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Clackamas County
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CLACKAMAS
WATER
ENVIRONMENT
SERVICES

August 12, 2026

Pablo Martos
Municipal Stormwater Program Coordinator
Oregon Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, OR 97232

RE: MS4 Permit Renewal Application Package from Clackamas WES, Clackamas County and the Cities of Happy Valley and Rivergrove

Mr. Martos:

This MS4 Permit Renewal Application Package (Package) from Clackamas Water Environment Services (WES), Clackamas County, and the Cities of Happy Valley and Rivergrove is submitted in accordance with Schedule B(4) in MS4 Permit Number 101348 (File Number 108016). This permit was issued on September 15, 2021, was modified on May 4, 2023, and will expire on September 30, 2026.

Permit Schedule B(4) says the Package shall be submitted to the Dept. of Environmental Quality (DEQ) at least 180 days prior to permit expiration. However, section A(4) in Permit Schedule F says "*DEQ may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date".* Your January 20, 2026 email granted an extension of time, specifying that the Package can be submitted to DEQ as late as September 29, 2026.

The attached Package has been submitted to DEQ via YDO and made available to the public on WES' website, hard copies are also available. If you have any questions, please contact me at 503-742-4581 or rwierenga@clackamas.us.

Sincerely,

Ronald E Wierenga

Ron Wierenga
Deputy Director

cc: Andrew Swanson (WES)
cc: Devin Patterson (Clackamas County's Dept. of Transportation & Development)
cc: Chris Randall (City of Happy Valley)
cc: Analeis Weidlich (City of Rivergrove)

MS4 Permit Renewal Application Package
for
Water Environment Services, Clackamas County, and the Cities of Happy Valley and Rivergrove

DEQ Permit #101348/DEQ File #108016

August 2026

Clackamas County
Water Environment Services
The City of Happy Valley
The City of Rivergrove

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT
RENEWAL APPLICATION PACKAGE

We, the undersigned, hereby submit this National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater System Renewal Application Package in accordance with NPDES Permit Number 101348. We certify under penalty of law that this document and all attachments were prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person, or persons, who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Ronald E Wierenga — Aug 12, 2026
Ron Wierenga, Deputy Director
Water Environment Services
Date

Jason Tuck
Jason Tuck (Aug 13, 2026 08:16:42 PDT) — Aug 13, 2026
Jason Tuck, City Manager
City of Happy Valley
Date

Analeis Weidlich
Analeis Weidlich (Aug 13, 2026 09:55:26 PDT) — Aug 13, 2026
Analeis Weidlich
City Manager/City Recorder
City of Rivergrove
Date

Dan Johnson
Dan Johnson (Aug 13, 2026 08:02:06 PDT) — Aug 13, 2026
Dan Johnson, Director
Clackamas County Dept. of
Transportation and Development
Date

TABLE OF CONTENTS

SECTION 1 INTRODUCTION AND OVERVIEW

This Phase I MS4 Permit Renewal Application Package (Package) is for the following four co-permittees in the Clackamas County group's MS4 Permit: Clackamas WES, Clackamas County, and the Cities of Rivergrove and Happy Valley. These 4 co-permittees co-implement the 2024 MS4 Permit Shared Stormwater Management Program Document (SWMP Document). Throughout the 2024 SWMP Document, the four co-permittees are referred to as the "SWMP Document Participants" and the same term is used in this Package when referring to them. The MS4 Permit requires co-permittees to develop and maintain a SWMP Document, which describes in detail how the co-permittees implement the permit's required control measures and reduce the discharge of pollutants. The MS4 permit overall requires the co-permittees to implement a comprehensive program which reduces the discharge of pollutants from its MS4s to the Maximum Extent Practicable (MEP).

The MS4 Permit was issued on September 15, 2021, was modified by DEQ on May 5, 2023, and expires on September 30, 2026. Although Schedule B(4) of the permit says the Package had originally been requested to be submitted to DEQ at least 180 days prior to the permit expiration date, Pablo Martos, MS4 permit manager, in January 2026, extended the due date until September 29, 2026 by invoking authority afforded in MS4 permit Schedule F's section (A)(4).

The Clackamas County Group's Phase I MS4 Permit (MS4 Permit) #101348 regulates all existing and new discharges of stormwater from the Municipal Separate Storm Sewer Systems (MS4s) within the service boundaries of the cities or within the surface water management service areas of Clackamas Water Environment Services (WES) and the Oak Lodge Water Services District (OLWS) that are within the Portland Metro Area's Urban Growth Boundary (UGB). The MS4 Permit authorizes discharges from the following 12 co-permittees:

Clackamas WES	Clackamas County
City of Gladstone	City of Happy Valley
City of Johnson City	City of Lake Oswego
City of Milwaukie	City of Oregon City
City of Rivergrove	City of West Linn
City of Wilsonville	OLWS

