Table 3.4**.

Table 3.4. INTAKE FLOW RATE, GRATE ANGLE 30 DEGREES

Hydraulic Head (ft.) ¹	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.0	10.0
Flow Rate (cfs) ²	2.0	5.6	10.3	11.9	13.3	14.6	16.8	18.8	22.3	26.6

¹Measured from bottom of grate to headwater.

²Cubic feet per second.

3.3.7 Channel Protection

Open channels shall be designed to prevent long-term scouring of the channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6-inch thick gravel base. **Table 3.5** provides additional design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

Table 3.5. CHANNEL PROTECTION, NEW CHANNEL CONSTRUCTION

Velocity at Design Flow (feet per second)		Required Protection	Thickness (feet)	Minimum Height Above Design Water Surface (feet)
Greater Than	Less Than or Equal to			
0	5	Vegetation lining	N/A	0.5
5	8	Bioengineered lining ¹ or ODOT Class 50 riprap ²	N/A 1.5	1
8	12	ODOT Class 200 riprap ²	2.5	2
12	20	Slope mattress, etc. ³	Varies	2

¹Bioengineered lining allowed for flows between 5 and 8 feet per second.

²ODOT riprap class in English units

³For high-velocity channels, engineering calculations are to be submitted to the Public Works Department authorized representative for review and approval.

3.3.8 Outfall Protection

Storm system outfalls shall be designed to prevent scouring at, or in association with, the outfall discharge and provide velocity reduction before discharge to the receiving channel. Engineered energy-dissipaters shall be required for outfalls with design flow discharge velocities greater than 3 feet per second (fps). **Table 3.6** provides design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

Table 3.6. ROCK PROTECTION

Discharge Velocity at Design Flow (fps)	Required Protection (Minimum Dimension)				
	Type	Thickness ²	Width	Length	Height
0 to 5	ODOT Class 50 riprap ¹	1.5 ft.	Diameter + 6 ft.	8 ft. or 4 x diameter, whichever greater	Crown + 1 ft.

5 to 10	ODOT Class 200 riprap ¹	2.5 ft.	Diameter + 6 ft. or 3 x diameter, whichever greater	12 ft. or 4 x diameter, whichever greater	Crown + 1 ft.
Greater than 10	Designed system ³	As required	As required	As required	Crown + 1 ft.

¹ODOT riprap class in English units.

²Riprap shall be grouted in place.

³For high-velocity outfalls, engineering calculations are to be submitted to the Public Works Department authorized representative for review and approval.

3.3.9 Detention/Retention Facility Protection

- a. Stormwater quantity detention/retention facilities and stormwater quality facilities shall be designed to prevent scouring at the inflow structure(s) by use of an engineered energy-dissipating device such as a Swale Inflow Spreader or other method approved by the Public Works Department authorized representative.
- b. The nearest upstream manhole from a stormwater quantity detention/retention pond or swale shall be a stormwater pretreatment manhole conforming to these standards.
- c. Safety
 1. Stormwater facilities shall include a vegetated buffer or a safety bench.
 2. Side slopes in stormwater facilities shall not exceed 4H:1V up to the maximum design water elevation.
 3. Stormwater facilities shall be posted with warning signs that prohibit swimming or wading.
 4. Where fencing is required by federal, state, and local laws and ordinances for public safety considerations or security reasons, the fencing shall be aesthetically designed. No barbed wire fencing shall be used.

3.3.10 Drainage Report

- a. The drainage report shall be on 8½-by-11 paper. Maps shall be folded to 8½-by-11 size unless another format is approved before the report is submitted.
- b. The drainage report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon and shall contain the following information:
 1. Cover sheet, including the project name, applicant's name, address, and telephone number, design engineer's name, and date of submittal.
 2. Table of contents, with page numbers for each section of the report, including exhibits, appendices, and attachments.
 3. Vicinity Map.
 4. Project description, specifying type of permit(s) for which the applicant is applying, size and location of the project site, address or parcel number, legal description of the property, and property zoning. Also describe other permits required (e.g., Corps of Engineers 404 fill permit). Describe the project, including proposed land use, proposed site improvements, proposed construction of impervious surfaces, proposed landscaping, and special circumstances.
 5. Existing Conditions
 - (a) Describe existing site conditions and relevant hydrological conditions, including but not limited to the following:
 - (1) Project site topography.
 - (2) Land cover and land use.
 - (3) Abutting property land cover, land use, and ownership information.

- (4) Off-site drainage to the property.
 - (5) Natural and constructed channels.
 - (6) Wetlands, creeks, ravines, gullies, steep slopes, springs, and other sensitive areas on or adjacent to the project site.
 - (b) General soil conditions in the project site, using SCS soil designations.
 - (c) Points of discharge for existing drainage from the project site.
 - (d) References to relevant reports, such as basin plans, flood studies, groundwater studies, wetland designations, watershed plans, sub-basin master plans, sensitive area designation, environmental assessments, water quality reports, or other relevant documents. Where such reports impose additional conditions on the applicant, those conditions shall be included in the report.
 - (e) Soils report(s), where applicable.
 - (f) Hydrologic analysis, pursuant to Subsection 3.3.1, "Hydrologic Analysis."
 - (g) Basin map(s), showing boundaries of project, any off-site contributing drainage basins, on-site drainage basins, approximate locations of all major drainage structures in the basins, and depicting the course of stormwater originating from the subject property and extending to the closest receiving body of water. Reference the source of the topographic base map (e.g., USGS), the scale of the map, and include a north arrow.
 - (h) Description of drainage basin(s) to which the project site contributes runoff, and identification of the receiving waters for each basin.
6. Developed Conditions
- (a) Developed site drainage conditions: Describe the land cover resulting from the proposed project; describe the potential stormwater quantity and quality impacts resulting from the proposed project; describe the proposed methods for collection and conveyance of runoff from the project site, for the control of any increase in stormwater quantity resulting from the development, and for maintaining stormwater quality.
 - (b) Description of upstream and downstream basins, identifying any sources of runoff to the project site. Description shall be based on field investigation. Any existing drainage or erosion issues upstream that may affect the proposed development shall be noted.
 - (c) Hydraulic design computations, supporting the design of all proposed stormwater conveyance, quantity and quality control facilities, and verifying the capacity of existing and proposed drainage facilities. These computations may include capacity and backwater analysis required either as part of the proposed drainage design or as part of the downstream drainage investigation, and flood routing computations required for the design of detention/retention storage facilities, for wetland impact analysis, or for floodplain analysis. Include a description of how the stormwater system will function during the water quality storm, 2-year storm, 10-year storm, 25-year storm, and 100-year storm.
 - (d) Operation and maintenance manual required for privately owned and maintained stormwater quantity and quality control facilities. The manual will be an attachment to the City's Stormwater Maintenance Covenant and Access Easement.
 - (e) Appendices shall include necessary technical information.

3.4 WATER QUANTITY FACILITY DESIGN

3.4.1 Mitigation Requirement for Quantity

Each new development is responsible for mitigating its impacts on the public stormwater system. The Public Works Department authorized representative shall determine which of the following techniques may be used to satisfy this requirement. Mitigation requirements shall meet applicable federal, state, and local standards and regulations.

- a. Construction of permanent on-site stormwater quantity detention/retention facilities, designed in accordance with Subsection 3.5, "Water Quality Facility Design."
- b. Enlargement or improvement of the downstream conveyance system shall be done in accordance with Subsection 3.5, "Water Quality Facility Design."

3.4.2 Criteria for Requiring On-Site Detention/Retention

On-site facilities shall be constructed when any of the following conditions exist:

- a. The proposed development establishes or increases the impervious surface area by more than 5,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.
- b. There is an identified downstream deficiency, and detention/retention rather than conveyance system enlargement is determined to be the more effective solution.
- c. There is an identified regional detention/retention site within the boundary of the development.
- d. A site within the boundary of the development would qualify as a regional detention/retention site under the criteria or capital plan adopted by the City.
- e. Water quantity facilities are required by City-adopted stormwater master plans or adopted sub-basin master plans.

3.4.3 Water Quantity Facility Design Standards (*Revised 06/17/20*)

- a. When required, stormwater quantity on-site detention/retention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the predeveloped (see Definitions) runoff rates, based on a 2- through 25-year, 24-hour return storm. Specifically, the 2-, 10-, and 25-year post-development runoff rates shall not exceed their respective 2-, 10-, and 25-year predevelopment runoff rates; unless other criteria are identified in an adopted stormwater master plan or sub-basin master plan.
- b. Water quantity facilities shall be designed to include inlet energy dissipation and a sediment forebay. The sediment forebay shall consist of an area in which heavier sediments can accumulate and receive periodic maintenance to remove these sediments. The forebay size shall be engineered with respect to the anticipated flow rate, and have a durable surface, such as concrete or rock, suitable for periodic maintenance. A minimum size of 20 square feet of water area is anticipated. Some type of barrier shall separate the forebay area from the main area of the water quantity facility. The invert of the incoming storm drain pipe shall be set at or above the top of the forebay barrier elevation and shall consider the pipe wall thickness. Pond inlets with a drainage area of less than one third-acre ($\frac{1}{3}$ AC) may not require a sediment forebay.
- c. Water quantity facilities shall be designed to allow for proper functioning with full sediment accumulation as allowed in Subsection 3.6.6, "Sediment Management/Pollutant Control"
- d. The average, wet-season groundwater elevation shall be determined for the proposed stormwater quantity facility. Groundwater elevation may be established through

measurements at existing wells, installation of piezometer(s), or other methods during the wet winter months as approved by the Public Works Department authorized representative. The facility shall be designed to exclude detention/retention capacity below the established wet-season groundwater elevation.

- e. Construction of on-site detention/retention facility shall not be allowed as an option if such a facility would have an adverse effect on receiving waters in the basin or sub-basin in the event of flooding or would increase the chance or severity of flooding problems downstream of the site.
- f. No water quantity facility shall be built in a public easement or right-of-way unless approved by the Public Works Department authorized representative or be located in an area designed or used for vehicular parking.
- g. Vegetation shall be planted in accordance with Section 8, "Landscape Requirements for Stormwater Facilities."
- h. Water Quantity Facilities shall be constructed in conformance with Subsection 3.2.3, "Design Criteria."
- i. Water Quantity Facilities shall be constructed in conformance with public safety considerations in "Safety" in Subsection 3.3.9, "Detention/Retention Facility Protection."
- j. Stormwater quantity facilities shall be protected in conformance with Subsection 3.3.9, "Detention/Retention Facility Protection."
- k. Access roads to stormwater facilities shall be in conformance with Subsection 3.4.4, "Access Road Design."

3.4.4 Access Road Design

Access roads are for maintenance and inspection purposes. All-weather access shall be provided to the stormwater facility, unless otherwise approved by the Public Works Department authorized representative. At a minimum, access shall be provided for maintenance and inspection of the inflow and outflow structures of the facility. The following criteria are the minimum City requirements:

- a. Three inches of Class C AC; over 8 inches of $\frac{3}{4}$ "-0" compacted crushed aggregate; over firm subgrade. Crushed aggregate and subgrade shall be compacted to 95% of maximum dry density, as determined by AASHTO T-180.
Or
The design engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.
- b. The plan shall include design of strengthened sidewalk sections where maintenance vehicles will cross.
- c. Maximum grade: 15% with a maximum 3% cross-slope.
- d. Minimum width: 15 feet on straight runs and curves. Curves shall be designed with a minimum 40-foot interior radius.
- e. A 2-foot wide gravel shoulder shall be provided on the facility side of the access road.
- f. Access shall extend to within 10 feet of all control structures, unless otherwise approved by the Public Works Department authorized representative.
- g. If fencing is required for public safety or security reasons, the fence shall include a 12-foot-wide lockable gate for maintenance access.

3.4.5 Flood Management Design Standards

3.5 WATER QUALITY FACILITY DESIGN

This section describes methods of designing water quality facilities. Water quality facilities should be designed to remove pollutants from stormwater runoff. The pollutants of concern include, but are not limited to, sand, silt, and other suspended solids; metals such as copper, lead, and zinc; nutrients such as nitrogen and phosphorus; certain bacteria and viruses; and organics such as oil, grease, petroleum hydrocarbons, and pesticides. Methods of removing pollutants include sedimentation or settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Floatable pollutants such as oil, debris, and scum can be removed with separators.

3.5.1 Water Quality Facility Design Standards

- a. Purpose: New development and other activities that create new pollutant generating impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site are required to construct or fund permanent water quality facilities to reduce contaminants entering the stormwater and surface water system. Water quality volume and flow shall be determined as described in Subsection 3.3.4, “Water Quality Volume and Flow.”
- b. Required criteria for construction of water quality facilities
A water quality facility shall be constructed on site unless, in the judgment of the Public Works Department authorized representative, any of the following conditions exist:
 - 1. The site location, size, gradient, topography, soils, or presence of a significant resource make it impractical or ineffective to construct an on-site facility.
 - 2. The sub-basin has a more effective, existing regional site designed to incorporate the development or which has the capacity to treat the site stormwater.

3. The development is for construction of one- or two-family (duplex) dwellings on existing lots of record which will establish or create less than 5,000 square feet of impervious surface.
- c. Design standards
1. Stormwater quality facilities shall be designed to capture and treat 80% of the average annual runoff volume, to the maximum extent possible, with the goal of 70% total suspended solids (TSS) removal. Impervious surfaces shall include pavement, gravel roads, buildings, public and private roadways, and all other surfaces with similar runoff characteristics.
 2. The removal efficiency standard for TSS specifies only the design requirements. It is not intended as a basis for performance evaluation or compliance determination of a stormwater quality control facility installed or constructed pursuant to this section.
 3. If an on-site water quality facility cannot be constructed to treat the runoff from the development's impervious surface, then with the approval of the Public Works Department authorized representative, an on- or off-site water quality facility may be designed to treat runoff from an equivalent area of adjacent untreated impervious surfaces. The water quality facility shall meet all applicable requirements of these standards.
 4. Water quality facilities shall be designed for the runoff generated by a 24 hour rainfall event totaling 1.25 inches.
 5. Water quality facilities shall be sized for impervious area, as outlined below in "Impervious Area Used in Design".
 6. Water quality facilities shall be designed to include inlet energy dissipation and a sediment forebay in conformance to Subsection 3.4.3, "Water Quantity Facility Design Standards."
 7. Water quality facilities shall be designed to allow for proper functioning with full sediment accumulation as allowed in Subsection 3.6.6, "Sediment Management/Pollutant Control."
 8. Water quality facilities shall be constructed as part of the development's public improvements.
 9. Other design options for meeting the requirements of this section may be considered by the Public Works Department authorized representative for approval, as referenced in Subsection 3.1.3, "Alternative Design and Construction Standards."
 10. Water quality facilities in which water is in direct contact with the soil must be lined with either a low permeability liner or a treatment liner when the soil does not have properties which reduce the risk of groundwater contamination from stormwater runoff that may infiltrate in the facility. Liners shall be designed in accordance with Section 11, "Stormwater Quality Facility Liners."
 11. Water Quality Facilities shall be constructed in conformance with Subsection 3.2.3, "Design Criteria."
 12. Stormwater quality facilities shall be protected in conformance with Subsection 3.3.9, "Detention/Retention Facility Protection."
- d. Impervious Area Used in Design
1. Water quality facilities are required when proposed development establishes or increases the impervious surface area by more than 5,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.
 2. For single-family and duplex residential subdivisions with more than two units, water quality facilities shall be sized for all impervious areas created by the subdivision, including all residences on

individual lots at the current rate of 2,750 square feet of impervious surface area per dwelling unit.

3. For all developments other than single-family and duplex dwellings, including row-houses and condominiums, the sizing of water quality facilities shall be based on the impervious area to be created by the development, including structures, all roads, parking lots, and other impervious areas. Impervious surfaces shall be based on building permits, construction plans, or other appropriate methods of measurement deemed reliable by the Public Works Department authorized representative.
4. The City encourages design initiatives that reduce the effective impervious area. For developments other than single-family and duplex dwellings, a smaller water quality facility may be possible.

3.5.2 General Requirements

- a. No water quality facility shall be built in a public easement or right-of-way, unless approved by the Public Works Department authorized representative.
- b. Vegetation shall be planted in accordance with Section 8, "Landscape Requirements for Stormwater Facilities."
- c. Safety of stormwater quality facilities shall be in conformance with Subsection 3.3.9, "Detention/Retention Facility Protection."

3.5.3 Access Road

Access roads to stormwater quality facilities shall be in conformance with Subsection 3.4.4, "Access Road Design."

3.5.4 Water Quality Treatment Methods

Methods used for water quality treatment facilities form several general categories:

- a. **Pretreatment Devices:** Pretreatment often must be provided for filtration and infiltration facilities to protect them from clogging or to protect groundwater. Appropriate pretreatment devices include trapped catch basins, a pre-settling basin, wet pond or vault, water quality manhole, or oil/water separator.
- b. **Filtration:** Filtration entails capturing and temporarily storing stormwater and then passing it through a filter bed of sand, organic matter, soil, or other acceptable treatment media. Specific media such as activated carbon or zeolite can remove hydrocarbons and soluble metals.
- c. **Ponds:** Ponds treat stormwater by settling particulates during quiescent conditions (sedimentation), by biological uptake, and by vegetative filtration. Ponds may be single-purpose facilities, providing only stormwater treatment, or they may be combined with a detention pond or vault to also control flow.
- d. **Wetlands:** Constructed wetlands, like natural wetlands, remove pollutants through sedimentation, filtration, and biologic processes. Wetlands typically have shallower water than ponds. They may also incorporate small permanent pools and extended detention storage.
- e. **Infiltration:** Infiltration refers to the use of the filtration, adsorption, and biological decomposition properties of soils to remove pollutants. Infiltration can provide multiple benefits, including pollutant removal, peak flow control, groundwater recharge, and flood control. Groundwater protection issues must be evaluated when considering infiltration facilities. The DEQ has identified drywells, sumps, and other infiltration-type facilities that inject untreated stormwater below the ground surface as Class V injection wells under the federal underground injection control program.
- f. **Significant Resource:** With approval of the Public Works Department authorized representative, certain water quality treatment facilities may be allowed within significant

resource areas. However, natural significant resources are not acceptable as a method for water quality treatment.

3.5.5 Pretreatment Devices – Water Quality Manholes

- a. Hydraulic criteria
 1. Minimum design flow = water quality flow.
 2. An upstream flow splitter may be used to bypass conveyance flows in excess of the Water Quality flow.
- b. Design criteria
 1. Shall be required immediately upstream of all detention/retention facilities, all water quality treatment facilities, or any release point to a natural drainage.
 2. Minimum manhole diameter shall be 60 inches.
 3. Sump depth shall be no deeper than 5 feet from invert to bottom of sump, unless approved by Public Works Department authorized representative.
 4. Volume of sump shall be 20 cubic feet per 1.0 cfs of flow into the water quality manhole, up to the 25-year flow. Flow calculations shall include the effect of an upstream flow splitter.
 5. Maintain a 3-foot clear access zone between the inside structure wall and the interior outlet structure.
 6. Orient access to structure in a clear zone.

3.5.6 Proprietary Pretreatment Devices

- a. Proprietary pretreatment devices are permitted on a case-by-case basis, with approval of the Public Works Department authorized representative.
- b. The devices shall be sized in accordance with the manufacturer's recommendations. However, the minimum treatment flow must be the water quality flow.
- c. Technical submittals from the manufacturer are required, including hydraulic design criteria, particulate removal efficiency, and maintenance requirements and schedule.

3.5.7 Filtration

a. Biofiltration Swale

Biofiltration swales are vegetated open channels that trap pollutants through filtration. General design requirements for biofiltration swales are given in **Table 3.7**. For more specific design criteria refer to Subsection 10.2.1, "Biofiltration Swale."

Table 3.7. BIOFILTRATION SWALE CRITERIA

Parameter	Requirement
Area to be served	Less than 10 acres
Soils requirements (NRCS classification)	A, B, C, or D
Maximum ground slopes	2.5 percent (if slope is greater than 2.5 percent check dams shall be implemented).
Maximum maintained side slopes	4H:1V
Water application rate	Peak flow rate from water quality flow

b. Sand Filter

3.5.8 Ponds

Inlet and outlet structures constructed in stormwater ponds shall follow the guidelines provided in Subsection 3.8.4, "Inlets," and Subsection 3.8.5, "Outlets."

Ponds safety shall be in conformance with "Safety" in Subsection 3.3.9, "Detention/Retention Facility Protection."

a. Wet Ponds

Wet ponds are constructed ponds with a permanent pool of water (called pool storage or dead storage). Pollutants are removed from stormwater by gravitational settling, biologic processes, and vegetative filtration. General design requirements for wet ponds are given in **Table 3.9**. For more specific design criteria refer to Subsection 10.3.1, "Wet Ponds."

Table 3.9. WET POND CRITERIA

Parameter	Requirement
Area to be served	2 to 150 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	10H:1V
Maximum maintained side slopes	4H:1V

b. Extended Wet Pond

Extended wet ponds are constructed ponds that have both a permanent pool of water and extended detention above the permanent pool. General design requirements for extended wet ponds are given in **Table 3.10**. For more specific design criteria refer to Subsection 10.3.2, "Extended Wet Pond."

Table 3.10. EXTENDED WET POND CRITERIA

Parameter	Requirement
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Area to be served	3 to 150 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	8 percent
Maximum maintained side slopes	4H:1V

c. **Extended Dry Pond**

Extended dry ponds are designed to drain completely between storm events. This allows the pond to detain stormwater runoff longer than a standard detention pond and provides some treatment for water quality.

Dry ponds alone seldom meet the design TSS removal requirements established in Subsection 3.5.1, "Water Quality Facility Design Standards," and shall be considered only when combined with other water quality facilities. For more specific design criteria refer to Subsection 10.3.3, "Extended Dry Pond."

3.5.9 Wetlands – Constructed Treatment Wetlands

Constructed treatment wetlands remove pollutants through several processes, including sedimentation, filtration, and biologic uptake. When enough volume is provided, constructed treatment wetlands can also provide a significant level of flow control. General design requirements for constructed treatment wetlands are given in **Table 3.11**. For more specific design criteria refer to Section 10, "Stormwater Quality Facility Design." Inlet and outlet structures constructed in wetland areas shall follow the guidelines provided in Subsection 3.8.4, "Inlets," and Subsection 3.8.5, "Outlets."

Table 3.11. CONSTRUCTED TREATMENT WETLANDS CRITERIA

Parameter	Requirement
Area to be served	No less than 10 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	Not applicable
Maximum maintained side slopes	5H:1V

3.5.10 Infiltration

a. A first step in siting and designing infiltration treatment facilities is to conduct a characterization study. Information gathered during initial geotechnical investigations can be used for the site characterization. Key data and issues to be characterized include the following:

1. Surface features.
2. Subsurface features.
3. Infiltration rate determination.
4. Soil testing.
5. Infiltration receptor.

- b. Site suitability criteria must also be considered for siting infiltration treatment systems, as follows:

1. Setbacks.
2. Groundwater protection areas.
3. High vehicle traffic areas.
4. Soil infiltration rate/drawdown time.
5. Depth to bedrock, water table, or impermeable layer.
6. Soil physical and chemical suitability for treatment.
7. Seepage analysis and control.
8. Cold climate and impact of roadway deicers.
9. Verification testing of the completed facility.

Note: Refer to Section 9, "Infiltration Requirements, Site Characterization, and Site Suitability Criteria" for a detailed description of site characterization and site suitability criteria. All infiltration systems shall comply with the requirements of the Oregon DEQ UIC (Underground Injection Control) Program.

- c. Infiltration Trench

1. An infiltration trench is a shallow trench in permeable soil that is backfilled with sand and coarse stone and lined with filter fabric. The trench surface may be covered with grating, stone, gabion, sand, or a grassed cover with a surface inlet. General design requirements for infiltration trenches are given in **Table 3.12**. For more specific design criteria refer to Subsection 10.5.1, "Infiltration Trench."

Table 3.12. INFILTRATION TRENCH REQUIREMENTS

Parameter	Requirement
Maximum area to be served	1 acre per trench
Soils requirements (NRCS classification)	A or B only for publicly maintained facilities; C soils may be used for privately owned facilities if drawdown standards are met.
Maximum ground slopes:	5 percent
Soil test requirement	ASTM D 3385

- b. Infiltration Basin

1. An infiltration basin is a depression created by excavation, berms, or small dams to provide for short-term ponding of surface water until it percolates into the soil. General design requirements for infiltration basins are given in **Table 3.13**. For more specific design criteria refer to Subsection 10.5.2, "Infiltration Basin."

Table 3.13. INFILTRATION BASIN REQUIREMENTS

Parameter	Requirement
Maximum area to be served	50 acres

Soils requirements (NRCS classification)	A or B only for publicly maintained facilities; C soils may be used for privately owned facilities if drawdown standards are met
Maximum ground slopes	5%
Maximum maintained side slopes	4H:1V
Soil test requirement	ASTM D 3385

3.5.11 Other Water Quality Treatment Facilities

The use of other forms of water quality treatment is allowed with the approval of the Public Works Department authorized representative. However, the applicant must provide evidence of the ability of the facility to meet the City's design standards criteria and long-term maintenance requirements and ability to meet TSS removal rates. Grass swales will not be allowed.

3.6 OPERATIONS & MAINTENANCE REQUIREMENT

This section describes operation and maintenance requirements that are generally applicable to all private stormwater facilities. The person designated as the responsible party in the Stormwater Maintenance Covenant and Access Easement shall be responsible for operation and maintenance of private stormwater facilities. An operation and maintenance plan (O&M plan) shall be prepared by the responsible party for the stormwater facility and shall be submitted to the City of Molalla Public Works Department for review and approval. Maintenance activities shall be documented annually by sending a report of what was completed to the City of Molalla Public Works Department, by May 1st of each year.

3.6.1 Inspection Program

- a. Routine facility inspection will provide three major benefits:
 1. Development of a condition history.
 2. Improved scheduling efficiency.
 3. Preventive maintenance opportunities.
- b. Inspection records shall be used to:
 1. Determine where special maintenance conditions exist.
 2. Determine optimal frequencies for future inspection and maintenance.
 3. Generate scheduled and unscheduled (i.e., repair) work orders.
 4. Assure facility operation and aesthetics.

3.6.2 Inspection Requirements

- a. The applicant shall be responsible for having inspections conducted, maintaining stormwater facilities, and submitting yearly reports documenting inspection and maintenance activities to the City of Molalla Public Works Department.

- b. Inspect the facility, with the record drawing plans in hand, on a quarterly basis for the first two years, and a minimum of semiannually thereafter. Inspections may be required more frequently, depending on site-specific conditions.
- c. All required inspections and any maintenance activities performed shall be documented in the annual report as required by the City's "Stormwater Maintenance Covenant and Access Easement."
- d. Inspection reports shall be submitted to the City by May 1st of each year.
- e. The applicant shall keep inspection records to track the progressive development of the system over time. The inspection records shall include:
 - 1. General condition of vegetative area(s), predominant plant species, distribution, and success rate (where applicable).
 - 2. Sediment condition and depth in forebay (or other pretreatment structure), treatment facility, bench planting zones, and other sediment-removal components.
 - 3. Water elevations and other observations (sheen, smell, etc.).
 - 4. Condition of the inlet, outlet, and overflow structures and devices, diversion structures, trash-removal devices, risers, spillway, embankments, and remaining storage capacity.
 - 5. Unscheduled maintenance needs.
 - 6. Components that do not meet the performance criteria and require immediate maintenance.
 - 7. Common problem areas, solutions, and general observations.
 - 8. Aesthetic conditions.

