

Multnomah County **Stormwater Master Plan - 2nd Draft**

September 2026



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MULTNOMAH COUNTY STORMWATER MASTER PLAN - 2nd DRAFT

September 28, 2026

Prepared for:



Acknowledgement

The development of this Stormwater Master Plan required a significant investment of time, effort, and collaboration from all parties involved. The project team gratefully acknowledges Chet Hagen, Kelly Mitchell, Alaina Floor, Lance Calvert, Roy Iwai, Rick Arriola, Omphemetse Olesitse, and other County staff for their valuable knowledge, guidance, and input throughout development of the plan and its Capital Improvement Projects. Special recognition is given to Rick Arriola, Omphemetse Olesitse, and other County Maintenance staff for their dedicated field-survey efforts, which provided essential information for the planning process. The project team also thanks Multnomah County residents and other members of the public for their participation and valuable input in identifying areas of concern and community needs.

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List of Abbreviations and Acronyms

1D	One-Dimensional
2D	Two-Dimensional
As-builts	Construction Plans
BMP	Best Management Practice (Water Quality Treatment Facility)
CB	Catch Basin
cfs	Cubic Feet per Second
CIP	Capital Improvement Plan
County	Multnomah County
DBL	Double
DEA	David Evans and Associates, Inc.
DEM	Digital Elevation Model
EPA	Environmental Protection Agency
FEMA	Federal Management Agency
GIS	Geographic Information System
HGL	Hydraulic Grade Line
IB	Infiltration Basin
ID	Identification
LID	Low Impact Development
MH	Manhole
N/A	Not Applicable
NC	Natural Channel
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
RCB	Reinforced Concrete Box
RCC	Rectangular Concrete Channel
RCP	Reinforced Concrete Pipe
RWQCB	Regional Water Quality Control Board
SWMP	Stormwater Master Plan
T _c	Time of Concentration
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WxH	“Width” by “Height”

EXECUTIVE SUMMARY

This Draft Stormwater Master Plan Report (SWMP) was prepared for Multnomah County by David Evans and Associates, Inc. (DEA) and presents a comprehensive summary of the analysis of existing stormwater infrastructure, identification of current and future drainage challenges, and evaluation of the effectiveness of the existing system. Evaluation of existing stormwater infrastructure was completed considering conveyance capacity, maintainability, and water quality. This report outlines proposed stormwater management strategies for a 20-year planning horizon and prioritizes system improvements to address issues identified for each area of evaluation. Relevant data, modeling results, conceptual design recommendations for future infrastructure upgrades, and Capital Improvement Plan (CIP) components are included in the appendices.

Analyses were divided into four separate areas of study to allow for an appropriate level of detail and for planning purposes. These areas included Troutdale, Fairview, and Wood Village (TFW), Green Hills (GH), Dunthorpe-Riverdale (DR), and Unincorporated areas. Tasks included performing a hydrologic and hydraulic analysis of the County's stormwater infrastructure. Hydrologic and hydraulic modeling was used to identify areas of insufficient conveyance capacity under current and projected development and climatic conditions. County maintenance staff provided input for model verification and identified recurring maintenance problem areas to support the analysis. Production of the hydraulic model revealed wide-spread data quality issues related to County-owned stormwater infrastructure. Where feasible based on data availability, proposed improvements were evaluated using the hydraulic model to assess their effectiveness in reducing flooding and increasing system capacity.

Water quality analyses were completed county-wide by estimating soil loss, stream instability, and pollutant generation potential based on land use, soil characteristics, and topography. A county-wide assessment of existing stormwater best management practices (BMPs) was also completed to determine critical areas lacking water quality treatment. Several major roadway corridors were found to have high pollutant generation potential and no stormwater BMPs. Based on the results of these analyses and discussions with County staff, stormwater BMPs and other water quality conceptual solutions were recommended in targeted areas to maximize water quality benefits.

This comprehensive evaluation resulted in the identification of 27 capital improvement projects to address existing and anticipated infrastructure needs. These projects include 3 county-wide efforts to collect or confirm stormwater infrastructure data, to replace all County-owned stream culverts past their expected service life, and to provide maintenance for the existing and proposed infrastructure over the planning horizon of this SWMP. The remaining 24 projects correct capacity, maintenance, or water quality problems in specific locations across the County. A triple bottom line analysis was developed to prioritize projects for the County. Project prioritization was completed based on financial, environmental, and social criteria. Each evaluation criteria had weighted subcategories that were scored from 1 to 5. The three main evaluation criteria had equal weight in the total project score, for a maximum score of 15.0. Proposed capital projects received prioritization scores between 7.3 to 12.0 with a median score of 9.5.

Proposed projects with scores exceeding 9.0 were included in the CIP from preliminary engineering through construction; projects with scores 9.0 and below were only included through the completion of preliminary engineering to further vet the projects. The total cost CIP is \$108,640,000, with an annual funding demand of approximately \$5.43 million for the next 20 years.

1 INTRODUCTION

1.1 PURPOSE OF THE MASTER PLAN

This Draft Stormwater Master Plan Report (SWMP) was prepared for Multnomah County by David Evans and Associates, Inc. (DEA). This is the first stormwater master plan developed by the County. The County's National Pollutant Discharge Elimination System (NPDES) permit requires the development of a stormwater master plan as a best management practice for reducing pollutant discharge. The County's development of a substantial asset database and available grant funding has facilitated the ability to complete a robust evaluation of the County's stormwater infrastructure at scale.

This SWMP is intended to be a user-friendly guidance tool for assessing, planning, and achieving goals for future stormwater management system improvements within Multnomah County over a 20-year planning horizon with proposed improvements being appropriate for the duration of their design life (roughly 70 years). The primary audience for this SWMP is County staff. This Draft SWMP summarizes analysis of the County's existing stormwater infrastructure, identifies current and future drainage challenges, and evaluates the effectiveness of the existing system. This report outlines proposed stormwater management strategies, prioritizes system improvements, and provides recommended solutions in the form of a Capital Improvement Plan (CIP).

1.2 MASTER PLAN OBJECTIVES AND APPROACH

The primary focus of this SWMP is to address stormwater conveyance limitations, maintenance issues, and stormwater quality. This SWMP is intended to address and support the goals and objectives listed below, be easy to use, and be easy to update for future revisions.

This SWMP has the following objectives:

1. Review available information, evaluate the information needed to appropriately manage County stormwater assets, and assess data gaps
2. Analyze County-owned and operated stormwater system capacities to identify hydraulic and water quality-related problem areas and conceptualize needed improvements.
3. Evaluate the presence and severity of maintenance issues impairing the function of the stormwater infrastructure and/or impacting the local community.
4. Evaluate current regulations and standards to determine if adjustments are needed to implement appropriate improvements to the performance of the stormwater system.
5. Fulfill the requirements of the County's NPDES permit.
6. Develop a CIP that recommends projects to address stormwater deficiencies (existing and future).

The CIP includes:

- A triple bottom line analysis developed in conjunction with County staff to prioritize projects based on social, environmental, and financial criteria.
- Project cost estimates to provide an understanding of the funding demand to implement the infrastructure improvements.

Once the objectives were established, the project assessment and analysis began. This step included researching past studies and recommended projects, interviewing City staff about known problems, and performing a hydrologic and hydraulic analysis of the City's stormwater infrastructure. Evaluation of the

stormwater system used the modeling software InfoWorks ICM. An integrated 1- and 2-dimensional (1D/2D) model was developed to represent the stormwater systems in each of the three detailed study areas which encompass Troutdale, Wood Village, Fairview, Dunthorpe-Riverdale, and Green Hills. Generally, the model was limited to drainage facilities of 12-inch diameter and larger. City and regional detention and recharge facilities were not analyzed for capacity as part of this analysis.

The stormwater system models were used to assess and identify areas of insufficient conveyance capacity and corresponding flooding. The model was also used to evaluate the effectiveness of some proposed capital improvement projects. Other capital improvement projects were established based on coordination with County staff on known problem areas outside of the modeled domain. The next step was to prioritize the potential projects based on a matrix of selection criteria established in collaboration between DEA and the County. A total of 27 potential capital improvement projects were identified to address existing capacity limitations, flooding, water quality, and asset management issues.

1.3 DESIGN CRITERIA

The Multnomah County Design and Construction Manual provides technical stormwater management design standards for projects and drainage systems within the public right-of-way (ROW), including water entering and leaving the ROW. This design and construction manual is intended to provide guidance to design professionals in addition to Federal, State, County, and City environmental land use regulations. An updated Design and Construction Manual is currently being developed.

A summary of the design standards used to develop this SWMP include:

- Flow control and volume storage is analyzed for the 2-, 5-, 10-, and 25-year storm events for pre- and post-development discharges. Public storm water infrastructure is designed to the 25-year storm unless the structure is within a 100-year flood plain. Infrastructure within a 100-year flood plain is designed for the 100-year storm. Below-ground stormwater systems are allowed to surcharge, but are not allowed to flood streets, ROW, and public or private property. The Design and Construction Manual, which is currently in development, will likely require pipes to be designed to limit the design flow to less than the pipe's full-flow capacity or allow surcharge up to 1 foot of freeboard below the ground elevation.
- The County accepts the use of the following hydrologic methods: Rational Method, the SCS Method from TR 55, and the SBUH Method.
- Water quality control facilities are designed to achieve, at a minimum, 70% removal of Total Suspended Solids (TSS). Design is based in accordance with the City of Portland's Stormwater Management Manual. Stormwater that drains to streams with established Total Maximum Daily Load limitations must have facilities that abide by regulations laid out by the Federal Clean Water Act, Oregon Law, Administrative Rules, as well as any other legal mechanisms regarding specific pollutants of concern.

1.4 PREVIOUS STUDIES AND AVAILABLE DATA

Multnomah County have not previously developed a stormwater master plan. County and city studies, plans, reports, permits, and other data were used to prepare this master plan. Table 1-1 lists documents used to provide data and supplementary information to complete this study.

Geospatial information (shapefiles) containing existing stormwater infrastructure were provided by the County and used to prepare a model of the existing drainage system. In addition to the studies and reports listed below, as-built plans were used to verify or amend model existing stormwater infrastructure across the detailed study areas. Additional shapefiles and as-builts were provided by Cities within detailed study areas, where necessary to confirm County information. Additional shapefiles and data (spreadsheets) were provided by the County with information concerning known flooding locations, problem area public reports, stormwater maintenance history, stormwater quality facilities, water quality data, land use planning, and City boundaries.

Table 1-1. Previous Studies, Plans, Reports, and Permits

Previous Study/Report	Year	Author	Purpose
Multnomah County Comprehensive Plan	2016	Multnomah County	Informed land use analysis
Multnomah County Design and Construction Manual	n/a	Multnomah County	Stormwater Design Standards
Multnomah County Transportation System Plan	2016	Kittelson & Associates, Inc.	Transportation Planning
Clackamas Water Environment Services Storm System Master Plan	2022	Otak, Inc.	Adjacent County Example SWMP
City of Fairview Consolidated Stormwater Master Plan Update	2016	Brown and Caldwell	TFW detailed study area
City of Fairview Storm Water Management Plan	2022	City of Fairview	TFW detailed study area
City of Troutdale Public Works Department Capital Improvement Plan	2016	City of Troutdale Public Works Department	TFW detailed study area
North Troutdale and Sandy Drainage Improvement Company Drainage Master Plan	2020	Brown and Caldwell	TFW detailed study area
South Troutdale Stormwater Master Plan 2012	2012	Brown and Caldwell	TFW detailed study area
City of Wood Village Stormwater System Facility Plan Update	2012	Keller Associates	TFW detailed study area
City of Wood Village SWMP 2025-26 Exhibit B	2025	City of Wood Village	TFW detailed study area
Multnomah County Stormwater Retrofit Strategy	2014	Multnomah County	Water quality analysis
Multnomah County NPDES MS4 Phase I Permit Stormwater Management Program – Stormwater Retrofit Strategy	2014	Harper Houf Peterson Righellis Inc and Multnomah County	Water quality analysis
Permit Evaluation Report for National Pollutant Discharge Elimination System Municipal Separate Storm Sewer Systems Phase I Individual Permit	2021	Pablo Martos, Oregon Department of Environmental Quality	Water quality analysis
Multnomah County Stormwater Management Plan – National Pollutant Discharge Elimination System (NPDES) Municipal Separate Stormwater System (MS4) Permit	2011	Multnomah County	Water quality analysis
Individual Permit - National Pollutant Discharge Elimination System Municipal Separate Storm Sewer Systems Phase I Individual Permit	2021	Christine Svetkovich, Department of Environmental Quality	Water quality analysis

2 STUDY AREA CHARACTERISTICS

This section provides descriptions of the local climate, topography, soils, existing stormwater infrastructure, and land use conditions used to complete hydrologic, hydraulic, and water quality analyses for each detailed study area.

2.1 STUDY AREA OVERVIEW

Multnomah County encompasses approximately 465 square miles along the border of Oregon and Washington, adjacent to Columbia, Washington, Clackamas, and Hood River counties in northwestern Oregon. Multnomah County contains the Portland, Oregon metropolitan area. The Willamette River runs north and west through the County, carrying flows from the eastern Coast Range mountains, western Cascade range, and Willamette Valley. Columbia River flows west along the northern border of the County. The Willamette River joins the Columbia River in the northwestern part of the County before continuing out to the Pacific Ocean. Multnomah County owns or maintains stormwater infrastructure in both unincorporated and incorporated areas of the County, including in the cities of Troutdale, Fairview, and Wood Village. Evaluation of the existing infrastructure and development of recommendations were completed for five sub-areas (Figure 2-1):

- Troutdale – Fairview – Wood Village (TFW)
- Green Hills (GH)
- Dunthorpe – Riverdale (DR)
- North Fork and Mainstem Johnson Creek
- Unincorporated Areas

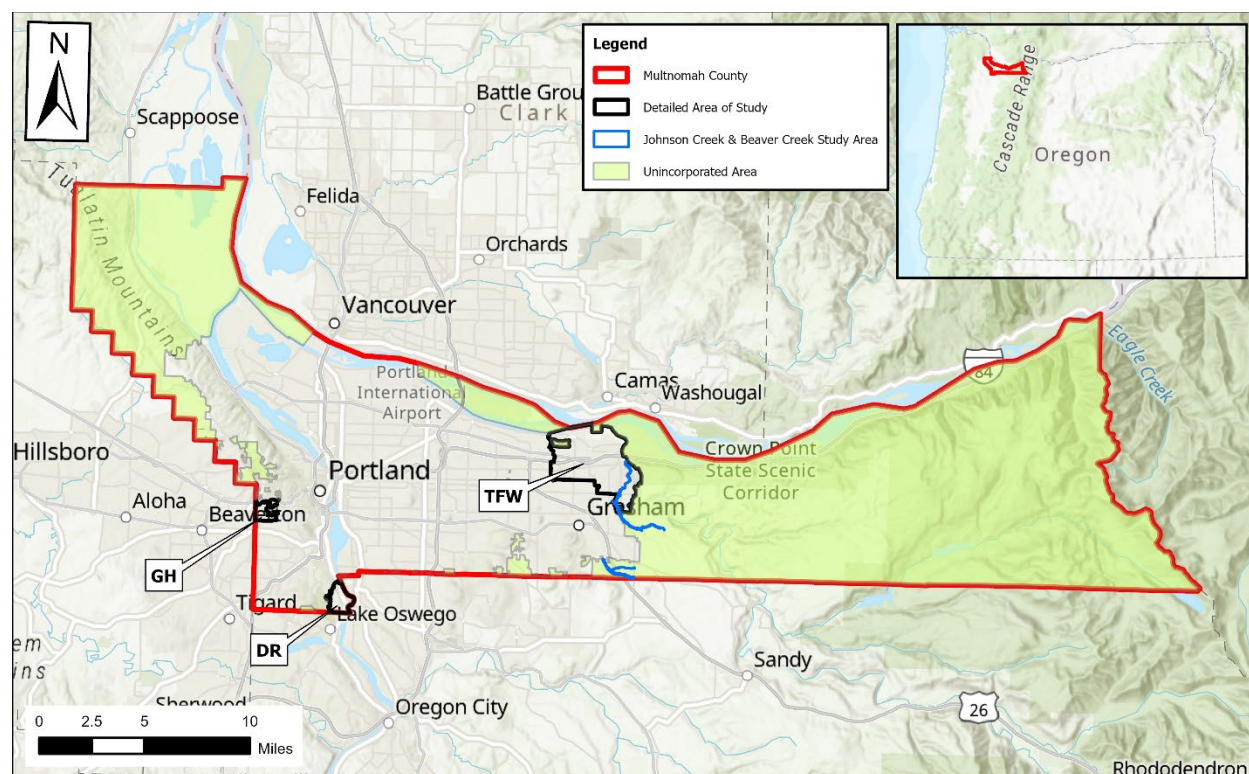


Figure 2-1. Project Location Overview

2.1.1 TROUTDALE, FAIRVIEW, AND WOOD VILLAGE (TFW)

This detailed study area includes the City of Troutdale, City of Wood Village, and City of Fairview. TFW has an area of approximately 10.6 square miles (6,760 acres). The area is located in the north central part of the County (Figure 2-2). TFW is bounded by Columbia River to the north, Sandy River to the east, and the City of Gresham to the south and west. Interstate 84 runs east-west through the middle of TFW. The southeast half of City of Troutdale drains towards Beaver Creek which is a tributary to Sandy River. The northwest half of the City of Troutdale drains to Arata Creek which becomes Salmon Creek before entering Columbia River. The western half of the City of Wood Village generally drains northeast into No Name Creek a tributary of Fairview Creek which eventually drains to Columbia River, and the eastern half of the City of Wood Village drains north to Arata Creek which becomes Salmon Creek before entering Columbia River. The City of Fairview generally drains north through Fairview Creek and Columbia River Slough towards Columbia River. Both areas ultimately drain to Columbia River and into the Pacific Ocean. TFW is nearly fully developed with largely industrial and residential land uses, and only limited forested stream corridors and isolated vacant or undeveloped lots. Within TFW is the Urban Flood Safety and Water Quality District (UFSWQD), this management area is excluded from the hydraulic analysis, as a parallel effort is underway to evaluate the drainage within the district.

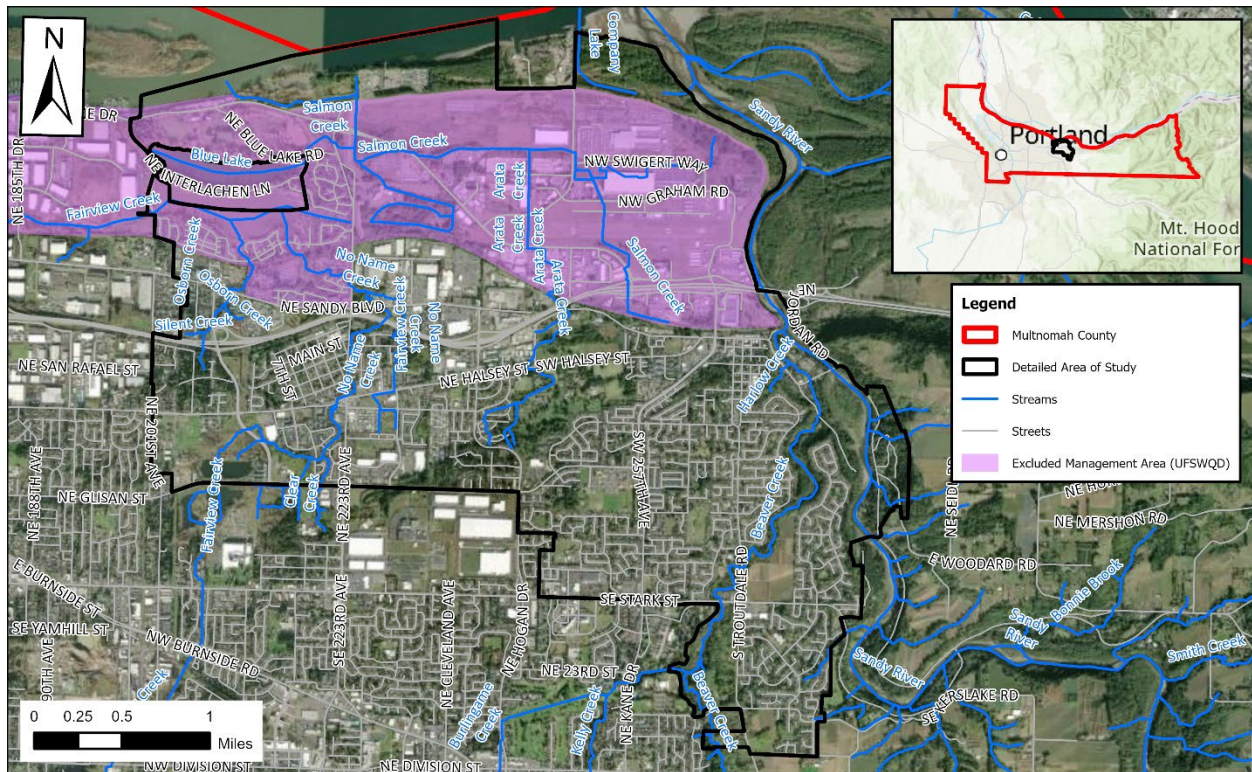


Figure 2-2. TFW Overview

2.1.2 GREEN HILLS (GH)

GH encompasses the unincorporated Green Hills area about 15 miles to the west-southwest of TFW. It has an area of approximately 0.7 square miles (469 acres). The area is bordered to the west by the Multnomah County border, to the north by Highway 26 as well as the City of Portland to the north, south, and east (Figure 2-3). Green Hills drains south toward Fanno Creek, which is a tributary of Tualatin River that then flows into Willamette River, eventually joining Columbia River. Nearly all the developable land with GH is developed with the main land use being residential. Riparian areas and regions with very steep slopes are generally forested.