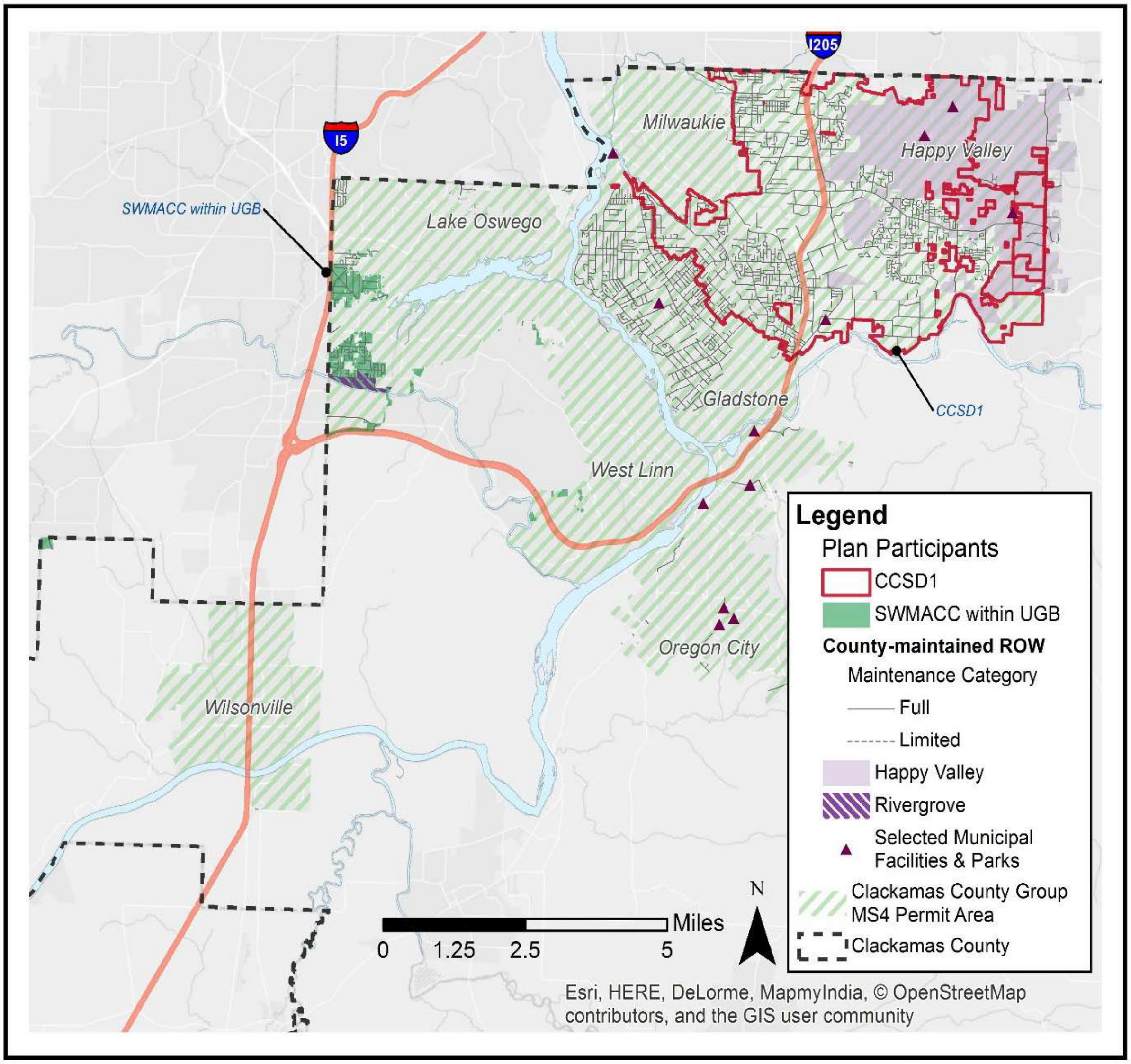
<u>The MS4 Permit Area</u>

The MS4 permit regulates discharges from the co-permittees' storm sewer systems to public surface waters such as creeks and rivers. The MS4 Permit does <u>not</u> regulate discharges from lands, buildings, facilities, and roads which are drained by:

- Stormwater injection devices (drywells, for example). Note that all of the stormwater injection devices which are owned and/or operated by Clackamas WES and Clackamas County are regulated by a Stormwater UIC WPCF Permit issued by DEQ, or
- Storm sewer systems which are owned by others, such as the State of Oregon's Transportation Dept. (ODOT), or a corporation, unless the other storm sewer system discharges into a surface-discharging storm sewer system owned/operated by a MS4 co-permittee. Note that a separate MS4 permit issued to ODOT by DEQ regulates discharges from the portion of ODOT's MS4 which is located in Clackamas County.

The SWMP Document Participants' MS4-permitted service area boundaries are shown in Figure 1 below. In Figure 1, *"CCSD1"* and *"SWMACC within UGB"* are shown and together they comprise the WES Stormwater Management Service Area.

Figure 1: Clackamas County group MS4 Permit Geographic Coverage Map



Note that Clackamas County's Department of Transportation and Development (DTD) manages a significant network of MS4s which serve Clackamas County-owned/operated road rights-of-way (ROW) and nearby lands in the MS4 Permit area. Some of these MS4s are located in the Oak Lodge Water Services service area (OLWS), while other MS4s are located within other cities in the Clackamas County MS4 permit area (for example, SE Johnson Creek Blvd in the City of Milwaukie). All Clackamas County-owned ROWs within the MS4 permit area are addressed by the SWMP Document Participants' 2024 SWMP Document. The operation of the

Clackamas County-owned/operated MS4s within the OLWS service area is described in a 2013 Memorandum of Understanding signed by the OLWS and Clackamas County. Please see the 2026 OLWS MS4 Permit Renewal Application Submittal for more information about compliance with the MS4 permit in the OLWS service area.