3.6.3 Structures

Applicant shall be responsible for maintaining all facility structures in good working order. Stormwater facility structures include, but are not limited to, the following: stormwater pipes, stormwater manholes, sand/oil separators, monitoring manholes, flow control devices, energy dissipaters, headwalls, trash grates, underground detention facilities, catch basins, ditch inlets, area drains, clean-outs, access roads, safety fences, sediment fences, and biofiltration bags. Maintenance may consist of cleaning, repairing, and/or replacing structures or portions of structures as needed to maintain their functional purpose.

3.6.4 Planting Bed Soils

- a. In areas where greater than 10% of planting bed vegetation has died, have soil tested as recommended by a Professional Landscape Architect registered in the State of Oregon.
- b. Amend soil as per recommendations of a Professional Landscape Architect registered in the State of Oregon; if needed redesign plantings to correct problems and reestablish soil coverage.

3.6.5 Vegetation Management

- a. Vegetated stormwater facilities may require a number of control practices during their initial 2-year period in order to meet the requirements for establishing healthy vegetation.
- b. Requirements
 - 1. Maintain plantings for a period of two years after the date of final construction approval by the Public Works Department authorized representative. During the establishment period, remove undesired vegetation with minimal (or preferably no) use of toxic herbicides and pesticides at least three times in year 1, and once or twice in the summer of year 2, unless otherwise approved by the Public Works Department authorized representative. Replace plants that die during this period as per recommendations and planting time frame given in Subsection 8.2, "Landscape Guidelines."
 - 2. At the end of the two-year warranty period, healthy plant establishment shall be achieved for at least 90% of the vegetation (see Subsection 3.13.2, "Landscaping

Inspection for Warranty,” for landscape survival criteria). The O&M plan shall specify the long-term maintenance schedule after the warranty period.

3. Selectively irrigate if necessary, during the establishment period, during times of drought, or until the vegetation becomes established. It is preferred that the facility be designed to sustain its function without a permanent irrigation system.
 4. Replenish mulch at least annually and specify the mulching schedule in the O&M plan. Mulching shall be done to retain topsoil, heat, and moisture, and to inhibit weed growth. Use temporary fencing to protect seedlings from foraging animals.
 5. Schedule maintenance outside sensitive wildlife and vegetation seasons. Minimize plant disturbance during maintenance activities.
 6. Do not use fertilizers, herbicides, or pesticides for vegetation maintenance, unless it is specifically called for in the O&M plan.
- c. Use replacement plants that conform to the initial planting plan and to Section 8, “Landscape Requirements for Stormwater Facilities.”

3.6.6 Sediment Management/Pollution Control

- a. Sediment and other pollutants that degrade water quality will accumulate in stormwater facilities. The contractor shall remove all accumulated pollutants and sediment to maintain proper facility operation. Periodic testing will help determine appropriate sediment-removal schedules.
- b. Requirements:
 1. Place a sediment marker in the forebay or in an area not likely to be damaged by incoming storm flows and where it can be easily seen by maintenance personnel.
 2. Remove sediment when accumulations reach 1 foot in depth, 50% of the designed sediment storage depth, or if sediment accumulation inhibits facility operation. The 50% full capacity shall be identified and marked on sediment marker during facility construction.
 3. Test sediment before removing it if the stormwater facility serves a commercial/industrial site or a multifamily structure or development. Sediment shall be tested according to protocol established in the O&M plan, and any additional information resulting from site-specific conditions and use. Testing could include parameters such as oil and grease, heavy metals (lead, zinc, and cadmium), nutrients (e.g., phosphorus), and organics such as pesticides that may accumulate. Testing must be site specific if a commercial/industrial discharger is being served; City of Molalla reserves the right to require testing of specific contaminants. Applicant shall provide the test results to the City of Molalla Public Works Department prior to excavation and disposal of sediment.
 4. Dispose of sediments at the time of excavation in a manner meeting applicable state and federal requirements. If sediment disposal requires special handling, disposal documentation shall be provided to the City of Molalla Public Works Department.
 5. Investigate and control, or report the pollutant source, if sediment or other pollutants are accumulating more rapidly than assumed when the O&M plan was formulated. Direct pollution-control complaints to the City of Molalla Public Works Department.

3.6.7 Insect/Vector Control

- a. Standing water associated with some types of treatment systems can attract insects.
- b. The following measures shall be the primary methods of insect control. The methods are not presented in order of implementation, but one or all of these methods shall be used before considering any other measures:
 1. Install predacious bird and bat nesting boxes.

2. Change the water level of ponds every four days or so to disrupt the larval development cycle of mosquitoes.
 3. Stock ponds and other permanent water facilities with fish or other predatory species.
 4. Use mosquito larvicide, such as *Bacillus thurengensis* or Altoside® formulations, only if absolutely necessary. Any pesticide or larvicide shall be applied by a licensed individual.
- c. Additional assistance with vector monitoring and control may be obtained from the local vector control office.

3.6.8 Access and Safety

O&M programs shall provide for safe and efficient access to a facility and shall be in compliance with Subsection 1.17.9, "Safety Requirements". The following are general requirements; specific conditions may require site-specific modifications:

- a. Secure easements necessary to provide facility and maintenance access (if applicable).
- b. Use only trained and certified personnel to access confined spaces.
- c. Maintain ingress/egress routes to design standards, in a manner that allows efficient maintenance of the facility.
- d. Ensure that fencing is in good repair.

3.7 CONSTRUCTED CHANNEL DESIGN STANDARDS

3.7.1 Application

This section applies to open channels constructed to convey runoff to the existing public stormwater and surface water conveyance system. For work in existing stream channels, applicant shall follow the recommendation and requirements set forth in ODFW's *Fish Passage Criteria*, or latest edition, or an equivalent study or guideline approved by the Public Works Department authorized representative. The applicant shall comply with all applicable requirements of the Army Corps of Engineers and Oregon Department of State Lands for construction activities that may impact wetlands or waterways. Development that regrades existing roadside ditches or constructs new roadside ditches shall meet applicable City codes and standards.

3.7.2 Channel Design

- a. Channel design shall be in accordance with Subsection 3.3, "Hydrology and Hydraulics."
- b. Vegetation-lined channels shall be used whenever practicable, as determined by the Public Works Department authorized representative. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion. Channels shall be protected in conformance with Subsection 3.3.7, "Channel protection."
- c. Constructed open channels shall be sized to pass the required flows, outlined in section 3.2.5 and have side slopes no steeper than 2H:1V. Any proposed constructed channel improvement that does not meet these requirements shall be piped, unless an exception is approved by the Public Works Department authorized representative.
- d. Normal maximum depth for open channels constructed adjacent to roadways shall be 2 feet.
- e. No protruding pipes, culverts, utilities, or other structures will be allowed that reduce or hinder the flow characteristics of the channel. Channels and connections shall be designed to prevent scouring. All pipe connections shall match side slopes, incorporate a headwall, and be designed with an energy dissipater device (see Subsection 3.3.7, "Channel Protection," and Subsection 3.3.8, "Outfall Protection").

3.7.3 Channel Construction for New Roadside Ditches

Roadside ditches shall be constructed in conformance with ODOT SSC Section 00330, "Earthwork."

3.8 CULVERT DESIGN STANDARDS

3.8.1 Application

- a. Culverts provide for passage of water under or through obstructions placed across streams and drainage ways. Culverts shall be designed to pass the required flows without compromising public safety or causing new or additional flooding.
- b. For pipe systems or culverts that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. Additionally, ODFW may require fish passage accommodations on any stream that has a history or the potential for fish production.
- c. Culverts, as determined by ODFW, shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria*, or latest edition, unless otherwise exempted by ODFW and the City design shall follow current ODOT standards.

3.8.2 Hydraulic Design

Culverts shall be designed to safely pass the 25-year flow.

3.8.3 Headwater

- a. For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter or three times the pipe diameter with a seepage collar, unless an exception is approved by the Public Works Department authorized representative.
- b. For new culverts larger than 18 inches in diameter, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter, unless an exception is approved by the Public Works Department authorized representative.
- c. The maximum headwater elevation of a design storm event for new culverts shall be at least 1 foot lower than the road or parking lot subgrade

3.8.4 Inlets

The embankment around the culvert inlet shall be protected from erosion by lining around the inlet with rock, bioengineering, or other protection approved by the Public Works Department authorized representative. The lining shall extend upstream of the culvert a minimum of 10 feet, be designed to provide a smooth transition for water flow into the culvert and shall be as high as the designed headwater elevation. Trash racks or debris barriers shall follow the design requirements of Subsection 3.9.6, "Trash Racks or Debris Barriers."

3.8.5 Outlets

The receiving channel of the outlet shall be protected from erosion by rock lining, bioengineering, or other energy dissipating devices (Subsection 3.3.7, "Channel Protection," and Subsection 3.3.8, "Outfall Protection") as approved by the Public Works Department authorized representative.

3.8.6 Inlet Control Analysis

The headwater depth for pipes under inlet control shall be determined using the nomographs as provided in details of these standards, the ODOT "Hydraulics Manual," or a modeling method consistent with FHWA's HY8 software.

3.8.7 Outlet Control Analysis

The headwater depth for pipes under outlet control shall be determined using the nomographs as provided in details of these standards, the ODOT "Hydraulics Manual", or a modeling method consistent with FHWA's HY8 software.

3.8.8 Outfall Design Standards

- a. Outfalls shall be above the mean low-water level, unless an exception is approved by the Public Works Department authorized representative. All outfalls shall be provided with a rock splash pad or other approved erosion-control measure. Erosion protection at outfalls shall be designed in accordance with the guidelines in Subsection 3.3.8, "Outfall Protection," unless exceptions are approved by the Public Works Department authorized representative.
- b. Mechanisms that reduce velocity before water discharges from an outfall are required. The dissipaters shall be designed using published references such as FHWA's "Hydraulic Design of Energy Dissipaters for Culverts and Channels," the ODOT "Hydraulics Manual", and others. Design references shall be cited in the construction plan submittal.
- c. Non-erosive stormwater flow velocities shall be maintained for the entire overland flow from the energy dissipating device to the receiving public waterway. The Public Works Department authorized representative shall approve structures and/or methods to maintain non-erosive flow velocities prior to construction or installation.

3.9 STORM MANHOLE & PIPE DESIGN STANDARDS

3.9.1 Manhole Design

- a. Manholes shall be provided at least every 400 feet, unless otherwise approved by the Public Works Department authorized representative. Manholes shall be located at every grade change, change in pipe size, and change in alignment. Unless an exception is approved by the City, manhole lids placed within the paved right-of-way shall have a minimum of 5 feet of clearance from the edge of a curb or gutter and shall not be in a wheel path of the traveled way (see Street detail drawings of these standards).
- b. When a manhole is 5 feet or less deep, a flat-top or shallow manhole shall be used. Flat-top manholes shall be designed to be installed at an elevation to permit construction of the full street section, allowing for the design gradients.
- c. All manholes shall be a minimum of 48 inches in diameter for pipe sized up to 18-inches diameter, minimum 60-inch diameter manhole for 18-inch to 30-inch pipe diameter, and minimum 72-inch manhole for 30-inch and larger pipe diameter.
- d. Suburban style manholes frames shall not be used in PCC streets.
- e. There shall be a maximum of 4 pipes entering/exiting a manhole unless otherwise approved by Public Works Department authorized representative.
- f. Detail(s) shall be submitted with the plans where pipes into or out of a manhole are larger than 24 inches or where more than four mainline connections are made. The manufacturer or design engineer shall provide the Public Works Department authorized representative with supporting calculations, stamped by a Professional Engineer registered in the State of Oregon, documenting the structural integrity of the manhole.
- g. Connections to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted with the plans.
- h. All precast manhole bases shall have smooth, clean openings at the design inlets and outlet points. Openings shall not be saw cut or broken out.
- i. All manhole bases shall be properly channelized. No more than three side laterals are allowed to be connected to a manhole, unless an exception is approved by the Public Works

Department authorized representative. There shall be a minimum of 8 inches separating connections, measured from the outside diameter of the core holes.

- j. All manholes shall have inlets at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.
- k. Manholes shall have a minimum freefall of 0.10 feet and a maximum freefall of 1.5 feet.
- l. Drop manholes: The maximum inside drop in a manhole shall be 18 inches. When more than 18 inches of drop exists, an outside drop manhole shall be used. Outside drops shall be constructed of ductile iron pipe.
- m. An oversize curb inlet manhole may be used in lieu of a manhole, as required by this subsection, when approved as part of a flow-through system. Oversized gutter or curb and gutter catch basins will be allowed in lieu of manholes, with approval of the Public Works Department authorized representative.
- n. Water Quality Manhole Design: Refer to Subsection 3.5.5, "Pretreatment Devices - Water Quality Manholes."

3.9.2 Storm Pipe Design

- a. **Pipe size:** The design size shall be based on hydraulic calculations provided by the design engineer. The minimum diameter of public storm pipe is identified below:
 - 1. Pipe from the catch basin to the mainline in the public right-of-way shall be nominal 10-inch-diameter pipe.
 - 2. Mainline pipe shall be no less than nominal 12-inch-diameter pipe.
 - 3. Storm pipes located out of a public street right-of-way, with no reasonable need to be extended, and with roof drains or area drains connected, shall be a minimum 10-inch-diameter pipe.
- b. **Location:** Storm pipes, wherever possible, shall be installed behind and parallel to the face of curb on either side of the street as indicated in the street detail drawings of these standards. All storm pipelocations shall be approved by the Public Works Department authorized representative. Storm drain inlets shall be designed as per Subsection 3.2.7, "Catch Basin System Standards" and Subsection 3.9.7, "Drain Inlet Design Standards."
- c. **Easements:** When it is not possible or practical to install the storm line in a dedicated public street, a minimum 15-foot public pipeline easement shall be provided. Storm lines shall be located in the center of the easement, unless an exception is approved by the Public Works Department authorized representative. The centerline of the pipe shall be at least 7½ feet from an easement side line.
- d. **Alignment:** Public storm pipe shall be laid on a straight alignment and at uniform grade, unless an exception is approved by the Public Works Department authorized representative.
- e. **Connections:** Lateral connections on new construction work shall be done using manufactured tees installed at surveyed locations. Lateral connections to existing storm lines may be done using either saddle tees or by using Inserta Tee® as per Subsection 3.10.3, "Stormwater Pipe and Fittings". Laterals shall be of same material as main.
- f. **Laterals:** Storm laterals shall be provided with a cleanout installed at the public right-of-way or easement. Cleanouts shall not be installed in the driveway or sidewalk, unless approved by the Public Works Department authorized representative.
- g. **Curb Marking:** Newly constructed curbs or replaced curbs shall be stamped with the capital letters "D" at the location of each storm lateral crossing. Letters shall be 3 inches in height and embossed a minimum of ⅛-inch deep.
- h. **Locating Wire and Tape:** Storm laterals and mains shall have tracer wire (14-gauge with white insulation) installed beside the pipe. Surface locating wire at right-of-way cleanouts or shall be tied off to the 2 x 4 marker until cleanout is installed.

- i. **Grade:** All storm lines shall have sufficient slope to maintain a minimum flow velocity of 3 feet per second when flowing full.
- j. **Steep Slopes:** Where soil conditions warrant it, storm pipes on slopes in excess of 20% gradient shall be secured with approved anchor walls. Spacing for anchors shall be as shown in **Table 3.14**.

Table 3.14. SECURING STORMS ON SLOPES

Minimum Anchor Spacing Storm Gradient >20%	
Grade (%)	Center to Center (feet)
<35	35
35-50	25
>50	15 (or concrete encasement)

- k. **Pipe Cover:** Minimum pipe cover shall be in compliance with this section, unless an exception is approved by the Public Works Department authorized representative. In paved areas, pipe cover shall be measured from the finished grade to the upper surface of the pipe barrel; the pipe bell shall not intrude into the base rock. In areas without pavement, the pipe cover shall be measured from the finish grade to the upper surface of the pipe barrel. Minimum cover requirements are shown in **Table 3.15**.

Table 3.15. MINIMUM PIPE COVER

Type of Pipe	Cover (inches)
Other Pipe Materials	30
Nonreinforced	30
RCP Class III	30
RCP Class IV	24
RCP Class V	12
AWWA C-900, C-905	12
ADS SaniTite HP	12
Ductile Iron	12

3.9.3 Distance between Structures

The maximum distance between structures, such as manholes, area drains, and catch basins, but excluding cleanouts, for 12-inch and larger pipe shall be 400 feet.

3.9.4 Access

Access roads are for maintenance and inspection purposes. All-weather access shall be provided to every manhole. Access roads shall be constructed as per Subsection 3.4.4, "Access Road Design."

3.9.5 Headwalls

Pipe end protection shall be required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to stabilize a slope. Details of all headwalls and end protection shall be included in the construction drawings.

3.9.6 Trash Racks or Debris Barriers

Trash racks or debris barriers are required by the City on inlets for pipe or culvert systems greater than 18 inches in diameter. The design engineer shall submit the trash rack/debris barrier system design to the Public Works Department authorized representative for approval.

3.9.7 Drain Inlet Design Standards

All inlets and catch basins shall be designed to accept a 10-year storm event. Grates shall be designed, as far as practical, to avoid failure due to accumulation of debris.

a. Design Criteria

- a. Precast and poured-in-place-catch basins and curb inlets are allowed.
- b. All catch basins shall be constructed with an 18-inch minimum sump unless they are part of a series or a flow-through catch basin system and approved by the Public Works Department authorized representative.
- c. A main storm line shall not pass through a sumped catch basin.
- d. Avoid placing curb inlets along curb radius at street intersections.
- e. Spacing of catch basins shall be determined by the capacity of each to pass a 10-year storm event. In addition, catch basins shall be installed just before the upstream curb radius at all intersections.
- f. Catch basins, except for CG-48 (curb inlet), shall be a maximum depth of 6 feet from the top of grate to the flow line of the lowest pipe invert. When depth from top of grate to flow line is greater than 5 feet, catch basins shall be oversized and have steps installed.
- g. Between the inlet and the mainline or mainline structure, the maximum length of pipeline shall be 40 feet for 10-inch pipe and 60 feet for 12-inch pipe, unless additional length is required to cross the street right-of-way.
- h. Tee connections may be used in street right-of-way only with approval of the Public Works Department authorized representative. The lateral shall be no larger than 50% the diameter of the main line, unless otherwise approved by the Public Works Department authorized representative. The connecting catch basin shall be oversized for cleaning purposes.

i. Area Drains and Ditch Inlets

1. The standard area drain shall be as shown in details of these standards, and the ditch inlet shall be as shown in details of these standards, unless an exception is approved by the Public Works Department authorized representative.
2. Area drains in rear or side yards shall not be sumped. Ditch inlets shall be equipped with an 18-inch sump unless the inlets are part of a flow-through system.
3. A main storm line shall not pass through an area drain or a ditch inlet.
4. Area drains or ditch inlets may be located at the upper terminus of a main storm line, may connect to the main storm line at a manhole, or may connect to the main storm line through a tee when the lateral is no larger than 50% of the diameter of the main line.

3.10 MATERIAL SPECIFICATIONS

3.10.1 Manholes and Structures

- a. General

Manholes shall be constructed at locations shown on the plans or as required by the Public Works Department authorized representative.

b. **Materials**

1. **Aggregate and Cement:** Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."
2. **Concrete:** PCC for poured in place manholes and structures shall conform to ODOT Class 3000 – 1½, Commercial Grade Concrete. Slump shall be between 2 and 4 inches.
3. **Manhole Frames and Covers:**
 - (a) Casting shall be of new material, tough, close-grained gray iron conforming to ASTM A-48, Class 30, and shall be smooth and clean, free of blisters, blowholes, and all defects. Bearing surfaces shall be planed or ground to ensure flat, true surfaces. Covers shall be true and set within rings at all points.
 - (b) Rings shall be grouted in place and made watertight with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Rings shall not be brought to grade with lumber.
 - (c) Frames and covers shall be standard or suburban, depending on the manhole location and as approved by the Public Works Department authorized representative. Suburban style manhole frames shall not be installed in PCC streets.
 - (d) Manholes installed outside of paved street or sidewalk areas shall be installed with a tamperproof frame and cover.
4. **Manhole Types:** Manholes shall be one of the following types or equal.
 - (a) **Precast 48-Inch-Diameter Manholes:** Materials shall conform to the requirements of ASTM C-478. Minimum wall thickness shall be 5 inches. Cones shall be eccentric. Before precast manhole sections of any size are delivered to the job site, the sections shall meet the permeability test requirements of ASTM C-14.
 - (b) **Precast Large-Diameter (60-inch or larger) Manholes:** Materials shall conform to the requirements of ASTM C-478.
 - (c) **Cast-in-Place Large-Diameter Manholes:** Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."
 - (d) **Precast Bases:** Precast base sections or manhole bases shall be used, except over existing pipe where poured-in-place bases shall be used. Precast manhole bases shall be inspected and approved by the Public Works Department authorized representative prior to installation. Where precast bases are not channelized, the contractor shall construct smooth channels to connect the flow from inlet pipe(s) to outlet pipe.
 - (e) **Poured-in-Place Bases:** Poured-in-place bases shall be used over existing pipelines. The contractor shall remove water from the excavated area, provide a minimum 8-inch-thick layer of compacted 1"-0" crushed aggregate for a base, and construct the concrete base so that the first precast manhole section has a uniform bearing throughout the full circumference. There shall be a minimum of 8 inches of concrete between the compacted gravel and the lowest invert of the manhole. The

contractor shall deposit sufficient concrete on the base to assure a watertight seal between base and manhole wall. Twenty-four hours shall be allowed to elapse before the remaining manhole sections are placed on the base, unless otherwise approved by the Public Works Department authorized representative.

5. **Pipe Stub-outs for Future Storm Connections:** Pipe stub-outs shall be the same type as approved for use in the lateral, main, or trunk storm construction. Strength classifications shall be the same class as in adjacent trenches. Where two different classes of pipe exist at a manhole, the higher-strength pipe shall govern strength classification. Connect stub-outs to manholes as specified in this subsection, "Connection to Existing Manholes." Rubber-gasketed, watertight plugs shall be furnished with each stub-out and shall be adequately braced against air test pressures.
 6. **Gaskets:** Manhole sections shall be installed with either preformed rubber gaskets or plastic gaskets. Rubber gaskets shall conform to ASTM C-443. Plastic gaskets shall be Kent-seal No. 2 or Ram Neck, or approved equal, and shall meet all requirements of ASTM C-990.
 7. **Manhole Steps:** Steps shall be required and shall be constructed unless otherwise approved by the Public Works Department authorized representative. When pipe is 24 inches in diameter or smaller, steps shall be located as indicated in standard details. For pipe larger than 24 inches in diameter, steps shall be located over a bench as coordinated with the Public Works Department authorized representative. Maximum drop from rim to first step shall be 27 inches.
- c. **Workmanship**
- a. **Foundation Stabilization:** If, in the opinion of the geotechnical engineer or the Public Works Department authorized representative, unstable subgrade material exists that will not support the manhole or other structure, the contractor shall excavate below grade and backfill with foundation-stabilization material approved by the Public Works Department authorized representative.
 - b. **Pipe Connections:** All rigid pipes entering or leaving the manhole shall be provided with flexible joints within 1 foot of the manhole structure and shall be placed on firmly compacted bedding. Special care shall be taken to see that the openings through which pipes enter the structure are completely watertight. All flexible pipe shall be connected to manholes according to the manufacturer's recommendations.
 - c. **Flexible Joints:** Where the last joint of the line laid up to the manhole is more than 1 foot from the manhole base, a 6-inch concrete encasement shall be constructed around the entire pipe, from the manhole base to within 1 foot of the pipe joint, at the discretion of the Public Works Department authorized representative. The pipe encasement shall be constructed integrally with the manhole base. Pipes laid out of the manhole shall be shortened to ensure that the first flexible joint is no more than 1 foot from the manhole base.
 - d. **Manhole Connections:** The contractor shall connect storm pipe to manholes as specified in this Subsection, "Types of Connections."
 - e. **Drop Manholes**
 - (a) The maximum inside drop in a manhole shall be 18 inches. See also in this Subsection, "Shallow Inside Drop Manhole," for construction of this connection.
 - (b) When more than 18 inches feet of drop exists, an outside drop manhole shall be used. Outside drop manholes shall use ductile iron pipe with mechanical joints.
 - f. **Placing Manhole Section:** The contractor shall clean the end of each sections of foreign material. Manholes shall be installed with either watertight rubber O-rings or preformed plastic gaskets in conformance with the manufacturers' recommendations. If plastic gaskets are used, the inside seams shall be grouted with a high-strength, non-shrink

- grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Manholes will be visually inspected for water leakage by the Public Works Department authorized representative. Any leakage observed shall be repaired at the contractor's expense, and the manhole re-inspected.
- g. **Manhole Inverts:** The contractor shall construct manhole inverts in conformance with these standards. Inverts shall have smooth transitions to ensure an unobstructed flow through the manhole. The contractor shall remove all sharp edges or rough sections that tend to obstruct flow.
 - h. **Manhole Stub-outs:** The contractor shall install stub-outs from manholes for future extensions, as shown in these standards or as required by the Public Works Department authorized representative. A watertight flexible connection shall be used for pipe sizes 6 inches through 18 inches in all new manholes. The contractor shall construct invert channels in accordance with standard details. The minimum length of stub-outs in existing manholes shall be 12 inches from the outside manhole wall. Pipes shall be grouted in precast walls or the manhole base to create a watertight seal around the pipes. The contractor shall add compacted base rock, as specified in these standards, to undisturbed earth under all stub-outs.
 - i. **Manhole Extensions, Rings, and Covers:** The contractor shall install rings and covers on top of manholes to prevent all infiltration of surface water or groundwater into manholes. Rings shall be set in a bed of high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, with the grout carried over the flange of the ring, and shall be set so that tops of covers are flush with the surface of the adjoining pavement, or 1 foot above natural ground, unless otherwise directed by the Public Works Department authorized representative. Unused grout shall be discarded after 20 minutes and shall not be used. Total thickness of grade rings shall not exceed 12 inches; rings shall be grouted watertight. Drop from rim to first manhole step shall not exceed 27 inches. In designated floodplain areas, all manholes shall be at an elevation of at least 2 feet greater than the 100-year storm event.
- d. **Types of Connections**
- 1. **Connection to Existing Manholes:** The contractor shall connect storms to existing manholes at the locations shown on the plans. Contractor shall submit a plan for diversion control and receive written approval from the Public Works Department authorized representative before proceeding with construction. The contractor shall provide all diversion facilities and shall perform all work necessary to maintain sewage flow in existing storms while connections are being made to the manholes. Connections to existing manholes shall be core-drilled, and the bases shall be grouted as necessary to allow a smooth flow into and through the existing manholes.
 - 2. **Manholes over Existing Storms:** The contractor shall construct manholes over existing operating storm lines at the locations shown on the plans. The contractor shall construct a poured-in place base under the existing storm and the precast sections as specified. The contractor shall not cut into any existing lines until the new manhole(s) are grouted and the new lines are balled, flushed, and deflection tested, and all portions of the storm line have been approved and accepted by the Public Works Department authorized representative. After acceptance, the contractor shall saw cut into the existing line; cut edges of concrete pipe shall be covered with grout and troweled smooth; with ductile iron or plastic pipe, grout shall be applied up to cutout and troweled smooth.

3. **Shallow Inside Drop Manhole:** Where the invert of the connecting pipe is above the manhole shelf and less than 18 inches above the outlet, an inside drop shall be constructed utilizing Portland cement concrete. The stormwater entering the manhole shall follow a smooth concrete channel transitioning evenly from the invert of the inlet pipe into the main channel. Stormwater shall not be allowed to fall freely to the manhole base.