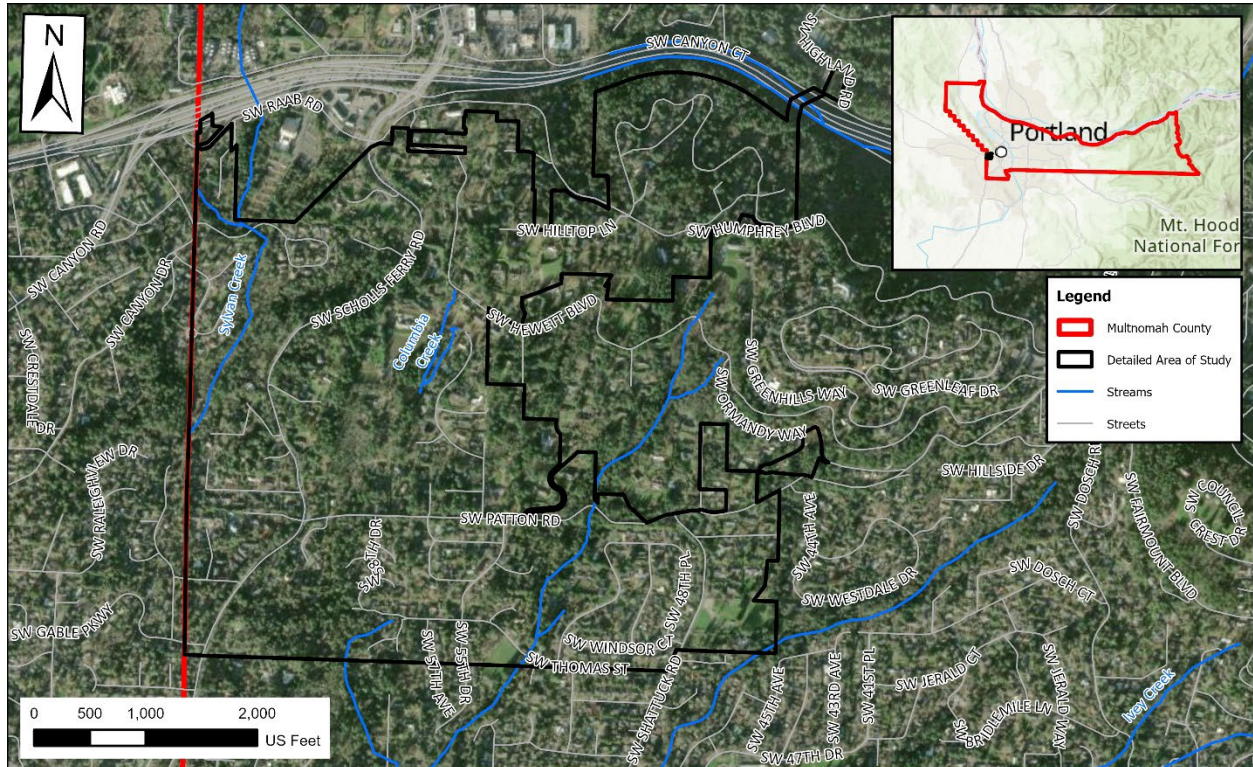


Figure 2-3. GH Overview

2.1.3 DUNTHORPE-RIVERDALE (DR)

DR encompasses the unincorporated Dunthorpe-Riverdale area and is located in the southernmost portion of the County bounded by the City of Portland to the north and west and bounded by Willamette River and County boundary to the east and south (Figure 2-4). DR has an area of approximately 1.2 square miles (752 acres). Most of the DR area drains to the east to Willamette River with a smaller western portion of DR draining to the southwest towards Tryon Creek which is a tributary to Willamette River. GH is fully developed with primarily residential land use.

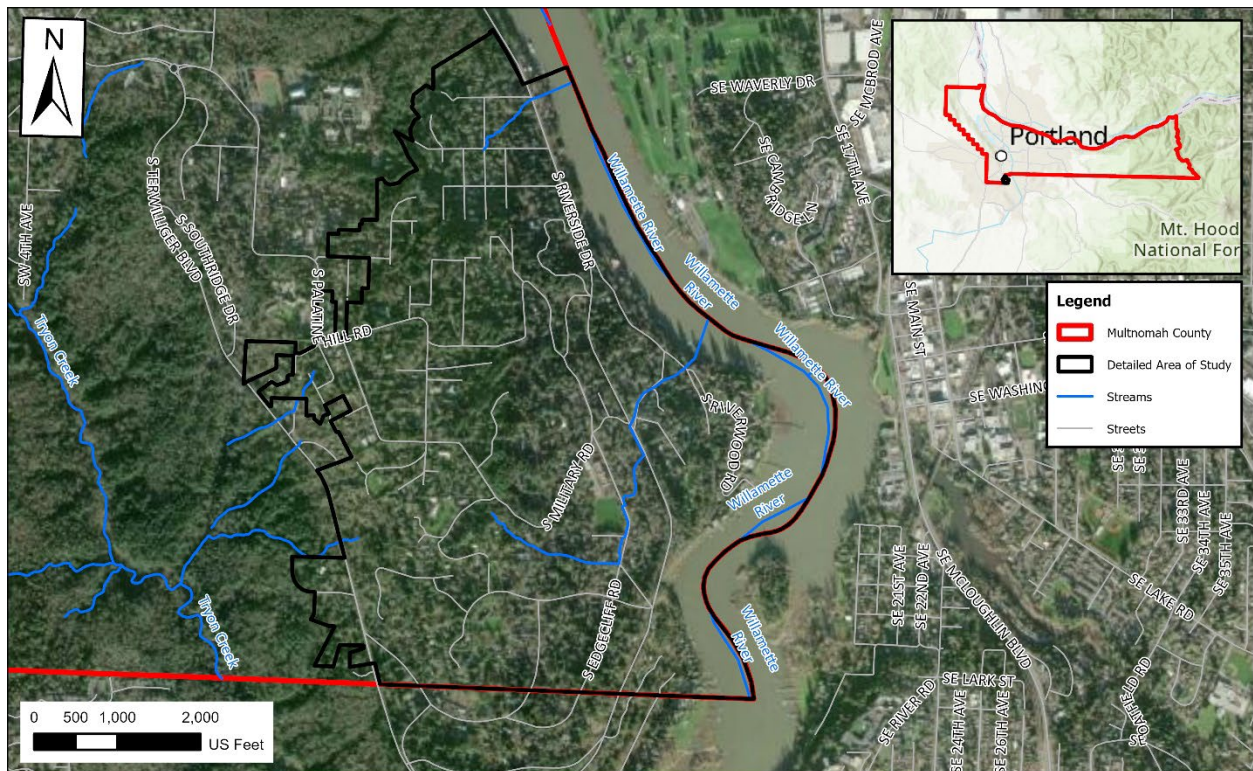


Figure 2-4. DR Overview

2.1.4 JOHNSON CREEK, NORTH FORK JOHNSON CREEK, AND BEAVER CREEK

This study area includes the North Fork and Mainstem Johnson Creek as it flows through unincorporated areas of south-central Multnomah County. Study extents include the areas modeled in the FEMA effective hydraulic modeling, which extends from SE 282nd Ave to the Springwater Corridor Trail for the North Fork and from SE 282nd Ave to SE 252nd Ave on the Mainstem Johnson Creek.

Beaver Creek was also included as part of the study area throughout the County, but primarily within Troutdale and areas to the south that are part of the FEMA designated floodplain. Analysis in these study areas included a cursory analysis of large drainage infrastructure to find opportunities to improve hydraulic performance and reduce flooding.

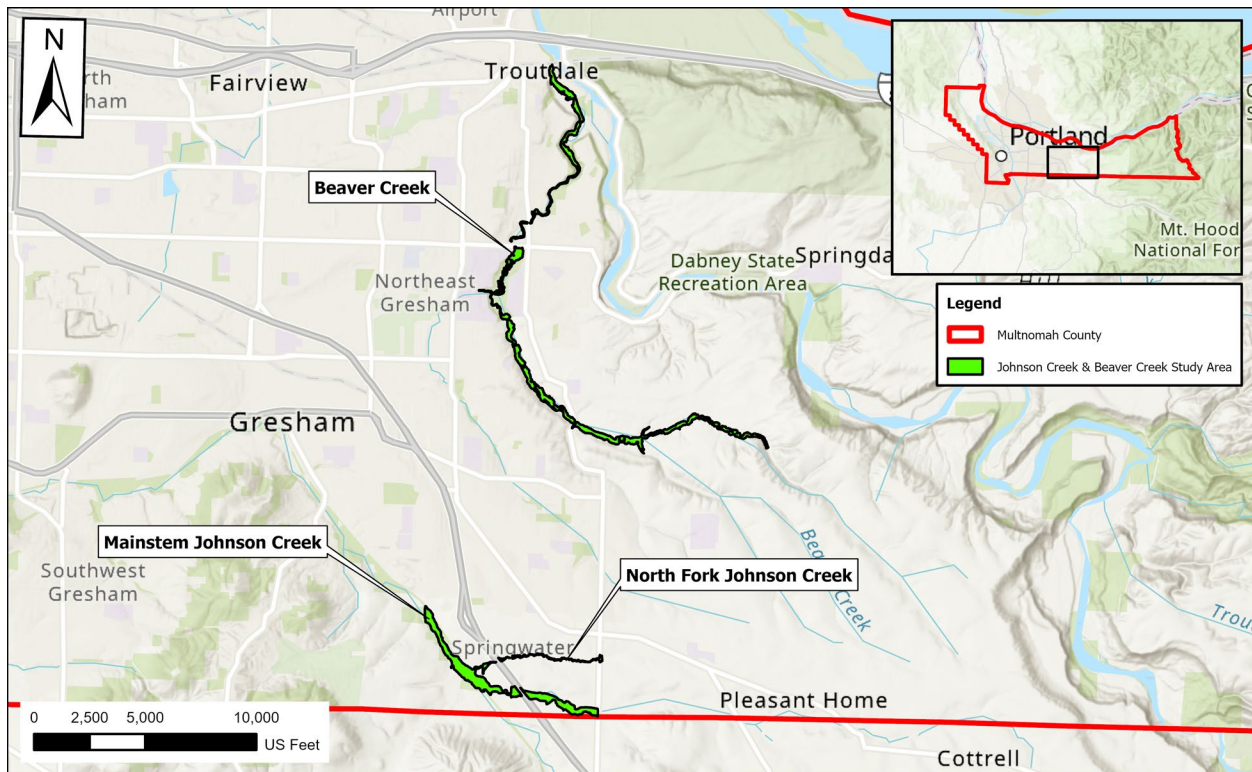


Figure 2-5. Johnson Creek and Beaver Creek Study Areas

2.1.5 UNINCORPORATED AREAS

Unincorporated Areas of Multnomah County include the eastern half and northwestern portion of the County. Additional unincorporated pockets are located along the western and southern edges of the County. Only hydrologic and water quality analysis was completed for these areas to develop tools for predicting peak flow rates at any point within Unincorporated Multnomah County and to find potential opportunities to improve water quality.

2.2 EXISTING STORMWATER INFRASTRUCTURE

The County owns and maintains stormwater infrastructure that includes pipes, manholes, underground injection controls (UICs), inlets, culverts, ditches, and stormwater facilities. Stormwater infrastructure is primarily installed along County-owned roadways but, in places, integrates with City owned infrastructure. Majority of the County owned infrastructure is contained within the Cities of Troutdale, Wood Village, and Fairview. Additional infrastructure is located in unincorporated pockets including the Dunthorpe-Riverdale area and Green Hills area. The density and adequacy of existing County-owned stormwater infrastructure varies across the County. Known install dates for infrastructure date back to 1957 but could date back farther. In many areas County infrastructure works in conjunction with municipal infrastructure. A summary of existing infrastructure by their detailed area of study is provided below. The existing County-wide storm conveyance system is shown in Appendix 2.

2.2.1 TROUTDALE, FAIRVIEW, AND WOOD VILLAGE (TFW)

TFW is the largest detailed area of study with the greatest amount of County infrastructure. County infrastructure within this area may often work in conjunction with the municipal infrastructure of Troutdale, Fairview, or Wood Village. Among the pipes with recorded install dates, pipes in the area appear to have been installed in the 1950s through 2020s. County stormwater infrastructure in TFW is focused along major collector roads up to principal arterial roads. Approximately 94% of pipes (including culverts) in the area are ≥ 12 inches with about 17% being ≥ 36 inches. About 53% of the pipes in the area are included in the InfoWorks ICM Model analysis. The analysis focused on major trunk lines with pipes ≥ 12 inches, with 27% of the modeled pipes being ≥ 36 inches (Figure 2-6).

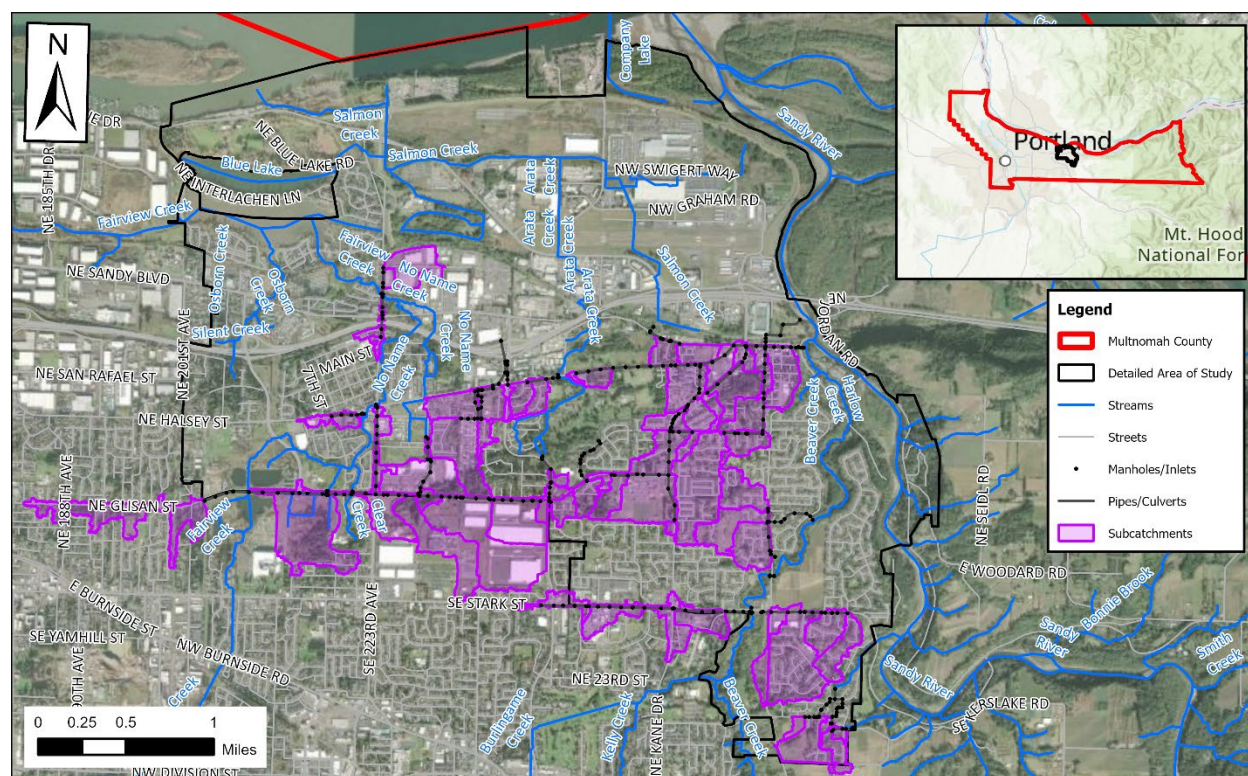


Figure 2-6. Modeled Existing Stormwater System in TFW

2.2.2 GREEN HILLS (GH)

GH is a smaller detailed area of study in a unincorporated, residential area. County infrastructure within this area sometimes work in conjunction with the municipal infrastructure of the City of Portland. Pipes in the area appear to have been installed in the 1950s through 1970s, where install date information is available. County stormwater infrastructure in GH typically occurs along local roads with some occurring on a minor collector and/or minor arterial road. A large portion of drainage in the area occurs via ditches with driveway or roadway culverts. Approximately 71% of pipes (including culverts) in the area are ≥ 12 inches with a maximum pipe size of 36 inches. About 20% of the pipes in the area are included in the InfoWorks ICM Model analysis. The analysis focused on main trunk lines with pipes diameters between 12 inches and 24 inches (Figure 2-7).

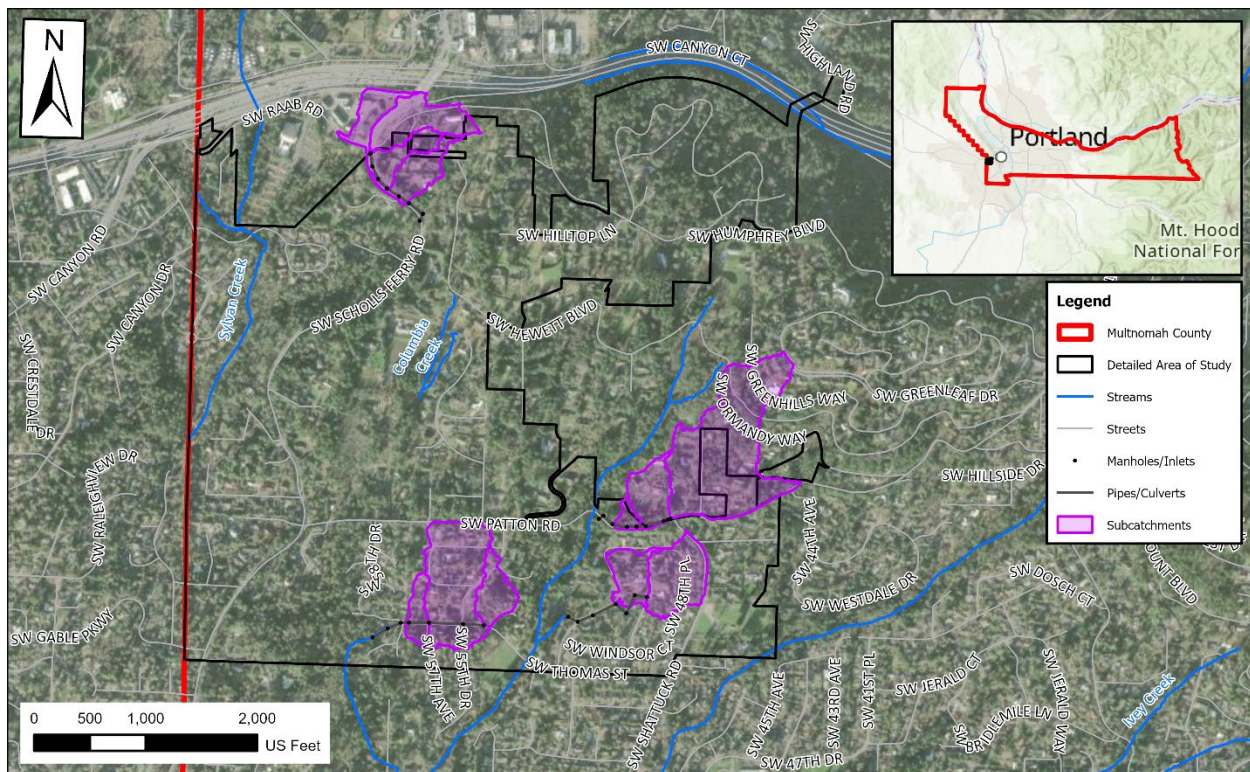


Figure 2-7. Modeled Existing Stormwater System in GH

2.2.3 DUNTHORPE-RIVERDALE (DR)

DR is a smaller detailed area of study in another unincorporated, residential area. County infrastructure within this area sometimes works in conjunction with the municipal infrastructure of the City of Portland. Pipes in the area appear to have been installed in the 1940s through 1990s, according to available records. County stormwater infrastructure in DR typically occurs along local roads with some occurring on a minor collector and/or minor arterial roads. A large portion of drainage in the area occurs via ditches with driveway or roadway culverts. Approximately 55% of pipes (including culverts) in the area are ≥ 12 inches with a maximum pipe size of 36 inches. About 12% of the pipes in the area are included in the InfoWorks ICM Model analysis. The analysis focused on main trunk lines with pipes between 8 inches and 24 inches (Figure 2-8).