Summary of required work products within this Submittal Package:

This section provides a guide to the organization of this Package's elements. Table 1 (below) summarizes the 2021-2026 MS4 Permit's requirements and provides the corresponding location within the Package for the items which comply with these requirements.

TABLE 1: Permit Renewal Application Submittal Package requirement locations in this document

Permit Renewal Package's Requirements:	Document Section where the Requirement is met:	MS4 Permit requirement
Signature Page	Page ii	Clean Water Act Req't
Introduction and Overview	Section 1	NA
Evaluation of Stormwater Management Program	Section 2	Schedule B(4), B(4)(b), and B(4)(c)
Fiscal Evaluation	Section 3	Schedule B(4)(g)
Service Area Expansion and Annual Pollutant Loads	Appendix A	Schedule B(4)(f) and B(4)(d)
303(d) List Evaluation	Appendix B	Schedule B(4)(d) and D(2)
Proposed Monitoring Program Objectives Matrix and Monitoring Plan	Appendix C	B(4)(e)
Maps	Appendix D	B(4)(h)
TMDL Pollutant Load Reduction Evaluation and Benchmarks	Appendix E	Schedule B(4)(d) and D(3)

SECTION 2

EVALUATION OF THE STORMWATER MANAGEMENT PROGRAM: REDUCTION OF POLLUTANTS IN DISCHARGES FROM THE MS4 TO THE MEP

Schedule B(4) of the 2021-2026 MS4 Permit says *"The application package must include an evaluation of the adequacy of the co-permittees' programs and stormwater control measures in reducing pollutants in discharges from the MS4 to the Maximum Extent Practicable (MEP), and the conclusions of the annual adaptive management process developed under this permit. The application package must contain…*
b. Any proposed program modifications or new areas of focus for the coming permit term, including the modification, addition or removal of BMPs incorporated into the SWMP Document, and associated measurable goals.
c. The information and analysis necessary to support the DEQ's independent assessment that the co-permittees' stormwater management programs address the requirements of this permit. The co-permittees must describe how the proposed management practices, control techniques, and other provisions implemented as part of the stormwater program were evaluated using a co-permittee-defined and standardized set of objective criteria relative to the following MEP general evaluation factors:
i. Effectiveness – program elements effectively address stormwater pollutants.
ii. Local Applicability – technically feasible considering local soils, geography, etc.
iii. Program Resources – program elements are being implemented considering availability to resources and the co-permittees' stormwater management program priorities."

Clackamas WES, Clackamas County, and the Cities of Rivergrove and Happy Valley co-implement the 2024 MS4 Permit Shared Stormwater Management Program Document (2024 SWMP Document). In the 2024 SWMP Document, these four co-permittees are referred to as the "SWMP Document Participants" and the same term is used in this 2026 MS4 Permit Renewal Application Package (Package) when referring to them. The MS4 Permit requires the SWMP Document Participants to develop and maintain a SWMP Document, which describes in detail how they will implement the permit's required stormwater control measures and reduce the discharge of pollutants. The SWMP Document Participants' integrated comprehensive program reduces the discharge of pollutants from their MS4 to the MEP.

On Feb. 6, 2023, DEQ approved the 2022 MS4 Permit Stormwater Management Program Document (the 2022 SWMP Document). The 2022 SWMP Document replaced the three 2012 Stormwater Management Plans which had been implemented separately since 2012 by Clackamas County, the Cities of Happy Valley and Rivergrove, and by WES' stormwater management service areas (Clackamas County Service District #1, or CCSD#1, and the Surface Water Management Agency of Clackamas County, or SWMACC). The 2022 Shared SWMP Document was then subsequently revised in 2024. The result is the 2024 Stormwater Management Program Document (2024 SWMP Document), which began to be implemented on July 1, 2024 and which is still in effect at this time.

The 2022 SWMP Document significantly improved overall program effectiveness and coordination amongst the SWMP Document Participants. To integrate the three separate 2012 SWMPs into the shared 2022 SWMP Document, WES led and adopted an extensive Adaptive Management-based process to ensure that the 2022 SWMP Document fully complies with the 2021-2026 MS4 Permit. A substantial number of modifications were made to various BMPs (Best Management Practices) during the process of integrating the three 2012 SWMPs into the 2022 SWMP Document. The 2022 SWMP Document had many BMPs with new, improved measurable goals and tracking measures and nearly all of them continue to be present in the 2024 SWMP Document.

The process of creating the 2022 SWMP Document included a project kickoff meeting and many workshops and meetings to receive input and direction from attendees, which was subsequently used to determine the depth and breadth of the program described in the 2022 SWMP Document. Attendees at the workshops and meetings included numerous staff from WES, Clackamas County's DTD, Clackamas County's Business and Community Services Dept., Clackamas County Finance Department's Facilities Management group, the City of Happy Valley and the City of Rivergrove. As was previously stated, the 2022 SWMP Document was approved by DEQ in Feb. 2023 and it was implemented from July 1, 2023 to June 30, 2024.