3.10.2 Catch Basins and Inlets

- a. **Materials**
 1. **Aggregate, Cement, and Concrete:** These materials shall meet the requirements of Subsection 3.10.2, "Manholes and Structures."
 2. **Frames, Grates, and Covers:** All materials shall be flat bar steel (standard grade), cast iron or ductile iron complying with the requirements of ASTM A-36, A-663, or A-709. Drainage grate inlets in paved roadways shall meet the requirements of "Drainage Grates" in Subsection 7.2.2, "On-Street Design Standards."
 3. **Forms:** All exterior surfaces shall be formed with steel or plywood. Other surfaces shall be formed with matched boards, plywood, or other approved material. Trench walls, rock, or earth will not be acceptable as form material.
 4. **Metal Reinforcement:** All metal reinforcement shall conform to the requirements of ASTM A-615, Grade 60, deformed bars.
 5. **Precast Concrete Units:** All precast units shall conform to the same requirements as manholes (ASTM C-478).
- b. **Workmanship**
 1. **Excavation and backfill** shall conform to the requirements of "Workmanship" In Subsection 3.10.1, "Manholes and Structures."
 2. **Bedding:** The contractor shall remove all water and debris from the excavation area and shall install an 8-inch-minimum layer of compacted 1"-0" crushed aggregate for a base.
 3. **Cast-in-Place:** Cast-in-place catch basins shall have a minimum of 6 inches of concrete between the compacted crushed aggregate and the lowest invert. The forms used for cast-in-place catch basins shall be tight and well-braced. The storm pipe material shall extend into the poured concrete of the catch basin. All corners shall be chamfered. Immediately after placement, the concrete shall be consolidated with an approved vibrator. The top surface shall be screed, and exposed surfaces shall be troweled to a smooth finish, free from marks or irregularities. After forms are removed, the contractor shall patch any defects in the concrete with approved material.
 4. **Precast:** After the base is prepared, the contractor shall set the precast catch basin to the proper line and grade. The storm pipe material being used shall connect to the precast catch basin.
 5. **Inverts, Stub-outs, and Sections:** Contractor shall clean the ends of all pipes and sections that contact the catch basin. All inverts, stub-outs, and sections shall be installed according to these standards, using a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, making sure all sharp edges or rough sections are removed, to prevent obstruction of the flow. Unused grout shall be discarded after 20 minutes and shall not be used.
 6. **Catch Basin Steps:** All catch basins deeper than 5 feet, measured from the top of the frame to the flow line, shall be oversized and have steps.

3.10.3 Stormwater Pipe and Fittings

- a. **General**

The materials used shall be adequate to carry anticipated dead and live loads within the deflection limits specified by the manufacturer. All pipe and culverts shall have a minimum design service life of 75 years. Joints shall be gasketed, unless otherwise approved by the Public Works Department authorized representative.

b. Materials

Materials shall be the following types or approved equal:

1. Concrete Pipe (NRCP/RCP):

- (a) Non-reinforced concrete pipe shall conform to requirements of ASTM C-14. Unless otherwise specified, pipe shall conform to Class 3 design requirements.
- (b) Reinforced concrete, non-pressure pipe shall conform to the requirements of ASTM C-76 or C-655 and shall be of the class specified. Unless otherwise specified, pipe shall meet the design requirements of Wall B. Reinforced concrete low-head pressure pipe shall conform to the requirements of ASTM C-361.
- (c) Gaskets shall conform to the requirements of ASTM C-443.
- (d) All steam-cured concrete pipe must be at least seven days old before it can be used. If the pipe has not been steam-cured, it must not be used before it has cured for 28 days.
- (e) Fittings shall be manufactured integrally and be of a class at least equal to that of the adjacent pipe. Field taps shall be machine-drilled.
- (f) Mortar used shall be standard non-shrink premixed mortar conforming to ASTM C-387 or in a proportion of one-part Type II Portland cement to two parts clean, well-graded sand that will pass a ¼-inch screen. Mortar mixed for longer than 30 minutes shall not be used.

2. Ductile Iron Pipe (D.I.):

- (a) Ductile iron pipe shall conform to the requirements of American Water Works Association (AWWA) C-151 or American National Standards Institute (ANSI) A21.51, cement lined push-on joint. The minimum thickness class shall be Class 50 (up through 12-inch diameter pipe) and Class 51 (for 14-inch diameter and larger pipe).
- (b) Fittings shall be mechanical or push-on. Mechanical joint ductile iron fittings shall conform to AWWA C-110. Push-on joint fittings shall be gray iron, with body thickness and radii of curvature conforming to ANSI A-21.10. Rubber gasket joints shall conform to AWWA C-111/ANSI A-21.11.

3. Polyvinyl Chloride Pipe (PVC):

- (a) PVC pipe shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-2729, ASTM D-1784, ASTM D-1785, ASTM F-679, ASTM F-794, AWWA C-900, and AWWA C-905.
- (b) PVC fittings shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-2729, ASTM D-1785, ASTM D-2466, and ASTM D-2467. Fitting joints shall be the same as the pipe joints. Threaded connections shall conform to the requirements of ASTM D-2464 for schedule 80 pipe.
- (c) A2000 (PVC): All A2000 PVC pipe and fittings shall conform to ASTM F-949 specifications.
- (d) PVC rib: PVC rib pipe and fittings shall be made of PVC, as defined in ASTM D-1784. The pipe stiffness shall correspond with the series, in accordance with ASTM D-2412. Series 46 and 28 are allowed. Gaskets shall conform to ASTM F-477.

4. Corrugated polyethylene (CPP):

- (a) Corrugated polyethylene pipe, double wall, and fittings shall be made of polyethylene compounds that conform with the physical requirements of Type III, Category 3, 4 or 5, P23, P33, P34, Class C, with the applicable requirements

defined in ASTM D-1248. Spiral pipe is not acceptable. Corrugated polyethylene pipe shall conform to AASHTO M-294 specifications.

5. Corrugated Aluminum (CAP) and Corrugated Aluminum Pipe Arches (CAPA):
 - (a) Corrugated aluminum pipe and fittings shall conform to the requirements of AASHTO M-196 and AASHTO M-197.
 - (b) The connecting bands shall conform to the requirements of AASHTO M-196, except that the minimum width of bands for 12-inch and larger pipe shall be 12 inches. The minimum width for pipes less than 12 inches shall be 7 inches. The base metal of the connecting bands shall be the same base metal as that of the pipe. The gauge of the connecting bands may be two standard-use thicknesses lighter than that used for the pipe, but not less than 0.060 inch thick. The band couplers shall be connected with stainless steel bolts not less than 0.5 inch in diameter.
 - (c) Corrugated aluminum pipe shall not be placed in a ditch in direct contact with hydrating Portland cement or lime.
6. Fittings:
 - (a) General
 - (1) Manufactured tee fittings shall be provided in the storm main for side storms. Fittings shall be of sufficient strength to withstand all handling and load stresses encountered.
 - (2) Fittings shall be of the same materials as the pipe. Material joining the fittings shall be of the same material as the pipe.
 - (3) Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.
 - (4) All fittings shall be capped or plugged and shall be gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout lug. The plug shall be able to withstand all test pressures without leaking. When later removed, the plug shall permit continuation of piping with jointing similar to joints in the installed line.
 - (b) Mechanical Couplings: Mechanical couplings shall be wrought steel. Installation procedures must meet the manufacturers' recommendations.
7. Line Tap Saddle:

All saddles approved for sanitary storm tap installation (see Subsection 4.4.2, "Gravity Storm Pipe and Fittings") shall be allowed on storm taps, except the following:

 - (a) DFW/HPI saddle—an elastomeric polyvinyl chloride saddle with steel-reinforced edges and stainless-steel bands, series 300. This saddle is allowed on PVC, clay, IPS, concrete, asbestos cement, and PE pipe.
 - (b) Saddles installed on corrugated aluminum pipe shall be fabricated and installed using stainless-steel nuts and bolts. Bolts and nuts shall conform to AWWA C-111/ANSI A21.11.
- c. Workmanship
 1. Line and Grade:
 - (a) Survey control hubs for both line and grade shall be provided by the design engineer in a manner consistent with accepted practice. The contractor shall establish line and grade for pipe by the use of lasers or by transferring the cut from the offset stakes to the trench at a maximum of 50-foot intervals to maintain the line and grade.
 - (b) Variance from the established line and grade shall not be greater than ¼ inch for grade and ½ inch for line, provided that such variation does not result in a level or reverse-sloping invert.

- (c) The contractor shall check line and grade as necessary. If the limits prescribed in these standards are not met, the work shall be immediately stopped, the Public Works Department authorized representative notified, and the cause remedied before proceeding with the work.
- (d) Variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, shall not exceed 1/64 per inch of pipe diameter, or ½ inch maximum.
- (e) Tee stations shall be staked as specified in Subsection 3.1.7, "Surveying," to enable the contractor to install services at the correct property location.
- 2. Pipe Handling:
 - (a) The contractor shall unload pipe only by approved means. Pipe shall not be unloaded by dropping it to the ground and pipe shall not be dropped or dumped into trenches.
 - (b) The contractor shall inspect all pipe and fittings before lowering them into trenches to ensure that no cracked, broken, or otherwise defective materials are used.
 - (c) The contractor shall clean the ends of pipe thoroughly, remove foreign matter and dirt from inside the pipe, and keep it clean during laying and joining.
 - (d) The contractor shall lower the pipe into the trench in such a manner as to avoid any physical damage to the pipe.
 - (e) The contractor shall remove all damaged pipe from the job site.
- 3. Foreign Material:
 - (a) The contractor shall take all necessary precautions to prevent excavated or other foreign material from entering the pipe during the laying operation.
 - (b) At all times, when laying operations are not in progress, the contractor shall use a mechanical plug at the open end of the last laid section of pipe to prevent entry of foreign material or creep of the gasketed joints.
- 4. Pipe Laying:
 - (a) Pipe laying shall proceed upgrade, with the spigot ends pointing in the direction of flow.
 - (b) After a section of pipe is lowered into the prepared trench, the contractor shall clean the end of the pipe to be joined, the inside of the joint, and the rubber ring (if required) immediately before joining the pipe.
 - (c) At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides, where necessary, to permit the joint to be made properly.
 - (d) The joint shall be assembled according to the recommendations of the manufacturer. The contractor shall provide all special tools and appliances required for the joint assembly. After the joint is made, the pipe shall be checked for alignment and grade.
 - (e) The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.
 - (f) Do not lay pipe in water or when, in the opinion of the Public Works Department authorized representative, trench conditions are unsuitable.
- 5. Movable Shield: When pipe is laid in a movable trench shield, the contractor shall take all necessary precautions to prevent the pipe joints from pulling apart when the shield is moved ahead. The bottom of the shield shall not extend below the spring line of the pipe without recompacting the pipe zone.
- 6. Cutting Pipe: When cutting or machining the pipe is necessary, the contractor shall use only the tools and methods recommended by the pipe manufacturer and approved by the Public Works Department authorized representative. The contractor shall cut ductile

- iron pipe using a method approved by the Public Works Department authorized representative; all burrs or rough edges shall be removed before joining pipe. The contractor shall not flame-cut the pipe.
7. Transition Fittings: Connections of service branches to existing storms shall be made watertight. Transition couplings between dissimilar pipe materials shall be made using approved commercial adapters with stainless steel bands such as Fernco, Caulder, or equal.
 - (a) PVC couplers or adapters shall meet the specifications for ASTM D-3034, SDR 35 pipe fittings.
 - (b) Ductile iron transition couplings shall be manufactured from ductile iron conforming to ASTM A-536, grade 65-45-12, for center and end rings. Rubber gaskets, bolts, and nuts shall conform to AWWA C-111/ANSI A21.11.
 8. Concrete Closure Collars
 - (a) The contractor shall pour closure collars against undisturbed earth, remove all water from the excavation, and construct suitable forms to obtain shapes that will provide full bearing surfaces against undisturbed earth, as indicated in these standards.
 - (b) Closure collars shall be used only when approved by the Public Works Department authorized representative, and then only to make connections between dissimilar pipe, or where standard rubber-gasketed joints are impractical.
 - (c) Before the closure collars are installed, the contractor shall wash the pipe to remove all loose material and soil from the surface where they will be placed.
 9. Pipe Zone Material: The contractor shall install pipe zone material uniformly on both sides of the pipe, up to the spring line of the pipe. Material shall be placed in lifts not exceeding 6 inches. Material shall be well worked with hand tools to ensure proper support in the haunching area.
 10. Line Taps
 - (a) Line taps shall be core-drilled unless otherwise approved by the Public Works Department authorized representative. Core-drilled holes shall be made using a cylinder-style hole saw for plastic pipe material only, or a diamond core bit for concrete and ductile iron pipes.
 - (b) Line tap connections to existing storm lines may be done using either saddle tees or by using Inserta Tee® as per Subsection 3.10.3, "Stormwater Pipe and Fittings".
 - (c) Line taps shall be centered on the spring line of the pipe being tapped.
 - (d) The area around the saddle installation site shall be cleaned and free of all rough edges before installing the saddle.
 - (e) While installing the saddle, no rock, dirt, or debris shall be allowed to enter the main storm line from the core hole.
 - (f) The contractor shall install ¾"-0" crushed aggregate in the pipe zone around the line tap, from 6 inches below the pipe to 12 inches above the pipe.
 - (g) Laterals shall have tracer wire (12-gauge with white THNN insulation) installed beside the pipe.

3.11 CONSTRUCTION SPECIFICATIONS

3.11.1 General Provisions

The specifications outlined here, together with the standards established by the Oregon DEQ, the U.S. Environmental Protection Agency, and any other applicable requirements of the City, shall govern the character and quality of material, equipment, installation, and construction procedures for gravity-flow portions of public storm systems.

3.11.2 Scheduling

The contractor shall plan their construction work in conformance with Subsection 1.17.2, "Scheduling."

3.11.3 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize the work's impact on the environment and shall control erosion, as outlined in Subsection 1.18, "Environmental Protection, Erosion Prevention, and Sediment Control."

3.11.4 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Subsection 1.17.5, "Interferences, Obstructions, and Abandoned Utilities."

3.11.5 Contaminated Soil or Hazardous Materials

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Subsection 1.18.2, "Contaminated Soils or Hazardous Materials."

3.11.6 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill Standards."

3.11.7 Preservation, Restoration, and Cleanup

- a. Cleanup: Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Subsection 1.17.16, "Preservation, Restoration, and Cleanup."
- b. Preservation of Drainage Ditches: After backfilling the trenches, the contractor shall restore all public and private storm drain ditches that were destroyed, damaged, or otherwise modified during construction to the condition of the ditch before construction. Ditches shall be built in their original locations unless otherwise redesigned as part of the project.

3.11.8 Bores

- a. General

The carrier pipe in all bores shall be installed inside a steel case, unless otherwise approved by the City's authorized representative.
- b. Installation
 1. Casing: The casing shall be smooth steel of a size to permit proper construction to the required line and grade. The steel casing shall be fabricated in sections for field-welded joints. The casing wall thickness shall be a minimum of $\frac{1}{8}$ inch for pipe diameters of 6 to 12 inches and shall be a minimum of $\frac{5}{16}$ inch for pipe diameters of 15 to 24 inches, or in accordance with the requirements of the jurisdiction of the right-of-way.
 2. Pipe Supports: The storm pipe shall be continuously supported on three sides by pipe supports, except at joints. Pipe supports shall be No. 2 HDPE plastic block or approved equal. Strapping and hardware shall be stainless steel.
 3. Placing Fill in Casing: The annular space shall be completely filled between the casing and pipe with lean grout or sand to prevent pipe flotation.
 4. Concrete Seals and Fill: After the storm pipe is tested and approved, concrete plugs shall be poured at each end of the casing. The annular space between the casing and pipe shall be completely filled with lean grout or sand to prevent pipe flotation.
- c. Railroad Crossings

Prior to beginning any under-track work, applicant shall obtain proper permit(s) from ODOT or present owner of railroad line and written approval of plans from user(s) of railroad line. Install the pipe by tunneling, jacking, boring or similar

methods, approved by the Railroad. Install the pipe to the lines and grades established and backfill completely all voids around the installation with specified material, to the satisfaction of the railroad.

3.12 TESTING PROCEDURES

3.12.1 General

- a. The contractor shall furnish all necessary testing equipment and perform the tests in a manner satisfactory to the City's authorized representative.
- b. All gravity storm systems shall be inspected and tested after backfill has passed the required compaction test(s) based on AASHTO T-180 and roadway base rock has been placed, compacted, and approved. All details of testing procedures shall be subject to approval of the City's authorized representative.
- c. If repair work is required on a section of the system, that portion of the system shall be retested.
- d. All testing shall be completed and accepted by the City's authorized representative before paving of overlying roadways will be permitted.

3.12.2 Line Cleaning

Before testing and City inspection of the system, the contractor shall ball and flush and clean all parts of the system. The contractor shall remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at or near the closest downstream manhole. If necessary, the contractor shall use mechanical rodding, bucketing or vactor equipment. When the City's authorized representative inspects the system, any foreign matter still present shall be flushed and removed from the system. Contractor shall provide screening; no material shall be flushed into the downstream city storm system.

3.12.3 Deflection Test for Flexible Pipe

Storm systems constructed of flexible pipe shall be deflection-tested by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95% of the nominal pipe diameter, unless otherwise specified by the City's authorized representative. The mandrel shall be a rigid, nonadjustable, odd-numbered-leg (9 legs minimum) mandrel having an effective length of not less than its nominal diameter. Testing shall be done manhole-to-manhole and after the line is completely balled and flushed with water, and after compaction tests of backfill are completed and accepted. The contractor shall be required to locate and repair any sections that fail the test and to retest those sections. All repairs shall follow and be in compliance with the manufacturer's recommendations.

3.12.4 Video Inspection of Gravity Systems

All storm systems shall be video-inspected and approved prior to City acceptance. Video inspection shall take place after trench backfill and compaction has been completed and accepted, and channels have been poured in manholes. All pipes shall be thoroughly flushed immediately prior to the video inspection; only that water remaining from flushing shall be present in the system. The camera shall have the ability to tilt up to 90 degrees and rotate 360 degrees on the axis of travel. An inspection of all lateral connections shall be conducted using the tilt capabilities of the camera. A 1.0-inch target ball shall be placed in front of the camera. Observed sags must be less than 0.5 inch.

The City's authorized representative shall be notified and shall be present during video-inspection of the system, unless otherwise approved by the City's authorized

representative. A copy of the video and a written video inspection report, on a City-approved form, shall be supplied to the City's authorized representative. The video shall be recorded in color and in DVD or CD format. Video shall include a visual footage meter recording. Problems revealed during the inspection shall be noted on the video and in the written report. After repairs have been made, the line shall be re-inspected and re-tested. If excessive foreign material, in the opinion of the City's authorized representative, is encountered during video inspection, the line shall be balled and flushed, and re-video inspected.

3.13 WARRANTIES & ACCEPTANCE

3.13.1 Stormwater and Surface Water Acceptance Policy

The City of Molalla will accept new stormwater and surface water installations or systems built to the "Public Works Standards," providing that the following conditions are met.

- a. Dedication of any required easements or rights-of-way have been recorded with the County Recorder and the Engineering Department receives a reproducible copy of the recorded documents.
- b. After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Subsection 1.17.17, "Project Closeout."
- c. The Contractor or Applicant shall be responsible for providing Maintenance Assurance for Public Improvements as outlined in Subsection 1.17.18, "Maintenance Assurance and Warranty." Public storm improvements shall be warranted for a minimum of one year; public landscape improvements shall be warranted for a minimum of two years.
- d. At any time during the warranty period, the City's authorized representative has reason to believe the public stormwater improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party's own cost, to video-inspect the storm line and repair any problems or faults revealed during video inspection by replacing those sections. The video inspection shall be done during the winter, if possible, or during the wet weather months, to identify all leaks.
- e. Before the end of the Construction Maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.
- f. The Landscape Maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection 3.13.2, "Landscape Inspection for Warranty").

3.13.2 Landscaping Inspection for Warranty

- a. The City's authorized representative shall inspect the condition of all landscaping located within the public right-of-way and/or the water quality/quantity facility at the end of the first year of the post-construction period. The City's authorized representative shall provide an interim inspection report to the applicant with a specific summary of any deficiencies. Failure of the City to provide the interim report shall not release the applicant from the responsibility for providing established landscaping at the end of the two-year landscaping maintenance period.
- b. If at any time during the warranty period the landscaping falls below the 90% survival level, the applicant shall reinstall all deficient planting at the next appropriate planting opportunity. The two-year maintenance period shall begin anew from the date of replanting.

- c. The 90% survival level shall meet the following criteria:
 - 1. In the opinion of the City's authorized representative, landscaping is established and healthy.
 - 2. Each plant group (trees, shrubs, herbaceous, and aquatics) shall meet the 90% survival level.
 - 3. Each planting zone (wet, moist, and dry) shall meet the 90% survival level.
- d. Areal coverage shall meet the 90% survival level.

SECTION 9 – INFILTRATION REQUIREMENTS, SITE CHARACTERIZATION, AND SITE SUITABILITY CRITERIA

9.1 INTRODUCTION

This Section specifies the site characterization and site suitability criteria that must be considered for siting infiltration treatment facilities. For infiltration treatment facilities site selection and design decisions, a geotechnical and hydrogeologic report shall be prepared by a qualified engineer with geotechnical and hydrogeologic experience. A comparable professional, acceptable to the City, may also conduct the work if it is under the seal of a Professional Engineer registered in the State of Oregon. The design engineer shall utilize a team of certified or registered professionals in soil science, hydrogeology, geology, and other related fields. A member of this design team shall be considered/designated the site professional (as referenced in this Section 9).

9.2 SITE CHARACTERIZATION

Applicant shall conduct a site characterization study prior to siting and designing infiltration treatment facilities. Information gathered during initial geotechnical investigations shall be used for the site characterization. Key data and issues to be characterized include, but are not limited to, the following.

9.2.1 Surface Feature Characterization

- a. Topography within 500 feet of the proposed facility. The plan shall show existing ground contours (shaded) and proposed ground contours at a minimum 2-foot contour interval. Slopes steeper than 6H:1V shall be identified.
- b. Anticipated site use (residential, commercial, or industrial).
- c. Location of water supply wells within 500 feet of proposed facility.
- d. Location of ground water protection areas and/or 1-, 5-, and 10-year time of travel zones for municipal well protection areas.
- e. A description of local site geology, including soil or rock units likely to be encountered, the groundwater regime, and geologic history of the site.
- f. Site location relative to identified flood plain or floodway.
- g. Site location relative to surface water features, such as waterways, wetlands, etc.

9.2.2 Subsurface Characterization

- a. Subsurface explorations (test holes or test pits) shall be performed to a depth of at least five times the maximum design depth of ponded water proposed for the infiltration treatment facility.
- b. Continuous sampling (representative samples from each soil type and/or unit) to a depth below the base of the infiltration facility of 2.5 times the maximum design ponded water depth, but not less than 6 feet.
 1. For basins, at least one test pit or test hole per 5,000 square feet of basin infiltrating surface (in no case less than two per basin).
 2. For trenches, at least one test pit or test hole per 50 feet of trench length (in no case less than two per trench).
- c. Prepare detailed logs for each test pit or test hole and a map showing the location of the test pits or test holes. Logs must include at a minimum, depth of pit or hole, soil descriptions, depth to water, presence of stratification.

9.2.3 Soil Testing

Soil characterization for each soil unit (soils of the same texture, color, density, compaction, consolidation and permeability) encountered should include:

- a. Grain-size distribution (ASTM D-422 or AASHTO T-311).
- b. Textural class (USDA).
- c. Percent clay content (include type of clay, if known) as determined by hydrometer testing (ASTM D-422 or AASHTO T-88).
- d. Cation exchange capacity (CEC) and organic matter content for each soil type and strata. Where distinct changes in soil properties occur, to a depth below the base of the infiltration treatment facility of at least 2.5 times the maximum design water depth, but not less than 6 feet. Consider if soils are already contaminated, thus diminishing pollutant sorptive capacity.
- e. For soils with low CEC and organic content, deeper characterization of soils may be required by the City (refer to Subsection 9.3, "Site Suitability Criteria").
- f. Color/mottling.
- g. Variations and nature of stratification.

9.2.4 Infiltration Rate Determination

- a. Determine the representative infiltration rate of the unsaturated vadose zone based on field infiltration tests and grain size/texture determinations. Field infiltration rates shall be determined using infiltration test methods as presented in the King County Surface Water Design Manual or comparable reference; infiltration testing shall be done in the soil stratum at the design elevation of the bottom of the infiltration facility.
- b. Site testing shall be performed to verify infiltration rate estimates based on soil size distribution and/or texture. As a minimum, one soil grain-size distribution analysis (ASTM D-422 or AASHTO T-311) per soil stratum in each test hole shall be performed within 2.5 times of the maximum design water depth, but not less than 6 feet.
- c. The infiltration rate is needed for routing and sizing purposes and for classifying the soil for treatment adequacy.

9.2.5 Infiltration Receptor

Infiltration receptor (unsaturated and saturated soil receiving the stormwater) characterization shall include:

- a. Installation of ground water monitoring wells, unless the highest ground water level is known to be at least 50 feet below the proposed infiltration facility. Use at least three wells per infiltration treatment facility, or three hydraulically connected surface and ground water features. This will establish a three-dimensional relationship for the ground water table. The monitoring wells will:
 - 1. Monitor the seasonal ground water levels at site through a minimum of one wet-season.
 - 2. Consider the potential for unconfined and confined aquifers, or confining units, at the site that may influence the proposed infiltration facility as well as the ground water gradient. Other approaches to determine ground water levels at the proposed site could be considered if pre-approved by the Public Works Director or the Public Works Department authorized representative.
 - 3. Determine the ambient ground water quality, if there is a concern identified by the City.
- b. Estimate the volumetric water holding capacity of the infiltration receptor soil. This is the soil layer below the infiltration treatment facility and above the seasonal high-water mark, bedrock, hardpan, or other low permeability layer. This analysis should be conducted at a conservatively high infiltration rate based on vadose zone porosity, and the water quality

- runoff volume to be infiltrated. Along with an analysis of ground water movement, this will be used in determining volumetric limitations that would adversely affect drawdown.
- c. Depth to ground water table and to bedrock/impermeable layers.
 - d. Seasonal variation of ground water table based on recorded well water levels and observed mottling.
 - e. Existing ground water flow direction and gradient.
 - f. Lateral extent of infiltration receptor.
 - g. Horizontal hydraulic conductivity of the saturated zone to assess the aquifer's ability to laterally transport the infiltrated water.
 - h. Impact of the infiltration rate and volume at the project site on ground water mounding, flow direction, and water table; and the discharge point or area of the infiltrating water. A ground water mounding analysis shall be conducted at all sites where the depth to seasonal ground water table or low permeability stratum is less than 15 feet and the runoff to the infiltration treatment facility is from more than one acre. The site professional can consider conducting an aquifer test or slug test and the type of ground water mounding analysis necessary at the site.

9.3 SITE SUITABILITY CRITERIA

This section specifies the site suitability criteria that must be considered for siting infiltration treatment facilities. When a site investigation reveals that any of the nine applicable criteria cannot be met, appropriate mitigation measures must be implemented so that the infiltration treatment facility will not pose a threat to safety, health, and the environment.

9.3.1 Setbacks

Setback requirements shall follow City regulations, uniform building code requirements, and/or state regulations. Also evaluate on-site and off-site structural stability due to extended subgrade saturation and/or head loading of the permeable layer, including the potential impacts to down-gradient properties, especially on hills with known side-hill seeps.

The following setbacks are provided as guidance.