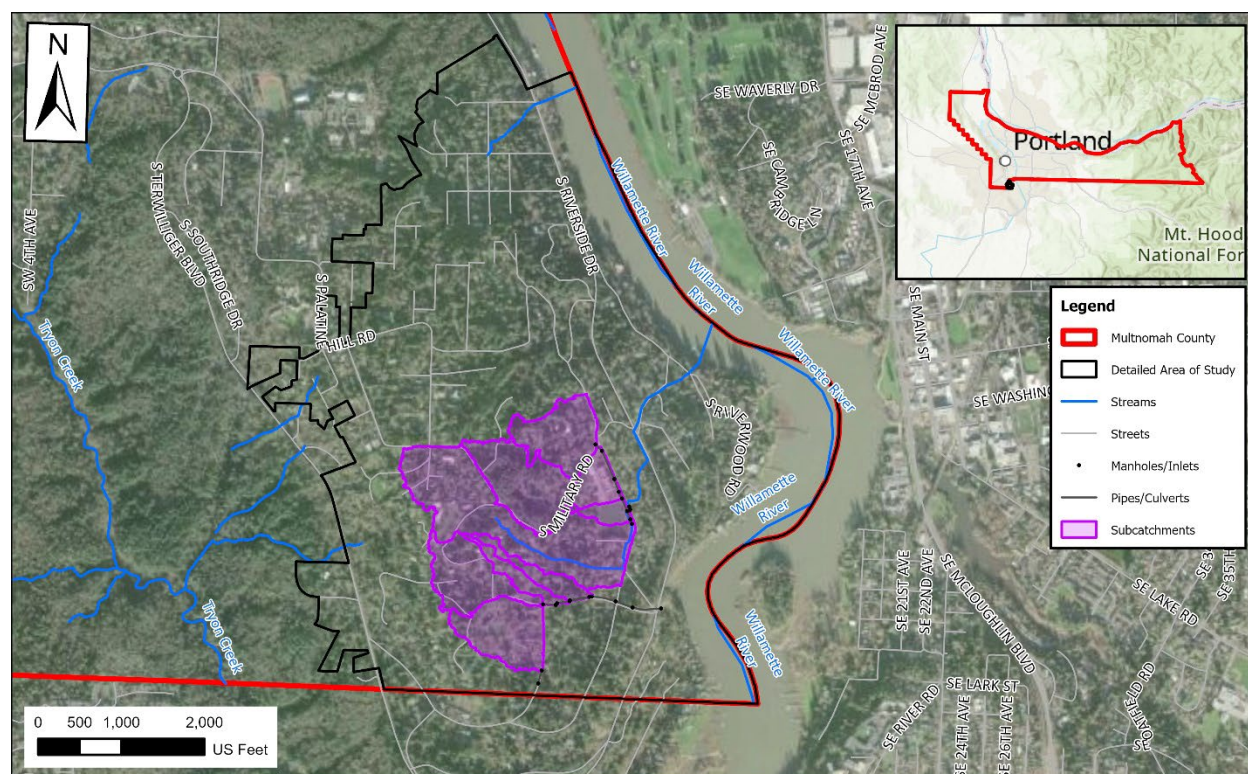


Figure 2-8. Modeled Existing Pipes in DR

2.2.4 UNINCORPORATED AREAS

In the unincorporated areas of the County there are 1,687 culverts according to the County's database. The majority of these culverts connect ditches in these rural areas to move stormwater. Anecdotal evidence from the County indicates that many of these culverts are undersized and may be rusted and in need of repair. The remainder of the culverts, 383, are instream culverts for natural or channelized streams with about 169 of them providing known fish bearing stream conveyance. Culverts outside the detailed study areas of TFW, GH, and DR were not included in the hydraulic modeling. However, available information indicates that many of these culverts may be in poor condition. Therefore, a Capital Project is proposed as part of this SWMP to begin addressing deteriorating culvert conditions, with initial efforts focused on instream culverts. Additional information is provided in Section 6.2.1.

2.3 CLIMATE AND RAINFALL

Multnomah County's climate is characterized by a temperate climate influenced by the Pacific Ocean, with warm, dry summers and mild, wet winters. Average annual rainfall within the County varies based on elevation. At the Willamette River in Portland, average annual rainfall is 39 inches and most of the rain typically occurs during winter storms between November and February. To the east and west of the Willamette River towards the Cascade Mountain Range and Coast Mountain Range, respectively, average annual rainfall increases to over 100 inches, with snowfall becoming dominate in higher elevations during the winter in the Cascades (FEMA, 2019).

Climate change is anticipated to increase rainfall depths and intensities for major recurrence interval storms (Fleishman, 2025). Extreme precipitation event depths (e.g., the rainfall depth during the 10, 50, and 100-year recurrence interval event) are expected to increase 11 to 20 percent, depending on location within Oregon. A transition is also expected from snowpack dominated winter precipitation in the mid- and high-elevations of the Cascades to more frequent rain and rain on snow events. Snowfall across much of Oregon is projected to decrease by 10 to 25 percent (Fleishman, 2025). With less snowpack, the annual peak of water input will shift to earlier in the spring and result in drier summer months. These two factors together are expected to cause wetter winters and drier summers throughout much of the Willamette Valley.

2.4 EXISTING AND FUTURE LAND USE

Existing land use was based on the 2024 National Landcover Database (NLCD) (USGS, 2024). An exhibit showing the existing land use applied to the hydrologic modeling is shown in Appendix 1. Future land use designations were based on comprehensive planning data provided by the County from the 2016 Multnomah County Comprehensive Plan. This data only applied to unincorporated areas; areas outside the limits of the comprehensive plan data was characterized by the same NLCD data used for existing conditions. An exhibit showing the future land use applied to the hydrologic modeling is shown in Appendix 1. A summary of impervious land use for existing and proposed conditions is shown in Table 2-1.

Table 2-1. Existing and Proposed Land Use County-Wide

Area	Total Sq. Mi ¹	Existing Land Use		Proposed Land Use	
		Impervious Sq. Mi	Impervious %	Impervious Sq. Mi	Impervious %
TFW	10.1	4.6	45.7	4.7	46.1
GH	0.7	0.2	27.7	0.2	27.7
DR	1.1	0.3	23.9	0.3	23.9
Unincorporated Areas	263	5.9	2.2	7.3	2.6
County Wide	447	90.1	20.7	91.5	20.5

¹Excludes areas classified as open water

2.5 SOILS AND TOPOGRAPHY

Soil data was extracted from the USDA Web Soil Survey (USDA, 2026) for the entire County. Soil texture varies across the County by location and elevation, with silty- and sandy-loams dominant throughout the valley, with silty loams becoming prevalent in the coast range mountains. Coarser soil is more common in the eastern, undeveloped portion of the County. Hydrologic soil group B soils are most prevalent across the County, with C and D type soils more common in the valley, and type A soils only present in the far east. An exhibit showing the soils data applied to the hydrologic modeling is shown in Figure 2-9. Table 2-2 below summarizes hydrologic soil types in each detailed study area and County wide.

Table 2-2. Hydrologic Soil Groups Summary Table

Area	Hydrologic Soil Group										Total Acres
	A		B		C		D		Other ¹		
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	
TFW	-	-	1,354	20	605	9	4,031	60	769	11	6,760
GH	-	-	-	-	401	86	67	14	-	-	468
DR	-	-	-	-	85	11	516	69	151	20	752
Unincorporated Areas	14,239	8	65,481	36	32,995	18	41,291	23	27,473	15	181,479
County Wide	14,387	5	107,889	36	59,178	20	69,875	24	46,315	15	297,643

¹Includes areas classified as water, pits, or dam

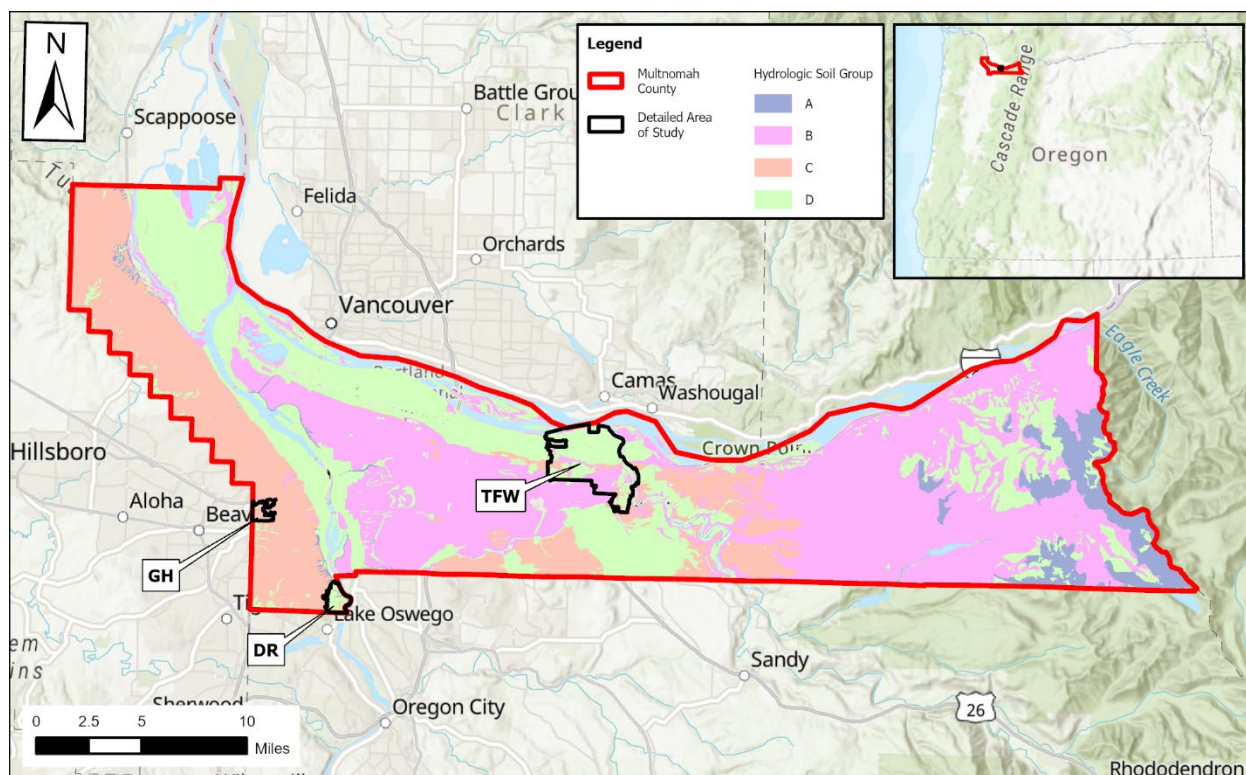


Figure 2-9. Hydrologic Soil Groups

Topography data for the entire County was derived from 1-meter LiDAR data obtained from the Oregon Department of Geology and Mineral Industries (DOGAMI). A composite digital elevation model (DEM) was created to cover the entire County and was used to support all analyses. Generally, the topography in the populated, urbanized center of the County, is relatively flat. The fringes of the County to the west are low elevation mountains called the West Hills, while the eastern half of the County rises to an elevation of 4,740 feet in the foothills of the Cascade Mountains, see Figure 2-10.

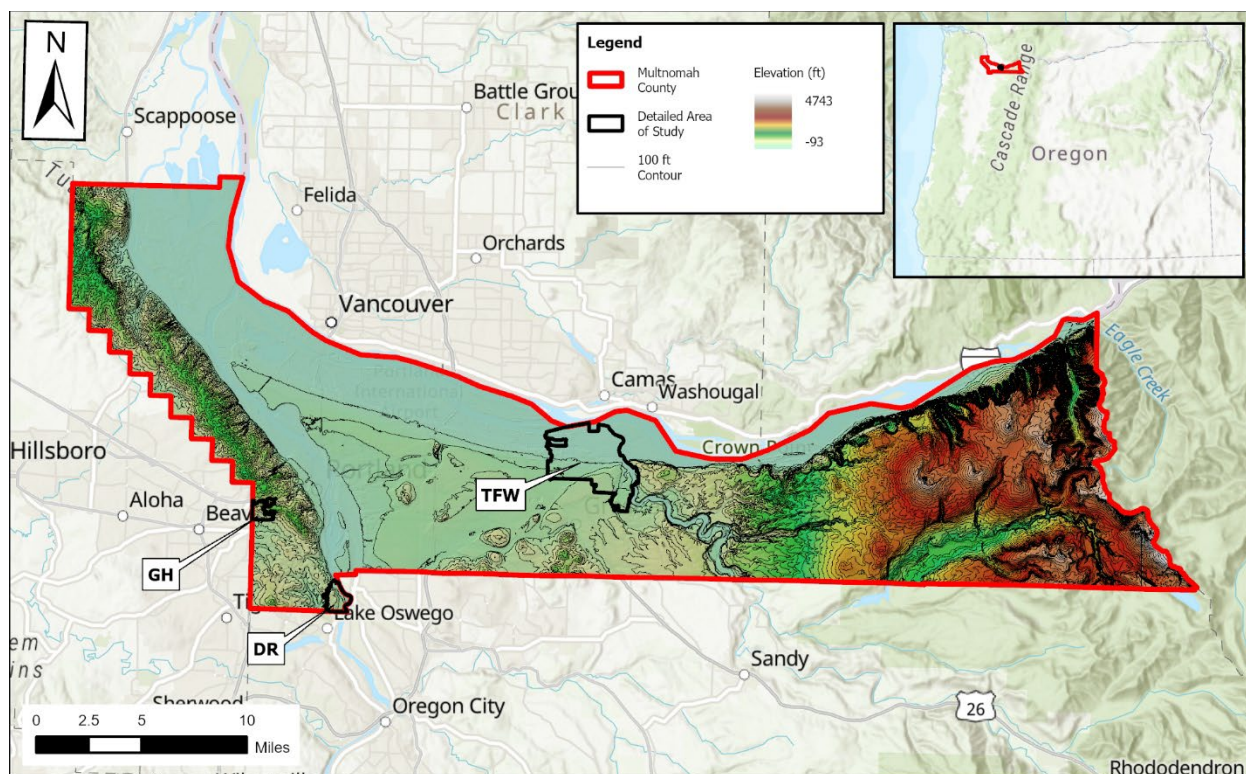


Figure 2-10. Multnomah County Topography

2.6 KNOWN SYSTEM DEFICIENCIES

2.6.1 DATA GAPS

Several data gaps and inconsistencies were found after reviewing publicly available and County-provided data. Observed data gaps were divided into two categories: Data gaps that affect the reliability of this SWMP and data that would be beneficial to begin collecting now for future versions of the SWMP.

Currently Observed Data Gaps

- Existing Stormwater Infrastructure:** Data provided by the County on critical stormwater infrastructure (pipes, culverts, manholes, inlets, etc.) were incomplete, conflicting, or missing important context. The majority of pipes, manholes, and inlets did not include information on invert or sump elevations, dimensions, or elevation datums. When elevation data was available, it frequently conflicted with connected infrastructure. Provided as-built information was also regularly missing a clarification of vertical datum. Additionally, County owned and maintained infrastructure information commonly disagreed with or conflicted with adjacent community GIS information. Several site visits were conducted by DEA and County staff in Winter and early Spring 2026 to reconcile the most critical issues for this analysis, but the majority of the stormwater system still requires a more comprehensive effort. Assumptions were made using engineering judgement where necessary to support the analysis for this SWMP.

GIS information on majority of manholes, inlets, catch basins, and UICs were missing rim and sump elevations, dimensions and/or type (e.g., ODOT Type D Inlet), and the assigned elevation datum (e.g., NAVD88 or NGVD29). Majority of pipes and culverts were missing invert elevations,

diameters, pipe material, length, and the assigned elevation datum. As-built information was provided by the County for certain areas, but much of the provided as-built data was also missing the elevation datum. These data are all critical for accurately assessing the capacity of the existing system.

- **Water Quality:** Water quality sampling data was provided by the County from two surface water quality sampling sites along Beaver Creek, which constitutes the minimum sampling requirements of the County's NPDES permit. The available surface water sampling data is not sufficient to properly characterize water quality spatially or temporally across urban areas of the County. Additional data was also provided from approximately 200 underground injection controls (UICs) sampled by the City of Gresham. No data was provided for unincorporated areas west of downtown Portland or east of the Sandy River. Many water quality constituents are sampled; however, 6ppd-quione is only sampled at 2 UICs. This constituent will likely become increasingly important to sample due to its toxicity to salmon.

Future Data Collection Considerations

- **Stormwater Infrastructure:** Collecting accurate elevation and physical information on existing and future stormwater infrastructure will increase the efficiency and accuracy of future stormwater master planning efforts. It will ensure that future conceptual solutions are designed using correct and up-to-date information. A full survey or review is recommended to confirm or update existing information and to produce a complete and accurate database of stormwater infrastructure (pipes, culverts, inlets, and manholes) managed by the County moving forward. The survey and review should prioritize trunklines and critical stormwater infrastructure. A process for updating the GIS database upon completion of future stormwater projects is also recommended to ensure data remains correct and up to date.
- **Water Quality:** Expanding water quality data collection, collaborating with other stakeholders within the County, and developing strict data screening procedures would create a more robust water quality database for the County to use in estimating pollutant loads, classifying stormwater runoff, completing calculations to support NPDES permits, and discovering problem areas. Additionally, expanding data collection for 6ppd-quione would allow more targeted installation of stormwater facilities to minimize exposure to salmon-bearing streams. Additional discussion is included on future data collection in Section 6.2.1 and Appendix 5.

2.6.2 FLOODING AND STORMWATER QUANTITY ISSUES

The County provided a dataset of flooding locations reported by the public. The cause of the flooding issue was not always reported or clear and could be due to either capacity issues or maintenance issues. Additionally, the County provided maintenance logs for stormwater infrastructure that includes both routine and emergency inspection and maintenance. Data points for these two data sets are distributed both within the detailed study areas and across unincorporated areas (see Figure 2-11).

Part of the analysis conducted for this SWMP included a public survey to the residents of Multnomah County requesting input from the public regarding observed stormwater issues. A total of 6 responses were collected from the survey, 4 of which were related to stormwater issues. Online Survey response locations can be seen in Figure 2-11.

County Maintenance staff have also identified eight locations within the detailed study areas that have had flooding issues, four are located in TFW, three in DR, and one in GH.

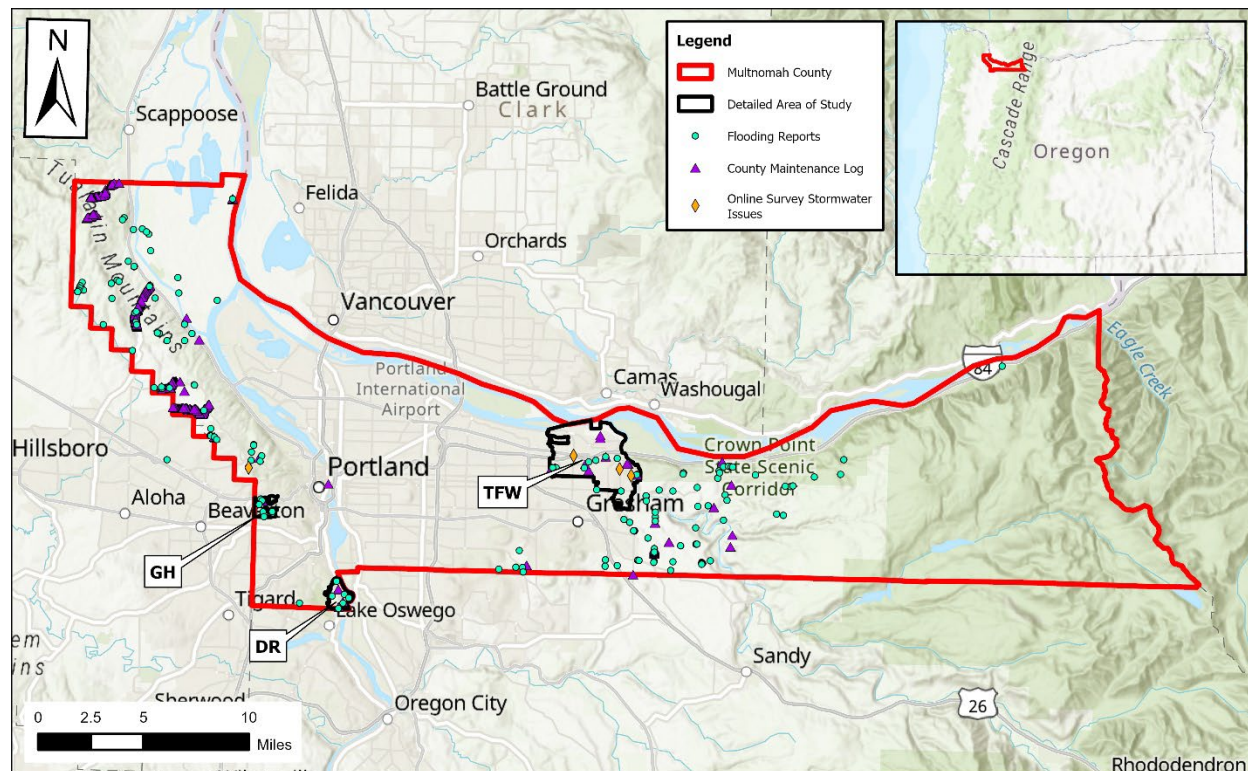


Figure 2-11. Known Flooding Locations

2.6.3 STORMWATER QUALITY ISSUES

There are currently seven Total Maximum Daily Load (TMDL) Waste Load Allocations (WLAs) designated for water bodies within the County, which are summarized in Table 2-3. These pollutants are anthropogenically introduced to aquatic ecosystems through stormwater runoff during and after storm events. These pollutants impair water quality in receiving waters and impact aquatic and terrestrial species. The 2016 Multnomah County Comprehensive Plan indicates increased urbanization and development within the County is anticipated to exacerbate pollutant loading to receiving waters.

Beyond the enacted TMDLs, Multnomah County has identified pollutants of concern in their service area, as outlined in the 2014 Stormwater Retrofit Strategy (Multnomah County, 2014). All the water bodies listed in Table 2-4 also support Endangered Species Act (ESA) listed salmonids or other aquatic species sensitive to urban stormwater pollutants, including Coho and Chinook Salmon, Steelhead, Coastal Cutthroat Trout, Pacific Lamprey, and White Sturgeon.

One pollutant of particular and recent concern is 6PPD-quinone (6PPD-q), which is a chemical byproduct produced by the breakdown of car and truck tires that has been linked to Coho Salmon and other salmonid mortality (Tian et al., 2021). 6PPD-q enters waterways via stormwater runoff from roads and highways. The County has expressed interest in monitoring and controlling 6PPD-q and that stormwater best management practices (BMPs) installed in the future should be effective at removing it.