Changes to SWMP program elements which were incorporated into the 2022 SWMP Document and which continue to be present in the 2024 SWMP Document include the following modifications which are expected to reduce the level of TMDL pollutants discharged:

- Portions of some improved Construction Site Runoff BMPs are expected to reduce levels of these pollutants in stormwater: Mercury, total phosphorus (Tualatin River only), total suspended solids (which is the surrogate for the settleable volatile solids Load Allocation in the Tualatin River's dissolved oxygen TMDL), and DDT & dieldrin (Johnson Creek only).
- Portions of some improved Post-Construction Site Runoff BMPs <u>and</u> Operation & Maintenance BMPs are expected to reduce levels of these pollutants in stormwater: Mercury, E. coli, total phosphorus (Tualatin River only), total suspended solids (which is the surrogate for the settleable volatile solids Load Allocation in the Tualatin River's dissolved oxygen TMDL), and DDT & dieldrin (Johnson Creek only). An example of a BMP improvement is when stormwater runoff is retained on-site by a structural infiltration-type Post-Construction BMP, because all of these pollutants will be expected to be filtered from the stormwater as it infiltrates into the earth.

<u>Annual Adaptive Management requirement in Schedule B(4):</u>
An example of an adaptive management activity which was implemented through the 2022 SWMP Document during the 2023-2024 MS4 Permit year is for BMP MAINT-4 ("*Regulated Private Storm System Inspection and Maintenance Program")*. In this BMP's section 4.2, which is titled "*Regulated Storm System Inspection and Enforcement",* the list of high, medium, and low priority facilities for future inspections was revised. In 2023-2024, WES staff continued to inspect more commercial/industrial/institutional sites in the WES SWM service area for the first time and as a result, the risk category for many sites was revised to reflect WES' improved understanding of the facility's characteristics.

The 2024 SWMP Document which is being implemented at this time contains several additional improvements compared to the 2022 SWMP Document. They include, but aren't limited to, the following:

- BMP IDDE-4 *("Dry Weather Illicit Discharge Inspections")* was revised to describe a new system for identifying the priority locations in the MS4 which are and shall be monitored. One of the BMP's Measurable Goals (MG) is to conduct an inspection at a priority location in 10% of the MS4s each year in WES' Surface Water Management (SWM) Service Area. If this MG is attained each year for 10 years, then each MS4-permitted storm sewer system will receive one dry weather illicit discharge inspection during the 10 year period. If several illicit discharges are identified and removed from MS4s during this 10 year period, some of these illicit discharges are expected to have contained TMDL pollutants such as mercury and E. coli.
- BMP Comm-1 ("*Identify Industrial NPDES Permit Facilities"*, which is about 1200-Z Permits) was revised. One change which was made clarifies that DEQ doesn't approve or decline the "No Exposure Certification" waiver forms which are submitted by businesses to DEQ.
- BMP Comm-2 (*"Industrial/Commercial Stormwater Pollutant Prevention")* was revised to include a summary of the updated Industrial/Commercial Facilities Strategy, which was submitted to DEQ on November 10, 2023.
- BMP POST-2 ("Post-Construction Stormwater Standards") includes Measurable Goals to review, update and improve stormwater design standards and to evaluate post-construction runoff activities. In May 2023 WES adopted new stormwater design standards that prioritized LID and other techniques that address hydromodification for on-site stormwater management; listed accepted BMPs for water quality treatment and provided design criteria; adopted new standard design details; adopted vegetated facility plant lists, plant material specifications, and planting guidelines; and developed infiltration testing and reporting requirements. The updated standards established numeric facility design performance requirements using a flow duration-based method for flow control and an average annual runoff-based method for runoff treatment. In October 2024 WES investigated whether the new standards met the requirements of Permit Schedule A.3.e.iii(B). After conducting a modeling study and policy analysis, WES concluded that its existing Rules and Regulations, Buffer Standards, Stormwater Standards, stormwater guidance, and review procedures together generate water quality benefits comparable to the NSRR approach for new development and redevelopment and result in significant retention in the post-developed landscape. This management practice will be incorporated into the next SWMP update.

<u>Proposed program modifications or additions/removals of BMPs in 2024 SWMP Document:</u>
Schedule B(4)(b) of the 2021-2026 MS4 Permit says *"The application package must contain…Any proposed program modifications or new areas of focus for the coming permit term, including the modification, addition or removal of BMPs incorporated into the SWMP Document, and associated measurable goals."* We do not have any proposed program modifications or new areas of focus for the coming permit term. We do not have any proposed addition of BMPs to, or removal of BMPs from, the 2024 SWMP Document, including any associated measurable goals. We do have one proposed minor modification to make to a BMP in the 2024 SWMP Document; see BMP POST-2 above for more information. We intend to make

this minor revision the next time the SWMP Document is revised. At this time, the SWMP Document Participants' overall Program, including the 2024 SWMP Document, is up-to-date and effective at reducing the discharge of pollutants from the MS4 to the MEP.