- a. From drinking water wells, septic tanks or drain fields, and springs used for public drinking water supplies. Infiltration treatment facilities up-gradient of drinking water supplies and within 1, 5 and 10-year time of travel zones must comply with Oregon Health Division requirements.
- b. From building foundations (a minimum of 20 feet down-slope and 100 feet upslope).
- c. From the top of slopes steeper than 10% (setback a minimum of 50 feet from crest of slope).

9.3.2 Ground Water Drinking Water Protection Areas

A site shall be deemed not suitable if the infiltrated stormwater will be in violation of OAR 340-044-0014.

9.3.3 High Vehicle Traffic Areas

Infiltration treatment facilities may be considered for runoff from areas of industrial activity and the high vehicle traffic areas described below, if appropriate pretreatment (including oil removal) is provided to ensure that ground water quality standards will not be violated and that the infiltration treatment facility will not be adversely affected.

High Vehicle Traffic Areas are defined as:

- a. Commercial or industrial sites subject to an expected ADT ≥ 100 vehicles/1,000 square feet gross building (trip generation); and
- b. Road intersections with an ADT of $\geq 25,000$ on the main roadway, or $\geq 15,000$ on any intersecting roadway.

9.3.4 Soil Infiltration Rate/Drawdown Time

- a. Infiltration rates short-term and long-term:
 1. For treatment purposes the short-term soil infiltration rate should be 2.4 inch/hour, or less, to a depth of 2.5 times the maximum design pond water depth, or a minimum of 6 feet below the base of the infiltration treatment facility. This infiltration rate is also typical for soil textures that possess sufficient physical and chemical properties for adequate treatment, particularly for soluble pollutant removal (see Subsection 9.3.6, "Soil Physical and Chemical Suitability for Treatment"). It is comparable to the textures represented by Hydrologic Groups B and C. Long-term infiltration rates up to 2.0 inches/hour can also be considered, if the infiltration receptor is not a sole-source aquifer, and in the judgment of the site professional, the treatment soil has characteristics comparable to those specified in criteria #6 to adequately control the target pollutants.
 2. The long-term infiltration rate should also be used for maximum drawdown time and routing calculations.
- b. Drawdown time:

It is necessary to empty the maximum ponded depth (water quality volume) from the infiltration basin within 24 hours from the completion of inflow to the storage pond in order to meet the following objectives:

 1. Restore hydraulic capacity to receive runoff from a new storm.
 2. Maintain infiltration rates.
 3. Aerate vegetation and soil to keep the vegetation healthy.
 4. Enhance the biodegradation of pollutants and organics in the soil.

9.3.5 Depth to bedrock, Water Table, or Impermeable Layer

The base of all infiltration basins or trench systems shall be ≥ 5 feet above the seasonal high-water mark, bedrock (or hardpan) or other low permeability layer. A minimum separation of 3 feet may be considered if the ground water mounding analysis, volumetric receptor capacity, and the design of the overflow and/or bypass structures are judged by the site professional to be adequate to prevent overtopping and to meet the site suitability criteria specified in this section.

9.3.6 Soil Physical and Chemical Suitability for Treatment

The soil texture and design infiltration rates should be considered along with the physical and chemical characteristics specified below to determine if the soil is adequate for removing the target pollutants. The following soil properties must be carefully considered in making such a determination:

- a. CEC of the treatment soil must be ≥ 5 millequivalents (meq) CEC/100 g dry soil (USEPA Method 9081). Consider empirical testing of soil sorption capacity, if practicable. Ensure that soil CEC is sufficient for expected pollutant loadings, particularly heavy metals. Lower CEC content may be considered if it is based on a soil loading capacity determination for the target pollutants that is accepted by the Public Works Director or the Public Works Department authorized representative.
- b. Depth of soil used for infiltration treatment must be a minimum of 18 inches.
- c. Organic content of the treatment soil as determined by ASTM D-2974: Organic matter can increase the sorptive capacity of the soil for some pollutants. The site professional should evaluate whether the organic matter content is sufficient for control of the target pollutant(s).

- d. Waste fill materials should not be used as infiltration media nor should such media be placed over uncontrolled or non-engineered fill soils.
- e. Engineered soils may be used to meet the design criteria in this section. Field performance evaluation(s), using acceptable protocols, would be needed to determine feasibility, and acceptability by the Public Works Director or the Public Works Department authorized representative.

9.3.7 Seepage Analysis and Control

Determine whether there would be any adverse effects caused by seepage zones on nearby building foundations, basements, roads, parking lots or sloping sites.

9.3.8 Impact of Roadway Deicers

Potential impact of roadway deicers on potable water wells must be considered in the siting determination. Mitigation measures must be implemented if infiltration of roadway deicers can cause a violation of ground water quality standards.

9.3.9 Verification Testing of the Completed Facility

Verification testing of the completed full-scale infiltration treatment facility is recommended to confirm that the design infiltration parameters are adequate to manage the design volume and meet the pollutant capture objectives of the infiltrating soil. The site professional should determine the duration and frequency of the verification testing program for the potentially impacted ground water. The ground water monitoring wells installed during site characterization may be used for this purpose. Long-term in-situ drawdown and water quality monitoring for a two-year period, would be preferable.

SECTION 10 – STORMWATER QUALITY FACILITY DESIGN

10.1 INTRODUCTION

The purpose of this Section is to outline the design and construction guidelines for water quality facilities in the City of Molalla. These guidelines may be used to comply with the water quality facility design standards in Subsection 3.5, “Water Quality Facility Design.” It is the responsibility of the design engineer to determine the appropriate design criteria that ensures compliance with the City of Molalla design standards, in combination with other federal, state, and local laws and ordinances. Safety of stormwater quality facilities shall be in conformance with “Safety” in Subsection 3.3.9, “Detention/Retention Facility Protection.”

10.2 FILTRATION

10.2.1 Biofiltration Swale

- a. Hydraulic design criteria
 1. Design storm = water quality storm
 2. Minimum hydraulic residence time = 9 minutes.
 3. Maximum water design depth = 0.5 feet.
 4. Minimum freeboard = 1.0 foot (for facilities not protected from high flows).
 5. Manning n value = 0.24.
 6. Maximum velocity = 2.0 feet per second based on 25-year flow.
- b. Design criteria
 1. Provide an energy dissipater at the entrance to the swale as per Subsection 3.3.7, “Channel Protection.” It shall be designed to reduce velocities and spread the flow across the treatment cross-section.
 2. Intermediate flow spreaders may be required.
 3. Minimum length = 100 feet.
 4. Minimum slope = 0.5%.
 5. Minimum bottom width = 2 feet.
 6. Maximum treatment depth (measured from top of gravel) = 0.5 feet.
 7. Maximum side slope:
 - (1) In treatment area = 4H:IV
 - (2) Above treatment area = 3H:IV
 8. Use 2”-¾” gap-graded river aggregate placed 2½ to 3 inches deep on jute matting placed over 6 inches of topsoil or use another base-stabilization method approved by the Public Works Department authorized representative. Extend river aggregate, jute, and topsoil to top of treatment area.
 9. If the swale slope is less than 1.5%, an underdrain shall be installed using a perforated pipe, or equivalent. Amend the soil if necessary, to allow effective percolation of water to the underdrain. Underdrains can be made of 6-inch diameter Schedule 40 PVC perforated pipe with 6 inches of drain gravel over the pipe. The gravel and pipe must be enclosed by geotextile fabric. Slopes greater than 2.5% need check dams (riprap) at vertical drops of 12-15 inches.
 10. Retaining walls are not allowed in the treatment area.
 11. Provide an approved outlet structure for all flows.
 12. All exposed areas shall be protected with jute matting or an alternative approved by the Public Works Department authorized representative.

13. Plant vegetation consistent with the requirements of Section 8, "Landscape Requirements for Stormwater Facilities."

10.2.2 Sand Filter

a. Design Criteria

1. The design of sand filters is based on Darcy's Law (Safety Factor = 2):

$$A = Q \div (k \times i)$$

Where: A = area of sand filter.

Q = peak flow rate (from hydrograph).

k = sand permeability (3.5 feet/day).

i = hydraulic gradient (see below).

$$I = (h + L) \div L$$

Where: h = height of water column over sand filter.

L = thickness of sand filter.

2. No drainage shall be allowed directly to the filter; it must first go through a catch basin, inlet, sedimentation manhole, or similar large debris collection device.
3. The sand filter shall infiltrate the entire water quality volume without overflow.
4. The drawdown period for sand filters shall not exceed 24 hours.
5. The sand filter shall consist of an inlet structure, a sand bed, underdrain piping, and a basin liner. Criteria for these components are given below.

b. Inlet Structure

The inlet structure shall spread the flow of incoming water uniformly across the surface of the filter medium during all anticipated flow conditions. At a minimum, the inflow spreader shall meet the requirements as provided in Subsection 3.3.8, "Outfall Protection". It shall be designed to reduce velocities and spread the flow across the treatment cross-section. Flow shall be spread in a manner that prevents roiling or otherwise disturbing the filter medium.

c. Sand Bed—Filter Medium

1. The length-to-width ratio shall be 2:1 or greater.
2. The filter bed medium shall consist of clean, medium to fine sand, with no organics, frozen pieces, or other deleterious materials. Sand used as a filter medium shall be certified by a certified testing laboratory as meeting or exceeding the gradation requirements in **Table 10.1**. Sieve analysis shall be determined according to AASHTO T-27.

**Table 10.1. GRADATION REQUIREMENTS
FOR FILTER BED MEDIUM**

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	45-85
No. 30	15-60
No. 50	3-15
No. 100	< 4

- d. Sand Bed with Gravel Filter
1. The top layer shall be a minimum of 18 inches of sand meeting gradation requirements of **Table 10.1**.
 2. The sand shall be placed over a non-woven geotextile fabric material, meeting the specifications provided in **Table 10.2**, covering a layer of ½- to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
 3. No gravel is required below the underdrain piping system.

Table 10.2. GEOTEXTILE FABRIC MATERIAL SPECIFICATIONS

Property	Test Method	Specification
Unit Weight	--	8 oz./SY (minimum)
Filtration Rate	--	0.08 inch/sec (minimum)
Puncture Strength	ASTM D-751 (modified)	125 lb (minimum)
Mullen Burst Strength	ASTM D-751	400 psi (minimum)
Tensile Strength	ASTM D-1682	200 lb (minimum)
Equivalent Opening Size	US Standard Sieve	80-120

- e. Sand Bed Using Trench Design
1. The top layer shall be a minimum of 12 inches of sand meeting gradation requirements of **Table 10.1**.
 2. The sand shall be placed over a non-woven geotextile fabric material, meeting the specifications provided in **Table 10.2**, covering a layer of ½- to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
 3. The piping and gravel shall be underlain with drainage matting meeting the specifications provided in **Table 10.3**.

Table 10.3. DRAINAGE MATTING MATERIAL SPECIFICATIONS

Property	Test Method	Specification
Unit Weight		20 oz./SY
Flow Rate (fabric)		180 gpm/SF (minimum)
Permeability	ASTM D-2434	0.124 cm/sec
Grab Strength (fabric)	ASTM D-1682	Dry Lg 90 Dry Wd 70 Wet Lg 95 Wet Wd 70
Puncture Strength (fabric)	COE CW-02215	42 (minimum)
Mullen Burst Strength	ASTM D-117	140 psi (minimum)
Equivalent Opening Size	US Standard Sieve	80 – 120
Flow Rate (drainage core)	Drexel Universal Test Method	14 gpm/ft. width

f. Underdrain Piping

1. The underdrain piping system shall consist of appropriately sized perforated pipes (minimum 4-inch diameter). The pipe used in this system shall be schedule 40 polyvinyl chloride (PVC) material, or an approved equal. Flexible perforated pipe will not be approved. Lateral spacing shall not exceed 10 feet.
2. The underdrain laterals shall be placed with positive gravity drainage to the collector pipe
3. The collector pipe shall have a minimum 1% grade toward the discharge point.
4. All laterals and collector pipe shall have cleanouts installed, accessible from the surface without removing or disturbing filter media.

g. Basin Liner

1. An impermeable liner is required for all sand filter systems. The liner shall comply with the requirements provided in Section 11, “Stormwater Quality Facility Liners.”
2. Geomembrane liners shall meet the requirements provided in Subsection 11.4.3, “Geomembrane Liners.” They shall be placed on a smooth, compacted bed of sand, minimum 6 inches thick, graded as necessary to facilitate the hydraulic performance designed into the facility.

10.3 PONDS

10.3.1 Wet Ponds

a. Hydraulic design criteria

1. Permanent pool volume = $0.55 \times \text{WQV}$ (Water Quality Volume).
2. Minimum water quality detention/retention volume = $1.0 \times \text{WQV}$.
3. Water quality drawdown time = 48 hours.
4. To calculate orifice size, use the following equation:

$$D = 24 \times [(Q / (\pi C_d [2gH]^{0.5}))]^{0.5}$$

Where: D = orifice diameter (inches).

Q (cfs) = WQV (cf)/(48 hr. $\times$ 60 min/hr. $\times$ 60 sec/min).

C_d = orifice coefficient (0.62 for square-edged entrance).

g = gravitational constant (32.2 ft./sec²).

H = $\frac{2}{3}$ temporary detention height (feet) to orifice centerline.

5. Maximum depth of permanent pool = 6 feet
 6. Maximum depth of water quality pool (not including permanent pool) = 2.5 feet.
 7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and shall be armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
 8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.
- b. Design Criteria
1. The pond configuration, as well as the inlet and outlet locations, shall maximize water travel time through the facility.
 2. The pond shall be designed using the following surface-area-to-depth relationship (for the volume required by a permanent pool):
 - 70% of the surface area @ 2- to 6-foot depth
 - 30% of the surface area @ 0- to 2-foot depthThe maximum depth of the permanent pool shall be 6 feet. The 0-to-2-foot depth shall be distributed evenly around the perimeter of the pond.
 3. The facility shall be divided into at least two cells. The first cell (forebay) shall contain approximately 10% of the design surface area.
 4. The construction of wet ponds and maintenance accessibility shall be in conformance with Subsection 3.2.3, "Design Criteria," Subsection 3.3.9, "Detention/Retention Facility Protection," and Subsection 3.4.4, "Access Road Design."
 5. Safety of stormwater quality facilities shall be in conformance with "Safety" in Subsection 3.3.9, "Detention/Retention Facility Protection."
 6. The slopes in the treatment and surrounding areas of the pond shall be 3H:1V or flatter, unless approved by the Public Works Department authorized representative. If steeper slopes are desired, the site shall be fenced as described in Subsection 3.3.9, "Detention/Retention Facility Protection." The applicant shall provide calculations and geotechnical data indicating adequate slope stability. Calculations and data shall be provided from a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
 7. The average length-to-width ratio shall be at least 3:1. This ratio is critical to prevent "short-circuiting," where water passes directly through the facility without being detained for any time.
 8. If a riser pipe outlet is used, it shall be protected by a trash rack and anti-vortex plate. If an orifice plate is used, it shall be protected with a trash rack with at least 10 square feet of open surface area. In either case, the rack must be hinged or easily removable to allow for cleaning. The rack shall be adequately secured to prevent it from being removed or opened when maintenance is not in progress.

- c. Dead Storage
 - 1. The dead (permanent) storage volume, V_{pond} , is equivalent to the post-development runoff.
 - 2. Calculating runoff volume using the SBUH method can be approximated by the following equation:

$$V = 25.9 \times A \times \% I + 27.7 \times A$$
 Where: V = runoff volume (cubic feet).
 A = total contributing land area (acres).
 $\% I$ = percent of land area that is impervious.
 (i.e., if the land is 20% impervious, enter 20 in the equation).

10.3.2 Extended Wet Ponds

- a. Hydraulic design criteria
 - 1. Permanent pool volume = $0.55 \times \text{WQV}$.
 - 2. Minimum water quality detention/retention volume = $1.0 \times \text{WQV}$.
 - 3. Water quality drawdown time = 48 hours.
 - 4. To calculate orifice size, use the following equation:

$$D = 24 \times [(Q / (\pi C_d [2gH]^{0.5}))^{0.5}]$$
 Where: D = orifice diameter (inches).
 Q (cfs) = $\text{WQV (cf)} / (48 \text{ hr.} \times 60 \text{ min/hr.} \times 60 \text{ sec/min})$.
 C_d = orifice coefficient (0.62 for square-edged entrance).
 g = gravitational constant (32.2 ft./sec²).
 H = $\frac{3}{4}$ temporary detention height (feet) to orifice centerline.
 - 5. Maximum depth of permanent pool = 2 feet.
 - 6. Maximum depth of water quality pool (not including permanent pool) = 2.5 feet.
 - 7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and shall be armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
 - 8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.
- b. Design criteria
 - 1. Minimum of two cells, with the first cell (forebay) at least 10% of the design surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
 - 2. Maximum side slopes in basin treatment area = 3H:1V
 - 3. Over excavate by a minimum of 20% to allow for sediment deposition.
 - 4. Minimum freeboard = 1 foot from 25-year design water surface elevation.
 - 5. Retaining walls are not allowed in the treatment area.
 - 6. Provide an approved outlet structure for all flows.
 - 7. The construction of wet ponds and maintenance accessibility shall be in conformance with Subsection 3.2.3, "Design Criteria," Subsection 3.3.9, "Detention/Retention Facility Protection," and Subsection 3.4.4, "Access Road Design."

10.3.3 Extended Dry Pond

- a. Hydraulic design criteria
 - 1. Permanent pool depth = 0.4 feet.
 - 2. Permanent pool is to cover the entire bottom of the basin.
 - 3. Minimum water quality detention/retention volume = $1.0 \times \text{WQV}$.

4. Water quality drawdown time = 48 hours.
 5. To calculate orifice size, use the following equation:

$$D = 24 \times [(Q / (\pi C_d [2gH]^{0.5}))]^{0.5}$$
 Where: D = orifice diameter (inches).
 $Q \text{ (cfs)} = \text{WQV (cf)} / (48 \text{ hr.} \times 60 \text{ min/hr.} \times 60 \text{ sec/min}).$
 C_d = orifice coefficient (0.62 for square-edged entrance).
 g = gravitational constant (32.2 ft./sec²).
 H = $\frac{2}{3}$ temporary detention height (feet) to orifice centerline.
 6. Maximum depth of water quality pool (not including permanent pool) = 4 feet.
 7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
- b. Design criteria
1. Minimum of two cells, with the first cell (forebay) at least 10% of the design surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
 2. Minimum bottom width = 4 feet
 3. Maximum side slope in basin treatment area = 4H:1V.
 4. Minimum freeboard = 1 foot from 25-year design water surface elevation.
 5. Retaining walls are not allowed in the treatment area.
 6. An approved outlet structure shall be provided for all flows.
 7. The construction of dry ponds and maintenance accessibility shall be in conformance with Subsection 3.2.3, "Design Criteria," Subsection 3.3.9, "Detention/Retention Facility Protection," and Subsection 3.4.4, "Access Road Design."

10.4 WETLANDS

- b. Hydraulic design criteria
1. Permanent pool volume = $0.55 \times \text{WQV}$.
 2. Water quality detention/retention volume = $1.0 \times \text{WQV}$.
 3. Water quality drawdown time = 48 hours.
 4. To calculate orifice size, use the following equation:

$$D = 24 \times [(Q / (\pi C_d [2gH]^{0.5}))]^{0.5}$$
 Where: D = orifice diameter (inches).
 $Q \text{ (cfs)} = \text{WQV (cf)} / (48 \text{ hr.} \times 60 \text{ min/hr.} \times 60 \text{ sec/min}).$
 C_d = orifice coefficient (0.62 for square-edged entrance).
 g = gravitational constant (32.2 ft./sec²).
 H = $\frac{2}{3}$ temporary detention height (feet) to orifice centerline.
 5. Maximum depth of permanent pool = 2.5 feet.
 6. Maximum velocity through the wetland should average less than 0.01 feet per second for the water quality flow. Design should distribute flow uniformly across the wetland.
 7. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and shall be armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.
 8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.
- b. Design Criteria

1. Minimum of two cells, with the first cell (forebay) at least 10% of the surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
2. Permanent pool depth to be spatially varied throughout wetland.
3. Provide a perimeter zone 10 to 20 feet wide that is inundated during storms.
4. Maximum side slopes for wetland planting = 5H:IV.
5. Maximum side slopes for non-wetland planting = 3H:IV.
6. Over excavate by a minimum of 20% to allow for sediment deposition.
7. Minimum freeboard = 1 foot from 25-year design water surface elevation.
8. Retaining walls are not allowed in the treatment area.
8. The construction of wetlands and maintenance accessibility shall be in conformance with Subsection 3.2.3, "Design Criteria," Subsection 3.3.9, "Detention/Retention Facility Protection," and Subsection 3.4.4, "Access Road Design."
9. Provide an approved outlet structure for all flows.

10.5 INFILTRATION

10.5.1 Infiltration Trench

Design criteria

- a. The design of infiltration trenches is based on Darcy's Law (Safety Factor = 2):

$$A = 2.0 \times Q \div (f \times i)$$

Where: A = area of trench bottom (square feet).
 Q = design flow rate (cfs).
 f = infiltration rate of soil or infiltration media (ft./sec).
 i = hydraulic gradient (see below).

$$i = (h + L) \div L$$
 Where: h = height of water column over infiltration media.
 L = distance from surface to bottom of trench
- b. The infiltration trench shall infiltrate the entire water quality storm without overflow.
- c. Infiltration facilities shall not be accepted in soils with a tested infiltration rate of less than 0.50 inches per hour.
- d. There shall be no less than 3 feet of undisturbed depth of infiltration medium between the bottom of the facility and any impervious layer (hardpan, solid rock, high groundwater levels, etc.).
- e. Drawdown time (time for the trench to empty water from the water quality storm) shall not exceed 24 hours.
- f. Infiltration trenches shall meet the following setback requirements for downstream slopes: minimum of 100 feet from slopes of 16%; add 5 feet of setback for each additional percent of slope up to 30%; 200-foot setback for slopes of 30%; infiltration trenches shall not be used where slopes exceed 30%.
- g. All infiltration trenches shall have an overflow installed that can transport the design capacity of the water delivery system through the facility to an approved stormwater receiving system if the facility infiltration capacity is exceeded. An approved stormwater receiving system is a stream, lake, or pond, or a storm sewer or drainage ditch. Overflows shall be designed with appropriate erosion-control devices.
- h. Each trench shall have one slotted observation pipe (4-inch) that extends to the bottom of the trench, at a point approximately halfway along the trench. The observation pipe shall have a threaded or hinged cap or plug.

- i. Drain medium shall have filter fabric between the medium and native soils or backfill meeting specifications established in Table 10.2.
- j. Infiltration areas shall be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular construction traffic, except that specifically used to construct the facility, shall be allowed within 10 feet of infiltration trench areas.
- k. A certified soils scientist (ARCPACS certification), or suitably trained person working under the supervision of a Professional Engineer registered in the State of Oregon, shall inspect the soil after the system is excavated and before trenches are filled with drain medium, to confirm that soils remain in suitable condition to perform at anticipated infiltration rates.

10.5.2 Infiltration Basin

Design criteria

- a. The design of infiltration trenches is based on Darcy's Law (Safety Factor = 2):
 - $A = 2.0 \times Q \div (f \times i)$
 - Where: A = area of trench bottom (square feet).
 - Q = design flow rate (cfs).
 - f = infiltration rate of soil or infiltration media (ft./sec).
 - i = hydraulic gradient (see below).
 - $i = (h + L) \div L$
 - Where: h = height of water column over infiltration media.
 - L = distance from surface to bottom of trench
- b. The infiltration basin shall infiltrate the entire water quality storm without overflow.
- c. Infiltration basins shall meet the following setback requirements for downstream slopes: minimum of 100 feet from slopes of 10%; add 5 feet of setback for each additional percent of slope up to 30%; 200-foot setback for slopes of 30%; infiltration trenches shall not be used where slopes exceed 30%.
- d. All infiltration basins shall have an overflow installed that can transport the design capacity of the water delivery system through the facility to an approved stormwater receiving system if the facility infiltration capacity is exceeded. An approved stormwater receiving system is a stream, lake, or pond, or a storm sewer or drainage ditch. Overflows shall be designed with appropriate erosion-control devices.
- e. Any imported drain medium shall have filter fabric between the medium and native soils or backfill.
- f. Two staff gauges shall be installed, at opposite ends of the bottom of the basin, to enable maintenance staff to measure the depth of accumulated silts.
- g. Infiltration areas shall be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, shall be allowed within 10 feet of infiltration basin areas.
- h. A certified soils scientist (ARCPACS certification), or suitably trained person working under the supervision of a Professional Engineer registered in the State of Oregon, shall inspect the soil after the system is excavated and before the basin is filled with drain medium, to confirm that soils remain in suitable condition to accept anticipated infiltration.
- i. Infiltration facilities shall not be accepted in soils with a tested infiltration rate of less than 0.50 inches per hour.
- j. There shall be no less than 3 feet of undisturbed depth of infiltration medium between the bottom of the facility and any impervious layer (hardpan, solid rock, high groundwater levels, etc.).
- k. Drawdown time (time for the basin to empty water from the water quality design storm) shall not exceed 24 hours.

SECTION 11 – STORMWATER QUALITY FACILITY LINERS

11.1 INTRODUCTION

The purpose of this Section is to provide guidelines for the design and construction of stormwater quality facilities in the City of Molalla.

11.2 STORMWATER QUALITY FACILITY LINERS

Liners are intended to reduce the likelihood that pollutants in stormwater will reach groundwater when water quality facilities are constructed. In addition to groundwater protection considerations, some facility types require permanent water for proper functioning. An example is the first cell of a wet pond.

Treatment liners amend the soil with materials that treat stormwater before it reaches more freely draining soils. The liners have slow rates of infiltration, generally less than 2.4 inches per hour (1.7×10^{-3} centimeters per second [cm/s]), but not as slow as low-permeability liners. Treatment liners may use in-place native soils or imported soils. Low-permeability liners reduce infiltration to a very slow rate, generally less than 0.02 inches per hour (1.4×10^{-5} cm/s). These types of liners should be used for industrial or commercial sites that have a potential for high pollutant loading in stormwater runoff. Low-permeability liners may be fashioned from compacted till, clay, geomembrane, or concrete. Till liners are preferred because of their general resilience and ease of maintenance.

11.2.1 General Design Criteria

- a. **Table 11.1** shows recommendations for the type of liner generally best suited for use with various water quality facilities.
- b. Liners shall be evenly placed over the bottom or sides of the treatment area of the facility, as shown in **Table 11.1**. Areas above the treatment volume that are required to pass flows greater than the water quality flow (or volume) need not be lined. However, the lining must extend to the top of the interior side slope and be anchored, if it cannot be permanently secured by other means.

Table 11.1. RECOMMENDED LINERS FOR STORMWATER FACILITIES

Type of Facility	Area to Be Lined	Recommended Liner
Pre-settling basin	Bottom and sides	Low-permeability liner or treatment liner. (If basin will intercept seasonal high groundwater table, treatment liner is recommended.)
Wet pond	First cell: bottom and sides to water quality design water surface	Low-permeability liner or treatment liner. (If wet pond will intercept seasonal high groundwater table, treatment liner is recommended.)
	Second cell: bottom and sides to water quality design water surface	Treatment liner

Combined detention/ water quality Facility	First cell: bottom and sides to water quality design water surface Second cell: bottom and sides to water quality design water surface	Low-permeability liner or treatment liner. (If facility will intercept seasonal high groundwater table, treatment liner is recommended.) Treatment liner
Constructed treatment wetland	Bottom and sides, both cells	Low-permeability liner. (If facility will intercept seasonal high groundwater table, treatment liner is recommended.)
Sand filtration basin	Basin sides only	Treatment liner
Sand filter vault	Not applicable	No liner needed
Media filter (in vault)	Not applicable	No liner needed
Wet vault	Not applicable	No liner needed

- c. For low-permeability liners, the following criteria apply:
1. Where the seasonal high groundwater elevation is likely to contact a low-permeability liner, liner buoyancy may be a concern. A low-permeability liner shall not be used unless evaluated and recommended by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
 2. Where the design calls for grass to be planted over a low-permeability liner, a minimum of 6 inches of good topsoil or compost-amended native soil (2 inches compost tilled into 6 inches native till soil) must be placed over the liner in the area to be planted; 12 inches of cover is preferred.