Table 2-3. TMDLs in Multnomah County

TMDL	Pollutants
Final Revised Willamette Basin Mercury TMDL/WQMP (2019-DEQ)	Total mercury
TMDL for Mercury in the Willamette Basin, OR (2019-EPA)	Total mercury
Willamette Basin Mainstem Bacteria TMDL (2006)	E.coli
Willamette Basin TMDL: Lower Willamette Subbasin (2006)	E.coli, DDT
Columbia Slough TMDLs (1998)	E.coli, DDT/dieldrin/PCBs/dioxin (via Total Suspended Solids), lead, Dissolved Oxygen (via Biochemical Oxygen Demand), chlorophyll a/pH (via Total phosphorous)
Sandy Basin TMDL (2005)	E.coli
Tualatin TMDL (2012)	Bacteria, Chlorophyll a (via Total Phosphorous), Dissolved Oxygen, pH

Table 2-4. Pollutants of Concern by Permit Area and Water Body
(adapted from Multnomah County, 2014)

Permit Area Name	Drainage Basin	Sub-Basin	Water Bodies	Pollutants of Concern
NW Portland – Unincorporated Pocket Area (Skyline Blvd)	Tualatin	Rock Creek	Bronson Creek, Beaverton Creek, Rock Creek	Temperature, Bacteria, DO, pH, chlorophyll, (nitrogen and phosphorus)
SW Portland – Unincorporated Pocket Area (Dunthorpe)	L. Willamette	*Tryon Creek L. Willamette	*Tryon Creek Willamette River	Temperature, Metals (Mercury)
SW Portland – Unincorporated Pocket Area (Scholls Ferry Rd, Patton Rd)	Tualatin	*Fanno Creek L. Willamette	*Fanno Creek Beaverton Creek	Temperature, Bacteria, DO, pH, Chlorophyll, (nitrogen and phosphorus)
Interlachen Residential Area	L. Willamette	Columbia Slough	Columbia Slough	Metals (Lead, Mercury), Organic Toxins (DDT, PCB, 2,3,7,8 TCDD), DO, pH, Chlorophyll
	L. Willamette	Fairview Creek	Fairview Creek	Temperature, Bacteria
Arterial Roadways in Wood Village, Fairview, and Troutdale	L. Willamette	Columbia Slough	Columbia Slough	Metals (Lead, Mercury), Organic Toxins (DDT, PCB, 2,3,7,8 TCDD), DO, pH, Chlorophyll
	L. Willamette	Fairview Creek	Fairview Creek	Temperature, Bacteria
	Sandy	Beaver Creek	Beaver Creek	Temperature, Bacteria
	Sandy	Sandy River	Gordon Creek	Temperature, Bacteria
SE Portland – Unincorporated Pocket Area (Between Portland and Gresham)	L. Willamette	Johnson Creek	Johnson Creek	Temperature, Metals (Mercury), Bacteria, DDT

*Areas are covered by intergovernmental agreements with other jurisdictions

The County currently operates and maintains 205 stormwater BMPs that treat runoff within the County ROW. These include those listed in Table 2-5. Eighty-five BMPs are installed on or near bridges over the Willamette River in downtown Portland and at Sauvie Island, 118 BMPs are in the TFW area, and the remaining 2 are located on the southern County border near the intersection of 282nd and Stone Road.

Table 2-5. Types of Stormwater BMPs Current Operated by Multnomah County

Stormwater BMP Type	Current Number Operated by County
Stormwater Filter	81
Underground Injection Controls	57
Water Quality Planter	37
Curb Inlet Facility	10
Bioretention Area	6
Infiltration Trench	4
Sediment Manhole	3
Detention Vault	2
Pollution Control Manhole	2
Water Quality Swale	2
Infiltration Pond	1

Stormwater BMPs are absent in many areas, and there are opportunities along higher average daily traffic (ADT) roads and truck routes to install additional facilities. Several high-traffic corridors with major outfalls to Beaver Creek, Fairview Creek, and other water bodies lack any stormwater BMPs. Locations at stream-road intersections would benefit from installation of BMPs to limit stormwater pollution directly adjacent to receiving waters. Additionally, several existing BMP types focus on sedimentation as the primary pollutant removal mechanism and therefore lack the ability to effectively remove 6PPD-q and other pollutants that require filtration, infiltration, or chemical adsorption as a removal mechanism. These BMPs include pollution control manholes, detention vaults, and sediment manholes and can be modified, replaced, or retrofitted to improve treatment.

3 STORMWATER QUANTITY ASSESSMENT

The purpose of the stormwater quantity assessment is to evaluate the performance of the existing stormwater infrastructure under Existing and Future conditions and identify areas with insufficient conveyance capacity. The results are used to identify problem areas and evaluate proposed improvements for the Capital Improvement Projects discussed in Section 6.2.

The assessment includes a hydrologic analysis, a hydraulic analysis, and an evaluation of stormwater quantity results for the following three scenarios:

- Existing Condition = Existing infrastructure + current climate
- Future Condition = Existing infrastructure + future land use + climate change
- Proposed Condition = Proposed improvements + future land use + climate change

3.1 HYDROLOGIC ANALYSIS

The hydrologic analysis is done to determine the volume, peak rate, and timing of stormwater runoff generated within the study area for both current and future climate conditions. These estimates provide the runoff inputs needed for the hydraulic model to evaluate the conveyance capacity and performance of the stormwater infrastructure. The following paragraphs outline the technical approach, design storms, subbasin delineation, runoff curve numbers, and times of concentration for the hydrologic analysis.

3.1.1 TECHNICAL APPROACH

Detailed Study Area Analysis

Hydrologic calculations were completed to analyze the capacity of existing and proposed storm infrastructure for detailed study areas (TFW, DR, GH). Subbasins were delineated at major junctions along County-owned stormwater infrastructure, and the hydrologic characteristics of each subbasin were determined. The design storms described in Section 3.1.2 were used as rainfall inputs. Runoff losses were calculated using the Natural Resources Conservation Service Curve Number methodology presented in Technical Release 55 (TR-55), as described in Section 3.1.4. Excess rainfall was then transformed into runoff hydrographs using the Santa Barbara Urban Hydrograph method, which relies on the subbasin time of concentration described in Section 3.1.5. The resulting runoff hydrographs and peak flows were used to characterize hydrologic inputs to the ICM model.

Unincorporated Area Analysis

Hydrologic analysis was also performed for the unincorporated areas of Multnomah County to develop geospatial data that can be used to estimate peak flows anywhere in the County to aid in planning or emergency infrastructure repairs. This analysis was completed for Existing and Future conditions due to climate change. Peak flow data for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events were calculated using USGS Regional Regression equations (Cooper, 2005). These equations estimate peak flows for a subbasin based on topographic and climatic data and output from these equations were summarized in raster layers that can be viewed using GIS programs such as ArcGIS Pro.

Topography data for the County was obtained from DOGAMI and used to delineate subbasins draining to major junctions in the natural drainage system. 130 subbasins were delineated that cover nearly all the County unincorporated areas, with 99 of the subbasins located east of the Sandy River and 31 located in

the northwest portion of the County. The regression equations require 5 variables: subbasin area (mi²), mean subbasin slope (degrees), mean minimum and mean maximum January temperatures (°F), and the 2-year, 24-hour precipitation depth (inches). Subbasin area and mean subbasin slope were computed in ArcGIS Pro; mean minimum and mean maximum January temperature, and the 2-year, 24-hour precipitation were extracted from ODOT TransGIS data and computed as a subbasin-averaged values.

Once subbasin peak flows were computed for each recurrence interval, the result was scaled to subbasin area by dividing the peak flow by the subbasin area. These values were then multiplied by a flow accumulation raster to compute peak flow on a cell-by-cell basis. This process was repeated to compute peak flows for Future Conditions by increasing the 2-yr 24-hr precipitation depth 15%. The resulting peak flow accumulation rasters are provided as digital files for County staff to estimate peak flows throughout the County.

Infiltration and UIC Suitability Analysis

Analyses were completed County-wide to determine the infiltration capacity of soils and the suitability for installing underground injection controls (UICs) to provide stormwater quantity control. The County currently owns and operates 49 UICs, based on County GIS data. Data on pertinent soil infiltration capacity characteristics, including soil saturated hydraulic conductivity, depth to soil restrictive layers, and infiltration system suitability ratings were acquired from the USDA Web Soil Survey (USDA, 2026). Suitability for UICs was determined by executing a screening procedure using collected soil and topographic characteristics that generally follows the requirements of the Section 2.2.2 of the 2025 Portland Stormwater Management Manual (City of Portland Bureau of Environmental Services, 2025). Areas were given a rating of Good, Moderate, or Poor, depending on adjacent ground slope, saturated hydraulic conductivity, depth to groundwater, and depth to a restrictive layer.

Groundwater well log data retrieved from the Oregon DEQ and data from the USGS Estimated Depth to Groundwater Mapper were used to corroborate the calculated suitability ratings. The depth to groundwater from approximately 800 wells were compiled and compared to the suitability ratings, and then manually checked against USGS data. The intent was to determine if areas with greater average depth to groundwater received a higher suitability rating (UICs are more appropriate in areas with deeper groundwater). Generally, this trend was well observed in areas with “Good” or “Moderate” ratings, and provided a level of confidence in the suitability ratings. Overall, UIC suitability was rated as Poor to Moderate across TFW and rated Poor in DR and GH; however, there were some areas in TFW rated as “Good” that may be appropriate for constructing UICs. An exhibit showing infiltration suitability can be found in Appendix 1.

3.1.2 DESIGN STORMS

Detailed Study Area Analysis

Rainfall depths from the PRISM Climate Group at Oregon State University (PRISM, 2014), via the ODOT TransGIS portal, were used in the analysis. Depths associated with the 2-year through 100-year, 24-hour design storm event were input into InfoWorks ICM with a Type 1A intensity pattern using the SCS Unit Hydrograph Model method to produce runoff hydrographs. Rainfall data was extracted from the centroid of each detailed study area. Table 3-1 shows the rainfall values used in the analysis.

Table 3-1. Present Rainfall Depth for 24-Hour Duration Design Storm Events

Area of Study	Depth (inches)					
	2-year	5-year	10-year	25-year	50-year	100-year
GH	2.53	2.98	3.39	3.94	4.36	4.78
DR	2.32	2.74	3.13	3.64	4.03	4.44
TFW	2.27	2.68	3.05	3.54	3.92	4.30

In addition to Existing rainfall conditions, Future rainfall conditions were modeled to account for climate change. Multnomah county exists between two similar ecoregions, Willamette Valley and Cascades. Late Century (2075-2100) projections (Fleishman, 2025) and coordination with County Staff indicate a 1.15 multiplier is appropriate to calculate future rainfall depths across the recurrence intervals being considered. Table 3-2 shows the future rainfall depths used in the analysis.

Table 3-2. Future Rainfall Depth for 24-Hour Duration Design Storm Events

Area of Study	Depth (inches)					
	2-year	5-year	10-year	25-year	50-year	100-year
GH	2.91	3.43	3.90	4.53	5.01	5.50
DR	2.67	3.15	3.60	4.19	4.63	5.11
TFW	2.61	3.08	3.51	4.07	4.51	4.95

Unincorporated Area Analysis

Peak flow raster calculations for the unincorporated area analysis described above in Section 3.1.1 were dependent on only the 2-year, 24-hour rainfall depth. This was extracted from ODOT TransGIS rainfall data using the centroid of each delineated subbasin. The 2-year, 24-hour rainfall depth was also increased 15% to account for climate change.

3.1.3 SUBBASIN DELINEATION

The area that drains to the stormwater system was identified and subdivided into subbasins to determine drainage areas at important locations along the stormwater system. Subbasin delineation for both the detailed study area analysis and the unincorporated analysis was completed using a semi-automated routine in ArcGIS Pro. This relied on topography information obtained from the USGS LiDAR Explorer and/or DOGAMI.

Subbasins were delineated primarily to major manholes that represent junctions along County-owned stormwater lines for detailed study areas. Additional subbasins were delineated near the upstream end of each line to assess pipes 12 inches in diameter or greater and to prevent unrealistic backwater conditions. Areas draining to segments that only contained pipes smaller than 12 inches in diameter were incorporated into larger subbasins that drained to a point further downstream where pipe diameters are 12 inches or larger. Additionally, areas draining to UICs that did not connect to downstream stormwater pipes were not included in the analysis and assumed to be standalone facilities. Subbasins were edited after initial delineation where necessary to match field conditions, critical pipe junction locations, and discussions with County staff.

3.1.4 RUNOFF CURVE NUMBERS

Runoff curve numbers (CNs) for each delineated subbasin for the detailed study area analysis were computed using ArcGIS Pro based on land use and underlying soil conditions. Land use was extracted from

2024 NLCD data and hydrologic soil group data was obtained County wide from the USDA Web Soil Survey (USDA, 2026). Composite CNs were calculated for each subbasin by first computing the area of each unique soil HSG and land use and assigning a representative CN from Table 3-3, which is based on guidance provided in TR-55.

Table 3-3. Runoff Curve Numbers by Land Use and Hydrologic Soil Group

Land Use Description	NLCD Gridcode	Hydrologic Soil Group			
		A	B	C	D
Open Water	11	100	100	100	100
Developed, Open Space	21	51	68	79	84
Developed, Low Intensity	22	61	75	83	87
Developed, Medium Intensity	23	75	84	89	91
Developed, High Intensity	24	89	92	94	95
Barren Land (Rock / Sand / Clay)	31	77	86	91	94
Deciduous Forest	41	25	55	70	77
Evergreen Forest	42	25	55	70	77
Mixed Forest	43	25	55	70	77
Shrub / Scrub	52	39	61	74	80
Grasslands / Herbaceous	71	30	58	71	78
Pasture / Hay	81	39	61	74	80
Cultivated Crops	82	64	75	82	85
Small Grains	83	39	61	74	80
Urban/Recreational Grasses	85	39	61	74	80
Woody Wetlands	90	30	55	70	77
Emergent Herbaceous Wetlands	95	49	69	79	84

3.1.5 TIME OF CONCENTRATIONS

The time of concentration (T_c) represents the time it takes water to travel from the most distant point in the subbasin to the subbasin outlet. The T_c influences the timing and magnitude of the peak flow. T_c values were determined for each subbasin delineated as part of the detailed sub area analysis by first delineating the longest flow path based on a flow accumulation raster that generated stream lines. The flow path was then divided into areas of sheet flow, shallow concentrated flow, and open channel flow. Sheet flow was limited to 100 feet (NRCS, 2008) and followed by shallow concentrated flow, where appropriate. Flow in roadside ditches was assumed to be shallow concentrated flow unless water was visible in aerial imagery. Flow in pipes or streams was classified as open channel, and travel time was computed using an assumed channel velocity.

For the detailed subarea analysis, the delineated subbasins, CNs, and T_c s were used as input into the InfoWorks ICM model described in Section 3.2 to compute peak flows during each recurrence interval storm event.

3.2 HYDRAULIC ANALYSIS

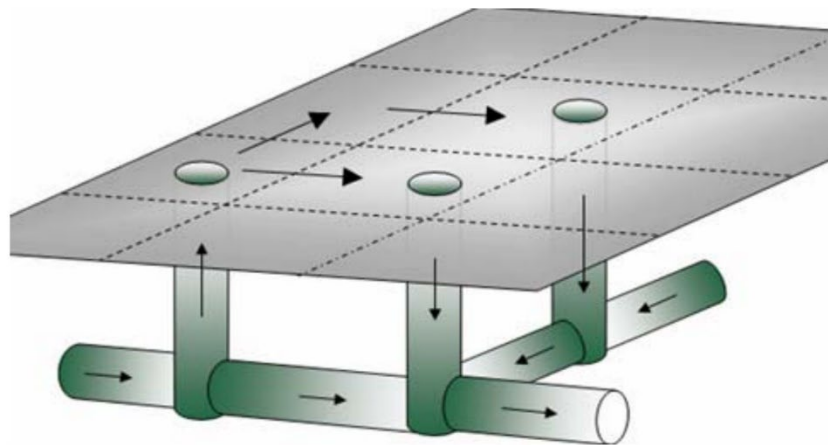
The hydraulic analysis utilizes the runoff inputs developed in the hydrologic analysis to simulate flow under the Existing, Future, and Proposed Conditions. The analysis evaluates system performance, identifies infrastructure with insufficient conveyance capacity, and outlines the extent and severity of flooding under each model scenario. The section includes a discussion of the technical approach, one-dimensional (1D)

modeling of the storm pipe network, two-dimensional (2D) modeling of surface flows, boundary conditions, and verification of model results.

3.2.1 TECHNICAL APPROACH

Detailed Study Area Analysis

A coupled 1- and 2-dimensional (1D/2D) hydraulic model was used to evaluate flow conveyance and flooding across the three study areas within the County. Autodesk InfoWorks ICM (version 2026.1.0) was used to perform this analysis. Dynamic modeling allows for consideration of the effects of storage, backwater in conduits and floodplains, and the timing of the hydrographs to yield a more realistic representation of hydraulic conditions. InfoWorks ICM can model flow over the ground surface using 2D flow, while linking to the subterranean stormwater system with a 1D analysis. The result is a comprehensive model that can dynamically communicate between the surface and stormwater pipes. Figure 3-1 provides a schematic of how a 1D/2D model is configured. Hydraulic analyses were completed for both the Existing, Future, and Proposed Conditions using this modeling setup. The InfoWorks ICM input and results can be found in Appendix 2.



*Figure 3-1. Graphic Representation of 1D/2D Surface/Subsurface Model
(from Barnard et al., 2007)*

North Fork and Mainstem Johnson Creek

The effective 1D HEC-RAS models for Johnson Creek and North Fork Johnson Creek were obtained through a FEMA data request in October 2025. The effective models were used to assess whether areas of flooding could be improved by infrastructure improvements. The effective hydrology was updated to include the 2-year and 25-year recurrence interval peak flows. These peak flows were interpolated using the effective peak flow hydrology for the 10-, 50-, 100-, and 500-year recurrence intervals. Peak flows were scaled to account for future climate change by increasing peak flows 15% to represent Future Conditions.

Additionally, a qualitative analysis of effective floodplains along Beaver Creek and Kelley Creek in Troutdale was done to identify ways to reduce flooding and/or address other issues.

3.2.2 1D MODEL FOR STORM PIPE NETWORK

As-built data and shapefiles showing existing stormwater pipes and manholes were provided by the County. After a thorough review of the data quality, this information was imported into the InfoWorks ICM model to create 1D elements representing existing pipes and manholes. For the three detailed areas of study, existing main trunk lines with pipes larger than 12-inches were included. Occasionally smaller diameter connector pipes were included where necessary to maintain flow connectivity. Existing pipes included in the hydraulic modeling can be viewed in Figure 2-6, Figure 2-7, and Figure 2-8; more detailed figures are provided in Appendix 2.

Physical characteristics for many pipes and structures were missing, and assumptions were made to assign values for pipe diameters, inverts, etc., where necessary to create a complete 1D network. The following assumptions were used in sequence to assign missing characteristics:

1. Pipe inverts were compared to adjacent pipes (where possible); elevations were set to provide 0.1 feet of drop toward the downstream pipe.
2. If no adjacent inverts were available, pipe inverts were calculated from the DEM by subtracting 60 inches from the surface elevation to estimate the pipe invert.
3. After that, pipes were adjusted to have a minimum of 2 feet of cover (first adjusting only the ones that have less than 2 feet of cover)
4. Adverse slopes were corrected to be a minimum of 0.5% (0.005 foot/foot) in the downstream direction
5. Drops were allowed to occur in the downstream direction
6. A maximum pipe slope of 5% was used for pipes exceeding this slope, with the downstream top of pipe held to a minimum of 2 feet of cover.

During the data-entry process, it was determined that the County historically used the NGVD 29 vertical datum but transitioned to NAVD 88 relatively recently. The exact date of this transition could not be confirmed due to staff retirements and the absence of supporting documentation; however, it likely occurred within the past 10 years.

Following the assumptions described above, pipes with known invert and rim elevations were reviewed to determine whether the elevations were already referenced to NAVD 88 or were referenced to NGVD 29 and required conversion. Elevations determined to be in NGVD 29 were converted to NAVD 88 by adding 3.389 feet. Datum assignments were informed by as-built information obtained from the County, the City of Gresham, and the City of Troutdale; installation dates; GIS import dates; and a review of the modeled pipe network for unrealistic pipe depths, large elevation drops, and apparent adverse slopes that were resolved by applying the datum conversion.

Following the initial Existing Conditions model runs, locations that relied on substantial assumptions and exhibited flooding were identified for field assessment by County or DEA staff. Field assessments were also conducted at locations where the infrastructure attributes still displayed unusual conditions, such as adverse pipe slopes or reductions in pipe diameter in the downstream direction. These field visits represented a significant data verification effort that included locating stormwater infrastructure, confirming pipe and flow directions, observing pipe diameters, and measuring the depths from structure rims to pipe inverts. The information collected during the field visits was used to update and refine the modeled infrastructure attributes.

3.2.3 2D MODEL FOR SURFACE FLOWS

The 2D model domain in InfoWorks ICM relies on topographic data, a computational mesh, and connections to the 1D stormwater model domain. Topography was represented in the model by a 3-foot resolution DEM using data retrieved from the DOGAMI. The DEM and associated 10-foot elevation contours are shown in Figure 3-2 for GH as an example. All elevations reference the North American Vertical Datum of 1988 (NAVD88).