Evaluation of the SWMP Document Participants' programs and stormwater control measures:
Schedule B(4) of the 2021-2026 MS4 Permit also says this Package shall include an Evaluation of the adequacy of the SWMP Document Participants' programs and stormwater control measures in reducing pollutants in discharges from the MS4 to the MEP. During our 2026 Evaluation of the adequacy of the SWMP Document Participants' programs and stormwater control measures in reducing pollutants in discharges from the MS4 to the MEP, we concluded the programs and stormwater control measures are adequate. This Evaluation included, but wasn't limited to, an assessment of the adequacy of the following MS4 Permit Programs when effectiveness, feasibility and cost were considered:

- Education and Outreach (2024 SWMP Document BMP ED-3)
- Public Participation (2024 SWMP Document BMP PP-3)
- Illicit Discharge Detection & Elimination (2024 SWMP Document BMP IDDE-6)
- MS4 Mapping (2024 SWMP Document BMP MAP-4)
- Construction Site Runoff Control (2024 SWMP Document BMP EPSC-5)
- Post-Construction Site Runoff (2024 SWMP Document BMP POST-6)
- Pollution Prevention for Municipal Operations (2024 SWMP Document BMP PREV-9)
- Industrial and Commercial Facilities (2024 SWMP Document BMP COMM-4)
- Stormwater System O & M (2024 SWMP Document BMP MAINT-8)

303(d) Listed Pollutants Evaluation required by MS4 Permit Schedule D(2)(a)(i):
Having reviewed the 303(d) Listed Pollutants Evaluation required by MS4 Permit Schedule D(2)(a)(i) in Appendix B, the SWMP Document Participants have concluded there isn't a reasonable likelihood for stormwater from the MS4 to cause or contribute to water quality degradation of receiving waters.

Schedule B(4)(c) requirement:
Schedule B(4)(c) says the Package shall include the information and analysis necessary to support the DEQ's independent assessment that the SWMP Document Participants' overall stormwater management program addresses the requirements of this permit, and it must describe how the program's management practices, control techniques, and other provisions implemented as part of the stormwater program were evaluated using a co-permittee-defined and standardized set of objective criteria relative to the following MEP general evaluation factors:
i. *Effectiveness* – program elements effectively address stormwater pollutants.
ii. *Local Applicability* – technically feasible considering local soils, geography, etc.
iii. *Program Resources* – program elements are being implemented considering availability to resources and the co-permittees' stormwater management program priorities."

The SWMP Document Participants' stormwater management program complies with all of the requirements in the 2021-2026 MS4 Permit, including the MEP requirement. Some of the evidence which supports this assessment can be found in the annual reports which have been submitted to DEQ during each year of this Permit's term.

From the development of their MS4 Permit Program in 1995 – in response to the issuance of the original Phase I MS4 Permit by DEQ – through thirty-one years of program implementation to the present time, the SWMP Document Participants have adhered to the adaptive management process to ensure that their overall Stormwater Management Program, including but not limited to the 2024 SWMP Document, meets the MEP standard.

MEP General Evaluation Factors and Objective Criteria
As part of this MEP evaluation and demonstration, the local government jurisdictions in Oregon with Phase I MS4 Permit coverage coordinated on the ideal approach to define and standardize objective criteria related to the three MEP general evaluation factors: Program Effectiveness, Local Applicability, and Program Resources. The collaborative process included identification of example objective criteria for consideration by the jurisdictions. Each jurisdiction scored and ranked the example criteria depending on deemed importance and applicability. The highest ranking objective criteria were deemed universally acceptable by all participating jurisdictions with Phase I MS4 permits in Oregon and are provided below:

Program Effectiveness
- The program includes a range of structural and non-structural BMPs that encompass pollution prevention, source control, and treatment approaches.
- The program includes structural and non-structural BMPs that are technically feasible, effective, and implementable.
- The program includes structural and non-structural BMPs that target applicable 303(d) parameters, help to achieve TMDL pollutant load reduction benchmarks, and make progress toward attainment of TMDL Waste Load Allocations.
- The program targets pollutant discharges from existing development, re-development, and new development activities.

Local Applicability
- The program is consistent with local ordinances and current legal authority.
- Stormwater design standards implemented as part of the program reflect local conditions specific to soils, rainfall, infiltration rates, and stream conditions.
- The program encourages and solicits feedback and involvement from stakeholders to ensure consistency with community-wide goals and objectives.

Program Resources
- The program is included in the current budget allocations.
- The program considers implementation costs and practicability within the overall context of co-permittee priorities and resources
- The program considers cost effectiveness in implementing stormwater management approaches, including public acceptance of program costs and benefits.

The SWMP Document Participants evaluated their overall Stormwater Management Program, including the 2024 SWMP Document, which is up-to-date and effective, against this standardized set of objective criteria for the MEP general evaluation factors and concluded their overall Stormwater Management Program, including the 2024 SWMP Document, has met all the criteria listed above for Program Effectiveness, Local Applicability, and Program Resources.

Summary:

In summary, the SWMP Document Participants' overall Stormwater Management Program, including the 2024 SWMP Document, was evaluated and found to:

- Be up-to-date and effective
- Comply with all of the requirements in the 2021-2026 MS4 Permit, and
- Reduce pollutants from the MS4 to the MEP, to protect surface water quality, and to satisfy the appropriate water quality requirements of the Clean Water Act.