11.2.2 Interference with Seasonal Groundwater

If a treatment liner will be below the seasonal high-water level, the liner's pollutant-removal performance must be evaluated by a qualified professional, and the liner's placement must be found as protective as if the liner were above the level of the groundwater. A qualified professional shall be either a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering, a Certified Engineering Geologist registered in the State of Oregon, or a Professional Hydrogeologist registered in the State of Oregon.

See Subsection 11.3, "Stormwater Quality Treatment Liners" and Subsection 11.4, "Low-Permeability Liner Options", below for more specific design criteria for treatment liners and low-permeability liners.

11.3 STORMWATER QUALITY TREATMENT LINERS

Design Criteria

- a. A 2-foot-thick layer of soil with a minimum organic content of 5% and a minimum CEC of 5 millequivalents/100 grams can be used as a treatment layer beneath a water quality or quantity facility.
- b. To demonstrate that in-place soils meet the above criteria, one sample per 1,000 square feet of facility area shall be tested. Each sample shall be a composite of subsamples taken throughout the depth of the treatment layer (usually 2 to 6 feet below the expected facility invert).

- c. Typically, sidewall seepage is not a concern if the seepage flows through the same stratum as the bottom of the stormwater facility. However, if the treatment soil is an engineered soil or has very low permeability, the potential to bypass the treatment soil through the sidewalls may be significant. In those cases, the stormwater facility sidewalls should be lined with at least 18 inches of treatment soil, as described above, to prevent untreated seepage. This lesser soil thickness is based on unsaturated flow as a result of alternating wet and dry periods.
- d. Organic content shall be measured on a dry-weight basis using ASTM D-2974.
- e. CEC shall be tested using EPA laboratory method 9081.
- f. Certification that imported soil meets the organic content and CEC criteria above shall be provided to the local approval authority by a soils-testing laboratory.
- g. Animal manures used in treatment soil layers must be sterilized because of the potential for bacterial contamination of groundwater.

11.4 LOW-PERMEABILITY LINER OPTIONS

This section specifies the design criteria for four low-permeability liner options: compacted till liners, clay liners, geomembrane liners, and concrete liners.

11.4.1 Compacted Till Liners

- a. Liner thickness shall be 18 inches after compaction.
- b. Soil shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180.
- c. A different depth and density sufficient to retard the infiltration rate to 2.4×10^{-5} inches per minute (1×10^{-6} cm/s) may also be used instead of Criteria 1 and 2.
- d. Soil should be placed in 6-inch lifts.
- e. Gradation requirements of the soil shall be as indicated in **Table 11.2**. Sieve analysis shall be determined according to AASHTO T-27.

Table 11.2. SOIL GRADATION REQUIREMENTS, COMPACTED TILL LINERS

Sieve Size	Percent Passing
6-inch	100
4-inch	90
No. 4	70-100
No. 200	20

11.4.2 Clay Liners

- a. Liner thickness shall be 12 inches.
- b. Clay shall be compacted to 95% of the maximum dry density, as determined by AASHTO T-180.
- c. A different depth and density sufficient to retard the infiltration rate to 2.4×10^{-5} inches per minute (1×10^{-6} cm/s) may also be used instead of the above criteria.
- d. The slope of clay liners must be restricted to 3H: 1V for all areas requiring soil cover. Otherwise, the soil layer must be stabilized by another method so that soil does not slip into the facility. Any alternative soil-stabilization method must take maintenance access into consideration.

- e. Where clay liners form the sides of ponds, the interior should not be steeper than 4H:1V, irrespective of fencing. This restriction is to ensure that anyone falling into the pond can climb out.
- f. Specification requirements of the clay soil shall be as indicated in **Table 11.3**.

Table 11.3. SPECIFICATIONS FOR SOIL IN CLAY LINERS

Property	Test Method	Unit	Specification
Permeability	ASTM D-2434	cm/sec	1×10^{-6}
Plasticity Index of Clay	ASTM D-423 & D-424	percent	Not less than 15
Liquid Limit of Clay	ASTM D-2216	percent	Not less than 30
Clay Particles Passing	ASTM D-422	percent	Not less than 30
Clay Compaction	ASTM D-2216	percent	95% of Max. Dry Density, AASHTO T-99

11.4.3 Geomembrane Liners

- a. Geomembrane liners shall be ultraviolet (UV) light resistant and have a minimum thickness of 30 mils. A thickness of 40 mils shall be used in areas of maintenance access or where heavy machinery must operate over the membrane.
- b. Liners shall be bedded according to the manufacturer's recommendations.
- c. Liners shall be installed so that they can be covered with 12 inches of top dressing forming the bottom and sides of the water quality facility, except for liner sand filters. Top dressing shall consist of 6 inches of crushed aggregate covered with 6 inches of native soil. The aggregate layer is to mark the location of the liner for future maintenance. As an alternative to crushed aggregate, 12 inches of native soil may be used if orange plastic safety fencing or another highly visible, continuous marker is embedded 6 inches above the membrane.
- d. If possible, liners should be of a contrasting color so that maintenance workers are aware of any areas where a liner may become exposed when maintaining the facility.
- e. Geomembrane liners shall not be used on slopes steeper than 5H:1V to prevent the top-dressing material from slipping. Textured liners may be used on slopes up to 3H:1V, provided that a Professional Engineer registered in the State of Oregon, whose area of expertise is geotechnical engineering, recommends that the top dressing will be stable for all site conditions, including maintenance.

11.4.4 Concrete Liners

- a. Portland cement liners are allowed irrespective of facility size, and shotcrete may be used on slopes. However, specifications must be developed by a Professional Engineer registered in the State of Oregon who certifies the liner against cracking or losing water retention ability under expected conditions of operation, including facility maintenance operations. Maintenance equipment can weigh up to 80,000 pounds when fully loaded.
- b. AC may not be used for liners because of its permeability to organic pollutants.
- c. If grass is to be grown over a concrete liner, slopes must be no steeper than 5H: IV to prevent the top dressing from slipping.

APPENDIX H

Private Facility Maintenance





Submit report to:
City of Molalla
117 N Molalla Ave.
Po Box 248
Molalla, OR 97038
Attn:

City of Molalla
Annual Stormwater Facility Inspection and Maintenance Report

Yearly report must be submitted to the City no later than May 1st

Name of Development:		
Location/Site Address:		
Contact Name:		
Telephone:		
Email:		
Check all that apply:		
Type of Infiltration: ☐ Basin ☐ Trench ☐ Permeable Pavement Facility Location: ☐ Surface ☐ Underground Hydraulic configuration: ☐ On-line facility ☐ Off-line facility	Filtration Media: ☐ No filtration media (e.g. dry well). ☐ Sand ☐ Bioretention soil ☐ Peat ☐ Other:	Type of Pretreatment: ☐ Sediment forebay (above ground) ☐ Sedimentation chamber ☐ Grass channel ☐ Grass filter strip ☐ Plunge pool ☐ Stone diaphragm

Facilities to be Maintained:

of ____ Catch Basin(s) # of ____ Pretreatment Manhole(s) # of ____ Flow Control Manhole(s)
 Detention Pond(s) # of inlets ____ outlets ____
 Rain Garden(s) # of inlets ____ outlets ____
 Stormwater Planter(s) # of inlets ____ outlets ____
 Vegetated Swale(s) # of inlets ____ outlets ____

All Other Facilities as Described on Plan:
--

The Owner(s) or Owner's designee shall be responsible for annually conducting inspections and performing maintenance on the above stormwater management facilities annually, in conformance with Section 3.6 "Operation and Maintenance Requirements," of the City of Molalla Public Works Standards. This requirement pertains to all Stormwater Facilities, including but not limited to: catch basins, pipes, treatment manholes, manholes, trash racks, vegetated swales, and detention ponds.

Inspection Requirements:

- General condition of vegetative area(s), predominant plant species, distribution, and success rate (where applicable).
- Sediment condition and depth in forebay (or other pretreatment structure), treatment facility, bench planting zones, and other sediment-removal components.
- Water elevations and other observations (sheen, Smell, etc.).
- Condition of the inlet, outlet, and overflow structures and devices, diversion structures, trash-removal devices, risers, spillway, embankments, and remaining storage capacity.
- Unscheduled maintenance needs.
- Common problems areas, solutions, and general observation.
- Aesthetic conditions.

For structural facilities and components, particular attention will be given to:

- Remove sediment at least once a year or when basin is half full of sediment.
- Remove trash, oils, and debris.
- Ensure facility is structurally sound by repairing or replacing cracked, loose, askew, or damaged pipes.
- Access covers, trash racks, and metal grates shall be kept free of trash and debris, closed, and in good working order.
- Maintain filter cartridges and other proprietary systems according to manufacturer's recommendations.

Vegetation Management:

- Examine inlets, outlets, and curb cuts for sediment buildup. Remove sediment as necessary to maintain flow into and out of facility.
- Inspect facility for erosion, gullies, and slope slippage. Repair if present.
- Check for evidence of ponding or slow draining soil media. If necessary, remove and clean or replace the clogged soil media.
- Remove weeds manually.
- Ensure that all plants are healthy. Replace all dead or dying plants with approved plantings.
- Remove trash and excess debris.
- Ensure overflow covers are in place.

Sediment Management/Pollution Control:

- *Remove all accumulated pollutants and sediment when accumulation reach 1 foot in depth and/or 50% of the designed sediment storage depth to maintain proper facility operation.*
- *Test sediment before removing it if the stormwater facility serves a commercial/industrial site or a multifamily structure or development. Sediment shall be tested according to protocol established in the O&M plan.*
- *Dispose of sediments at the time of removal in a manner meeting applicable state and federal requirements.*

Access and Safety

- *Maintain ingress/egress routes to design standards, in a manner that allows efficient maintenance of the facility.*
- *Ensure that fencing is in good repair.*

Inspection Date:
Describe Inspection, Maintenance, Repair, or Replanting Activities (attach invoices for work performed)

Owner or Representative Signature

Date

City of Molalla Public Works Department 117 N. Molalla Avenue, Molalla, OR 97038 (503) 829-6855

A GREATER SYSTEM

All public and privately owned roads, parking lots, residential developments, commercial, industrial developments, or school facilities have various components that make up a storm system. These components consist of conveyance pipes, catch basins, manholes, roadside ditches, stormwater facilities (such as bioswales, detention ponds, wet ponds, treatment filters, etc.), landscaping and any other structure that collects, conveys, controls, and/or treats stormwater. Regardless of the component, all storm systems eventually discharge into 'waters of the state' which are streams, rivers, lakes, and wetlands.

Under the Federal Clean Water Act (FCWA) and in compliance with the Department of Ecology's NPDES Phase II Permit, 'waters of the state' are to be protected from contamination. This in turn protects threatened and endangered species under the Federal Endangered Species Act (FESA).

One way to protect 'waters of the state' is to provide the proper maintenance of all storm system components. It is the responsibility of the City of Molalla (City) to ensure that all components of the public storm system be properly maintained and operated. The City is responsible for those components that are located within the City's right-of-way, such as the conveyance pipes, manholes, catch basins, roadside ditches, and stormwater facilities. A large part of the stormwater facilities in the City are privately owned and maintained by the property owners. These property owners include, but are not limited to, Homeowners Associations (HOAs), school district, businesses, and commercial/industrial site owners.



CITY OF MOLALLA PUBLIC WORKS

ALL DRAINS LEAD TO OUR WATERWAYS



EXPERIENCING A PUBLIC WORKS EMERGENCY?

MOLALLA PUBLIC WORKS: (503)-829-6855
AFTER HOURS: (503)-793-9043



STORMWATER MAINTENANCE



CITY OF MOLALLA PUBLIC WORKS
117 N. MOLALLA AVE. MOLALLA, OR 97038
(503)-829-6855

OUR LOCAL HYDROLOGY

The City of Molalla's watershed is primarily drained by Creamery Creek and Bear Creek, which eventually run to the Molalla River (Bear Creek by way of the Pudding River)

There are numerous wetlands and riparian areas within the City.

Maintaining public and privately owned stormwater systems are vital for protecting these wetlands and Waters of the State.

The City requires onsite stormwater management for new construction and redevelopment on public and private property.

You are required to inspect your facility at a minimum of once per year to determine maintenance needs. Routine inspection and maintenance can help keep overall maintenance costs low by detecting problems early and avoiding large repair costs.

As a property owner, you are legally required to follow all of the maintenance tasks and schedules outlined in your recorded Stormwater Maintenance Agreement, or as required by Municipal Code. An Annual Inspection and Maintenance Report must be submitted to the City of Molalla no later than May 1 of each year.

We recommend providing photographs and/or Contractor invoices with your report as evidence of maintenance.

Map courtesy of National Wetlands Inventory

Every stormwater system will have different maintenance needs based on design and usage, but below are general recommendations

VEGETATED FACILITIES

- Examine inlets, outlets, and curb cuts for sediment buildup. Remove sediment as necessary to maintain flow into and out of facility.
- Inspect facility for erosion, gullies, and slope slippage. Repair if present.
- Check for evidence of ponding or slow draining soil media. If necessary, remove and clean or replace the clogged soil media.
- Remove weeds or overgrowth of plants that may restrict flow.
- Ensure that all plants are healthy. Replace all dead or dying plants with acceptable plantings (See Public Works Standards section 8.3 for recommended plantings).
- Remove trash and excess debris.
- Ensure overflow covers are in place.

STRUCTURAL FACILITIES

- Remove sediment at least once a year or when basin is half full of sediment.
- Remove trash, oils, and debris.
- Ensure facility is structurally sound by repairing or replacing cracked, loose, askew, or damaged pipes.
- Access covers, trash racks, and metal grates shall be kept free of trash and debris, closed, and in good working order.
- Maintain filter cartridges and other proprietary systems according to manufacturer's recommendations.
- You should review the Operation & Maintenance manual for all manufactured facilities such as filter manholes or other proprietary systems.

SUBMITTING YOUR ANNUAL REPORT

Your Annual Inspection and Maintenance report will be mailed to you in January and is due to the City by May 1 of each year.

The first section of your inspection report is identifying your property's stormwater facilities. This includes swales, catch basins, manholes, retention facilities, ditches, culverts, outfalls, and potentially other unique facilities that may be part of your system.

A full list of your on-site facilities should be in your Stormwater Maintenance Agreement. If you need help identifying your facilities, Public Works can assist.

Inspection and maintenance guidelines can be found on your report to help identify deficiencies or maintenance items.

Within the inspection description section, include a narrative with observations of the present condition of facilities and maintenance tasks performed.

Please attach with your report photos, and copies of invoices if you hire a Contractor or Landscaper.

The City may inspect your facilities to ensure maintenance has been performed satisfactorily.

Submit your completed report (in-person or by mail) and all accompanying documents to:

City of Molalla
117 N Molalla Ave.
Molalla, OR 97038
Attn: Engineering Section

A Manual for the Operation & Maintenance of Privately Owned Stormwater Facilities



People working together in a strong community with a shared goal and a common purpose can make the impossible possible.



City of Molalla
Public Works Division
(503) 829-6855
www.cityofmolalla.com

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CARING FOR YOUR STORMWATER FACILITY

THANK YOU

As the owner of a stormwater management facility, you are making a meaningful contribution to the health of Molalla's creeks, streams, wetlands and the Molalla River. This handbook will help you maintain your facility to make sure it performs the work it is designed to accomplish.



WHAT ARE STORMWATER FACILITIES?

Stormwater facilities are any combination of landscape and structural features that slow, filter, or infiltrate (absorb) runoff on your property after a rainfall. Types of facilities include vegetated systems (planters, swales, ponds, created wetlands, etc.), and structural systems piping, inlets and catch basins are also important components that need adequate maintenance to assure facility function. All of these serve a common purpose: controlling the quality and quantity of stormwater runoff from your site to help safeguard our valuable water resources.

PROPERTY OWNER RESPONSIBILITIES

Federal, state and local agencies created management regulations and guidelines so as to improve stormwater quality and protect watersheds, rivers, streams and drinking water resources. The City of Molalla has a Stormwater Maintenance and Access Easement that includes the following requirements:

- Annual maintenance on storm drainage facilities in conformance with City of Molalla Public Works Standards. For more information go to: <https://www.cityofmolalla.com/publicworks/page/design-standards>. Click on the 2021 Molalla Standard Specifications for Public Works Construction. (section 3.6 Operations and Maintenance Requirements)
- Inspection report shall be submitted to the city by May 1st of each year.
- General condition of vegetative area(s), predominant plant species, distribution and success rate.
- Sediment condition and depth in forebay (or other pretreatment structure), treatment facility, bench planting zones, and other sediment-removal components.
- Water elevations and other observations (sheen, smell, etc.)
- Condition of the inlet, outlet, and overflow structures and devices, diversion structures, trash-removal devices, risers, spillway, embankments, and remaining storage capacity.
- Unscheduled maintenance as needed.
- Components that do not meet the performance criteria and require immediate maintenance.
- Common problem areas, solutions, and general observations.

YOUR CONNECTION TO MOLALLA'S STREAMS, WETLANDS AND RIVERS



The Problem With Stormwater Runoff

When it rains, stormwater runs off impervious surfaces (such as roofs and paved areas) instead of soaking into the ground. Conventional stormwater management directs runoff into drains and pipes that carry it offsite and eventually discharge it into a river or stream. This approach has a number of harmful effects:

- Impervious areas generate large volumes of runoff relatively quickly. The increased volume and speed of the runoff can cause flooding and erosion and damage natural habitat.
- The runoff picks up a variety of pollutants including oil, pesticides, metals, chemicals, and sediment that negatively impact water quality and fish habitat.
- During warm weather, the runoff absorbs heat from impervious surfaces. This increases the temperature of the receiving waters, with negative impacts on fish and other aquatic life.
- Less water is able to infiltrate into the ground. This reduces groundwater recharge, which reduces summer flows in streams.
- Runoff can push excess nutrients from fertilizers, pet waste, trash and other sources into streams and rivers.

As Molalla continues to grow and develop, these negative impacts will increase unless we do things differently. Help prevent sediment, chemicals, garbage and other debris from winding up in our local streams and rivers.



City of Molalla
Public Works Division
(503) 829-6855
www.cityofmolalla.com

A BETTER WAY TO FLOW

The City of Molalla is actively pursuing a variety of measures to reduce stormwater impacts. One important approach is to manage stormwater on the property where it originates. This is commonly referred to as Low Impact Development. It includes the use of Water Quality Facilities (WQFs), such as detention ponds, vegetated swales, underground retention systems, rain gardens, etc. Onsite stormwater management uses processes that mimic nature. Onsite WQF's allow runoff to soak into the ground, help filter out pollutants, and slow the flow rate of runoff leaving your site. This significantly reduces the volume and pollution levels in stormwater leaving your property and ending up in our local streams and rivers.



WHAT ELSE IS THE CITY DOING?

Onsite management, through the use of Low Impact Development, is just one component of a comprehensive citywide program to limit stormwater runoff impacts. Here are some other steps the City is taking:

- The City requires onsite stormwater management for new construction and redevelopment on public and private property.
- Adhering to and updating the procedures outlined in the Stormwater Master Plan.
- Natural areas, especially riparian areas adjacent to rivers and streams, help filter out pollution, control erosion, and provide shade, food, and habitat for fish and wildlife. The City uses a variety of measures to preserve these critical areas including development and land use zoning requirements and enhancement and restoration efforts.
- Develop an inventory of existing drainage pipes using City as-built drawings and maps and input from City staff. Evaluate the pipes using hydrologic and hydraulic modeling for existing and future land-use conditions.
- Identify measures for improving the conveyance of the piped and natural drainage systems. Investigate alternatives and recommend improvements to reduce existing and predicted future capacity problems.
- Develop a capital improvement program for recommended projects with cost estimates and priorities for each recommendation.

INSPECTING AND MAINTAINING YOUR FACILITY

PROTECTING YOUR RESOURCES

It is essential to maintain your facility so it functions as intended and limits off-site environmental impacts. You are required to inspect your facility at a minimum of once a year to determine maintenance needs. Routine inspection and maintenance can help keep overall maintenance costs low by detecting problems early and avoiding large repair or replacement costs. This section identifies general guidelines on what to look for and how to maintain your facility. It also notes non-routine maintenance that may require professional assistance. **If you are unsure of what type of facility you have, call the City of Molalla**

Public Works Division at (503) 829-6855.



LEGAL REQUIREMENTS: OPERATIONS AND MAINTENANCE PLAN

As a property owner, you are legally required to follow all of the maintenance tasks and schedules outlined in your recorded maintenance and access easement. An Annual Inspection and Maintenance Report must be submitted to the City of Molalla no later than May 1 each year (see sample form on page 7). Pictures included with the report are very helpful. Include copies of invoices of work performed by contractors. While inspecting your facility, please keep in mind that it will be necessary for you to refer to your landscape plan in order to maintain your facility as it was originally designed.

INSPECTION SCHEDULE: HOW OFTEN

It is recommended that you inspect your facility at least::

- Quarterly for the first two years
- Once a year thereafter, and
- Within 48 hours of major rainfall events (more than one inch of rain over a 24-hour period).

City of Molalla
Public Works Division
(503) 829-6855
www.cityofmolalla.com

SAMPLE REPORTING FORM



Submit report to:
City of Molalla
117 N Molalla Ave.
Po Box 248
Molalla, OR 97038
Attn: Sam Miller

City of Molalla
Annual Stormwater Facility Inspection and Maintenance Report
Due Every May 1st

Name of Development:		
Location/Site Address:		
Contact Name:		
Telephone:		
Email:		
Check all that apply:		
Type of Infiltration: ☐ Basin ☐ Trench ☐ Permeable Pavement		
Facility Location: ☐ Surface ☐ Underground	Filtration Media: ☐ No filtration media (e.g., dry well). ☐ Sand ☐ Bioretention soil ☐ Peat ☐ Other:	Type of Pretreatment: ☐ Sediment forebay (above ground) ☐ Sedimentation chamber ☐ Grass channel ☐ Grass filter strip ☐ Plunge pool ☐ Stone diaphragm
Hydraulic configuration: ☐ On-line facility ☐ Off-line facility		

Facilities to be Maintained:

of ____ Catch Basin(s) # of ____ Pretreatment Manhole(s) # of ____ Flow Control Manhole(s)

Detention Pond(s) # of inlets ____ outlets ____

Rain Garden(s) # of inlets ____ outlets ____

Stormwater Planter(s) # of inlets ____ outlets ____

Vegetated Swale(s) # of inlets ____ outlets ____

All Other Facilities as Described on Plan:
--

SEDIMENT REMOVAL AND DISPOSAL

Impact on Facility Performance

The purpose of a stormwater treatment facility is to remove pollutants, including suspended solids, by capturing sediment. Sediment can include dirt, leaves, and litter. These materials can restrict or clog the facility. Timely removal of sediment will improve infiltration rates, water quality, and help prevent clogging and flooding.

Facilities and System Components This Applies To:

Vegetated Facilities: infiltration basins, planters, ponds, sand filters, swales, trees, vegetated filters, and wetlands

Structural Facilities: catch basins, curb cuts, inlets, manufactured facilities, piping, sedimentation manholes, and vaults

Underground Infiltration Facilities: soakage trenches, and drywells Pervious Pavement

City of Molalla

A GUIDE TO THE STORMWATER MAINTENANCE & ACCESS EASEMENT



January 2022

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"You could write the story of man's growth in terms of his epic concerns with water."



~Bernard Frank,
journalist and writer

WHAT IS THE PURPOSE OF THE

The loss of wetland and floodplain areas along with an increase in impervious surfaces necessitates the active management of stormwater runoff. Through the use of structural controls, such as water quality facilities and detention ponds, or other management measures within most urbanized areas these losses can be mitigated.



Federal, state and local agencies created management regulations and guidelines so as to improve stormwater quality and protect watersheds, rivers, streams and drinking water resources.

WHY AM I REQUIRED TO HAVE AN AGREEMENT?

Anytime there is new development or new ownership of a property with a stormwater facility, built in accordance with the City of Molalla Public Works Standards, it is required to be maintained following these Public Works maintenance standards.

WHICH STORMWATER FACILITIES ARE SUBJECT TO THIS AGREEMENT?

- Catch basins
- Curb inlets
- Stormwater manholes
- Vegetated Swales
- Rain Gardens
- Stormwater planters
- Detention ponds
- Created wetlands
- Stormwater pipes
- Area drains
- Access roads
- Safety fences
- Energy dissipaters
- Headwalls
- Underground detention facilities
- Manufactured devices
(examples: Hydrodynamic separators, Storm Filter, etc.)

**Below is an example of a catch basin
that is poorly maintained and
one that is well maintained:**

Poorly maintained catch basin



Well maintained catch basin



WHAT AM I REQUIRED TO DO UNDER THE MAINTENANCE PLAN?

- Annual maintenance on storm drainage facilities in conformance with City of Molalla Public Works Standards (see page 4).
- Removal of debris, leaves and sediment from catch basins, inlets, outlets, curb cuts, and manholes.
- Disposal of all oils, sediment and debris in an approved dumpsite.
- Replacement of all dead or dying plants in ponds and swales. Maintenance on original plantings.
- Removal of trash from ditches, swales, catch basins, or any stormwater conveyance.

IMPORTANT: For a more complete list of inspection and maintenance requirements, please reference the City of Molalla's Stormwater Maintenance and Access Easement Agreement.

Below is an example of a swale that is poorly maintained and one that is well maintained:

Poorly maintained swale



Well maintained swale



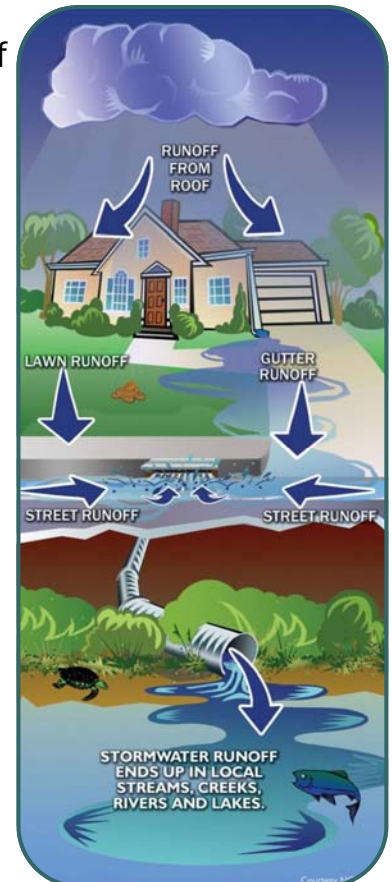
City of Molalla

117 N. Molalla Avenue
Molalla, OR. 97038
Phone: (503) 829-6855

WHY SHOULD I CARE ABOUT MAINTAINING MY STORMWATER FACILITY?

People and their actions are the most significant sources and causes of urban runoff and pollution.

Uncontrolled or untreated stormwater from the urban environment and from construction activities can runoff the landscape into surface waters. This runoff can include such pollutants as sediments, pathogens, fertilizers/nutrients, hydrocarbons, and metals. Pavement and compacted areas, roofs, and reduced tree canopy and open space increase runoff volumes that rapidly flow into our waters. This increase in volume and velocity of runoff often causes stream bank erosion, channel incision and sediment deposition in stream channels. In addition, runoff from these developed areas can increase stream temperatures that along with the increase in flow rate and pollutant loads negatively affect water quality and aquatic life.