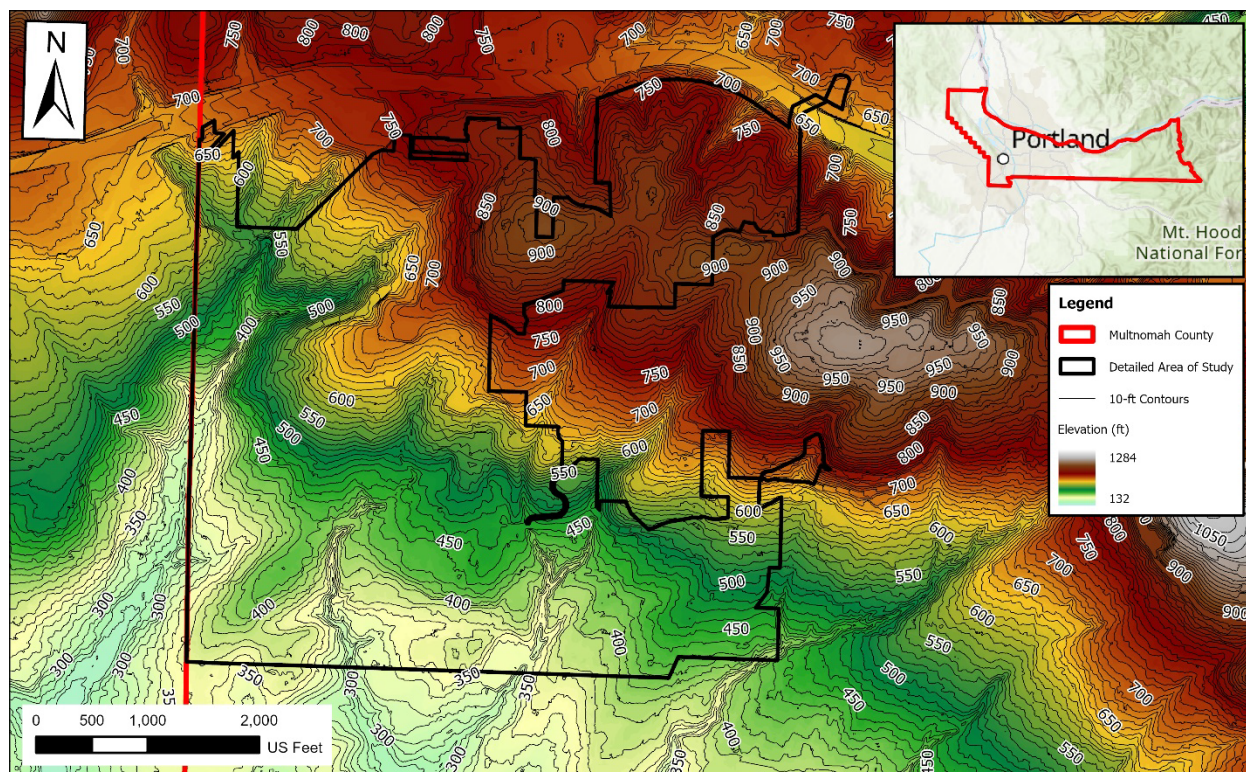


Figure 3-2. GH DEM and 10-foot Elevation Contours

Computational mesh resolution is an important consideration in 2D modeling. Small mesh element size increases accuracy but requires additional computational effort; larger mesh element size reduces computational effort, but reduces accuracy. Multiple element sizes can be specified within one InfoWorks ICM model, allowing a larger mesh size to be used in areas where conditions are expected to be similar from one element to the next and/or high level of detail is not required for an accurate model result, such as areas with flat topography. A smaller mesh size should be used in primary areas of interest, where depth and velocity are expected to vary over short distance, or where topography changes rapidly. The mesh size specified in this study was intended to replicate the hydraulic behavior of the drainage watershed. It is recommended to have major 2D surface flow paths (such as streets, open channels) to be represented by at least three to five elements. This study used a dynamic 500-square foot maximum mesh element area size that decreased in size where topography rapidly changes, to a minimum element size of 5-square feet. This variable mesh element size approach resulted in a balance of computational efficiency and accuracy to adequately reflect conveyance within the County, while also capturing enough detail for appropriate hydraulic routing to 1D elements. An example of the mesh size resolution is shown in Figure 3-3.

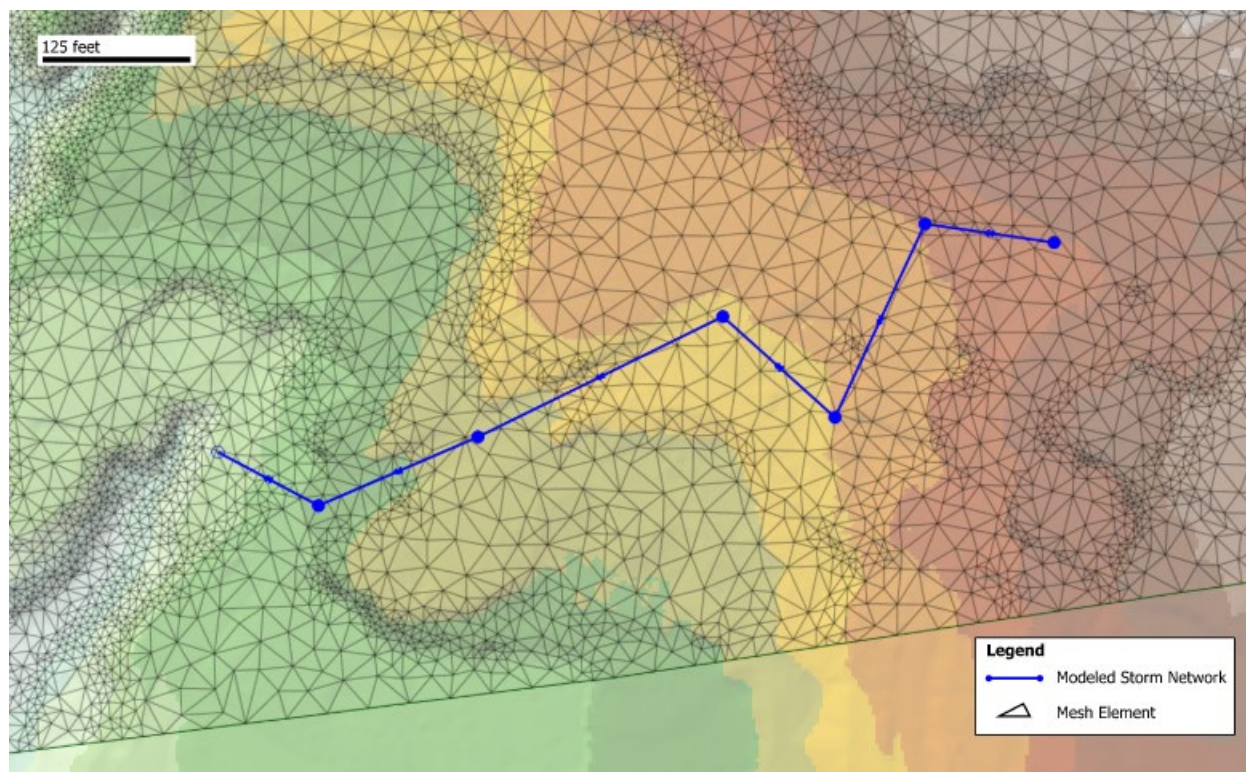


Figure 3-3. Example of 2D Mesh Element Resolution in GH

3.2.4 BOUNDARY CONDITIONS

Boundary conditions define how flow enters, exits, or interacts within the hydraulic model. Inflow boundary conditions represent external flow entering the model, in this case, rainfall. Outflow boundary conditions define how water leaves the system; in this model this could occur at a 1D pipe network outfall or at the 2D mesh boundary. Internal boundary conditions can define known flows, water levels, or hydraulic controls applied at locations within the model to assist in realistically simulating how water moves through the system; internal boundary conditions were applied to manholes within this model.

Hydrographs from the hydrologic analysis were applied to subbasins and input at discrete 2D points, node locations (manholes), or the upstream end of culverts to accurately capture the input of runoff throughout the County (as shown on Figure 3-1). In one case of five culverts crossing under Glisan Street in TFW the subbasin outflow was applied to the 2D mesh to then be more realistically collected by the culvert inlets.

Within the model, manholes were modeled to allow flow exchange between the 1D network and 2D mesh to simulate flooding out of the manholes. The 1D-2D linkage basis for these nodes was set to "Depth" with the other option being "Elevation". This defines that the exchange of flow at the node is determined by the depth of water relative to either the 1D node or to the 2D mesh element to determine the head difference. Setting it to "depth" was useful in this case since slight data discrepancies between rim elevations (1D ground levels) and mesh elevations (2D ground levels) would be ignored.

Modeling ended at the downstream end of trunklines where they either flowed outside the County's sphere of influence or into, ditches, streams, or rivers that then discharge at the edge of the 2D mesh. Downstream boundary conditions for these locations were set to outfall with or without considering flow onto the 2D mesh, depending on location and DEM quality. 2D outfall locations were modeled using a mesh boundary

type of “normal condition” as the downstream boundary condition. At 1D outfall locations water freely flows out from the system based on a normal depth condition. 1D outfalls were used where DEM quality was poor and outfalling to the mesh elevation did not work based on the known or estimated outfall invert.

3.2.5 VERIFICATION OF MODEL RESULTS

Model results were verified by cross-referencing locations with model-simulated flooding (Figure 2-11) with anecdotal input from County Maintenance staff. No high-water mark or gage information was available from the County.

Figure 3-4 and Figure 3-5 highlight locations where anecdotal data from County Maintenance staff have confirmed the presence of flooding issues in these locations as well as public reports of flooding in the area.

Anecdotal Evidence - Figure 3-4:

- County Maintenance staff have reported flooding issues along SW Cherry Park Road and its junction with Buxton Road and SE Sandy Avenue as well as a report of stormwater quality issues collected from the public as part of the online survey conducted during the development of this SWMP (Note 1 in figure).
- County Maintenance staff have reported flooding issues where W Historic Columbia River Highway crosses under the railroad (Note 2 in figure).
- Public reporting indicates flooding at the intersection of SW 257th Drive and E Columbia River Hwy (Note 3 in figure).

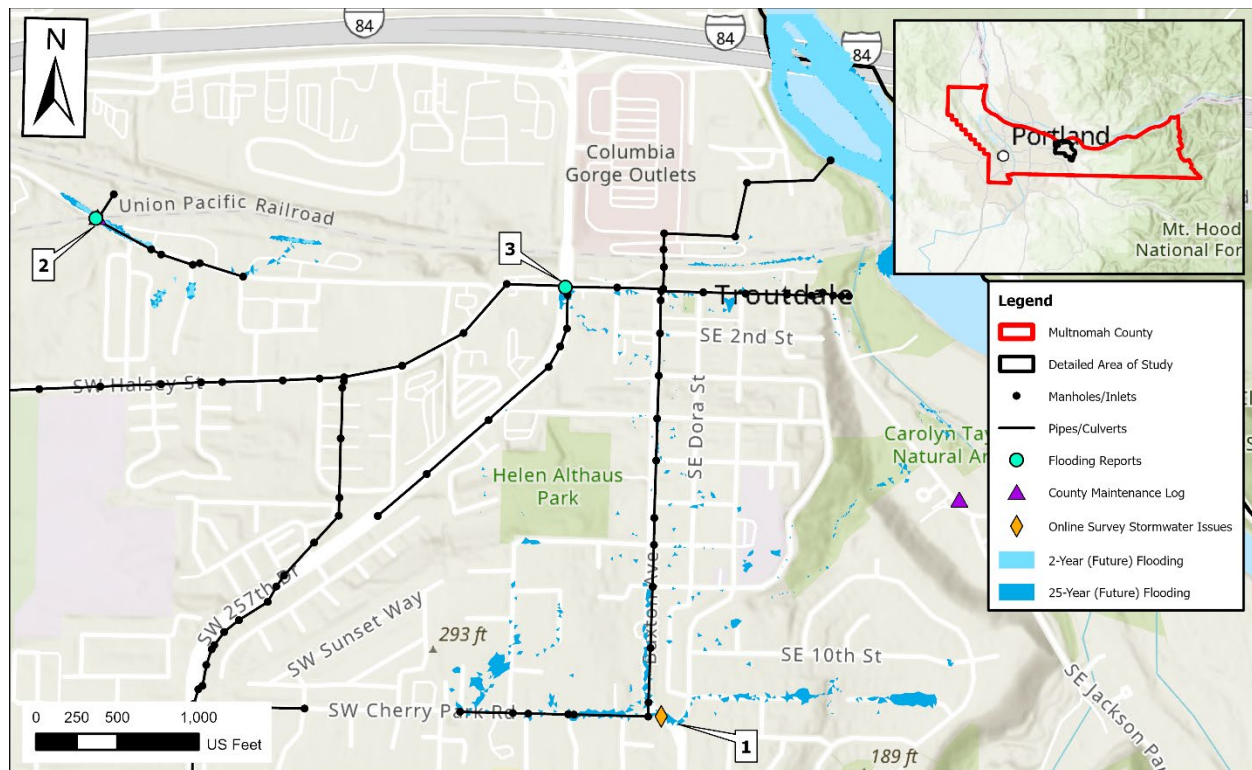


Figure 3-4. ICM Model Results in Troutdale During the 25-year Event Used for Model Validation

Anecdotal Evidence - Figure 3-5:

- County Maintenance staff have reported flooding issues along Breyman Avenue especially at the southern end of the modeled trunk line (Note 1 in figure).
- County Maintenance staff have reported flooding issues at the junction of Riverside Drive, Fletcher Road, and Palatine Hill Road (Note 2 in figure).
- County Maintenance staff have reported flooding issues along Military Road as well as two public flooding reports have been submitted at this location (Note 3 in figure).

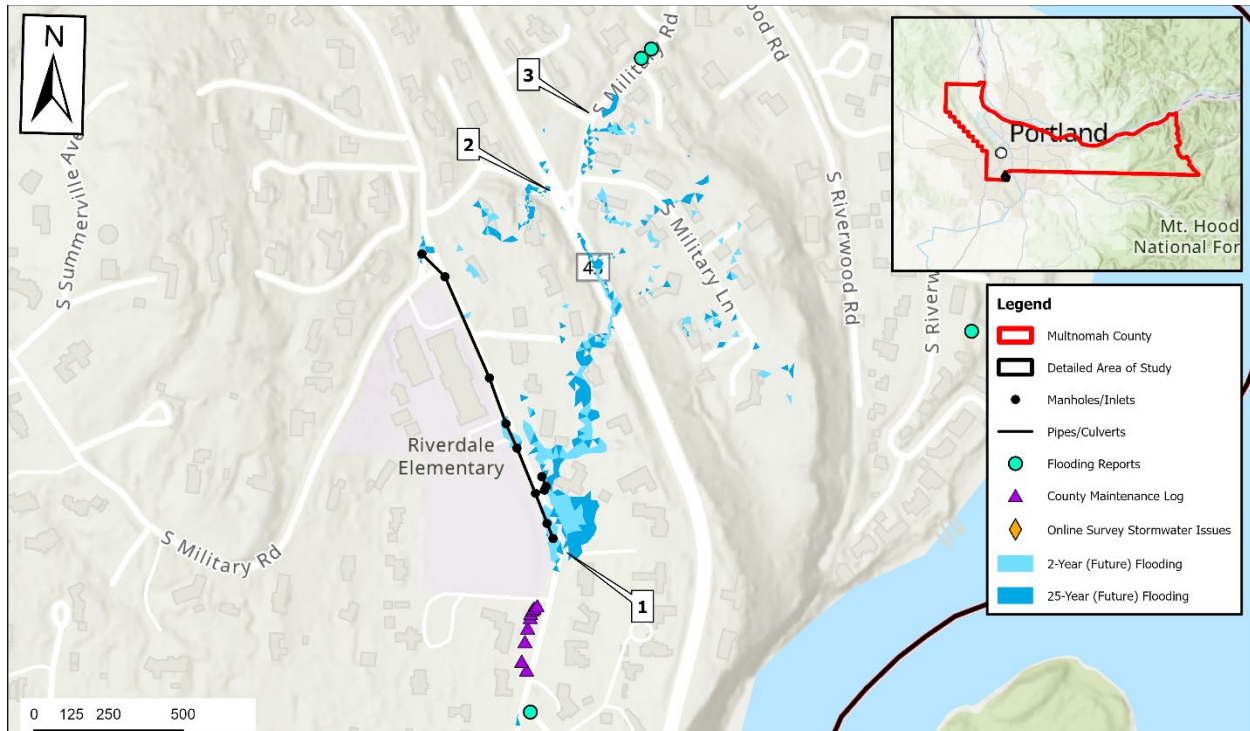


Figure 3-5. ICM Model Results at Breyman Avenue Used for Model Verification

Modeling of the 25-year Future Conditions event in Green Hills resulted in minimal flooding on private residential property (See Appendix 2). No public or County Maintenance staff reports of flooding are present in the areas of modeled flooding and therefore were not used for model validation.

3.3 STORMWATER QUANTITY RESULTS

3.3.1 HYDRAULIC MODEL RESULTS

The Existing Condition hydraulic results provide a baseline to assess drainage infrastructure deficiencies and the effectiveness of proposed drainage improvements. Modeling results indicate that flooding of the existing stormwater infrastructure during the 25-year event is not extensive across the detailed areas of study and the majority of existing infrastructure modeled can convey Existing and Future runoff with little-to-no flooding. Most of the flooding issues occurred in the DR and TFW areas. Existing Condition results maps in Appendix 2 show the extent of flooding for the 2-year, 25-year, and 100-year Future Condition events to highlight flood prone areas and includes a table of flooding pipes in the 25-year Future Conditions event. for each detailed area of study. These exhibits also include the 100-year Existing Conditions flooding to show the differences between the Existing and Future Conditions; the difference is not extensive but is still discernable.

The model results were also evaluated for anticipated maintenance issues. The exhibits include a list of pipes that have flow velocities that remain below 3 feet per second, which is a commonly used minimum velocity for design. This is due to the increased likelihood for sediment to accumulate in pipes with low velocities, which then require more frequent maintenance to maintain function and capacity.

Flooding during the 25-year Future event in TFW occurs at 34 out of 858 modeled manholes. Flooding occurs in the following trunk lines: the eastern Stark Street trunkline, the Troutdale Road and 21st Street trunkline, the Cherry Park trunkline before turning north on Buxton Road, and the trunkline on Historic Columbia River Highway near the train track undercrossing. Most of the flooding appears to travel along the roadway or next to the roadway on the road shoulder or adjacent properties. The maximum flooding depth out of the flooded manholes is 1.04 feet; however, most of the flooding has a depth below 0.5 feet.

Flooding during the 25-year Future event in GH occurs at 3 out of 148 manholes. Flooding is minimal and is isolated to pipes flowing adjacent to a residential neighborhood (between 50th Street and 52nd Street) that collects runoff from private homes. The maximum flooding depth out of the flooded manholes is 0.11 feet.

Flooding during the 25-year Future event in DR occurs at 11 out of 151 manholes and in all three modeled storm lines. Flooding occurs upstream of a culvert along Iron Mountain Boulevard, along Greenwood Road, and along Breyman Avenue. The maximum flooding depth out of the flooded manholes is 1.55 feet; however, most of the flooding has a depth below 0.5 feet.

3.3.2 CONCEPTUAL SOLUTIONS

Conceptual solutions for the potential Capital Projects were developed using a combination of hydraulic modeling and qualitative assessment, depending on the location and available data. Areas experiencing more significant flooding within the hydraulic model extents were identified through model results, and proposed pipe improvements were modeled to confirm that the conceptual designs would eliminate the modeled flooding. Additional problem areas located outside the model extents were identified by County Maintenance staff based on their knowledge of recurring drainage issues; conceptual solutions for these locations were developed qualitatively. For Johnson Creek, North Fork Johnson Creek, and Beaver Creek, a hydraulic model was used to evaluate whether modifying or removing existing structures could reduce backwater effects and potentially remove insurable structures from the effective floodplain.

Detailed Study Areas

Eight of the Capital Projects (discussed further in Section 6) include water quantity stormwater improvements that were modeled under the Proposed Conditions. Areas experiencing more significant flooding under the 25-year Future Conditions were identified within the model. These storm lines became the focus for future Capital Projects. Adjustments were made to the modeled infrastructure through increases in pipe diameter and slope adjustments to increase system capacity. Adjustments were made iteratively until flooding out of the manholes was eliminated in the 25-year Proposed Conditions. Exhibits displaying those results can be viewed in Appendix 2. Modeled conceptual solutions only occurred in TFW and DR detailed study areas, as GH had minimal flooding. Table 3-4 lists all water quantity related conceptual solutions.

An analysis was conducted to determine whether UICs could provide a viable alternative to extensive pipe upsizing for Capital Projects involving long roadway corridors. As discussed in Section 3.1.1, a County-wide

assessment ranked soil infiltration capacity and UIC suitability as good, moderate, or poor. The DR and GH study areas were rated as having poor conditions, ruling out UICs as a feasible alternative to pipe upsizing. Most of the TFW study areas were rated as poor to moderate, with some areas rated as good. All flooding addressed through pipe upsizing in the TFW Capital Projects was in areas with poor UIC suitability, except at the upstream end of the Cherry Park Rd/Buxton Avenue Stormwater Improvements Capital Project. Unfortunately, the soils in this area were not rated because essential saturated hydraulic conductivity data were unavailable; however, the area is surrounded by soils rated as good, and UICs are known to have been installed nearby. Therefore, UICs were evaluated as an alternative to pipe upsizing for this project using an inferred infiltration rate from the surrounding area. The analysis found that eliminating flooding through infiltration would require a prohibitively large number of UICs and more area than is available within the right-of-way.

Nine other Capital Projects include water quantity improvements located outside of model limits. These locations were identified by County Maintenance staff as areas experiencing recurring stormwater issues. Because the locations were not modeled, conceptual solutions were developed qualitatively based on the available information. The proposed improvements generally included upsizing pipes to the next standard diameter, establishing or regrading ditches, correcting pipe alignments, and improving stormwater system connectivity.

Eight of the conceptual solutions listed in Table 3-4 include both water quantity and water quality improvements. Water quality improvements are discussed further in Section 4.2.4.