SECTION 3

FISCAL EVALUATION: PROGRAM EXPENDITURES AND PROJECTED FUTURE PROGRAM ALLOCATIONS

Schedule B(4)(g) of the 2021-2026 MS4 Permit states the following shall be provided in this Package: "*A fiscal evaluation of program expenditures for the current permit cycle and projected program allocations for (the) next permit cycle.*"

The 2024 SWMP Document Participants (WES, Clackamas County, and the Cities of Happy Valley and Rivergrove) dedicated a significant and sufficient amount of resources to implement their overall MS4 Permit Stormwater Management Program during the 2021-2026 MS4 Permit term. The following is provided in the remaining portion of this section:
I. Time spent by SWMP Document Participants
II. Clackamas WES' Expenditures and Funding Sources
III. Clackamas County DTD's Expenditures and Funding Sources
IV. The City of Happy Valley's Expenditures and Funding Sources

I. Full Time Equivalent/Time Spent:
During the 2024-2025 MS4 Permit year, WES dedicated over **23,900 employee hours or the equivalent of 13.4 full-time employees** (FTEs) to WES' portion of the overall MS4 Permit Stormwater Management Program, to the Stormwater Underground Injection Control (UIC) Water Pollution Control Facilities (WPCF) Permit program, to the Willamette/Tualatin TMDL Non-Point Source TMDL Implementation Plan program, and to the WES drainage improvement program – all of which make up WES' Surface Water Management Program. A combined FTE figure is provided because WES doesn't separately track the hours and dollars which are spent solely on the MS4 Permit Stormwater Management Program.

WES is the primary stormwater management service provider in the City of Rivergrove (population of 545 residents) and the figures in Table 2 below include the portion of the City of Rivergrove which is located in Clackamas County. Because the City dedicates a sufficient but very limited amount of funding and staff time to implement their portion of the overall MS4 Permit Program, the FTE and dollars expended by the City of Rivergrove aren't provided in this document. Also during the 2024-2025 MS4 Permit year:

- The City of Happy Valley had 4.5 FTEs in the Public Works Department and 4 FTEs in the Engineering Division, and an undefined portion of these FTEs were dedicated to completing Happy Valley's portion of the overall MS4 Permit Stormwater Management Program.
- Clackamas County's Office of Facilities Management and the Clackamas County Department of Transportation & Development (DTD) dedicated a significant number of their FTEs to completing their portions of the overall MS4 Permit Stormwater Management Program.

II. Clackamas WES' Expenditures and Funding Sources:
In this section, expenditures are addressed first and then the sources of funding are provided. WES' Operating and Construction Funds and Stormwater System Development Charge Fund resources, including Fund Balances, budgeted in the recent past and in the current fiscal year, are in Table 2 below.

Table 2: WES Surface Water Management Program Resources and Requirements from 2021-26

WES	2021-22 Actual	2022-23 Actual	2023-24 Actual	2024-25 Actual	2025-26 Adopted
Resources	24,312,086	25,154,022	27,101,334	31,149,617	35,093,686
Materials & Services	4,694,975	4,508,085	4,756,366	5,427,065	6,095,020
Capital Outlay	755,936	1,264,390	986,306	2,491,232	7,603,350
Transfers	3,000,000	2,132,500	2,000,000	2,000,000	3,625,280
Contingency	0	0	0	0	2,916,800
Ending Fund Balance	15,861,175	17,249,047	19,358,662	21,231,320	14,853,236
Total Requirements	**24,312,086**	**25,154,022**	**27,101,334**	**31,149,617**	**35,093,686**

WES' projected program allocations during the next MS4 Permit cycle:
WES expects to have allocations per year which are similar to the allocations in 2025-26, except for Capital Outlay, which is expected to vary from year to year.

Annual funding for WES' Surface Water Management Program:
Annual funding for WES' Surface Water Management Program (which includes the MS4 Permit Program, the Stormwater UIC WPCF Permit Program, the NPS TMDL Implementation Plan Program, and the drainage improvement services Program) in FY 2024-25 came from the following six sources: monthly stormwater utility fees, facility maintenance fees, SDCs, real estate development permit fees (erosion control permit, for example), miscellaneous income and interest earnings, and grants.

In 2025-2026, WES customers in the North Clackamas unit of Rate Zone 2 (CCSD#1) paid a monthly program fee of $9.55 per Equivalent Service Unit (ESU) and customers in Rate Zone 3 (SWMACC) paid a monthly fee of $5.70 per ESU. An ESU is a single-family residence or 2,500 square feet of impervious surface for nonresidential customers.

Since 1999, most newly constructed single-family residential properties in Rate Zone 2 also pay a monthly maintenance agreement fee of **$3.00** per ESU which is dedicated for maintenance of local subdivision stormwater conveyance, detention, treatment, and retention/infiltration structures. WES also collects Stormwater System Development Charges from new development and dedicates those revenues to planning, design, and construction of additional stormwater infrastructure capacity needed to accommodate growth. As of November 1, 2025, this **SDC rate is $265.00** per ESU.

WES's Long Range Financial Plan projects monthly stormwater utility fees over the next 10 years increasing by about 4-5% annually, which will adequately fund the surface water program.

III. The County's Dept. of Transportation & Development's Expenditures & Funding Sources:
The primary funding source for DTD's MS4 Permit Program activities is the Clackamas County Road Fund. In this section, expenditures are addressed first and then their primary source of funding is provided. See Table 3 for DTD's Program Expenditures for their portion of the overall MS4 Permit Program. Note that most of the County's road system is outside the MS4 Permit Boundary.