RESOURCES

• For maintenance questions, contact:

- Sam Miller, City of Molalla Sr. Engineer Tech Phone: 503-759-0217 Email: smiller@cityofmolalla.com
- Andy Peters, City of Molalla Operations Supervisor Phone: 503-829-6855 x 220 Email: apeters@cityofmolalla.com

• City of Molalla Public Works Standards:

Molalla Standard Specifications for Public Works Construction - [Vhfwrq# 9#R shudwlrqv## #P dhwqdgfh](#)
2015 Stormwater & Surface Water Standards (Section 3) (section 301.13.00 Operations and Maintenance Req.)

- **Environmental Protection Agency:** <https://www.epa.gov/npdes/npdes-stormwater-program>
- **Department of Environmental Quality:** www.oregon.gov/DEQ

Private Maintenance Companies (listed below are just a few examples of companies that provide maintenance services, more companies are available)

- Bravo Environmental NW in Portland (503) 261-9800
- Columbia Drain in Portland Metro (503) 313-7246
- River City Environmental in Portland (503) 252-6144

APPENDIX I

Capital Improvement Plan





PROJECT 1 – UNDERGROUND PORTIONS OF CREAMERY CREEK (ID 8)



PROJECT NEED

The underground, piped portion of Creamery Creek, previously constructed below structures, should be addressed, as failure would pose a risk to public health and infrastructure. Maintenance is challenging due to its alignment beneath several buildings, including the City Post Office. The pipes are believed to be in poor condition; however, further investigation is needed to confirm their condition as data is currently limited. Although there are no current capacity limitations, the potential consequences of failure represent a significant concern.

In addition, the City experiences localized ponding around catch basins and manholes near the intersection of Center Avenue and E Heintz Street. Hydraulic modeling indicates flooding several hundred feet upstream



along Heintz Street due to undersized pipes. Realigning Creamery Creek along E. Heintz Street presents an opportunity to address these issues by increasing system capacity.

PROJECT DESCRIPTION

Realign Creamery Creek by constructing new stormwater conveyance within the public right-of-way and abandoning the existing piped section that currently passes beneath structures. This project is anticipated to be implemented in multiple phases.

Phase 1:

- Construct approximately 460 linear feet of 36-inch stormwater pipe along E. Heintz Street, and remove the existing storm pipe within the same alignment.
- Construct approximately 420 linear feet of 38 × 60-inch horizontal elliptical stormwater pipe along E. Heintz Street, and remove the existing storm pipe within the same alignment.

Phase 2:

- Construct approximately 180 linear feet of 30-inch stormwater pipe along Kimberly Court.
- Construct approximately 1,050 linear feet of 36-inch stormwater pipe Fenton Avenue, and remove the existing storm pipe within the same alignment.
- Abandon and fill the existing Creamery Creek pipe that crosses diagonally beneath private property.

Phase 3:

- Construct approximately 650 linear feet of 43 × 68-inch horizontal elliptical stormwater pipe along Kennel Road and Toliver Road, and remove the existing storm pipe within the same alignment.
- Abandon and fill the existing Creamery Creek pipe that crosses diagonally beneath private property.

Phase 4:

- Perform CCTV inspection of the existing Creamery Creek pipe from the intersection of Center Street and E. Heintz Street to the upstream extent of the Phase 3 improvements along Kennel Avenue.

DESIGN CONSIDERATIONS

- Potential private drainage connections from homes may tie into the existing Creamery Creek pipe between Kimberly Court and Fenton Avenue. These connections should be verified prior to abandoning this segment. If present, the pipe could remain in place to serve local drainage while Creamery Creek is redirected.
- The existing pipe along Grange Avenue will need to connect to the proposed alignment. Available records and modeling suggest this extension may already exist and is sloped north as needed; field verification is recommended.
- The existing pipe along Fenton Avenue (from E. Main Street) will need to be extended approximately 690 feet north to E. Heintz Street, as it currently discharges into Creamery Creek piping proposed for abandonment. This extension is included in the proposed alignment and Alternative 1, but not in Alternative 2, which would increase project costs for that alternative.



- Additional flooding has been identified from Finneys Avenue north to E. Heintz Street and west to Fenton Avenue (see Project 3). Addressing this area requires pipe replacement along these corridors. Realignment Alternative 2 includes a portion of this work and could be coordinated with Project 3, incorporating approximately 600 of the 900 feet of needed pipe replacement.
- Replacements must conform to current City standards for materials and minimum diameters.
- Construction will require coordination with existing utilities in a constrained urban corridor.
- Construct manholes and catch basins associated with the new stormwater infrastructure. Renew any catch basins that are connected to the existing stormwater infrastructure.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$2,507,300
Mobilization, Bonding, Overhead, and Wages	\$952,800
Design, Permitting, Legal, and Construction Services	\$1,349,400
Contingency (30%)	\$1,442,900
Total Project Cost	\$6,252,400



PROJECT 2 – HIGHWAY 213 INLET SOUTH OF MEADOWLAWN PLACE (MCLEOD'S DITCH) (ID 31)



PROJECT NEED

The Highway 213 Inlet south of Meadowlawn Place (McLeod's Ditch) conveys a significant amount of water from the northwest subdivision south towards Bear Creek. During modeling, the inlet showed flooding as the channel transitions from open channel back to a closed channel at a relatively shallow connection point. The model also showed flooding in the system upstream of this location which should be addressed, in part, during the completion of this project.

The City has noted that the ditch frequently experiences blockages, requiring maintenance to prevent flooding into nearby areas. Additionally, the parcels just south of McLeod's Ditch are currently being developed into residential housing which will limit options for City access to the ditch. As a result, the City



would like to pipe and pave over the ditch to allow for continued access after development and easier maintenance of the system.

PROJECT DESCRIPTION

The project includes piping the McLeod's Ditch and paving over the extent of the piped ditch to address capacity and future access concerns.

- Construct 615 linear feet of 18-inch stormwater pipe to convey the water currently flowing through the open-channel ditch.
- Upsize 85 linear feet of 12-inch stormwater pipe along Highway 213 to 18-inch pipe to prevent bottlenecks and match the capacity of the proposed piped ditch.

DESIGN CONSIDERATIONS

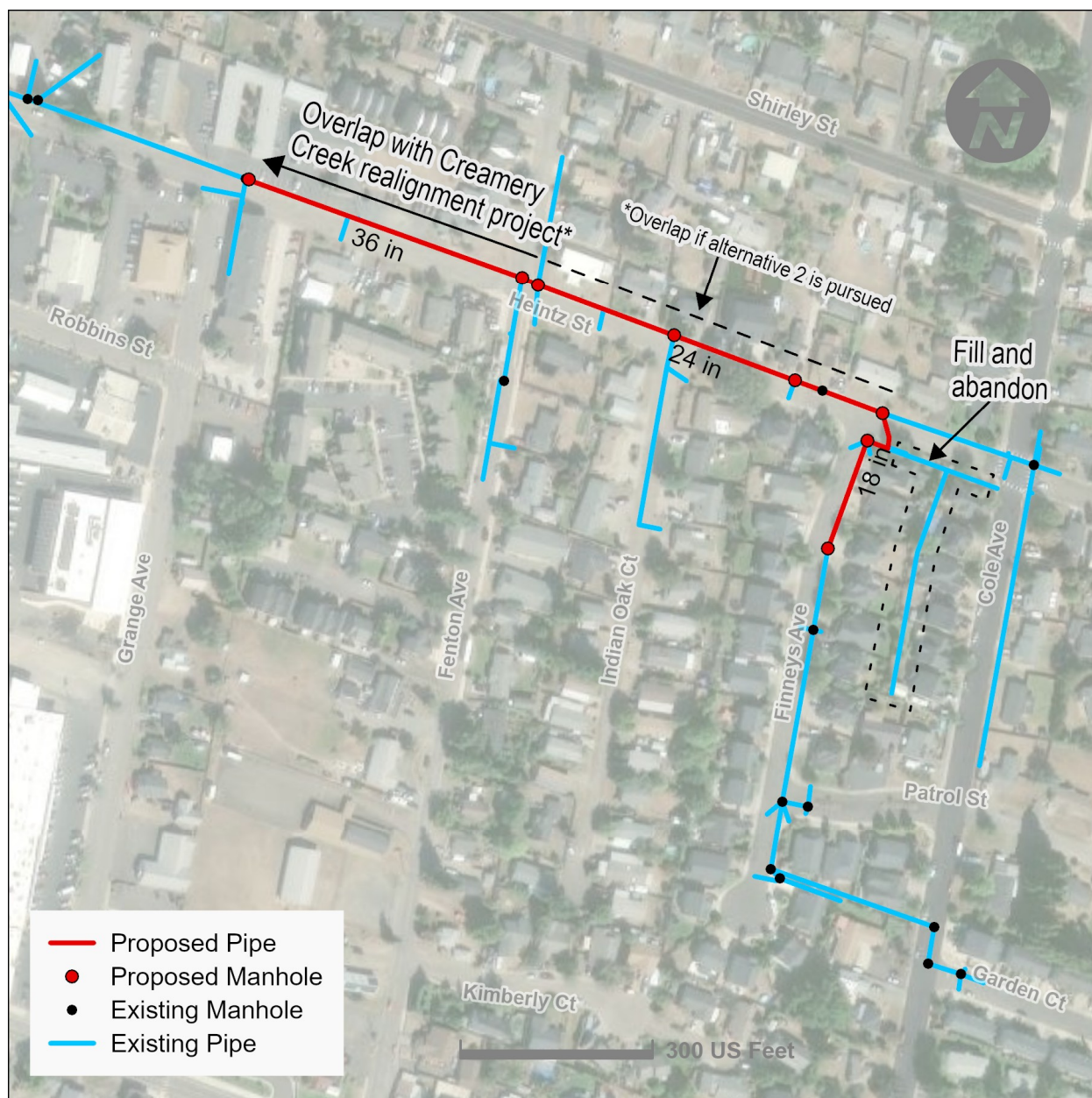
- Replacements must conform to current City standards for materials and minimum diameters.
- Construction will require coordination with existing utilities in a constrained urban corridor.
- Construct manholes and catch basins associated with the new stormwater infrastructure. Renew any catch basins that are connected to the existing stormwater infrastructure.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$361,200
Mobilization, Bonding, Overhead, and Wages	\$137,300
Design, Permitting, Legal, and Construction Services	\$184,600
Contingency (30%)	\$204,900
Total Project Cost	\$888,000



PROJECT 3 – FINNEY'S AVENUE AND E HEINTZ STREET (ID 27)



PROJECT NEED

The intersection of Finneys Avenue and E Heintz Street experiences recurring flooding, likely due to a failing detention facility located within adjacent residential backyards. In addition, hydraulic modeling indicates that the existing upstream pipes are undersized and unable to convey design storm flows without surcharging and flooding.

PROJECT DESCRIPTION

This project proposes to bypass and abandon the existing detention facility to prevent continued performance and maintenance issues. Upstream conveyance improvements are also recommended to increase system capacity.



- Construct approximately 270 linear feet of 18-inch stormwater pipe along Finneys Avenue.
- Construct approximately 600 linear feet of 24-inch stormwater pipe along E. Heintz Street.
- Construct approximately 460 linear feet of 36-inch stormwater pipe along E. Heintz Street (overlaps with Project 1 – Creamery Creek Realignment).

DESIGN CONSIDERATIONS

- Coordinate with the Creamery Creek Realignment (Project 1), as it is located directly downstream and includes overlapping improvements, particularly east of Fenton Avenue.
- Verify ownership of the existing detention facility and associated piping (e.g., private vs. HOA responsibility). Coordination may be required to determine ownership, maintenance responsibilities, and implementation approach.
- Prior to abandoning the detention facility, confirm that roof drains or other private connections are not directly tied into the system.
- Replacements must conform to current City standards for materials and minimum diameters.
- Construction will require coordination with existing utilities in a constrained urban corridor.
- Construct manholes and catch basins associated with the new stormwater infrastructure. Renew any catch basins that are connected to the existing stormwater infrastructure.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$682,300
Mobilization, Bonding, Overhead, and Wages	\$259,200
Design, Permitting, Legal, and Construction Services	\$367,100
Contingency (30%)	\$392,600
Total Project Cost	\$1,701,200



PROJECT 4 – CREAMERY CREEK RAILROAD CULVERT (ID 30)



PROJECT NEED

The railroad culvert crossing Creamery Creek frequently becomes blocked, resulting in upstream flooding within the adjacent wetlands and along the creek corridor. Hydraulic modeling also suggests the culvert is undersized and is a bottleneck to the system. Although the culvert is not owned by the City, its condition directly impacts City infrastructure and drainage performance, necessitating coordination for replacement and maintenance.



PROJECT DESCRIPTION

Coordinate with the culvert owner to pursue replacement and regular maintenance of the crossing. Hydraulic modeling indicates that two adjacent 6-foot by 3-foot box culverts would be sufficient to convey the 100-year design storm.

DESIGN CONSIDERATIONS

- The existing culvert is constructed of railroad ties treated with creosote. Potential environmental impacts should be evaluated when considering replacement of the structure.
- Adjustments to Creamery Creek may require environmental permitting or analysis to confirm that the adjustments won't negatively impact the ecology of the creek and nearby areas. The same constraints will need to be considered when completing work associated with this project.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$146,900
Mobilization, Bonding, Overhead, and Wages	\$55,700
Design, Permitting, Legal, and Construction Services	\$79,000
Contingency (30%)	\$84,500
Total Project Cost	\$366,100



PROJECT 5 – MEADOWLARK/MEADOWLAWN/HARVEST (WEST CUL-DE-SACS) (ID 25)



PROJECT NEED

Currently, the cul-de-sacs at the west end of Meadowlark Place and Meadowlawn Place frequently flood. It was noted by the City that there is a lack of catch basins along these streets, preventing the water from flowing into the stormwater system. Additionally, the current alignment of this system connects these cul-de-sacs to the McLeod's Ditch to the south via a stormwater pipeline that flows through private properties. During modeling this area was identified as a problem area due to limited capacity starting at the 2-year design storm.



PROJECT DESCRIPTION

This project includes installing additional catch basins in both Meadowlark and Meadowlawn Place cul-de-sacs and connecting the cul-de-sacs to the stormwater pipelines running down Harvest Lane to mitigate capacity concerns. All locations of catch basins shown are merely proposed and actual catch basin location will be decided during design processes.

- Construct 275 linear feet of 10-inch stormwater pipe to connect the new catch basins to the system.
- Construct 450 linear feet of 12-inch stormwater pipe on Meadowlawn Place.
- Construct 325 linear feet of 18-inch stormwater pipe on Meadowlark Place.
- Construct seven new catch basins (four in Meadowlark Place and three in Meadowlawn Place) and any manholes associated with the new infrastructure. Renew any catch basins that are connected to the existing stormwater infrastructure that will be replaced in this project.

DESIGN CONSIDERATIONS

- Replacements must conform to current City standards for materials and minimum diameters.
- Construction will require coordination with existing utilities in a constrained urban corridor.
- ADA compliance needs to be addressed as appropriate.
- Detailed siting and design of the proposed pipes, manholes, and catch basins are outside of the scope of this master plan.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$487,900
Mobilization, Bonding, Overhead, and Wages	\$185,400
Design, Permitting, Legal, and Construction Services	\$229,000
Contingency (30%)	\$270,700
Total Project Cost	\$1,173,000



PROJECT 6 – BEAR CREEK AT ONA WAY CULVERT (ID 6)





PROJECT NEED

Generally, the Bear Creek crossings in the City need to be improved due to overgrowth blockages which result in flooding, and infrastructure that is aging and deteriorating. The crossing at Ona Way needs to be replaced.

PROJECT DESCRIPTION

This project includes replacing the existing corrugated metal pipes culvert with a bridge crossing to address capacity and conditions concerns. Additionally, this project will include design elements that meet fish passage requirements, which the crossing does not currently meet.

- Replace the existing culvert with an approximately 31.5-foot-wide bridge crossing that includes fish passage design elements such as native stream bed materials and restoration planting.
- Removal of the existing culvert crossing and reconstruction of Ona Way.

DESIGN CONSIDERATIONS

- Bridge crossing will be designed to accommodate fish passage.
- Adjustments to Bear Creek will require environmental permitting or analysis to confirm that the adjustments won't negatively impact the ecology of the creek and nearby areas. The same constraints will need to be considered when completing work associated with this project.



COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$817,700
Mobilization, Bonding, Overhead, and Wages	\$310,800
Design, Permitting, Legal, and Construction Services	\$462,700
Contingency (30%)	\$477,400
Total Project Cost	\$2,068,600



PROJECT 7 – CREAMERY CREEK LANE CULVERT (ID 15)



PROJECT NEED

Hydraulic modeling and observed conditions indicate that the existing culverts beneath Creamery Creek Lane are undersized and contribute to upstream flooding, impacting nearby residential properties.

PROJECT DESCRIPTION

Replace the existing culverts with two adjacent 6-foot by 3-foot box culverts to convey the 100-year design storm and reduce upstream flooding risk.



DESIGN CONSIDERATIONS

- Adjustments to Creamery Creek may require environmental permitting or analysis to confirm that the adjustments won't negatively impact the ecology of the creek and nearby areas. The same constraints will need to be considered when completing work associated with this project.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$234,600
Mobilization, Bonding, Overhead, and Wages	\$89,100
Design, Permitting, Legal, and Construction Services	\$126,300
Contingency (30%)	\$135,000
Total Project Cost	\$585,000



PROJECT 8 – EAST SIDE OF N MOLALLA AVENUE FROM FRANCES STREET TO CHURCH STREET (ID 17/16)



PROJECT NEED

The City experiences flooding near Frances Street and Miller Street along Molalla Avenue.

PROJECT DESCRIPTION

Reported flooding along Molalla Avenue is associated with two separate stormwater drainage systems: one conveying flow south from Frances Street and one conveying flow north from Miller Street. The project approach is described separately for each system below.

South System (From Frances Street south along Molalla Avenue):



Hydraulic modeling suggests there are no capacity limitations in the existing storm system. Flooding is likely related to blockages, root intrusion, deteriorated infrastructure, or inadequate surface drainage infrastructure.

- Perform CCTV inspection of existing pipes to assess condition, identify blockages, and confirm connectivity.
- Implement surface drainage improvements, which may include installation of new catch basins and laterals to improve runoff collection, particularly along the west side of Molalla Avenue.

North System (From Miller Street north along Molalla Avenue):

Existing drainage infrastructure in this area is not well documented. Three catch basins are shown in GIS along Molalla Avenue; however, no corresponding pipe connections are documented in the existing database. A survey conducted in April 2026 identified each catch basin as having a single outlet pipe, with direction shown by dashed black arrows in the figure above. Locate and perform CCTV inspection of existing pipes to confirm alignment, condition, and existing outfall locations.

- Construct approximately 800 linear feet of 12-inch stormwater pipe along Molalla Avenue from Miller Street to Thunderbird Street to provide a continuous conveyance system. Abandon and fill existing storm pipes serving the three catch basins, as well as additional segments as identified during field verification.
- Install curb and gutter and additional catch basins, as needed, to improve runoff collection and reduce flooding.

DESIGN CONSIDERATIONS

- Replacements must conform to current City standards for materials and minimum diameters.
- Construction will require coordination with existing utilities in a constrained urban corridor.
- Construct manholes and catch basins associated with the new stormwater infrastructure. Renew any catch basins that are connected to the existing stormwater infrastructure.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$383,200
Mobilization, Bonding, Overhead, and Wages	\$145,700
Design, Permitting, Legal, and Construction Services	\$206,200
Contingency (30%)	\$220,500
Total Project Cost	\$955,600



PROJECT 9 – BEAR CREEK AT LOWE ROAD (ID 5)





PROJECT NEED

Generally, the Bear Creek crossings in the City need to be improved due to overgrowth blockages which result in flooding, and infrastructure that is aging and deteriorating. The crossing at Lowe Road needs to be replaced.

PROJECT DESCRIPTION

This project includes replacing the existing corrugated metal pipe culvert with a bridge crossing to address capacity and conditions concerns. Additionally, this project will include design elements that meet fish passage requirements, which the crossing does not currently meet.

- Replace the existing culvert with an approximately 16.5-foot-wide bridge crossing that includes fish passage design elements such as native stream bed materials and restoration planting.
- Removal of the existing culvert crossing and reconstruction of Lowe Road.

DESIGN CONSIDERATIONS

- Bridge crossing will be designed to accommodate fish passage.
- Adjustments to Bear Creek will require environmental permitting or analysis to confirm that the adjustments won't negatively impact the ecology of the creek and nearby areas. The same constraints will need to be considered when completing work associated with this project.



COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$427,400
Mobilization, Bonding, Overhead, and Wages	\$162,400
Design, Permitting, Legal, and Construction Services	\$241,800
Contingency (30%)	\$249,500
Total Project Cost	\$1,081,100



PROJECT 10 – HOMESTEAD PLACE LINE (ID 47)



PROJECT NEED

A line has been in service carrying stormwater from the Homestead Place cul-de-sac under Highway 213 to the property to the west. This cul-de-sac often floods and the City would like to prevent future flooding in this location.

PROJECT DESCRIPTION

This project includes adding two catch basins near the Homestead Place cul-de-sac to capture more water and prevent flooding. As survey results and subsequent modeling efforts revealed that the existing pipes have sufficient capacity to manage flows in the area, if flooding continues additional investigation, specifically into the condition of the outfall is recommended.



- Construct two new catch basins near the Homestead Place cul-de-sac.
- Construct approximately 70 linear feet of 10-inch stormwater pipe to connect catch basins to the storm main.

DESIGN CONSIDERATIONS

- Highway 213 is not under City jurisdiction, depending on the results from adding catch basins, coordination with the Oregon Department of Transportation (ODOT) may be necessary.
- Construct manholes and catch basins associated with the new stormwater infrastructure. Renew any catch basins that are connected to the existing stormwater infrastructure.

COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$38,100
Mobilization, Bonding, Overhead, and Wages	\$14,400
Design, Permitting, Legal, and Construction Services	\$17,900
Contingency (30%)	\$21,100
Total Project Cost	\$91,500



PROJECT 11 – BEAR CREEK AT MATHIAS ROAD (ID 24)





PROJECT NEED

Generally, the Bear Creek crossings in the City need to be improved due to overgrowth blockages which result in flooding, and infrastructure that is aging and deteriorating. The crossing at Mathias Road needs to be replaced.

PROJECT DESCRIPTION

This project includes replacing the existing corrugated metal pipe culverts with a bridge crossing to address capacity concerns and reduce constant maintenance due to overgrowth. Additionally, this project will include design elements that meet fish passage requirements, which the crossing does not currently meet.

- Replace the existing culvert with a 15-foot-wide bridge crossing or box culvert that includes fish passage design elements such as native stream bed materials and restoration planting.
- Removal of the existing culvert crossing and reconstruction of Mathias Road.

DESIGN CONSIDERATIONS

- Bridge crossing will be designed to accommodate fish passage.
- Adjustments to Bear Creek will require environmental permitting or analysis to confirm that the adjustments won't negatively impact the ecology of the creek and nearby areas. The same constraints will need to be considered when completing work associated with this project.
- Mathias Road is owned and maintained by Clackamas County; this project will require coordination with any additional county-specific design requirements.



COSTS

Planning Level Cost	
Construction Subtotal (materials)	\$388,300
Mobilization, Bonding, Overhead, and Wages	\$147,400
Design, Permitting, Legal, and Construction Services	\$219,600
Contingency (30%)	\$226,600
Total Project Cost	\$981,900

APPENDIX J

Capital Project Cost Estimates



Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Underground Creamery Creek Realignment

Project Identifier: 1

Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	30-inch Pipe - Excavation, Backfill	180	LF	\$340	\$ 61,200	
1.2	36-inch Pipe - Excavation, Backfill	1,050	LF	\$430	\$ 451,500	
1.3	36-inch Pipe - Excavation, Backfill	460	LF	\$430	\$ 197,800	
1.4	60 x 38 Arch Pipe - Excavation, Backfill	420	LF	\$575	\$ 241,500	
1.5	68 x 43 Arch Pipe - Excavation, Backfill	650	LF	\$633	\$ 411,500	
1.6	Abandon Existing Pipe, no excavation (54-60")	1,695	LF	\$69	\$ 117,000	
1.7	Pipe CCTV Inspection	2,350	LF	\$8	\$ 18,800	
1.8	72-Inch, Standard Manhole	7	EA	\$16,500	\$ 115,500	
1.9	Concrete Vault, 8'x8'x10'	5	EA	\$21,200	\$ 106,000	
1.10	Catch Basin	24	EA	\$3,500	\$ 84,000	
1.11	Asphalt Pavement Roadway Restoration (Full Lane)	2,760	LF	\$125	\$ 345,000	
1.12	ADA Compliance	4	EA	\$4,000	\$ 16,000	
1.13	Water Quality Facility (planter)	1,822	SF	\$40	\$ 72,900	
1.14	Traffic Control (signs, flagging)	1	LS	\$111,900	\$ 111,900	
1.15	Construction Surveying	1	LS	\$44,800	\$ 44,800	
1.16	Removal of structures and obstructions (demolition)	1	LS	\$111,900	\$ 111,900	
Construction Subtotal (ROUNDED)						\$2,507,300
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$376,100	
2.2	Bonding			5%	\$125,400	
2.3	Contractor Overhead and Profit			15%	\$376,100	
2.4	Prevailing Wages			3%	\$75,200	
Additional Elements Subtotal (ROUNDED)						\$952,800
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$692,000	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$276,800	
3.3	Construction Permitting, includes 1200-C			1.5%	\$51,900	
3.4	Geotechnical Investigation			2%	\$69,200	
3.5	Environmental and Permitting			5%	\$173,000	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$86,500	
Plans and Contract Documents Subtotal (ROUNDED)						\$1,349,400
Total Project Costs (ROUNDED, without escalation or contingency)						\$4,809,500
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$1,442,900	
Total Project Costs (rounded)						\$6,252,400

EA = each, LF = linear foot, LS = lump sum

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: McLeod's Ditch and Cascade Highway						
Project Identifier: 2						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	18-inch Pipe - Excavation, Backfill	700	LF	\$250	\$ 175,000	
1.2	60-Inch, Standard Manhole	5	EA	\$8,500	\$ 42,500	
1.3	Re-connect catch basin	1	EA	\$500	\$ 500	
1.4	Connect to Existing Structure	4	EA	\$4,250	\$ 17,000	
1.5	Asphalt Pavement Roadway Restoration (Full Lane)	700	LF	\$125	\$ 87,500	
1.7	Traffic Control (signs, flagging)	1	LS	\$16,100	\$ 16,100	
1.8	Construction Surveying	1	LS	\$6,500	\$ 6,500	
1.9	Removal of structures and obstructions (demolition)	1	LS	\$16,100	\$ 16,100	
Construction Subtotal (ROUNDED)						\$361,200
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$54,200	
2.2	Bonding			5%	\$18,100	
2.3	Contractor Overhead and Profit			15%	\$54,200	
2.4	Prevailing Wages			3%	\$10,800	
Additional Elements Subtotal (ROUNDED)						\$137,300
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$99,700	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$39,900	
3.3	Construction Permitting, includes 1200-C			1.5%	\$7,500	
3.4	Geotechnical Investigation			2%	\$10,000	
3.5	Environmental and Permitting			3%	\$15,000	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$12,500	
Plans and Contract Documents Subtotal (ROUNDED)						\$184,600
Total Project Costs (ROUNDED, without escalation or contingency)						\$683,100
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$204,900	
Total Project Costs (rounded)						\$888,000