Table 3-4. Water Quantity Conceptual Solutions

Project Name	Watershed	Solution(s)
SE Stark Street Stormwater Improvements ^{1, 3}	Beaver Creek	Pipe capacity increase ²
West Glisan Street Stormwater Improvements ¹	Fairview Creek	Pipe capacity increase ²
SW 257th Dr Stormwater Improvements ^{1, 3}	Beaver Creek	Pipe capacity increase ²
Troutdale Road Stormwater Improvements ^{1, 3}	Beaver Creek	Pipe capacity increase ²
Cherry Park Rd/Buxton Ave Stormwater Improvements ^{1, 3}	Beaver Creek	Pipe capacity increase ²
East Glisan Street Stormwater Improvements ¹	Fairview Creek	Pipe capacity increase ²
HCRH Railroad Undercrossing Road Stormwater Improvements	Salmon Creek	Pipe capacity increase, pipe alignment correction ²
NE Sandy Blvd Stormwater Improvements ^{1, 3}	Fairview Creek	Pipe capacity increase, combining parallel culverts
S Breyman Ave Stormwater Improvements ¹	Willamette River	Pipe capacity increase, ditch regrading ²
Interlachen Lane Stormwater Improvements ³	Fairview Lake	Pipe capacity increase
Halsey Street Stormwater Improvements	Osburn Creek	Pipe capacity increase, ditch regrading
233rd Avenue & Arata Road Stormwater Improvements ¹	Fairview Creek	Pipe capacity increase
Riverside Drive Stormwater Improvements	Willamette River	Pipe capacity increase
Radcliffe Road Stormwater Improvements	Lewis & Clark Ravine	Pipe capacity increase
Greenwood Road Stormwater Improvements	Willamette River	Pipe capacity increase, trunk line realignment, ditch regrading
Military Road Stormwater Improvements	Willamette River	Pipe capacity increase, redirection of system connection, ditch regrading
Patton Road Stormwater Improvements	Fanno Creek	Pipe capacity increase, ditch regrading

¹Conceptual solutions that also have proposed stormwater quality improvements.

²Conceptual solutions that were modeled.

³Use of UICs may be viable within project area.

Johnson Creek, North Fork Johnson Creek, and Beaver Creek

Improvements to existing flooding along Johnson Creek and North Fork Johnson Creek were considered by evaluating structures (bridges and culverts) in the effective modeling. Structure improvements that were considered included upsizing or removing existing structures. Improvements were considered based on the perceived potential to reduce backwater effects and/or remove insurable structures from the effective floodplain, and secondarily on the structure location and feasibility of making such improvements.

There are ten structures included in the effective modeling for Johnson Creek and nine structures along North Fork Johnson Creek within unincorporated areas of Multnomah County. These structures are in primarily undeveloped locations or locations where flooding does not currently impact insurable structures.

After preliminary analysis, removing or replacing structures along either Johnson Creek or North Fork Johnson Creek is not recommended because the expected flood-reduction benefits are minimal and would not remove insurable structures from the floodplain.

The review of the delineated floodplain along Beaver Creek did not indicate meaningful or practicable opportunities to improve flooding conditions by updating or removing existing infrastructure included in the effective mapping. There would be limited improvement to flooding during major rain events by upsizing or replacing existing infrastructure and the impact to insurable structures would be negligible.

4 STORMWATER QUALITY ASSESSMENT

The purpose of the stormwater quality assessment is to evaluate areas across the County for water quality issues due to erodible soils, steep slopes, or pollutant generation potential. The assessment also determines areas that would benefit from additional water quality BMPs. The results are used to identify problem areas and evaluate proposed improvements for the Capital Projects discussed in Section 6.2. The water quality assessment includes an analysis of soil loss, stream instability, and pollutant generation potential under both Existing Conditions and Future Conditions.

4.1 BACKGROUND AND TECHNICAL APPROACH

Water quality data was provided by the County. This data included discrete surface water and UIC sampling data collected by the City of Gresham and reference data on pollutant Event Mean Concentrations (EMCs) that is currently used to estimate pollutant loads. Both data are currently used by the County to support National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permitting. In anticipation of the County's MS4 permit renewing on September 30, 2026, this stormwater master plan will aid the County in developing updates to their Stormwater Management Plan and provide suggested locations for additional stormwater BMPs.

Additional data used to assess water quality included land use data, comprehensive planning data, topography data, and soil data. Data sources are discussed in Chapter 2.

Stormwater quality was analyzed County-wide by aggregating data sources in ArcGIS Pro to compute and assess anticipated soil loss, stream channel stability, and stormwater pollutant generation potential (PGP) for several stormwater pollutants. Input from County staff was also used to provide additional information on where water quality issues exist and potential locations for stormwater BMPs.

4.1.1 SOIL LOSS

Anticipated soil loss was calculated County-wide for existing and proposed land-use conditions in tons per acre per year adapted from the Revised Universal Soil Loss Equation (RUSLE) methodology. The RUSLE method was originally developed for individual slopes; however, studies have used the method to characterize soil loss of entire watersheds. RUSLE calculations were performed using a 30-foot grid; this resolution allowed for a detailed analysis to help pinpoint the highest sediment producing areas within the County. The sources of information and methods used to determine the 5 factors of the modified version of the RUSLE equation, shown below, are described in the following sections.

Rainfall Erosivity Factor

The Rainfall Erosivity Factor (R Factor) accounts for the erosive potential of rain in a given area during any given year; the rainfall energy, and thus erosive potential, is directly related to the rainfall intensity. The R Factor values used for the analysis were derived from the isoerodent map of the western United States produced by the USDA (Renard et al., 1997) to characterize the R Factor in the RUSLE method. The R Factor values used in the analysis ranged from 39 to 120.

Soil Erodibility Factor

The Soil Erodibility Factor (K Factor) was determined from soil properties derived from the Multnomah County SSURGO dataset. The K Factor varied from 0.0 to 0.55 and are generally consistent with the relationship between soil texture and soil erodibility shown in Table 4-1.

Table 4-1. Soil Erodibility by Soil Texture

Texture Class	Soil Erodibility Factor
Fine Sand	0.14 - 0.16
Very Fine Sand	0.36 - 0.42
Loamy Sand	0.10 - 0.12
Loamy Very Fine Sand	0.38 - 0.44
Sandy Loam	0.24 - 0.27
Very Fine Sandy Loam	0.41 - 0.47
Silt Loam	0.42 - 0.55
Clay Loam	0.25 - 0.28
Silty Clay Loam	0.32 - 0.37
Silty Clay	0.23 - 0.25

Field Length Factor and Slope Length Factor

The Field Length Factor and Slope Length Factor are often merged into a single factor (LS Factor) to describe the length and steepness of the slope over which erosion will occur. The traditional method of determining the LS Factor uses an equation to compare the field slope in question to the test slope used during development of the RUSLE method. The application of the RUSLE method beyond a single slope prevents the direct use of the traditional LS Factor determination. Research by Mitsova et al. in 1996 led to the development of the Upslope Contributing Area Method which allows for consideration of flow accumulation over a raster surface and soil loss calculations on the cell basis. The LS Factor is calculated using an equation presented in Moore and Wilson (1992) that considers ground slope, flow accumulation, and cell size.

Cover Management Factor

The Cover Management Factor (C Factor) was assigned based on values presented in Woznicki et al. 2020. Table 4-2 shows the C Factor used for each NLCD land use classification under current management practices.

Table 4-2. C Factors for NLCD Land Use Classification

Land Use Description	NLCD Gridcode	C Factor
Open Water	11	0.00
Perennial Ice/Snow	12	0.00
Developed, Open Space	21	0.03
Developed, Low Intensity	22	
Developed, Medium Intensity	23	
Developed, High Intensity	24	
Barren Land (Rock/Sand/Clay)	31	0.29
Deciduous Forest	41	0.002
Evergreen Forest	42	
Mixed Forest	43	
Shrub/Scrub	52	0.04
Grassland/Herbaceous	71	0.01
Pasture/Hay	81	0.07
Cultivated Crops	82	0.17
Woody Wetlands	90	0.001
Emergent Herbaceous Wetlands	95	0.001

Conservation Practice Factor

The Conservation Practice Factor (P Factor) accounts for the use of soil conservation practices for reducing runoff velocity. The P Factor value is a ratio of the soil loss expected from the given conservation practice to an up-and-down slope culture (tillage and planting perpendicular to the slope). A cursory review of aerial photography and topography suggests that conservation practices more effective than the up-and-down slope method are not widely used. As a result, the P Factor values were set to 1.0.

4.1.2 *STREAM STABILITY*

A desktop analysis of channel stability County-wide was completed. The stability assessment used a series of evaluations with increasingly detailed scrutiny to confirm areas that exhibit instability. The starting point for the stream stability analysis was a 1-meter resolution County-wide DEM and the analysis was completed in ArcGIS Pro. A raster was also created to visualize slope and soil erodibility (K factor from the RUSLE analysis) by multiplying the values together for each cell County-wide. This raster indicated areas where there are both steep slopes and soils that are highly erodible. The following evaluations were completed, with only those areas being identified in the previous step, continuing to the following:

- Level 1 - Evaluation of topography and soil erodibility to determine high-slope areas along waterways and those with highly erodible soils. Slopes exceeding 1.5H:1V indicate instability.
- Level 2 – Evaluation of aerial imagery to confirm the apparent presence of a cut bank, significant and unvegetated sediment deposits within the stream reach, or significant debris loading.
- Level 3 – Evaluation of historical aerial imagery to improve the understanding of the onset of instability and/or the apparent duration.
- Level 4 – Evaluation of existing water quality monitoring data and indices in an attempt to appropriately correlate the type(s) and loading with the observed channel instability.

4.1.3 *POLLUTANT GENERATION POTENTIAL*

Stormwater pollutant EMCs currently used by the County for NPDES permitting were modified using literature values to calculate pollutant generation potential County-wide. This index is based on land use, soils data, and pollutant EMCs. Pollutant generation potential was calculated by computing runoff curve numbers county-wide and by classifying NLCD data with pollutant EMCs provided in Table 4-3. Pollutant EMC land use classifications were made based on engineering judgement using County provided and literature values that classify each NLCD land use type. Literature values were obtained from several regional studies (Washington Department of Ecology, 2015, 2001; Oregon DEQ, 2025; USGS, 2012) and averaged to get a representative value for each land use.

The two resulting rasters were multiplied together to generate a raster that displayed the combined influence of runoff generation and pollutant generation potential based on land use. The resulting raster can be used to make a qualitative assessment of where elevated pollutant loading is likely to occur based on land use and was used in conjunction with other data sources to make recommendations on where additional stormwater BMPs should be installed.

Table 4-3. Land Use Descriptions and Associated Pollutant EMC's

Land Use Description	NLCD Gridcode	TSS (mg/L)	TP (mg/L)	E. Coli (CFU/100 mL)	Total Zn (mg/L)
Developed, Open Space	21	35	0.15	5000	0.040
Developed, Low Intensity	22	75	0.30	20000	0.100
Developed, Medium Intensity	23	110	0.25	15000	0.180
Developed, High Intensity	24	180	0.22	8000	0.300
Barren Land (Rock/Sand/Clay)	31	120	0.10	1000	0.030
Deciduous Forest	41	15	0.04	300	0.015
Evergreen Forest	42	12	0.04	300	0.015
Mixed Forest	43	15	0.04	300	0.015
Shrub/Scrub	52	25	0.08	500	0.020
Grassland/Herbaceous	71	35	0.10	800	0.020
Pasture/Hay	81	150	0.60	40000	0.040
Cultivated Crops	82	250	0.80	20000	0.050
Woody Wetlands	90	15	0.10	1000	0.015
Emergent Herbaceous Wetlands	95	20	0.12	1500	0.015

4.1.4 STORMWATER BMP LOCATIONS

GIS information on County-owned stormwater treatment facilities and UICs, average daily traffic (ADT), truck routes, pollutant EMCs, and Oregon Department of Fish and Wildlife (ODFW) data on fish distribution were used in conjunction with discussions with County staff to determine locations that would most benefit from the installation of new stormwater BMPs or retrofitting existing stormwater BMPs. Stormwater retrofits should be prioritized in watersheds that discharge to streams that support ESA-listed salmonids. The expected water quality benefit depends on the sensitivity of the receiving stream and the pollutants conveyed to it. Within priority watersheds, locations with high pollutant-generating potential, major outfalls, limited existing treatment, or BMPs that do not effectively remove pollutants such as 6PPD-q provide the greatest opportunities for water quality improvement. Research indicates that stream proximity to roads and other impervious surfaces is another factor that increases 6PPD-q concentrations in receiving waters (Tian et al., 2022).

Multiple factors were used to determine initial suggested locations for additional or retrofitted stormwater BMPs. These included locations:

1. Within 1,000 feet of a fish-bearing stream, with priority to those with water quality issues
2. Within 100 feet of a trucking route
3. Within 100 feet of a County-operated roadway with ADT above 750
4. At least 200 feet from an existing BMP (including UICs)

GIS analysis in ArcGIS Pro was used to determine initial locations that met the above criteria and then these locations were further analyzed for site suitability. There are also several high traffic corridors with County-owned stormwater infrastructure that discharge to sensitive streams but currently have no BMPs in place. These corridors were considered highest priority for BMPs though they were not revealed by the GIS analysis.

4.2 STORMWATER QUALITY RESULTS

4.2.1 SOIL LOSS

Soil loss was calculated for Existing and Proposed land use conditions. A cursory analysis indicates estimated soil loss is highest in agricultural areas or urban areas with silt loam soils that are most susceptible to detachment and transport. Stormwater BMPs available to help reduce soil loss in urban areas (structural BMPs) are present but disparate along many major roadways. A desktop analysis of agricultural areas with high estimated soil loss indicate the current use of windrows, riparian buffers, and vegetated filter strips likely help prevent soil loss from reaching calculated values; however, these land conservation BMPs were not considered in the calculations.

Urban areas associated with high soil loss potential have highly erodible soils such as silt loams, but soil loss estimates obtained by this analysis assume the presence of open, uncovered ground, so urban areas that are paved, developed, or otherwise stabilized would experience less soil loss than expected. However, open areas and ditches, such as near stormwater outfalls or along the edge of uncurbed roadways, are vulnerable to soil loss and erosion due to concentrated stormwater runoff.

A soil loss difference calculation was also done to compare Existing and Proposed land use conditions. The greatest estimated increases in soil loss are anticipated in the agricultural areas east of the Sandy River and adjacent to the City of Troutdale. This is likely because this area contains highly erodible soils, has relatively steep slopes, and is primarily used for agriculture. An assumption was made that many of the areas currently classified as pasture or hay would transition to cultivated crops, which would also increase soil loss in these areas. Soil loss exhibits are available in Appendix 3 showing Existing and Proposed soil loss County-wide.

4.2.2 STREAM STABILITY

Slopes greater than 1.5:1 are ubiquitous across the County due to the hilly terrain and are frequent along stream channels. Exhibits in Appendix 3 show areas with slopes 1.5:1 and greater.

Slopes along Sandy River, its tributaries to the east, and throughout the Columbia River Gorge are exceedingly steep and have soils that are highly erodible. These areas reached level 3 of the stream stability analysis, discussed above in Section 4.1.2. Lower Sandy River specifically has a defined Channel Migration Area that denotes where the river has moved historically based on LiDAR data. The area along SE Lewellyn Avenue in Troutdale is located immediately adjacent to a meander bend that flows along a steep cliff face, on top of which are residential homes. Historical aerial imagery suggests the channel has remained relatively stable since 1990 and that large diameter riprap is located at the foot of the cliff. No additional analysis was done at this location.

Similarly, the banks along lower Beaver Creek in Troutdale reached analysis level 3 because they are very steep and have soils that are highly erodible. Historical aerial imagery suggests that the banks have remained well vegetated with mature trees and the channel does not shift dramatically over time, at least since 1990. Therefore, no additional analysis was done at this location.

Another area that reached level 3 of the analysis is located along Beaver Creek just upstream of Stark Street. The stream reach immediately upstream is very dynamic and is currently flowing along the Stark Street road embankment (Figure 4-1). Aerial imagery indicates that the channel has become braided and

anastomosing since a new culvert was constructed in 2018. Discussions with the County indicate that this culvert was constructed long in anticipation of a roadway widening project that has since been cancelled. The channel migration has caused flow to begin flanking the new culvert. Bank stabilization and channel realignment are likely necessary to alleviate risk to Stark Street. This location is included in the conceptual solutions discussed in Section 4.2.4.



Figure 4-1. Upstream Channel Instability at Stark Street and Troutdale Road in Troutdale.

4.2.3 POLLUTANT GENERATION POTENTIAL

Pollutant generation potential rasters were created for the stormwater pollutants Total Suspended Solids, Total Zinc, Total Phosphorus, and E. Coli. These pollutants have or are acting as proxies for pollutants that have active TMDLs in at least one location within the County. In general, this analysis revealed that pollutant generation potential is highest in urban and agricultural areas and lowest in undeveloped and forested areas. Higher levels of imperviousness coupled with higher pollutant EMCs are expected to generate the most stormwater pollution. Exhibits detailing pollutant generation potential are provided in Appendix 3. A brief description of pollutant generation potential for each pollutant is below.

Total Suspended Solids (TSS)

TSS pollutant generation potential is highest in agricultural areas east of the Sandy River, near Sauvie Island, and southwest of Forest Park along the County border. TSS is removed from stormwater via sedimentation and filtration, so BMPs that detain runoff and/or force runoff through a filter media will be most successful at removing it. Vegetated filter strips, vegetated ditches, and riparian buffers are also effective at removing TSS.

Metals and 6PPD-q

Total Zinc was used as a proxy to represent other metals and 6PPD-q due to its chemical affinity to sediment and organic matter, similar to 6PPD-q, and because they both originate from vehicle tires. Water quality sampling data for 6PPD-q was not sufficiently available to generate results without using another constituent as a proxy. Total Zinc was used as an indicator of likely locations of high 6PPD-q concentrations only. Results indicate that pollutant generation potential for metals and 6PPD-q by proxy is highest in

heavily urbanized areas, specifically high traffic areas in TWF and industrial areas adjacent to Willamette River and Columbia Slough. Metals and 6PPD-q bind readily to organic matter and smaller sediment size fractions, so BMPs that contain filter media rich in organic matter, such as bioretention facilities or vegetated stormwater planters, are effective at removing it.

Nutrients

Total phosphorus was used as a proxy for all nutrients. Although the fate and transport in stormwater differs between phosphorus and nitrogen, both are expected to enter the environment primarily from fertilizer and secondarily from atmospheric deposition and organic matter decomposition. For that reason, pollutant generation potential for nutrients is highest in agricultural areas, similar to TSS. Lawn fertilizer in urban areas is also expected to contribute nutrients to stormwater, but this analysis was unable to assess pollutant generation potential for that source in urban areas. BMPs that combine sedimentation to remove the particulate fraction of phosphorus and nitrogen and filtration through an adsorptive media will be most effective at removing it.

E. Coli

E. Coli pollutant generation potential is highest in agricultural areas similar to TSS and moderately high in urban and residential areas. Sources of E. Coli include feces from pet waste and farm operations, manure fertilizer, and combined sewer overflows. Removing E. Coli in stormwater BMPs relies on chemical removal and filtration, such as in a bioretention cell or proprietary filtration device that has media amended with biochar or another positively charged media.

4.2.4 CONCEPTUAL SOLUTIONS

Forty-five initial locations met the criteria laid out in Section 4.1.4, where installing stormwater BMPs are expected to produce the greatest stormwater quality benefits. These locations were further analyzed for site-suitability based on conversations with the County, topography, pollutant generation potential, ADT, space availability, and the ability to incorporate a new facility with existing stormwater infrastructure.

BMPs were suggested based on the target pollutants and site constraints, and included bioretention facilities, vegetated stormwater planters, proprietary stormwater filters, and permeable friction course. Bioretention facilities are vegetated basins designed to temporarily detain and infiltrate stormwater runoff through engineered media to remove pollutants. Discharge is through an outlet structure or underdrain to a downstream outfall or pipe. Vegetated planters are similar in mechanism to bioretention facilities, but for purpose of this SWMP, they are smaller, constructed depressions located along curbed roadways to collect surface runoff directly, whereas bioretention facilities can provide larger scale treatment.

Proprietary stormwater filters are underground chambers filled with filter media to provide pollutant removal prior to discharging downstream. Proprietary filters are advantageous where site constraints (e.g., ROW) prevent a facility from being installed at ground level or where other facility types are cost prohibitive. A notable downside to implementation is that maintenance is required routinely to prevent facility clogging and subsequently bypassing flow without treatment.

Finally, permeable friction course (PFC) is a type of asphalt concrete pavement (ACP) designed with higher porosity than typical ACP so that it can drain stormwater from the roadway. Multiple studies have demonstrated that it also offers significant water quality benefits (Barrett, 2006; Eck et al., 2012; Holzer & Poor, 2024). It can be installed in a single 3-inch layer that drains stormwater laterally from the roadway

and can provide up to 92% removal of TSS (Barrett, 2006). The benefits of PFC are two-fold: it provides stormwater pollutant removal and improves roadway safety by reducing road spray and hydroplaning during heavy rainfall. A downside of PFC is that it may not last as long as typical ACP in certain locations, such as intersections or where short-radius vehicle turning is frequent. It also may incur a higher initial cost where installed quantities are low and may require increased maintenance since additional street vacuuming may be required to maintain its performance or to maintain PFC areas that are not immediately adjacent to the curb. PFC is used in uncurbed roadways such as along freeways primarily to improve safety conditions, and the absence of a curb does not exclude its use. PFC was proposed in areas with anticipated or documented water quality issues where other BMPs were not considered feasible or that were devoid of other stormwater infrastructure. Additional information can be found in the Porous Asphalt Guidebook currently in preparation by the County (Mission Green Infrastructure, 2026).

The initial 45 locations were reduced to 15 final locations, and these had conceptual solutions prepared for the CIP. Fourteen of the 15 locations were corridor-wide water quality improvement projects that included one retrofit of an existing sediment manhole to improve pollutant removal for 6PPD-q via filtration. Scour repair upstream of the culvert on Beaver Creek at Stark Street is also included as a project in the CIP. These locations are summarized in Table 4-4 and Appendix 3 and listed as projects in the CIP (See Section 6.2). Project fact sheets detailing each location can be found in Appendix 5.