Table 3: DTD's Program Expenditures for the MS4 Permit Program from 2023-2026

Program	2023-24 Expenditures within the MS4 Permit Area	2024-25 Total County-wide Expenditures[1]	2024-25 Expenditures within the MS4 Permit Area[2]	2025-26 Anticipated Expenditures within the MS4 Permit Area
Cleaning Storm Sewer Systems	$102,783	$658,109	$217,646	$224,175
Ditch Maintenance	$17,765	$373,114	$23,181	$23,876
Street Sweeping	$246,868	$425,607	$230,312	$237,221
Grand Total	**$367,416**	**$1,456,830**	**$471,139**	**$485,272**

Source: Clackamas County Road Fund, Updated 9/23/2025

1 Data sources are DTD's Job Cost System and DTD's OpenGov Enterprise Asset Management system. All costs include overhead charges.

2 These expenditures include work done by DTD within the Oak Lodge Water Services service area. Also includes work done by DTD in areas served by County-maintained drywells, which are regulated by the Stormwater UIC WPCF Permit. Derived from the DTD's Job Cost System, DTD's OpenGov Enterprise Asset Management system and Clackamas County's MS4 Permitted Area boundary in ArcGIS. All costs include overhead charges.

DTD's projected program allocations during the next MS4 Permit cycle:
For DTD's projected program allocations during the next MS4 Permit cycle, DTD expects to have allocations per year which are similar to the allocations in 2025-26.

IV. City of Happy Valley's MS4 Permit Program Expenditures and Funding Sources:
In this section, expenditures are addressed first and then the sources of funding are provided.

The City of Happy Valley's MS4 Permit Program Expenditures:

- **Street Sweeping Program:** The City of Happy Valley spent $426,200 on their street sweeping program in 2024-25.
- **Erosion Control Program**: The City of Happy Valley funds this Program with Erosion Control Permit fee revenue. The City spent approximately $89,800 to administer this program in 2024-25.
- **MS4 Permit Program Administration:** The City of Happy Valley spent approximately $5,336 in 2024-25 to administer their portion of the overall MS4 Permit Program.

The City of Happy Valley's projected program allocations during the next MS4 Permit cycle:
Happy Valley's allocations per year, compared to those in 2025-2026, are expected to steadily increase based on population growth.

Annual funding for Happy Valley's Surface Water Management Program:
Annual funding for Happy Valley's Surface Water Management Program (which includes the MS4 Permit Program, the NPS TMDL Implementation Plan Program, and the drainage improvement services Program) in FY 2024-25 came from permit fees for land development and erosion control, road fund fees for street sweeping, and general funds for administration.

Appendix A

Service Area Expansion and Annual Pollutant Loads

Description of Service Area Expansion and Total Annual Pollutant Load Updates

Prepared for
Clackamas Water Environment Services (WES),
Clackamas County,
the City of Rivergrove, and
the City of Happy Valley, Oregon
April 2026

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µg	microgram(s)
ac	acre(s)
ACWA	Association of Clean Water Agencies
BMP	best management practice
CCSD#1	Clackamas County Service District #1
CFU	colony-forming unit(s)
cities	City of Happy Valley and City of Rivergrove
COM	commercial
DDT	dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality
DO	dissolved oxygen
EHV	East Happy Valley
EPA	U.S. Environmental Protection Agency
EMC	event mean concentration
GI	green infrastructure
IND	industrial
L	liter(s)
lb	pound(s)
LCL	lower confidence level
LUCS	Land Use Compatibility Statement
MEP	maximum extent practicable
MFR	multi-family residential
mg/L	milligram(s) per liter
mL	milliliter(s)
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
PLRE	pollutant load reduction evaluation
POS	parks and open space
RES	residential
ROW	right-of-way
SFR	single-family residential
SVS	settleable volatile solids
SWMACC	Stormwater Management Agency of Clackamas County
SWMP	stormwater management plan
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence level
UGB	urban growth boundary
UIC	underground injection control
UPA	Urban Planning Area
WLA	waste load allocation
WPCF	water pollution control facility

Section 1

Introduction

Clackamas Water Environment Services (WES), Clackamas County, and the cities of Rivergrove and Happy Valley, hereby referred to as the “cities,” are co-permittees on the Clackamas County National Pollutant Discharge Elimination System (NPDES) Phase I municipal separate storm sewer system (MS4) permit. The MS4 permit coverage extends to the stormwater management service areas of WES within the Portland Metro Area’s Urban Growth Boundary (UGB) and the service boundaries of the incorporated cities within the UGB.

WES’ stormwater management service area boundary includes the portion of the city of Rivergrove that is within Clackamas County, as well as portions of the City of Happy Valley. There is a portion of the City of Happy Valley located outside WES’ stormwater management service area but within the UGB. This area is referred to as East Happy Valley (EHV) and is covered by the City of Happy Valley’s MS4 permit.

WES, Clackamas County, and the cities are required to provide a description of anticipated service area expansions and an updated estimate of total annual stormwater pollutant loads for applicable total maximum daily load (TMDL) pollutants as part of theirMS4 permit renewal application, due September 29, 2026, in accordance with the extension provided by the Oregon Department of Environmental Quality (DEQ) per Schedule F.A.4 of the MS4 permit.