EA = each, LF = linear foot, LS = lump sum

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Finney's Avenue and E Heintz Street Project Identifier: 3						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	18-inch Pipe - Excavation, Backfill	270	LF	\$250	\$ 67,500	
1.2	24-inch Pipe - Excavation, Backfill	600	LF	\$310	\$ 186,000	
1.3	36-inch Pipe - Excavation, Backfill	460	LF	\$430	\$0 due to overlap	
1.4	Abandon Existing Pipe, no excavation (42-48")	577	LF	\$57	\$ 33,100	
1.5	48-Inch, Standard Manhole	6	EA	\$7,500	\$ 45,000	
1.6	Catch Basin	12	EA	\$3,500	\$ 42,000	
1.7	Connect to Existing Structure	8	EA	\$4,250	\$ 34,000	
1.8	Asphalt Pavement Roadway Restoration (Full Lane)	1,300	LF	\$125	\$ 162,500	
1.9	ADA Compliance	4	EA	\$4,000	\$ 16,000	
1.10	Water Quality Facility (planter)	574	SF	\$40	\$ 23,000	
1.11	Traffic Control (signs, flagging)	1	LS	\$30,500	\$ 30,500	
1.12	Construction Surveying	1	LS	\$12,200	\$ 12,200	
1.11	Removal of structures and obstructions (demolition)	1	LS	\$30,500	\$ 30,500	
	Construction Subtotal (ROUNDED)					\$682,300
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$102,300	
2.2	Bonding			5%	\$34,100	
2.3	Contractor Overhead and Profit			15%	\$102,300	
2.4	Prevailing Wages			3%	\$20,500	
	Additional Elements Subtotal (ROUNDED)					\$259,200
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$188,300	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$75,300	
3.3	Construction Permitting, includes 1200-C			1.5%	\$14,100	
3.4	Geotechnical Investigation			2%	\$18,800	
3.5	Environmental and Permitting			5%	\$47,100	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$23,500	
	Plans and Contract Documents Subtotal (ROUNDED)					\$367,100
	Total Project Costs (ROUNDED, without escalation or contingency)					\$1,308,600
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$392,600	
	Total Project Costs (rounded)					\$1,701,200

EA = each, LF = linear foot, LS = lump sum

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Creamery Creek Railroad Culvert Project Identifier: 4						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	Precast Reinforced Box Concrete Box Culvert, 3' x 6'	36	LF	\$1,728	\$ 62,200	
1.2	Precast Reinforced Box Concrete Box Culvert, 3' x 6'	36	LF	\$1,728	\$ 62,200	
1.3	Native Stream Bed Materials	32	CY	\$30	\$ 1,000	
1.4	Restoration Planting	48	SY	\$5	\$ 200	
1.5	Traffic Control (signs, flagging)	0	LS	\$6,300	\$ -	
1.6	Construction Surveying	1	LS	\$2,500	\$ 2,500	
1.7	Removal of structures and obstructions (demolition)	1	LS	\$18,800	\$ 18,800	
	Construction Subtotal (ROUNDED)					\$146,900
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$22,000	
2.2	Bonding			5%	\$7,300	
2.3	Contractor Overhead and Profit			15%	\$22,000	
2.4	Prevailing Wages			3%	\$4,400	
	Additional Elements Subtotal (ROUNDED)					\$55,700
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$40,500	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$16,200	
3.3	Construction Permitting, includes 1200-C			1.5%	\$3,000	
3.4	Geotechnical Investigation			2%	\$4,100	
3.5	Environmental and Permitting			5%	\$10,100	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$5,100	
	Plans and Contract Documents Subtotal (ROUNDED)					\$79,000
	Total Project Costs (ROUNDED, without escalation or contingency)					\$281,600
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$84,500	
	Total Project Costs (rounded)					\$366,100

EA = each, LF = linear foot, LS = lump sum

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Meadowlark and Meadowlawn West Cul-de-sacs						
Project Identifier: 5						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	10-inch Pipe - Excavation, Backfill	275	LF	\$180	\$ 49,500	
1.2	12-inch Pipe - Excavation, Backfill	450	LF	\$200	\$ 90,000	
1.3	18-inch Pipe - Excavation, Backfill	325	LF	\$250	\$ 81,300	
1.4	48-Inch, Standard Manhole	5	EA	\$7,500	\$ 37,500	
1.5	60-Inch, Standard Manhole	1	EA	\$8,500	\$ 8,500	
1.6	Re-connect catch basin	4	EA	\$500	\$ 2,000	
1.7	Curb Inlet	7	EA	\$5,500	\$ 38,500	
1.8	Connect to Existing Structure	3	EA	\$4,250	\$ 12,800	
1.9	Asphalt Pavement Roadway Restoration (Half Lane)	1,050	LF	\$110	\$ 115,500	
1.10	Traffic Control (signs, flagging)	1	LS	\$21,800	\$ 21,800	
1.11	Construction Surveying	1	LS	\$8,700	\$ 8,700	
1.12	Removal of structures and obstructions (demolition)	1	LS	\$21,800	\$ 21,800	
Construction Subtotal (ROUNDED)						\$487,900
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$73,200	
2.2	Bonding			5%	\$24,400	
2.3	Contractor Overhead and Profit			15%	\$73,200	
2.4	Prevailing Wages			3%	\$14,600	
Additional Elements Subtotal (ROUNDED)						\$185,400
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$134,700	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$53,900	
3.3	Construction Permitting, includes 1200-C			1.5%	\$10,100	
3.4	Geotechnical Investigation			2%	\$13,500	
3.5	Environmental and Permitting			0%	\$0	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$16,800	
Plans and Contract Documents Subtotal (ROUNDED)						\$229,000
Total Project Costs (ROUNDED, without escalation or contingency)						\$902,300
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$270,700	
Total Project Costs (rounded)						\$1,173,000

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Bear Creek at Ona Way Culvert Project Identifier: 6						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	Creek Bridge Crossing	31.5	LF	\$23,000	\$ 724,500	
1.2	Native Stream Bed Materials	150	CY	\$30	\$ 4,500	
1.3	Restoration Planting	210	SY	\$5	\$ 1,100	
1.4	Traffic Control (signs, flagging)	1	LS	\$36,500	\$ 36,500	
1.5	Construction Surveying	1	LS	\$14,600	\$ 14,600	
1.6	Removal of structures and obstructions (demolition)	1	LS	\$36,500	\$ 36,500	
					Construction Subtotal (ROUNDED)	\$817,700
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$122,700	
2.2	Bonding			5%	\$40,900	
2.3	Contractor Overhead and Profit			15%	\$122,700	
2.4	Prevailing Wages			3%	\$24,500	
					Additional Elements Subtotal (ROUNDED)	\$310,800
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$225,700	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$90,300	
3.3	Construction Permitting, includes 1200-C			1.5%	\$16,900	
3.4	Geotechnical Investigation			2%	\$22,600	
3.5	Environmental and Permitting			7%	\$79,000	
	Wetland Delineation			5%	\$56,400	
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits			2%	\$22,600	
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$28,200	
					Plans and Contract Documents Subtotal (ROUNDED)	\$462,700
					Total Project Costs (ROUNDED, without escalation or contingency)	\$1,591,200
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$477,400	
					Total Project Costs (rounded)	\$2,068,600

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Creamery Creek Lane Culvert Project Identifier: 7						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	Precast Reinforced Box Concrete Box Culvert, 3' x 6'	60	LF	\$1,728	\$ 103,700	
1.2	Precast Reinforced Box Concrete Box Culvert, 3' x 6'	60	LF	\$1,728	\$ 103,700	
1.3	Native Stream Bed Materials	53	CY	\$30	\$ 1,600	
1.4	Restoration Planting	80	SY	\$5	\$ 400	
1.5	Traffic Control (signs, flagging)	1	LS	\$10,500	\$ 10,500	
1.6	Construction Surveying	1	LS	\$4,200	\$ 4,200	
1.7	Removal of structures and obstructions (demolition)	1	LS	\$10,500	\$ 10,500	
	Construction Subtotal (ROUNDED)					\$234,600
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$35,200	
2.2	Bonding			5%	\$11,700	
2.3	Contractor Overhead and Profit			15%	\$35,200	
2.4	Prevailing Wages			3%	\$7,000	
	Additional Elements Subtotal (ROUNDED)					\$89,100
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$64,700	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$25,900	
3.3	Construction Permitting, includes 1200-C			1.5%	\$4,900	
3.4	Geotechnical Investigation			2%	\$6,500	
3.5	Environmental and Permitting			5%	\$16,200	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$8,100	
	Plans and Contract Documents Subtotal (ROUNDED)					\$126,300
	Total Project Costs (ROUNDED, without escalation or contingency)					\$450,000
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$135,000	
	Total Project Costs (rounded)					\$585,000

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: N Molalla Avenue, Frances to Church Street

Project Identifier: 8

Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	12-inch Pipe - Excavation, Backfill	760	LF	\$200	\$ 152,000	
1.2	48-Inch, Standard Manhole	2	EA	\$7,500	\$ 15,000	
1.3	Catch Basin	3	EA	\$3,500	\$ 10,500	
1.4	Asphalt Pavement Roadway Restoration (Half Lane)	760	LF	\$110	\$ 83,600	
1.5	Concrete Curbs, Curb and Gutter	430	LF	\$55	\$ 23,700	
1.6	Pipe CCTV Inspection	800	LF	\$8	\$ 6,400	
1.7	ADA Ramp Reconstruction (Compliance)	2	EA	\$4,600	\$ 9,200	
1.8	Water Quality Facility (planter)	228	SF	\$40	\$ 9,100	
1.9	Catch Basin	2	EA	\$3,500	\$ 7,000	
1.10	48-Inch, Standard Manhole	1	EA	\$7,500	\$ 7,500	
1.11	Pipe CCTV Inspection	1,500	LF	\$8	\$ 12,000	
1.12	Asphalt Pavement Roadway Restoration (Half Lane)	56	LF	\$110	\$ 6,200	
1.11	Traffic Control (signs, flagging)	1	LS	\$17,100	\$ 17,100	
1.12	Construction Surveying	1	LS	\$6,800	\$ 6,800	
1.11	Removal of structures and obstructions (demolition)	1	LS	\$17,100	\$ 17,100	
	Construction Subtotal (ROUNDED)					\$383,200
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$57,500	
2.2	Bonding			5%	\$19,200	
2.3	Contractor Overhead and Profit			15%	\$57,500	
2.4	Prevailing Wages			3%	\$11,500	
	Additional Elements Subtotal (ROUNDED)					\$145,700
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$105,800	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$42,300	
3.3	Construction Permitting, includes 1200-C			1.5%	\$7,900	
3.4	Geotechnical Investigation			2%	\$10,600	
3.5	Environmental and Permitting			5%	\$26,400	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$13,200	
	Plans and Contract Documents Subtotal (ROUNDED)					\$206,200
	Total Project Costs (ROUNDED, without escalation or contingency)					\$735,100
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$220,500	
	Total Project Costs (rounded)					\$955,600

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Bear Creek at Lowe Road Project Identifier: 9						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	Creek Bridge Crossing	16.5	LF	\$23,000	\$ 379,500	
1.2	Native Stream Bed Materials	50	CY	\$30	\$ 1,500	
1.3	Restoration Planting	110	SY	\$5	\$ 600	
1.4	Traffic Control (signs, flagging)	1	LS	\$19,100	\$ 19,100	
1.5	Construction Surveying	1	LS	\$7,600	\$ 7,600	
1.6	Removal of structures and obstructions (demolition)	1	LS	\$19,100	\$ 19,100	
					Construction Subtotal (ROUNDED)	\$427,400
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$64,100	
2.2	Bonding			5%	\$21,400	
2.3	Contractor Overhead and Profit			15%	\$64,100	
2.4	Prevailing Wages			3%	\$12,800	
					Additional Elements Subtotal (ROUNDED)	\$162,400
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$118,000	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$47,200	
3.3	Construction Permitting, includes 1200-C			1.5%	\$8,800	
3.4	Geotechnical Investigation			2%	\$11,800	
3.5	Environmental and Permitting			7%	\$41,300	
	Wetland Delineation			5%	\$29,500	
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits			2%	\$11,800	
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$14,700	
					Plans and Contract Documents Subtotal (ROUNDED)	\$241,800
					Total Project Costs (ROUNDED, without escalation or contingency)	\$831,600
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$249,500	
					Total Project Costs (rounded)	\$1,081,100

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Homestead Place Line						
Project Identifier: 10						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	10-inch Pipe - Excavation, Backfill	70	LF	\$180	\$ 12,600	
1.2	Curb Inlet	2	EA	\$5,500	\$ 11,000	
1.3	60-Inch, Standard Manhole	1	EA	\$8,500	\$ 8,500	
1.4	Pipe CCTV Inspection	275	LF	\$8	\$ 2,200	
1.11	Traffic Control (signs, flagging)	1	LS	\$1,600	\$ 1,600	
1.12	Construction Surveying	1	LS	\$600	\$ 600	
1.11	Removal of structures and obstructions (demolition)	1	LS	\$1,600	\$ 1,600	
Construction Subtotal (ROUNDED)						\$38,100
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$5,700	
2.2	Bonding			5%	\$1,900	
2.3	Contractor Overhead and Profit			15%	\$5,700	
2.4	Prevailing Wages			3%	\$1,100	
Additional Elements Subtotal (ROUNDED)						\$14,400
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$10,500	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$4,200	
3.3	Construction Permitting, includes 1200-C			1.5%	\$800	
3.4	Geotechnical Investigation			2%	\$1,100	
3.5	Environmental and Permitting			0%	\$0	
	Wetland Delineation					
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits					
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$1,300	
Plans and Contract Documents Subtotal (ROUNDED)						\$17,900
Total Project Costs (ROUNDED, without escalation or contingency)						\$70,400
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$21,100	
Total Project Costs (rounded)						\$91,500

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Client: City of Molalla
Project: Stormwater Master Plan
Project No.: 223122
Date: 8/3/2026
Reviewed By: RR



Summary Capital Improvement Cost Estimates

Project Title: Bear Creek at Mathias Road Project Identifier: 11						
Item No.	General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2026 Dollars)
1	Goods and Services					
1.1	Creek Bridge Crossing	15	LF	\$23,000	\$ 345,000	
1.2	Native Stream Bed Materials	50	CY	\$30	\$ 1,500	
1.3	Restoration Planting	50	SY	\$5	\$ 300	
1.4	Traffic Control (signs, flagging)	1	LS	\$17,300	\$ 17,300	
1.5	Construction Surveying	1	LS	\$6,900	\$ 6,900	
1.6	Removal of structures and obstructions (demolition)	1	LS	\$17,300	\$ 17,300	
					Construction Subtotal (ROUNDED)	\$388,300
2	Additional Elements (estimated % of above)					
2.1	Mobilization and General Conditions			15%	\$58,200	
2.2	Bonding			5%	\$19,400	
2.3	Contractor Overhead and Profit			15%	\$58,200	
2.4	Prevailing Wages			3%	\$11,600	
					Additional Elements Subtotal (ROUNDED)	\$147,400
3	Plans and Contract Documents					
3.1	Engineering Design and Bid Phase Services			20%	\$107,100	
3.2	Engineering - Construction Contract Administration and Observation			8%	\$42,900	
3.3	Construction Permitting, includes 1200-C			1.5%	\$8,000	
3.4	Geotechnical Investigation			2%	\$10,700	
3.5	Environmental and Permitting			7%	\$37,500	
	Wetland Delineation			5%	\$26,800	
	Removal Fill Permits (USACE/ODSL/ODEQ)					
	Floodplain Permits			2%	\$10,700	
3.6	Legal, Administrative, and Funding, including right-of-way			2.5%	\$13,400	
					Plans and Contract Documents Subtotal (ROUNDED)	\$219,600
					Total Project Costs (ROUNDED, without escalation or contingency)	\$755,300
4	Contingency			Percentage		
4.1	Contingency on Design and Construction			30%	\$226,600	
					Total Project Costs (rounded)	\$981,900

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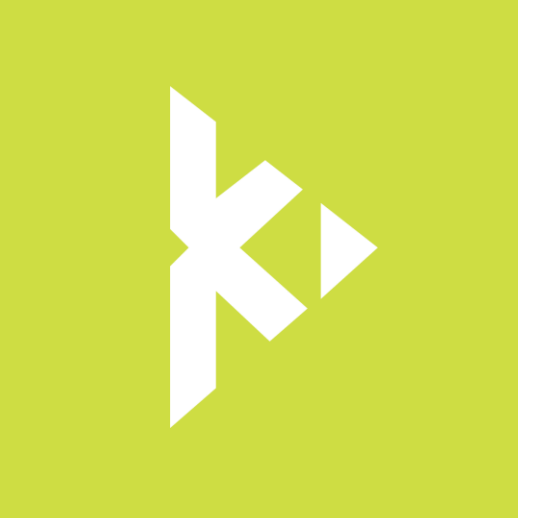


STORMWATER MASTER PLAN

City of Molalla
August 12, 2026



AGENDA

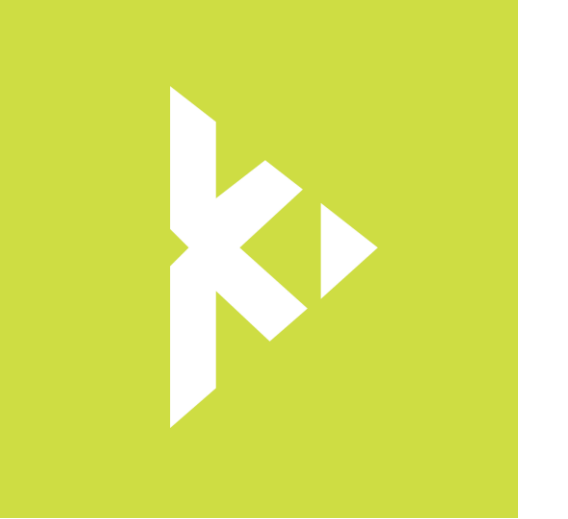


STORMWATER MASTER PLAN



- Plan (SWMP) Need
- Planning Process
- Public Works Design Standards
- System Evaluation
- Problem Areas
- Capital Improvement Plan
 - Staffing
 - Maintenance
 - Programs
 - Projects
- Summary

PLAN (SWMP) NEED

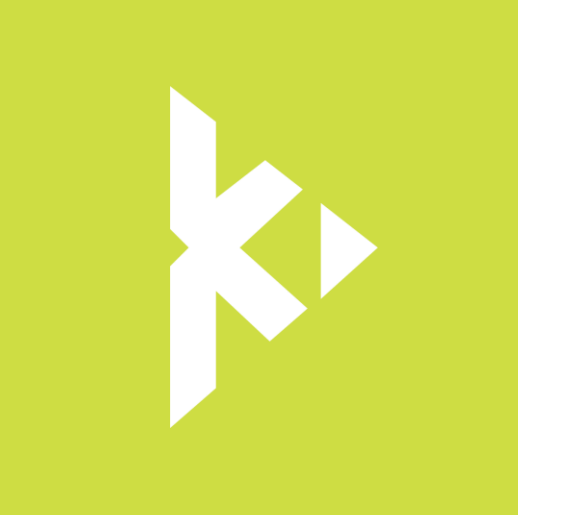


STORMWATER MASTER PLAN

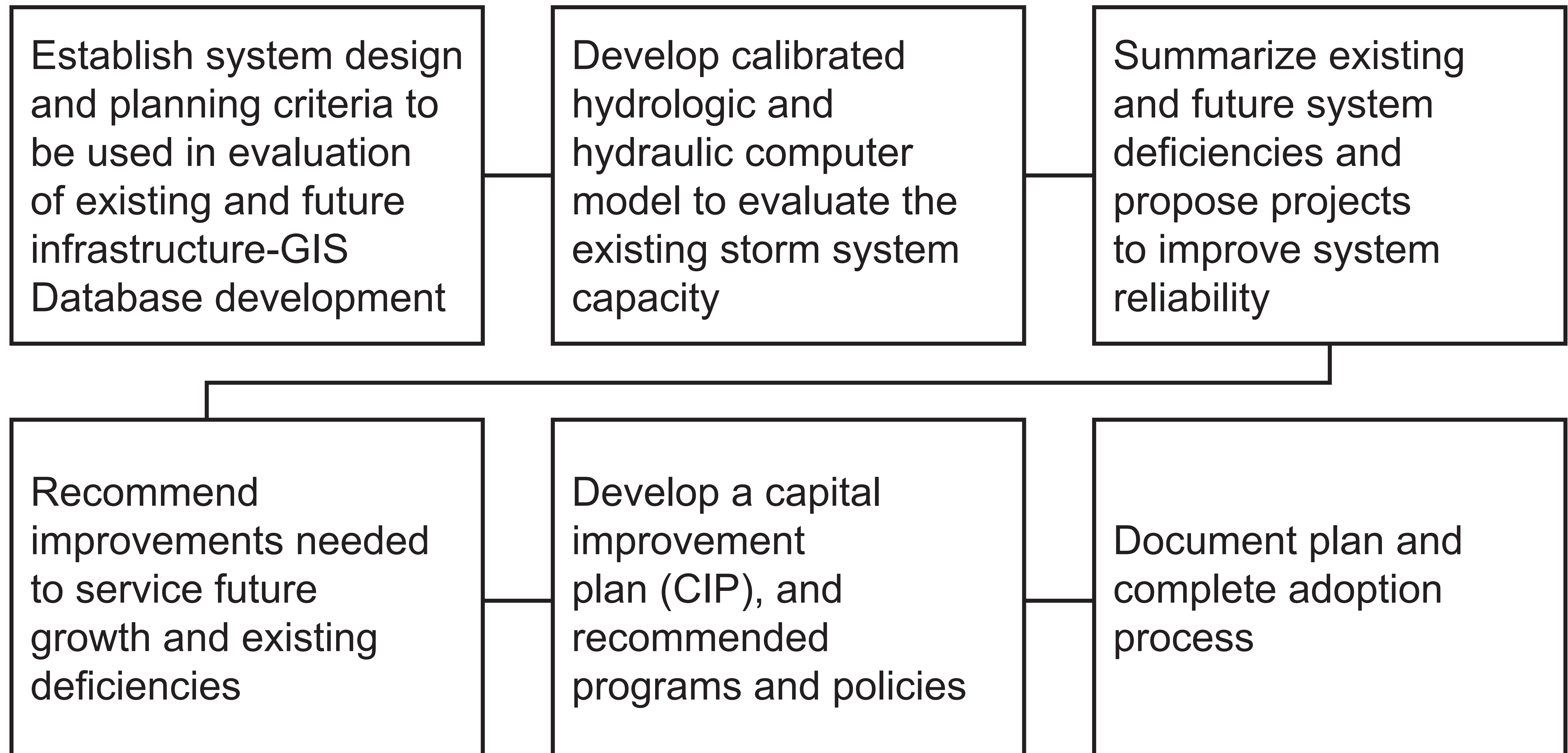


- City growth
- Private development pressure
- Asset management
- Plan for future
- Funding
- Increasing regulatory requirements

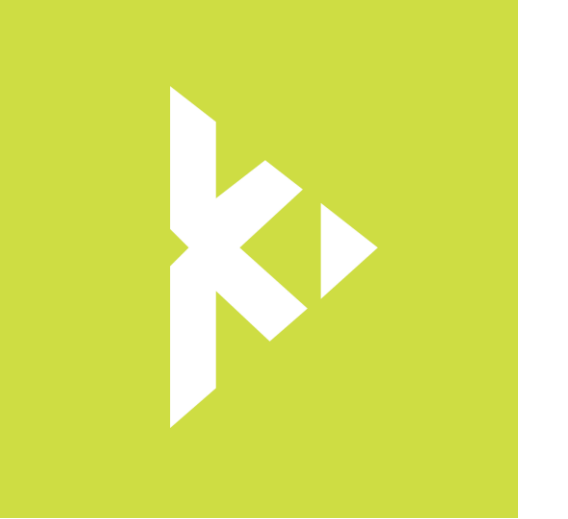
PLANNING PROCESS



STORMWATER MASTER PLAN



PUBLIC WORKS DESIGN STANDARDS

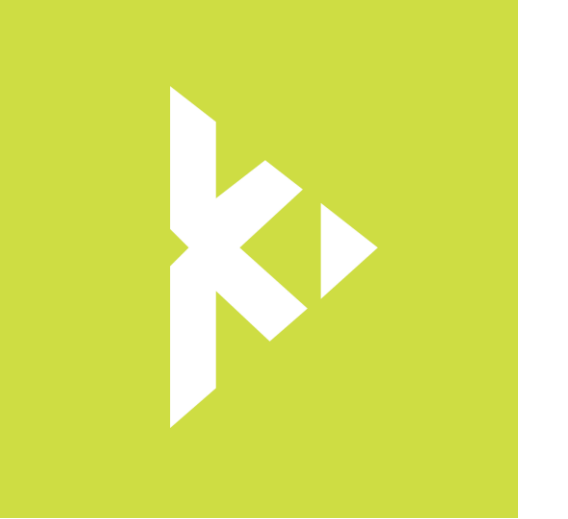


STORMWATER MASTER PLAN

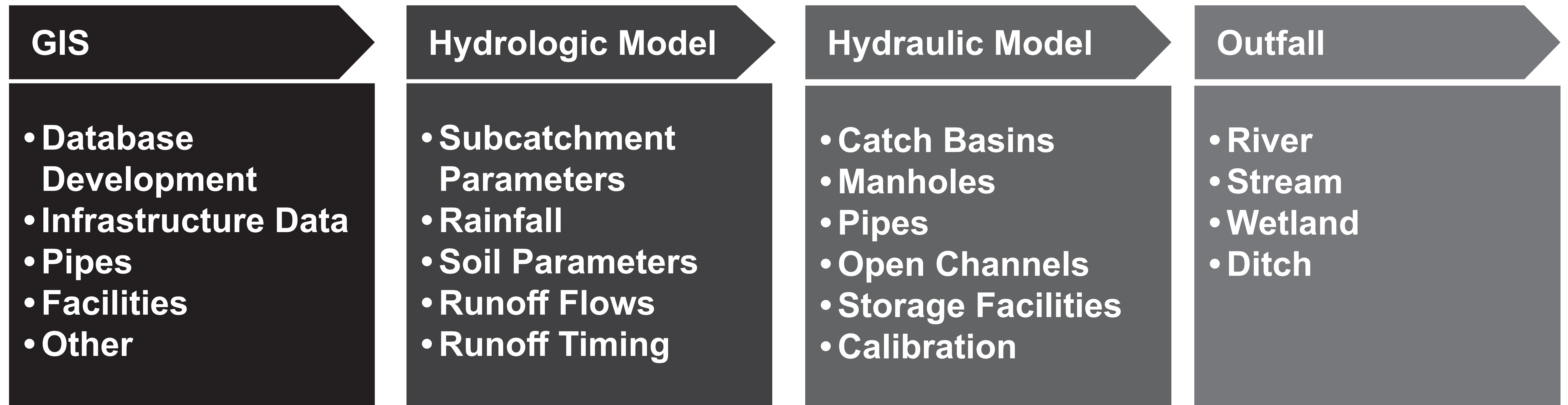
- Review of Design Standards and City Code
- Provide suggested edits/changes/updates
- Current Design Standards are based on 20+ year old language
- City Code requires minor edits
- Focus areas
 - Downstream system evaluation
 - Water quality
 - Water quantity
 - Culvert design
 - Flood plain management