Table 4-4. Water Quality Conceptual Solutions

Project Name	Watershed	Facility Type(s)/Solution(s)²
Beaver Creek Culvert Scour Repair	Beaver Creek	Biotechnical bank stabilization/ Scour repair
Cherry Park Rd/Buxton Ave Stormwater Improvements ¹	Beaver Creek	Stormwater filters and planters
East Glisan Street Stormwater Improvements ¹	Fairview Creek	Stormwater filters and planters, bioretention facility
Halsey Street Stormwater Quality Improvements	Fairview Creek	Stormwater filters and planters, bioretention facility
NE 223rd Ave Stormwater Improvements	Fairview Creek	Stormwater filters and planters, bioretention facility, permeable friction course
NE Fairview Parkway Stormwater Improvements	Fairview Creek	Stormwater filters and planters, bioretention facility
NE Sandy Blvd Stormwater Improvements ¹	Fairview Creek	Stormwater filters and planters, permeable friction course
S Breyman Ave Stormwater Improvements ¹	Willamette River	Stormwater filters and planters, bioretention facility, permeable friction course
SE Orient Dr Stormwater Improvements	NF Johnson Creek	Stormwater filters and planters, permeable friction course
SE Stark Street Stormwater Improvements ¹	Beaver Creek	Stormwater filters and planters, bioretention facility, permeable friction course
SW 257th Dr Stormwater Improvements ¹	Beaver Creek	Stormwater filters and planters, bioretention facility
Troutdale Road and Division Dr Stormwater Improvements	Beaver Creek	Permeable friction course
Troutdale Road Stormwater Improvements ¹	Beaver Creek	Stormwater filters and planters, permeable friction course
W Historic Columbia River Hwy Stormwater Improvements	Beaver Creek	Retrofit to stormwater filter, stormwater filters and planters, permeable friction course
West Glisan Street Stormwater Improvements ¹	Fairview Creek	Stormwater filters and planters, permeable friction course

¹ Conceptual solutions that also have proposed stormwater capacity improvements.

² Each project should be evaluated for the most appropriate facility type in each location during the preliminary engineering and design phases.

5 REGULATORY FRAMEWORK, DEVELOPMENT STANDARDS, AND POLICY

The intent of this analysis was to review the existing regulatory framework, policies, and operations and maintenance protocols for stormwater infrastructure within the County ROW. The goal of this assessment was to find opportunities to improve and/or streamline existing standards to increase clarity, design quality, as well as efficiency for future stormwater projects and SWMPs.

5.1 DEVELOPMENT CRITERIA, STANDARDS, AND POLICY RECOMMENDATIONS

Development within the County ROW must currently follow the Multnomah County Design and Construction Manual (manual) (Multnomah County, n.d.). This manual "...is a comprehensive reference to all relevant roadway design standards in Multnomah County. The standards and specifications are to be applied on all roadways either currently under County jurisdiction, or for which the County will assume maintenance responsibility upon the completion of construction." The manual contains two sections – the design manual and the construction manual. Section 5 of the design manual contains information pertinent to stormwater management within the County, including design standards and recommended calculation procedures. The construction manual contains a brief section on pipe bedding and backfill but no other stormwater related discussion.

In general, the manual is outdated, with no source listed being written on or after the year 2000. Many sections are also "in development" that require resolution. The Water Quality Design Standards listed in Section 5 does not provide an easily measurable guideline for water quality facility design, nor does the manual provide a list of recommended or preferred stormwater BMPs to use for County projects. Both would provide clarity on stormwater design within County ROW. Additionally, the construction manual does not have any recommended specifications or testing methods for water quality facilities (e.g., for media, soil, compost, perforated pipe, etc.). Some suggested edits and comments for Section 5 of the manual are provided in Appendix 4.

Revisions to the current Design and Construction manual are being completed concurrently with the creation of this SWMP. Design recommendations will be reconciled in the new manual. Moving forward, the manual should incorporate climate change into design guidelines for stormwater infrastructure to increase resilience in future stormwater system design. This can be accomplished by increasing design storm rainfall depths, increasing the design recurrence interval, or referring readers to a citation of the County's choosing. The Seventh Oregon Climate Assessment (Fleishman, 2025) provides information on how climate change is expected to change rainfall patterns in Oregon. The analysis for this SWMP accounted for climate change by increasing design rainfall depths 15%. An example design requirement could be that all stormwater infrastructure must be able to convey the 25-year peak flow while also accounting for a 15% increase in the 25-year design rainfall depth. This could be a simple requirement to provide resilience for future development.

5.2 OPERATION & MAINTENANCE PRACTICES

The County currently provides maintenance to stormwater infrastructure at a frequency that varies depending on infrastructure type. The frequency of maintenance is also partially dependent on drainage

complaints from citizens. The County currently has an online portal (SeeClickFix) for the public to report maintenance issues or issues with the stormwater infrastructure across the County.

Based on discussions with the County, the current need for maintenance for existing infrastructure outweighs the available monetary and staff resources to complete the work. The addition of new infrastructure due to the proposed projects in this SWMP will require more maintenance moving forward that the County cannot currently support.

6 CAPITAL IMPROVEMENT PLAN

The development of capital projects is intended to provide the County with a comprehensive action plan to identify and address stormwater infrastructure issues and propose improvements to effectively manage runoff within County ROW. Chapters 3 and 4 summarize the process used to identify problem areas and develop conceptual solutions; this chapter details how these projects were prioritized, introduces the project locations, describes how corresponding cost estimates were developed, and provides a detailed timeline and funding demand for implementing the CIP.

6.1 CAPITAL PROJECT SELECTION AND PRIORITIZATION

The methodology used for identifying proposed projects included researching past studies, known maintenance issues, coordination with County staff, and performing a hydraulic model analysis of County owned infrastructure. The model results were reviewed for areas not meeting the design criteria discussed in Section 1.3 and to alleviate flooding. Conveyance and water quality solutions were then developed into individual capital projects. Capital projects were spatially divided between major roadways to minimize project impacts during construction.

A total of 27 capital projects were identified to address infrastructure needs. Each project was assessed using a set of weighted criteria to prioritize projects using a Triple Bottom Line (TBL) analysis. Project cost estimating and implementation timelines are discussed in Section 6.3 and Section 6.4.

6.1.1 TRIPLE BOTTOM LINE ANALYSIS METHODOLOGY

The purpose of conducting a TBL analysis is to evaluate the financial, environmental, and social impacts (Categories) of proposed stormwater management strategies. These three categories are considered equally when analyzing perceived project benefits to provide a more holistic evaluation of the anticipated project benefit. The analysis helped guide decision-making to ensure that the plan provides sustainable, long-term solutions that maximize benefits across all three categories.

The TBL analysis was applied to the stormwater quantity and quality conceptual solutions within the SWMP, and included the considerations outlined in Table 6-1.

TBL prioritization criteria and weighting factors were determined based on County input and discussion. Each category (Financial, Environmental, and Social) was sub-divided into 3 Criteria that were then weighted and scored (Table 6-1). Each Criteria received a score from 1 to 5, with higher scores indicating higher anticipated project benefit. Criteria scores were multiplied by their individual weighting factors and the results for each project were summed up to produce a final score, with 15 being the maximum project score and 3 being the minimum score.

Table 6-1. TBL Prioritization Criteria and Criteria Weights

Category	Criteria	Description of Criteria Considerations	Criteria Weight
Financial	Implementation Cost *	Capital investment required for full implementation	40%
	Asset Stewardship & Maintainability	Maintenance cost, expertise, and/or equipment needs	30%
	Risk Reduction / Avoided Future Costs	Ability to reduce cost associated with legal risk, flooding or asset damage, and/or reducing future capital expenditure for repairs	30%
Environmental	Water Quality Improvement	Ability to remove pollutants from stormwater runoff and the scale of the water quality benefits that can be expected.	25%
	Habitat & Stream Function Benefit	Ability to improve aquatic species habitat and if the habitat benefits improve or protect high-value habitat	25%
	Climate / Resilience Performance	Ability to reduce localized and/or widespread flooding; ability to provide resilience to severe events and climate change	50%
Social	Socio-economic Benefit	Usability / impact of the project in providing benefit to more socially vulnerable communities, as observed by median income statistics	40%
	Community Safety & Property Protection	Ability of the project to improve safety and/or reduce public hazards during inclement weather	50%
	Community Livability & Co-Benefits	Ability of the project to improve the quality and/or provide amenities to a community, rather than providing infrastructure function alone	10%

6.1.2 TRIPLE BOTTOM LINE SCORING AND RESULTS

Scoring in the TBL was completed co-operatively by DEA and County Staff, with DEA providing project scoring for quantitatively-based criteria. More subjective and/or qualitatively-based Criteria were determined directly from County input. The final TBL can be found in Appendix 7. The resulting project prioritization scores were used to rank projects and prioritize the allocation of funds over the planning horizon of this SWMP.

The scoring for the identified conceptual solutions ranged from 7.3 to 12.0. Project that were highest scoring were generally multi-faceted projects that include stormwater capacity improvements and water quality improvements. Despite having significantly higher implementation costs, these projects were judged to offer a more holistic benefit to the local community. The TBL matrix with scores is provided in Table 6-2.

Projects with scores of 9.0 and below were deemed to be insufficiently justified for full implementation without additional evaluation. These conceptual solutions were based on anecdotal information without more detailed analysis with a stormwater model. Additional analysis is necessary to further refine the solution and provide model-backed improvements and updated cost estimates.

Table 6-2. Triple Bottom Line Matrix with Project Scores

Conceptual Solution Name	Category	Financial			Environmental			Social			Total Score (max of 15)	Priority Rank	
	Criteria	Implementation Cost	Asset Stewardship & Maintainability	Risk Reduction / Avoided Future Costs	Water Quality Improvement	Habitat & Stream Function Benefit		Climate / Resilience Performance	Socio-economic Benefit	Community Safety & Property Protection			Community Livability & Co-Benefits
	Scoring Guidance	1 > \$10M	1 Requires specialized equipment/expertise and/or substantial O&M burden	1 Negligible reduction in future costs or risk	1 No measurable benefit	1 No habitat benefit	1 Negligible flooding reduction	1 Project not adjacent to or within zip code with below median income	1 Minimal reduction in safety or property risk	1 No measurable community benefit beyond basic infrastructure function			
		2 \$5M - \$10M	2 Above-average maintenance effort and specialized inspections	2 Minor reduction in maintenance or emergency costs, or regulatory risk	2 Minor pollutant reduction or localized treatment	2 Small habitat benefit	2 Minor localized flooding reduction	2 Project adjacent to but not within zip code below median income	2 Minor reduction in nuisance flooding or safety concerns	2 Minor aesthetic or neighborhood improvements			
		3 \$1M - \$5M	3 Routine maintenance similar to existing stormwater assets and staff capabilities	3 Moderate reduction in flooding, maintenance, or regulatory risk	3 Moderate treatment	3 Improvement to habitat connectivity or riparian condition	3 Addresses current flooding	3 Project in a zip code with below median income	3 Moderate reduction in flood, erosion, or property damage risk	3 Noticeable enhancement to neighborhood appearance, walkability, or public spaces			
		4 \$500k - \$1M	4 Minimal maintenance effort using existing resources / practices	4 Significant reduction in emergency response, asset damage, or compliance risk	4 Significant reduction pollutant loading	4 Sensitive area habitat benefit	4 Severe event performance improvement	4 Project in a zip code where median income is <90% of the median income	4 Significant reduction in public safety hazards and property damage	4 Significant improvement to gathering spaces, character, or quality of life			
		5 < \$500k	5 Reduces overall maintenance burden and/or simplifies operation	5 Major reduction in future capital costs, flood damages, and regulatory exposure	5 Major watershed-scale water quality benefit	5 High-value habitat benefit	5 Long-term resilience to future climate / extreme storms	5 Project in a zip code where median income is <80% of the median income	5 Major reduction in life-safety risk, flood damages, and service disruption	5 Transformational benefit creating highly valued public amenities and opportunities			
Criteria Weight	40%	30%	30%	25%	25%	50%	40%	50%	10%				
SE Stark Street Stormwater Improvements	2	3	4	4	3	5	5	5	3	12.0	1		
Maintenance Budget	3	5	5	5	2	3	5	4	3	11.8	2		
West Glisan Street Stormwater Improvements	3	3	3	4	2	5	5	5	2	11.7	3		
SW 257th Dr Stormwater Improvements	3	3	4	4	3	5	3	5	3	11.6	4		
Troutdale Road Stormwater Improvements	3	3	4	4	3	5	3	5	3	11.6	5		
Cherry Park Rd/Buxton Ave Stormwater Improvements	2	2	4	5	4	5	3	5	3	11.4	6		
East Glisan Street Stormwater Improvements	2	2	3	4	2	5	5	5	3	11.1	7		
County Culvert Replacements	5	3	5	2	3	3	5	3	1	10.8	8		
Beaver Creek Culvert Scour Repair	4	4	4	2	4	3	5	3	2	10.7	9		
NE 223rd Ave Stormwater Improvements	3	2	3	5	3	3	5	3	3	10.0	10		
HCRH Railroad Undercrossing Stormwater Improvements	3	3	3	1	1	5	3	5	1	9.8	11		
NE Fairview Parkway Stormwater Improvements	3	2	2	5	3	3	5	3	2	9.6	12		
NE Sandy Blvd Stormwater Improvements	3	1	2	5	4	3	5	3	2	9.6	13		
Halsey Street Stormwater Quality Improvements	3	1	4	4	2	3	5	3	3	9.5	14		
S Breyman Ave Stormwater Improvements	3	2	2	3	2	5	1	5	3	9.4	15		
Data Collection	3	5	3	1	1	3	5	3	1	9.2	16		
W Historic Columbia River Hwy Stormwater Improvements	3	3	3	4	3	3	3	3	2	9.2	17		
Interlachen Lane Stormwater Improvements	5	3	2	1	1	3	5	3	1	9.1	18		
Halsey Street Stormwater Improvements	4	3	3	1	1	3	5	3	1	9.0	19		
Troutdale Road and Division Dr Stormwater Improvements	2	4	3	4	3	3	3	3	1	9.0	20		
223rd Ave and Arrata Rd Stormwater Improvements	3	4	3	1	1	3	5	3	1	8.9	21		
Riverside Drive Stormwater Improvements	5	4	3	2	1	3	1	3	1	8.4	22		
Radcliffe Road Stormwater Improvements	5	4	3	2	1	3	1	3	1	8.4	23		
SE Orient Dr Stormwater Improvements	2	3	4	4	2	3	1	3	2	8.0	24		
Greenwood Rd Stormwater Improvements	3	5	3	2	1	3	1	3	2	8.0	25		
Military Road Stormwater Improvements	3	3	3	2	1	3	1	3	1	7.3	26		
Patton Road Stormwater Improvements	3	4	2	2	1	3	1	3	1	7.3	27		

6.2 CAPITAL IMPROVEMENT PROJECTS

Eighteen of the conceptual solutions were identified for inclusion in the CIP to alleviate data, maintenance, stormwater capacity, and stormwater water quality issues across Multnomah County (Table 6-5.). The remaining nine conceptual solutions are proposed to undergo a Preliminary Engineering phase before being considered for inclusion in a future update to the CIP. A summary of the Capital Projects in each study area is provided in Section 6.2.2 through Section 6.2.5. Appendix 5 contains project fact sheets that detail elements and anticipated benefits of each Capital Project. Appendix 6 provides detailed cost estimates of each Capital Project.

6.2.1 COUNTY-WIDE

Three County-wide capital improvement projects are proposed to address or facilitate the resolution of widespread issues with the County's stormwater system.

Data collection: Development of this SWMP identified gaps in stormwater system asset data that limit effective asset management, hydraulic analysis, and long-term planning. This Capital Project proposes collecting and updating critical infrastructure information within the County's GIS database to improve the accuracy and completeness of stormwater system records and establish a process for maintaining data as the system evolves. The project also includes expanded stormwater quality monitoring to supplement regulatory requirements, improve understanding of watershed conditions, and better inform future water quality improvement efforts.

Maintenance Budget: County maintenance staff and public reports have identified recurring flooding associated with obstructed stormwater infrastructure and deferred maintenance. Many stormwater pipes require sediment removal, roadside ditches need clearing and regrading, and existing stormwater quantity and quality facilities require ongoing maintenance. This Capital Project increases funding for stormwater maintenance to address these needs, improve system performance, reduce flood risk throughout the County, and account for the additional maintenance effort required to operate the infrastructure proposed in this CIP in good working order.

County Culvert Replacements: Based on available installation date data, approximately 85% of metal stream culverts over 18" will reach or exceed 70 years of age and 3% of concrete or plastic stream culverts over 18" will reach or exceed 100 years of age within the next 20 years and are expected to require replacement. Many culverts lack installation date records and will require inspection to estimate their age and remaining service life. Available data and anecdotes confirm that a significant portion of the County's culvert inventory is approaching or has exceeded its expected service life, increasing the risk of reduced hydraulic performance, structural failure, flooding, and costly emergency repairs. This Capital Project focuses on approximately 100 stream culverts larger than 18 inches that are anticipated to exceed their expected service life before the end of the CIP, representing a subset of the County's 383 stream culverts and 1,687 total culverts. Approximately 44% of the 383 stream culverts are fish-bearing. As part of preliminary engineering, condition assessments will be completed for all County culverts 18 inches and larger to support prioritization. This project represents one component of a broader, long-term effort to inspect, rehabilitate, and replace County culverts. This project represents one component of a broader, long-term effort to inspect, rehabilitate, and replace all County culverts that have exceeded their expected service life, which has an estimated cost around \$43,000,000.

6.2.2 UNINCORPORATED AREAS

Two water quality focused Capital Projects are proposed in unincorporated areas: Troutdale Road and Division Dr Stormwater Improvements where both roads cross Beaver Creek, and SE Orient Dr Stormwater Improvements near Orient, Oregon that drains to North Fork Johnson Creek. Both Capital Projects provide stormwater treatment to high traffic truck routes.

6.2.3 TROUTDALE, FAIRVIEW, AND WOOD VILLAGE (TFW)

There are 14 Capital Projects in the TFW detailed study area. The following projects with water quantity improvements were evaluated using the hydraulic model to determine pipe sizes that increase system capacity and eliminate flooding: Cherry Park Rd/Buxton Ave Stormwater Improvements, East Glisan Street Stormwater Improvements, HCRH Railroad Undercrossing Road Stormwater Improvements, SE Stark Street Stormwater Improvements, Troutdale Road Stormwater Improvements, W Historic Columbia River Hwy Stormwater Improvements, and West Glisan Street Stormwater Improvements. The remaining water quantity projects were identified by County maintenance staff based on known problem areas and were not evaluated using the hydraulic model. For planning purposes, proposed improvements assumed the next larger standard manufactured pipe size. These projects will require additional Preliminary Engineering and investigation during design to confirm the causes of the deficiencies and confirm / develop appropriate solutions. For all water quantity improvements, proposed stormwater infrastructure is located within existing drainage corridors where infrastructure already exists; no new stormwater conveyance infrastructure is proposed in previously undeveloped locations.

Water quality related project elements in TFW are proposed to provide stormwater treatment along otherwise untreated corridors that discharge to either Beaver Creek or Fairview Creek. Stormwater BMPs were proposed where appropriate to connect with the existing stormwater system and primarily remain within County ROW.

6.2.4 GREEN HILLS (GH)

Green Hills contains one water quantity Capital Project. Hydraulic modeling of the GH detailed study area did not identify modeled trunk lines with major flooding issues. County Maintenance staff identified a corridor along Patton Road which consists of pipes, culverts, and ditches as an area of concern. For planning purposes, proposed improvements assumed the next larger standard manufactured pipe size and ditch regrading along the existing system alignment. This project is in a location where existing infrastructure characteristics like pipe inverts and rim elevations are largely unknown and the cause of the system deficiency has not been identified at this time, therefore, the project will require additional Preliminary Engineering and investigation during design to confirm / develop appropriate solutions.

6.2.5 DUNTHORPE-RIVERDALE (DR)

There are 5 Capital Projects in the DR detailed study area. All projects are water quantity Capital Projects except for the Breyman Ave Stormwater Improvements project which proposes water quantity and quality elements.

The Capital Project along Breyman Ave was modeled in Infoworks ICM to determine pipe sizes that increase system capacity and eliminate flooding. The remaining water quantity projects were identified during site visits and with input from County maintenance staff based on known problem areas and were not evaluated using the hydraulic model. Stormwater BMPs are proposed along Breyman Ave to improve water quality

and provide moderate detention via bioretention. The stormwater infrastructure database in DR is lacking existing characteristics like pipe inverts and rim elevations and will require additional site surveys. Additional Preliminary Engineering and investigation will be required for projects during design to confirm the cause of deficiencies and confirm / develop appropriate solutions.

6.3 CAPITAL PROJECT COST ESTIMATING

Cost estimates were prepared for each of the proposed Capital Projects. The cost estimates include all phases of the project, which were established using the general approach described in Table 6-3.

Table 6-3. Capital Project Cost Estimating Approach by Project Phase

Capital Project Phase	Approach for Determining Cost
Preliminary Engineering	Computed as a percentage of the estimated construction cost, ranging between 2% - 10%
Environmental Permitting	Computed as a percentage of the estimated construction cost, ranging between 2% - 15%
Right of Way Acquisition	Computed as 2x the assessed property value on a \$ / sf basis for the estimated amount of property that would need to be acquired. The same methodology was used for permanent right-of-way purchase and temporary construction easements.
Survey and PS&E Development	Computed as a percentage of the estimated construction cost, ranging between 5% - 24%, with the percentage decreasing linearly as construction costs increase.
Construction + Construction Related Services	Construction costs were established using determined quantities and unit costs, as well as percentage-based bid items for more general construction costs. Construction Related Services were estimated as 12% of construction cost.

6.3.1 COUNTY-WIDE CAPITAL PROJECTS

The County-wide Capital Projects were conceptualized in a way that required different methods for establishing the project costs. While the projects were generally determined using a unit cost approach, the units and costs are not typical cost items. The following paragraphs provide a brief overview of the approach for each Capital Project; detailed cost estimates are provided in Appendix 6.