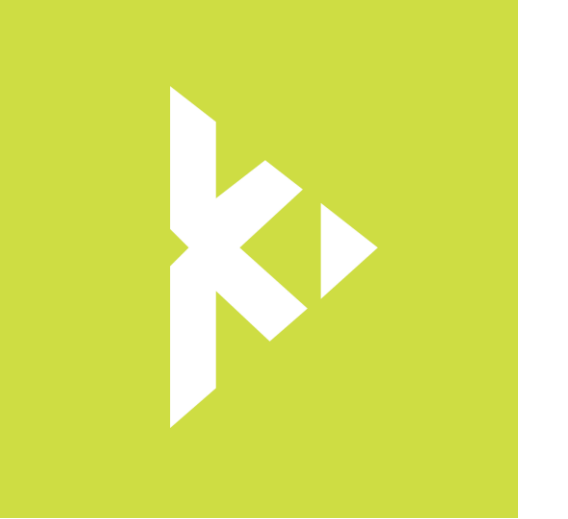
SYSTEM EVALUATION



STORMWATER MASTER PLAN



PROBLEM AREAS



STORMWATER MASTER PLAN

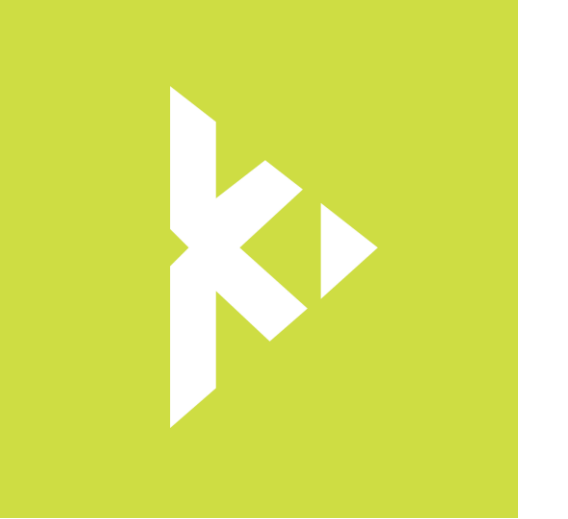


SUMMARY OF CHALLENGES

- Old pipes/infrastructure
- Undersized infrastructure
- Underserved areas
- Limited flow control
- Limited water quality treatment
- Continued growth
- Limited resources

(Figures available for viewing)

CAPITAL IMPROVEMENT PLAN



STORMWATER MASTER PLAN

PROJECTS

- 11 projects
- Primarily capacity

PROGRAMS

- Cleaning
- CCTV
- Sweeping
- Facilities
- Repair and Replacement

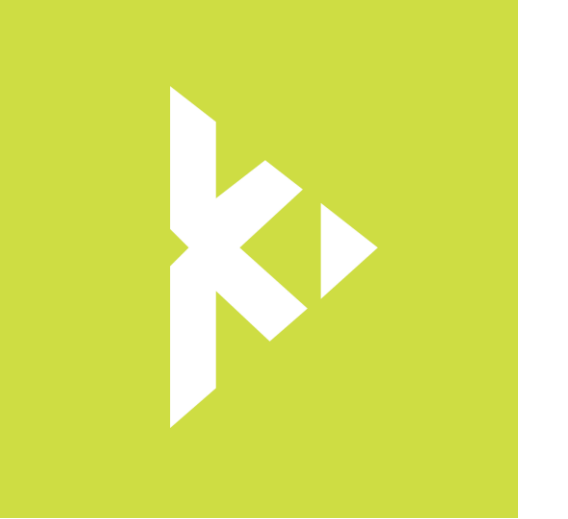
STAFFING

- 2.0 FTE

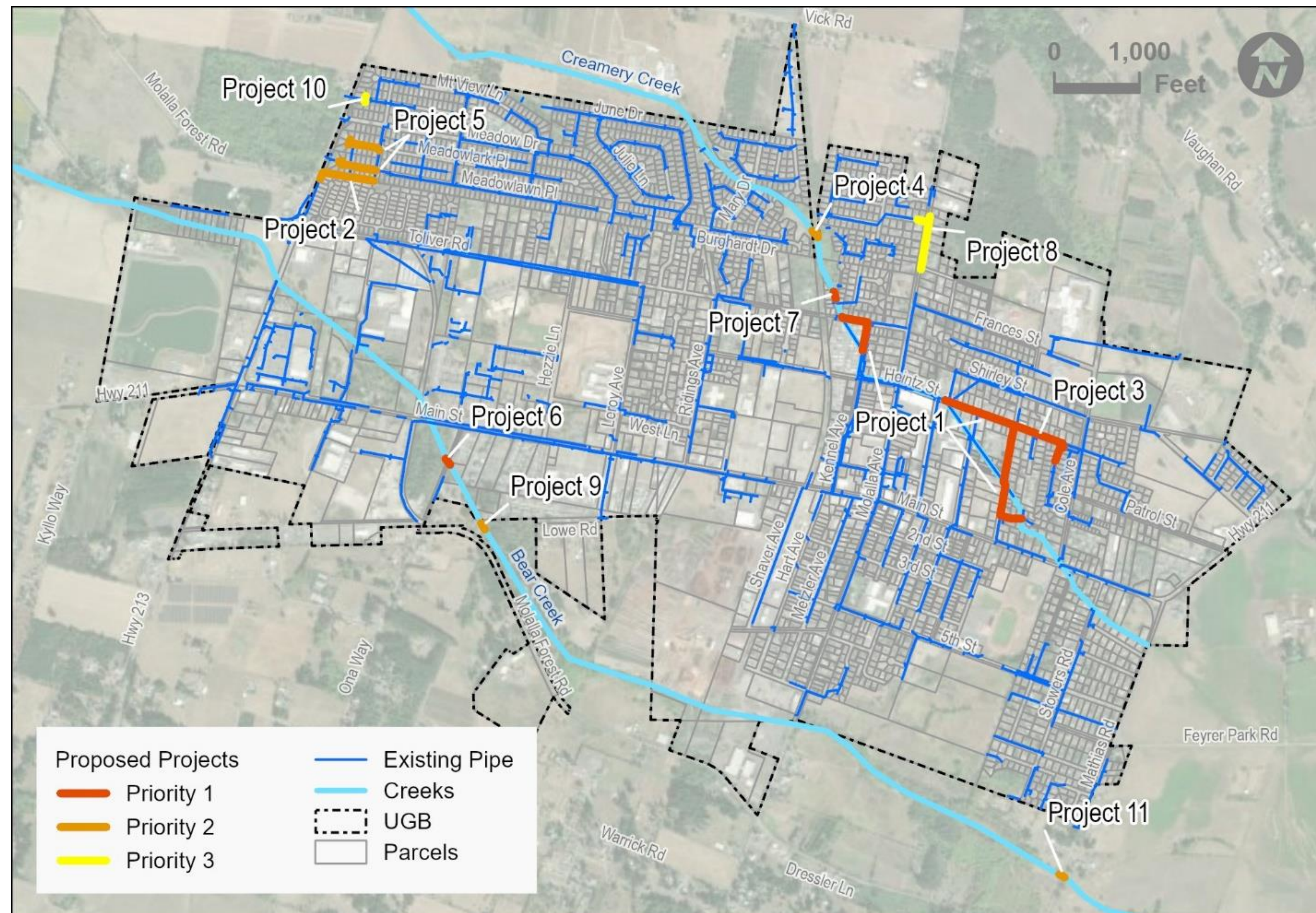
MAINTENANCE



CAPITAL IMPROVEMENT PROJECTS

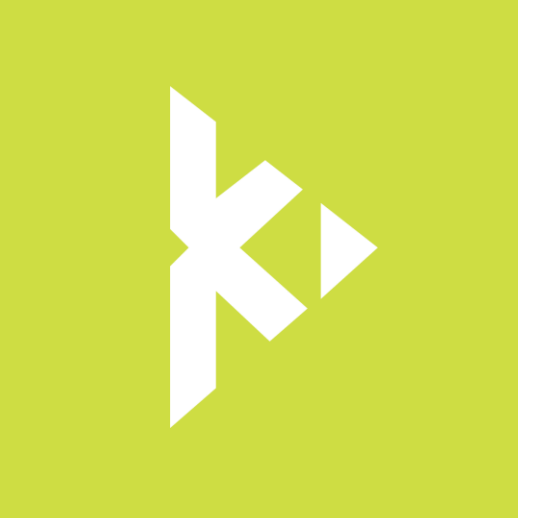


STORMWATER MASTER PLAN



- P1 – Creamery Creek
- P2 – McLeod's Ditch
- P3 – Finney's Ave/Heitz Street
- P4 – Creamery Creek RR
- P5 – Meadowlark/Meadowlawn
- P6 – Ona Way at Bear Creek
- P7 – Creamy Creek Lane
- P8 – N Molalla Ave
- P9 – Lowe Road at Bear Creek
- P10 – Homestead Place
- P11 – Mathias Road at Bear Creek

PROGRAMS

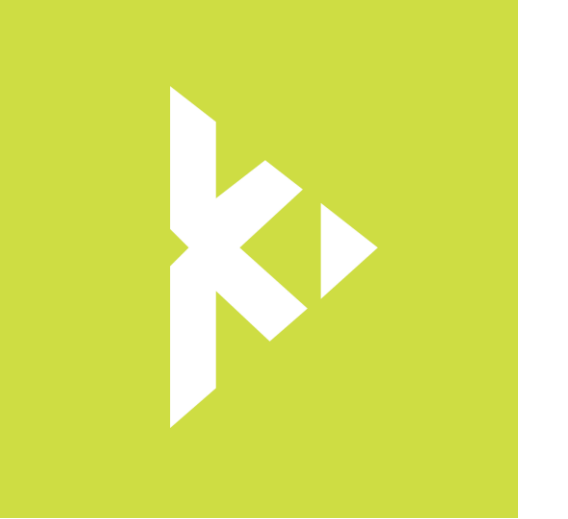


STORMWATER MASTER PLAN

- **Manhole/Catch Basin Cleaning**
 - Three-year cycle
- **CCTV and Pipe Cleaning**
 - Six-year cycle
- **Street Sweeping**
 - Continue existing
- **Facility Maintenance**
 - Inspection/maintain
- **Repair and Replacement**
 - One-hundred-year cycle



STAFFING/MAINTENANCE

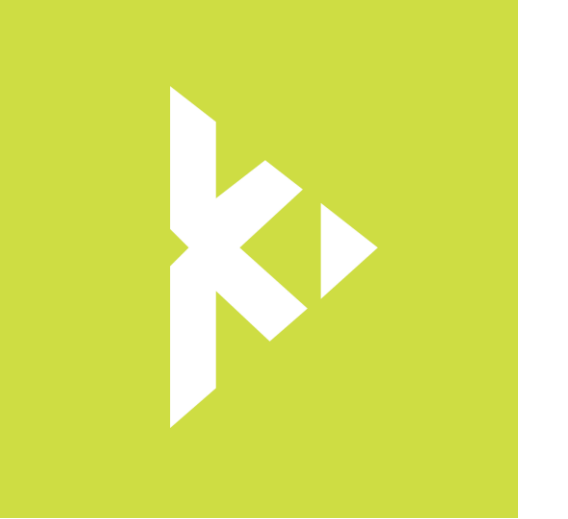


STORMWATER MASTER PLAN



- Increased staffing
- Maintenance staff
- Engineering staff
- Increase regular system maintenance
 - Collection
 - Conveyance
 - Treatment
 - Outfall
 - Open channels
 - Culverts

FINANCIAL SUMMARY



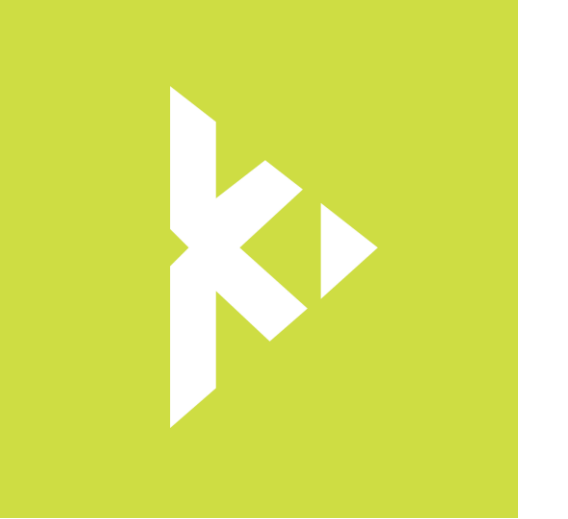
STORMWATER MASTER PLAN



ANNUAL BUDGET BASED ON TWENTY-YEAR HORIZON

- CIP Projects
 - \$806,000
- Programs
 - \$1,460,000
- Staffing
 - \$400,000
- Annual Stormwater Budget
 - \$2,666,000/year

QUESTIONS AND COMMENTS



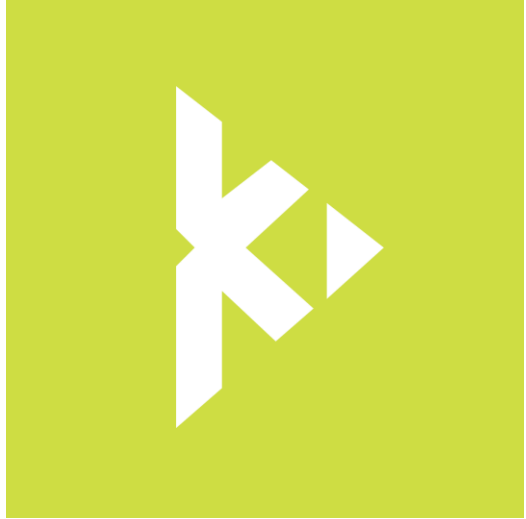
STORMWATER MASTER PLAN



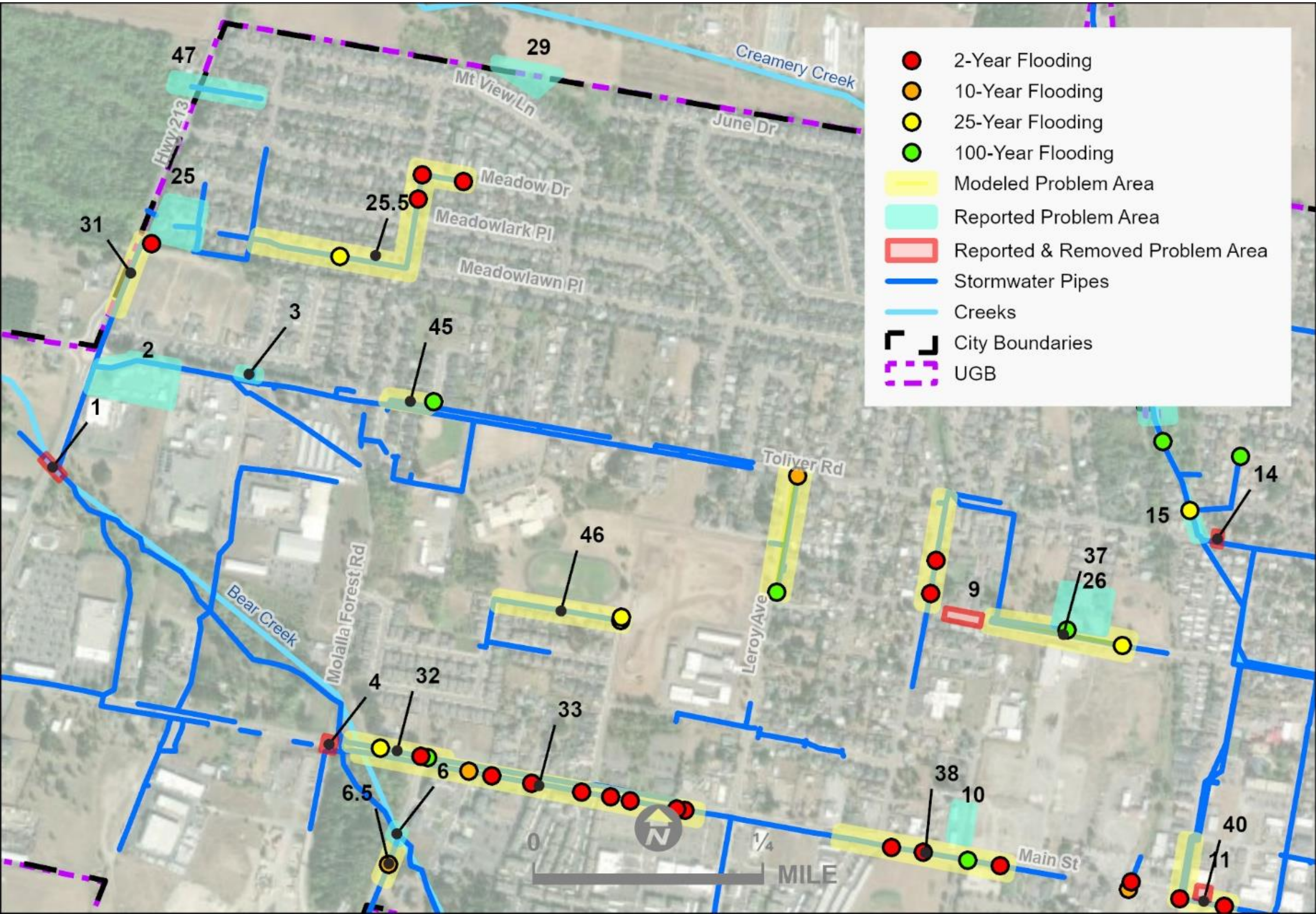
Growing Possibilities.



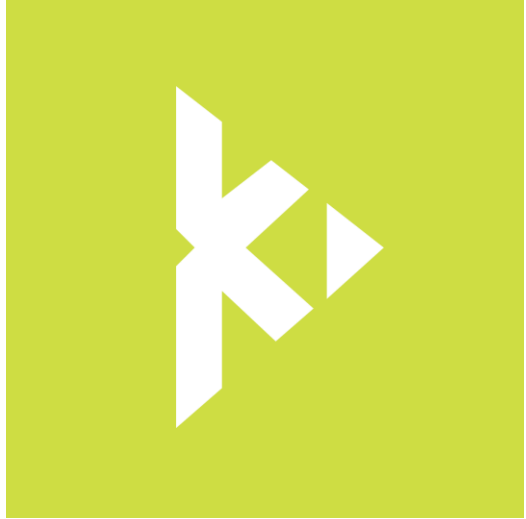
PROBLEM AREAS - NW



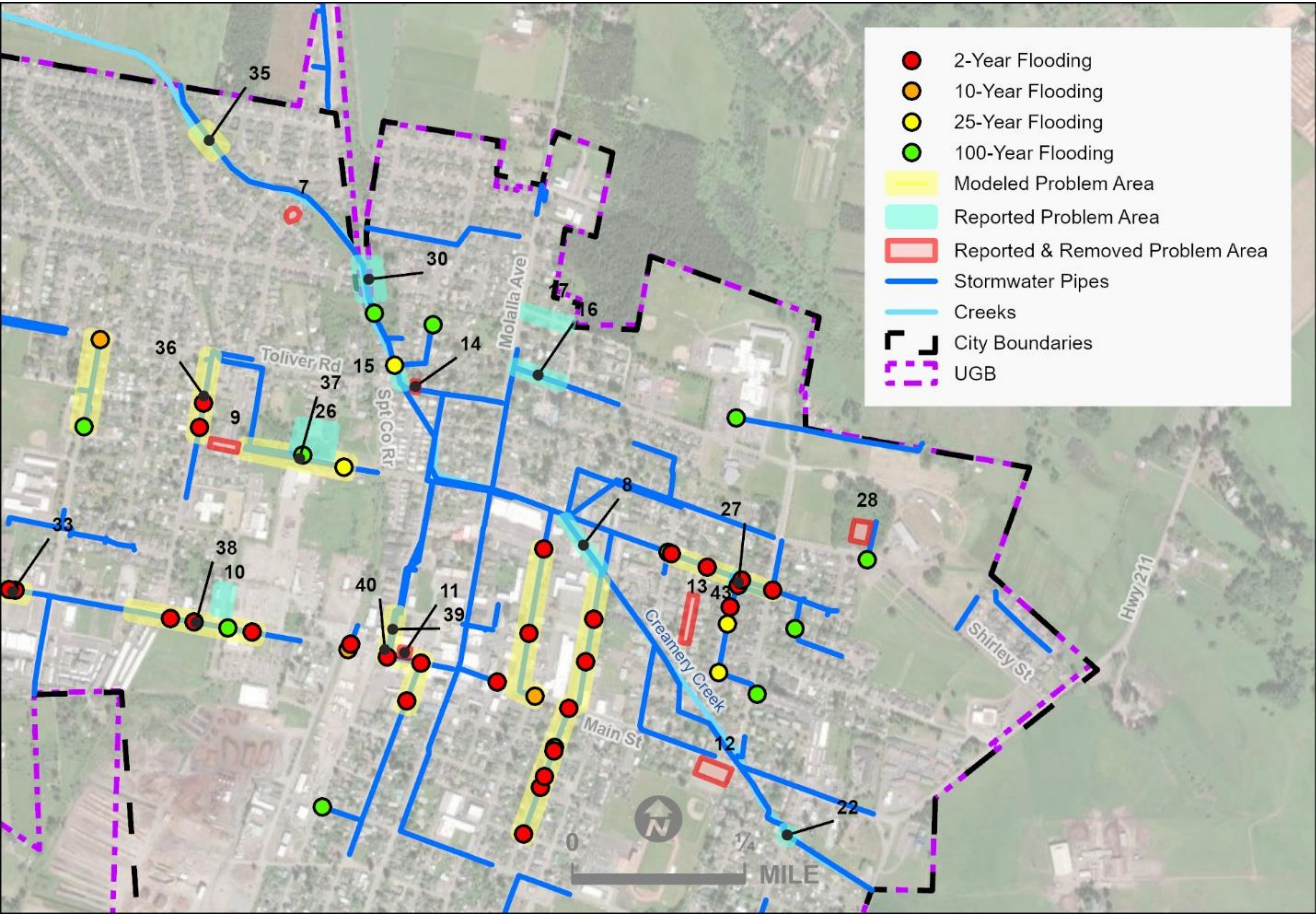
STORMWATER MASTER PLAN



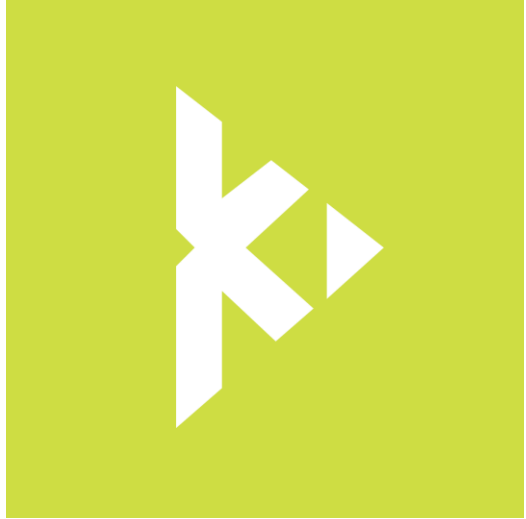
PROBLEM AREAS - NE



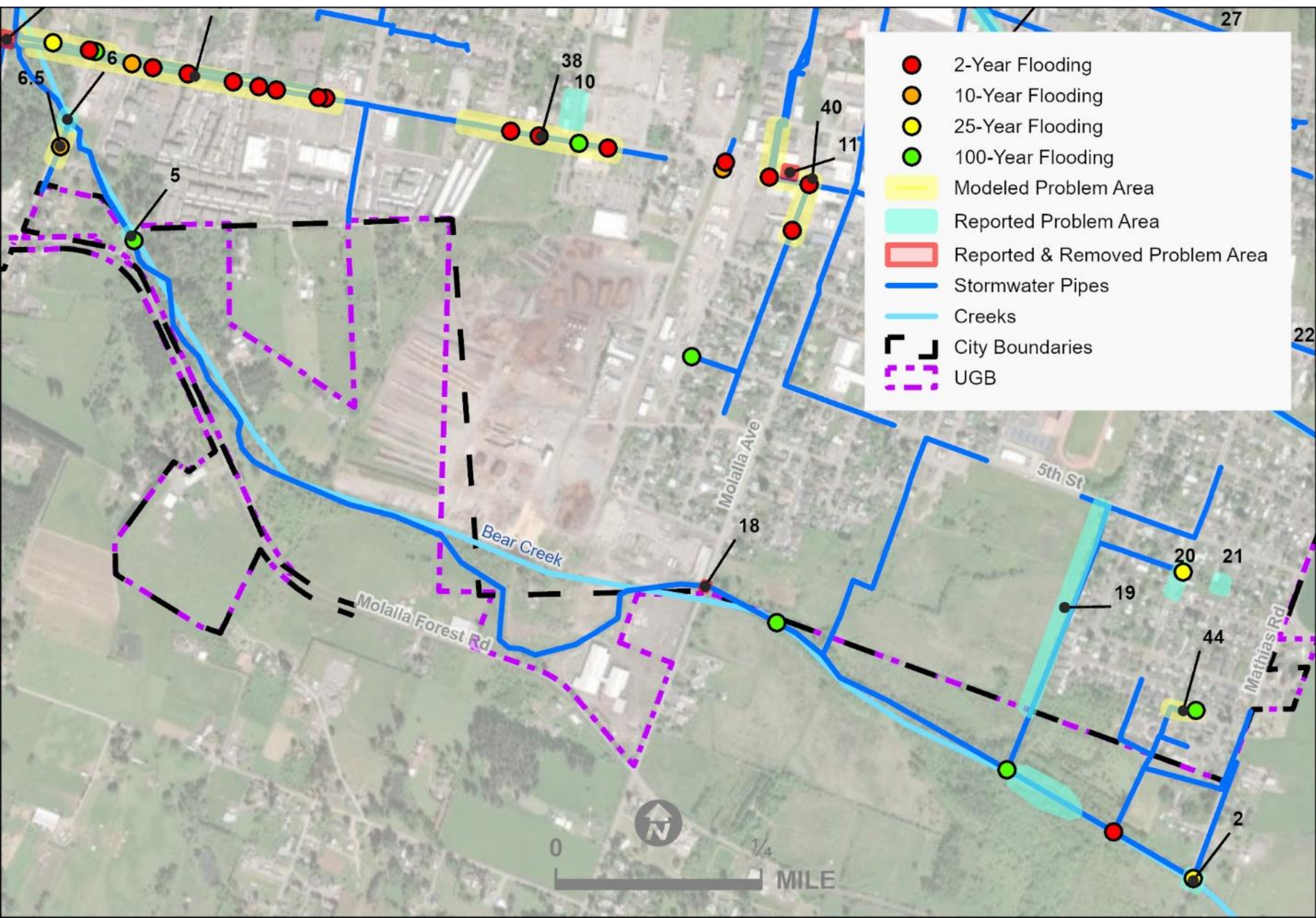
STORMWATER MASTER PLAN



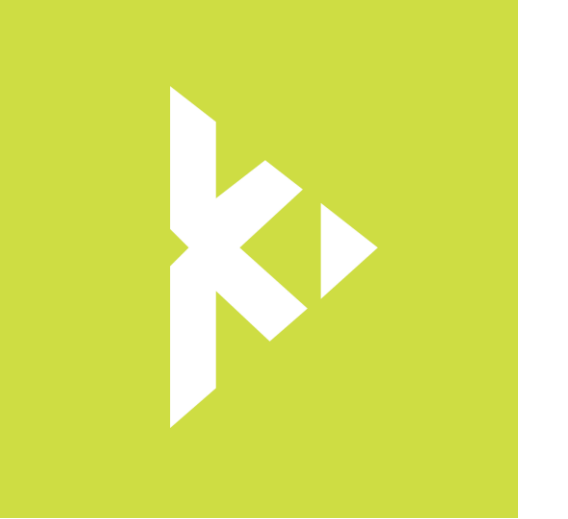
PROBLEM AREAS - SOUTH



STORMWATER MASTER PLAN



GOALS AND OBJECTIVES



STORMWATER MASTER PLAN



- Share status of SWMP
- Provide transparency
- Receive feedback/input
- Integrate feedback/input