Quantities for the County Culvert Replacements Capital Project were determined assuming only around 100 culverts greater than 18 inches in diameter that convey streams would be replaced. Around 44% of the in-stream culverts are fish bearing. Culverts that will have exceeded their functional life prior to or during the 20-year implementation of the CIP were included for removal and replacement. The cost estimates include approximated quantities for work beyond the replacement of the culvert pipe that are scaled to the size and length of the culvert. Additional details for the County Culvert Replacement Capital Project are included in Appendix 6.

Quantities for the Maintenance Budget Capital Project were determined by assigning approximate durations required for maintenance staff to complete the maintenance for specific infrastructure components. The number of components that are accounted for was determined using the County's GIS database and the additional stormwater infrastructure included in the CIP.

Quantities for the Data Collection Capital Project were determined through multiple assumptions made using engineering judgement and subject matter experts. For water quantity needs, costs were determined by estimating staff costs, expenses, and the time each data collection task requires. Water quality items associated with the data collection Capital Project included staff time, expenses, sample collection and processing time and associated lab fees, and time to analyze and assess the collected data.

6.3.2 CONTINGENCY

Contingency is an allowance included in cost estimating to account for uncertainties inherent in planning-level cost estimates, including future scope refinement and unforeseen conditions. Contingency was determined as a percentage of the estimated construction cost for each Capital Project. The amount of contingency allotted to a given project was dependent on the information available and the detail of the analysis completed in support of this SWMP. No additional contingency was applied to professional services costs, as the percentage-based determination applied to the construction cost inherently includes additional cost associated with the effort required to design and permit the unknown project components.

Table 6-4. Summary of Contingency Allowances

Contingency Allowance	Capital Project Characteristics
30%	Baseline contingency allowance for Capital Projects where confidence in the supporting data is high and a technical analysis was completed to develop the Capital Project.
40%	Increased contingency allowance for Capital Projects where no explicit analysis was conducted or the data used to develop the conceptual solution was not entirely reliable
50%	Highest contingency allowance for Capital Projects that were developed solely on communication with County Maintenance staff or it is known there are data issues with key pieces of information used to develop the conceptual solution.

6.3.3 CAPITAL PROJECT COST SUMMARY

A cost estimate for each Capital Project is provided in Appendix 6 and a summary is provided in Table 6-5.

Table 6-5. Capital Project Rank and Cost Summary

Project Name	Project Total Score	Priority Rank	Preliminary Engineering	Env. Permitting and Compliance	Right of Way Acquisition	Engineering, Design, and Survey	Construction Related Services	Construction	Total Cost
SE Stark Street Stormwater Improvements	12.0	1	\$311,000	\$311,000	\$0	\$621,000	\$745,000	\$6,208,000	\$8,196,000
Maintenance Budget	11.8	2	\$0	\$0	\$0	\$0	\$0	\$3,753,000	\$3,753,000
West Glisan Street Stormwater Improvements	11.7	3	\$146,000	\$146,000	\$393,000	\$291,000	\$349,000	\$2,904,000	\$4,229,000
SW 257th Dr Stormwater Improvements	11.6	4	\$97,000	\$97,000	\$0	\$194,000	\$233,000	\$1,939,000	\$2,560,000
Troutdale Road Stormwater Improvements	11.6	5	\$141,000	\$141,000	\$0	\$281,000	\$337,000	\$2,806,000	\$3,706,000
Cherry Park Rd/Buxton Ave Stormwater Improvements	11.4	6	\$344,000	\$206,000	\$0	\$687,000	\$824,000	\$6,862,000	\$8,923,000
East Glisan Street Stormwater Improvements	11.1	7	\$192,000	\$192,000	\$0	\$383,000	\$460,000	\$3,828,000	\$5,055,000
County Culvert Replacements	10.8	8	\$819,000	\$2,455,000	\$819,000	\$1,637,000	\$1,964,000	\$16,363,000	\$24,057,000
Beaver Creek Culvert Scour Repair	10.7	9	\$19,000	\$55,000	\$0	\$75,000	\$44,000	\$363,000	\$556,000
NE 223rd Ave Stormwater Improvements	10.0	10	\$94,000	\$94,000	\$0	\$187,000	\$225,000	\$1,867,000	\$2,467,000
HCRH Railroad Undercrossing Stormwater Improvements	9.8	11	\$70,000	\$70,000	\$0	\$140,000	\$168,000	\$1,397,000	\$1,845,000
NE Fairview Parkway Stormwater Improvements	9.6	12	\$54,000	\$54,000	\$0	\$108,000	\$130,000	\$1,078,000	\$1,424,000
NE Sandy Blvd Stormwater Improvements	9.6	13	\$156,000	\$156,000	\$23,000	\$312,000	\$375,000	\$3,117,000	\$4,139,000
Halsey Street Stormwater Quality Improvements	9.5	14	\$121,000	\$121,000	\$0	\$242,000	\$290,000	\$2,416,000	\$3,190,000
S Breyman Ave Stormwater Improvements	9.4	15	\$108,000	\$108,000	\$38,000	\$216,000	\$259,000	\$2,151,000	\$2,880,000
Data Collection	9.2	16	\$2,311,000	\$0	\$0	\$0	\$0	\$0	\$2,311,000
W Historic Columbia River Hwy Stormwater Improvements	9.2	17	\$113,000	\$113,000	\$0	\$226,000	\$272,000	\$2,260,000	\$2,984,000
Interlachen Lane Stormwater Improvements	9.1	18	\$11,000	\$11,000	\$96,000	\$50,000	\$26,000	\$212,000	\$406,000
Halsey Street Stormwater Improvements	9.0	19	\$28,000	\$28,000	\$0	\$97,000	\$67,000	\$558,000	\$778,000
Troutdale Road and Division Dr Stormwater Improvements	9.0	20	\$92,000	\$229,000	\$0	\$229,000	\$229,000	\$4,576,000	\$5,355,000
223rd Ave and Arrata Rd Stormwater Improvements	8.9	21	\$49,000	\$30,000	\$0	\$102,000	\$118,000	\$987,000	\$1,277,000
Riverside Drive Stormwater Improvements	8.4	22	\$21,000	\$21,000	\$0	\$48,000	\$25,000	\$204,000	\$319,000
Radcliffe Road Stormwater Improvements	8.4	23	\$31,000	\$16,000	\$0	\$67,000	\$37,000	\$307,000	\$458,000
SE Orient Dr Stormwater Improvements	8.0	24	\$146,000	\$97,000	\$0	\$339,000	\$581,000	\$4,837,000	\$6,000,000
Greenwood Rd Stormwater Improvements	8.0	25	\$78,000	\$78,000	\$0	\$155,000	\$186,000	\$1,542,000	\$2,039,000
Military Road Stormwater Improvements	7.3	26	\$91,000	\$46,000	\$0	\$105,000	\$109,000	\$902,000	\$1,253,000
Patton Road Stormwater Improvements	7.3	27	\$71,000	\$141,000	\$112,000	\$141,000	\$169,000	\$1,403,000	\$2,037,000
SUBTOTALS:			\$5,714,000	\$5,016,000	\$1,481,000	\$6,933,000	\$8,222,000	\$74,831,000	\$102,197,000

* All costs are shown in 2026 dollars

6.4 RECOMMENDED CAPITAL IMPROVEMENT PLAN TIMELINE AND FUNDING

The ability to implement a stormwater CIP is reliant on the ability to appropriately sequence and fund the projects. The following paragraphs summarize the process and considerations used to identify the sequence and duration of Capital Projects and the resulting funding demand created by the CIP. Existing funding and possible funding sources are also explored. The recommended CIP timeline is contingent on funding availability. Existing funding limitations will not fully fund the planned CIP so additional sources of funds will be needed and/or the timeline modified in the future.

6.4.1 IMPLEMENTATION TIMELINE

The general sequence of the Capital Projects was determined by the priority ranking from the TBL analysis. Several 'big picture' focused exceptions were made to enhance or facilitate other parts of the overall CIP. The exceptions and rationale for deviating from the priority rankings are summarized in .

Table 6-6. Capital Project Sequence Exceptions

Capital Project Name	Adjustment Description and Rationale
County Culvert Replacements	This Capital Project was the 8 th highest ranked project; however, the proposed implementation timeline includes the work beginning in the first year of the CIP. This adjustment was made to allow for additional prioritization effort prior to beginning design or construction of improvements. Additionally, this change was made to acknowledge that the replacement of around 100 stream culverts (around 44% fish bearing) will take a considerable amount of time and condensing it within a subset of the 20-year CIP would have negative consequences for the consistency in the funding demand.
Data Collection	This Capital Project was ranked 16 th ; however, the information that will be provided by this Capital Project is a pre-requisite for all of the other Capital Projects in the CIP. As a result, the data collection effort was planned to begin in the first year of the CIP.
Capital Projects Recommended for Partial Implementation: • Halsey Street Stormwater Improvements • Troutdale Road and Division Dr Stormwater Improvements • 223rd Ave and Arrata Rd Stormwater Improvements • Riverside Drive Stormwater Improvements • Radcliffe Road Stormwater Improvements • SE Orient Dr Stormwater Improvements • Greenwood Rd Stormwater Improvements • Military Road Stormwater Improvements • Patton Road Stormwater Improvements	The Capital Projects that score the lowest were hindered by poor quality data or a lack of ability to prepare a technical analysis to fully evaluate the improvements included in the Capital Projects. It is likely that the scores for the projects would improve after additional evaluation. These Capital Projects are only recommended to be included for the Preliminary Engineering phase of the work to provide sufficient justification to fully implement or fully exclude the proposed improvements from the CIP. The Preliminary Engineering work was shifted to the 1 st and 3 rd year of the CIP to provide better information for future updates to the SWMP and CIP, as well as to better balance the annual funding demand.

Other factors that affected the proposed project timing were the magnitude of the analysis and design effort, the presence or absence of ROW acquisition needs, and the magnitude of the construction cost. The following rules were applied to the Capital Projects:

- Preliminary Engineering and Survey and PS&E Development efforts were allowed to begin in the same calendar year if the combined professional services fee for the two phases was less than \$500,000.
- Environmental Permitting was assumed to begin the same year as the Survey and PS&E Development.
- The Right-of-Way phase was assumed to begin and end at the same time as the Survey and PS&E Development.
- The Survey and PS&E Development phase was assumed to take two years if the cost of the phase was less than \$500,000; Capital Projects where this cost exceeded \$500,000 were assumed to be completed in three years.
- Capital Projects where the Construction and Construction Related Services cost exceeded \$2 million were assumed to require 2 or more years to construct; lower cost projects were assumed to be possible to construct in a single year.
- Capital Project construction was assumed to begin the year following the Survey and PS&E Development phase, with the exception of projects that needed to have construction delayed to avoid years with above-average funding demand.
- Funding is proposed to be allocated for the County Culvert Replacement Capital Project in varying amounts to balance the funding demand for the overall CIP. The cumulative cost of the Capital Project matches the inflation adjusted cost of completing all the identified culvert replacements.

The resulting implementation sequence and funding needs for each project are provided in Table 6-7. The timing of the necessary phases of the Capital Projects are provided in Capital Project Fact Sheets in Appendix 5.

Table 6-7. Recommended Capital Project Implementation Timeline and Funding Demand

Capital Project Name	Annual CIP Spending (in millions of dollars)																				Capital Project Total Cost
	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	
SE Stark Street Stormwater Improvements	\$0.32	\$0.22	\$0.23	\$0.58	\$4.03	\$4.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$9.53
Maintenance Budget	\$0.19	\$0.20	\$0.21	\$0.21	\$0.22	\$0.22	\$0.23	\$0.24	\$0.24	\$0.25	\$0.26	\$0.27	\$0.28	\$0.28	\$0.29	\$0.30	\$0.31	\$0.32	\$0.33	\$0.34	\$4.85
West Glisan Street Stormwater Improvements	\$0.30	\$0.73	\$1.78	\$1.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$4.63
SW 257th Dr Stormwater Improvements	\$0.40	\$1.15	\$1.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$2.74
Troutdale Road Stormwater Improvements	-	-	-	-	\$0.33	\$0.34	\$1.93	\$1.99	-	-	-	-	-	-	-	-	-	-	-	-	\$4.59
Cherry Park Rd/Buxton Ave Stormwater Improvements	-	-	-	-	\$0.40	\$0.27	\$0.28	\$0.55	\$3.34	\$3.44	\$3.55	-	-	-	-	-	-	-	-	-	\$11.84
East Glisan Street Stormwater Improvements	-	-	-	-	-	-	-	-	\$0.25	\$0.26	\$0.53	\$3.06	\$3.15	-	-	-	-	-	-	-	\$7.24
County Culvert Replacements	\$2.85	\$1.91	\$1.56	\$2.81	\$0.46	\$0.45	\$2.99	\$2.65	\$1.40	\$0.93	\$1.09	\$2.11	\$1.05	\$0.38	\$1.12	\$1.94	\$1.84	\$2.02	\$1.63	\$0.20	\$31.19
Beaver Creek Culvert Scour Repair	-	-	-	-	-	-	-	-	\$0.19	\$0.55	-	-	-	-	-	-	-	-	-	-	\$0.74
NE 223rd Ave Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	\$0.55	\$1.58	\$1.63	-	-	-	-	-	\$3.76
HCRH Railroad Undercrossing Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	\$0.41	\$2.37	-	-	-	-	-	-	\$2.78
NE Fairview Parkway Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.33	\$1.88	-	-	-	-	-	\$2.21
NE Sandy Blvd Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.49	\$0.50	\$2.80	\$2.89	-	-	-	\$6.68
Halsey Street Stormwater Quality Improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.39	\$0.40	\$2.30	\$2.37	-	\$5.46
S Breyman Ave Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.40	\$0.41	\$2.18	\$0.81
Data Collection	\$1.19	\$1.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$2.42
W Historic Columbia River Hwy Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.38	\$0.40	\$2.29	\$0.78
Interlachen Lane Stormwater Improvements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.29	\$0.43	\$0.29
Halsey Street Stormwater Improvements	\$0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.03
Troutdale Road and Division Dr Stormwater Improvements	\$0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.09
223rd Ave and Arata Rd Stormwater Improvements	\$0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.05
Riverside Drive Stormwater Improvements	-	-	\$0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.02
Radcliffe Road Stormwater Improvements	-	-	\$0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.03
SE Orient Dr Stormwater Improvements	-	-	\$0.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.16
Greenwood Rd Stormwater Improvements	-	-	\$0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.09
Military Road Stormwater Improvements	-	-	\$0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.10
Patton Road Stormwater Improvements	-	-	\$0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	\$0.08
Annual CIP Spending:	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	\$5.43	
Cumulative CIP Spending	\$5.43	\$10.86	\$16.30	\$21.73	\$27.16	\$32.59	\$38.02	\$43.45	\$48.89	\$54.32	\$59.75	\$65.18	\$70.61	\$76.04	\$81.48	\$86.91	\$92.34	\$97.77	\$103.20	\$108.64	

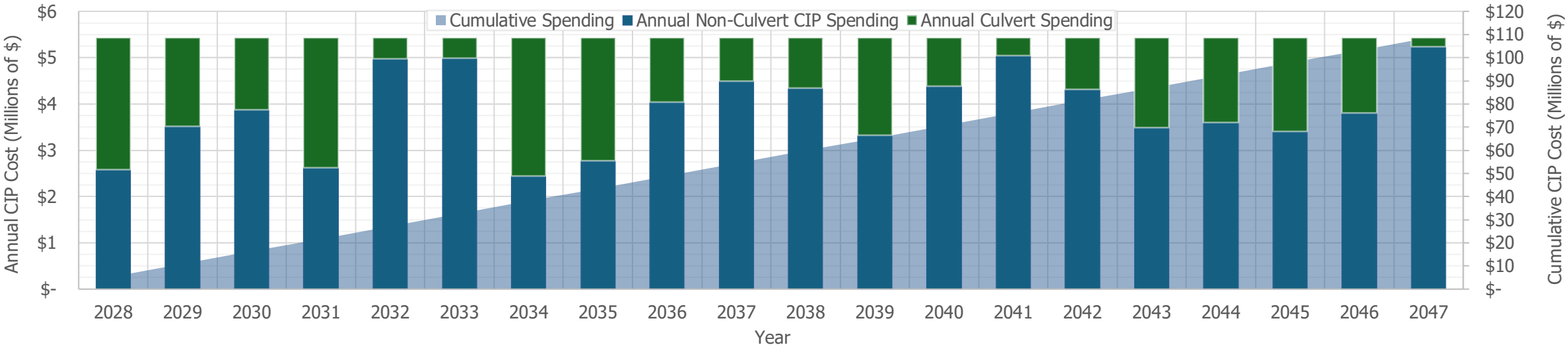


Figure 6-1. Recommended Annual and Cumulative CIP Spending

6.4.2 FUNDING REQUIREMENTS AND AVAILABILITY

The annual funding demand for the proposed CIP is \$5.43 million and accounts for annual inflation at 3% per year from 2026. The resulting total, inflation adjusted, CIP cost is \$108.6 million over the 20-year period. The proposed implementation balances the cost to be equal to the average funding demand by varying the County Culvert Replacement spending, as shown in Table 6-7 and Figure 6-1.

Currently, Multnomah County's budget does not include a line item for stormwater projects. Improvements and/or expansion of the County's stormwater infrastructure have more commonly been incorporated into the costs of other projects, where stormwater improvements were not the main objective of the project. This means that while there have been funds expended on stormwater infrastructure improvements / expansion, the 'budgeted' amount is neither consistent nor substantial enough to allow for implementation of the proposed stormwater CIP. The anticipated budget shortfall is essentially equal to the cost of the stormwater CIP.

Funding of the magnitude required for implementation of the proposed CIP typically requires significant external funding opportunities, or the institution of a stormwater fee to supplement the current County budget and provide consistent funding to intentionally execute the CIP. It is anticipated that the Capital Projects that include corridor wide water quality improvements and culvert replacements that enhance disaster resilience may have grant opportunities that materially affect the cost borne by Multnomah County. Grant opportunities that may be available for applicable Capital Projects are listed in Table 6-8.

Table 6-8. Potential Grant Funding Sources

Grant Program	Administering Agency	Applicable Project Types
Clean Water State Revolving Fund (CWSRF)	Oregon Department of Environmental Quality	Planning, design, and construction of stormwater facilities, green infrastructure, water quality treatment, habitat restoration, and flood mitigation (low-interest loans with potential principal forgiveness).
Oregon Watershed Enhancement Board (OWEB)	OWEB	Floodplain reconnection, stream restoration, wetland creation/restoration, fish passage, riparian restoration, and green stormwater projects with ecological benefits.
FEMA Hazard Mitigation Assistance (HMGP/FMA)	FEMA via Oregon Department of Emergency Management	Flood reduction, property protection, culvert replacements, detention facilities, and resilience projects that reduce future disaster losses.
National Fish and Wildlife Foundation (NFWF)	NFWF	Urban stormwater retrofits, green infrastructure, habitat restoration, floodplain enhancement, and watershed resilience.
Community Development Block Grant (CDBG)	U.S. Housing and Urban Development (HUD)	Storm drainage improvements that primarily benefit low- and moderate-income areas.

7 CONCLUSION AND RECOMMENDATIONS

Multnomah County is large, diverse, and has a stormwater system that serves an array of incorporated and unincorporated areas across several urban and rural pockets. As Multnomah County's first SWMP, this study works to set the stage for future versions by providing a framework to detect existing stormwater issues and shortfalls, develop conceptual solutions, prioritize Capital Projects, and identify funding needs.

The analysis completed for the SWMP found that there are not widespread stormwater capacity issues; however, there are specific locations that model simulations and coordination with County staff identified as having capacity and/or maintenance issues to correct. The stormwater quality analysis identified areas that are anticipated to experience increased runoff pollution as development occurs and also identified several high-traffic corridors that do not have stormwater quality measures in place. These water quantity and quality issues were underpinned by stormwater asset database integrity issues, insufficient maintenance capacity, and aging infrastructure. These issues are not unique to Multnomah County; however, action is needed to improve the reliability of the system, upgrade currently underperforming components, replace functionally obsolete infrastructure, and make adaptations to combat the negative impacts of climate change.

Twenty-seven conceptual solutions were prepared to address the noted concerns: 18 are recommended for full implementation as part of the CIP, and 9 are recommended to receive additional evaluation prior to considering full implementation. The selection and prioritization of the projects was completed using a TBL approach to promote the advancement of holistic projects that bring multiple benefits to Multnomah County and the community at-large.

It is recommended that Multnomah County implement the following actions based on the findings of this SWMP:

- Update the Multnomah County Roadway Design and Construction Manual to consider climate change and provide better guidance on stormwater quality BMPs.
- Resolve the current data gaps by implementing the Data Collection Capital Project and implementing a more refined process that ensures a more complete and/or accurate entry of data for new infrastructure to the County asset database.
- Collaborate with local communities regarding the Capital Projects embedded within their boundaries, and identify partnering opportunities to deliver the Capital Projects.
- When other public or private infrastructure projects are anticipated for areas that overlap with the Capital Projects, the projects should be planned and possibly constructed concurrently.
- When development projects file tentative maps or preliminary plans, the County should recommend or require CIP elements to be constructed, if possible.
- Evaluate and implement one or more options for resolving the significant funding gap between the current stormwater spending and the funding demand for the CIP. Establishing a stormwater fee is anticipated to provide a consistent and focused source of funding to implement the CIP.
- Complete updates to this stormwater master plan as new information substantively informs or changes accuracy, validity, or appropriateness of the findings of this master plan, and as needed to mitigate emerging stormwater concerns in the County.

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APPENDIX 1 HYDROLOGIC INPUTS AND RESULTS

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APPENDIX 2 HYDRAULIC RESULTS SUMMARY

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APPENDIX 3 WATER QUALITY RESULTS

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***APPENDIX 4 DEVELOPMENT STANDARDS & DESIGN
CRITERIA RECOMMENDATIONS***

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APPENDIX 5 CAPITAL PROJECT FACT SHEETS

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APPENDIX 6 CAPITAL PROJECT COST ESTIMATES

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***APPENDIX 7 CAPITAL PROJECT PRIORITIZATION
TABLE***

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