Schedule B.4 of the Permit requires co-permittees to provide a description of service area expansions anticipated to occur during the following permit term:

> *f.* *A description of any service area expansions that are anticipated to occur during the following permit term and a finding as to whether the expansion is expected to result in a substantial increase in area, intensity, or pollutant loads.*

Additionally, as part of the permit renewal application, co-permittees are required to prepare an updated estimate of total annual stormwater pollutant loads for applicable TMDL pollutants or applicable surrogate parameters, and additionally listed parameters:

> *d.* *.....as well as an updated estimate of total annual stormwater pollutant loads for applicable TMDL pollutants or applicable surrogate parameters, and the following pollutant parameters: nitrate, total phosphorus, ortho-phosphorus, copper, lead, and zinc. The estimates must be accompanied by a description of the procedures for estimating pollutant loads and concentrations, including any modeling, data analysis and calculation method.*

In conjunction with the methodology and assumptions detailed in the WES,’ Clackamas County’s, and the cities’ 2008 and 2017 MS4 permit renewal applications, the updated estimate of total annual stormwater pollutant loads needs to account for projected annexations through the end of the permit term. Therefore, these two evaluations are provided together in this report.

To address these requirements, this report is organized as follows:

Section 2 Description of Service Area Expansions

Section 3 Updated Estimate of Total Annual Pollutant Loads

Section 4 Qualitative Evaluation of Impacts

Section 2

Description of Service Area Expansions

This section defines the MS4 permit area for WES, Clackamas County [1], and the cities, as well as describes the projected expansion of the WES and city of Happy Valley (specifically EHV) MS4 service area anticipated over the next permit term (2026-2031).

2.1 Definition of the NPDES MS4 Permit Coverage Area

WES' MS4 permit area or "stormwater management service area" is defined as the area for which WES has responsibility for implementing a stormwater management program, which is also regulated by their MS4 permit. This area is defined as predominantly unincorporated Clackamas County within the Portland Metro UGB, including the urbanized portions of the cities.

Historically, WES' boundary has fluctuated due to areas being annexed from WES into adjacent co-permittee cities (i.e., Milwaukie, Lake Oswego, etc.) or due to previously unsewered areas being annexed into the WES stormwater management service area. Annexed area is most often located in the city of Happy Valley (specifically EHV).

WES' stormwater management service area is predominately in the Lower Willamette and Clackamas River watersheds, with portions extending into the Johnson Creek, Middle Willamette, and Tualatin River watersheds. The portion of WES' service area within the Tualatin River watershed includes the portion of the city of Rivergrove within Clackamas County. New areas are not being annexed into the WES service area in the Tualatin River watershed, and so WES' service area in the Tualatin River watershed has decreased over time.

The city of Happy Valley's city limits extend east of the WES stormwater management service area, predominately in the Clackamas River watershed. In these non-urban portions of the city, the City of Happy Valley maintains responsibility for implementing their MS4 permit and stormwater management program until the area is annexed into the WES stormwater management service area.

The MS4 service area for WES and the cities generally exclude open water bodies and areas operated by another entity that is permitted to manage their stormwater. Figure 2-1 provides an overview of the WES (including EHV) service area within each of the watersheds. For this analysis, areas excluded from WES and the cities MS4 service area include the following:

- Major open water bodies.
- The rights-of-way (ROW) that are associated with state highways and freeways. The Oregon Department of Transportation (ODOT) has its own MS4 permit covering ROW associated with state highways and freeways.

[1] This technical memorandum includes only the portions of Clackamas County covered by WES' stormwater management service area, and the cities of Happy Valley and Rivergrove. Portions of unincorporated Clackamas County that are covered by other MS4 Phase 1 co-permittees (e.g., Oak Lodge Water Services) are not discussed in this evaluation.

- Areas managed under the WES/Clackamas County Stormwater Underground Injection Control (UIC) Water Pollution Control Facility (WPCF) permit for drywells and other types of stormwater injection devices. These structures typically do not discharge to the MS4.

Clackamas County is a co-permittee on the Clackamas County MS4 permit, and shares responsibility with WES and the cities for management of stormwater runoff within the ROW and for implementation of stormwater management best management practices (BMPs) as specified under the 2024 MS4 Permit Shared Stormwater Management Program (SWMP) Document for Clackamas County, WES, City of Happy Valley, and City of Rivergrove. However, for purposes of this analysis and the calculation of total annual pollutant loads, the Clackamas County service area within the WES stormwater management service area and the cities is accounted for as part of the WES service area.

Through November 2025, the WES MS4 permit area was estimated to be 14,393 acres. Non-urban area within the city of Happy Valley (i.e., EHV), not otherwise included in WES' service area, was calculated to be 2,726 acres.

It should be noted that there is a significant amount of area within these 14,393 acres that drains directly to surface waters and is not served by any MS4. This large non-point source water pollution area was included in this pollutant load estimate, consistent with the methodology used in 2008 and 2017,because digitization of these areas in GIS would have required significant time and resources As a result, estimated pollutant loads documented in this report are much higher than the actual pollutant loads discharged by the MS4s within the WES and the cities' stormwater management service area.

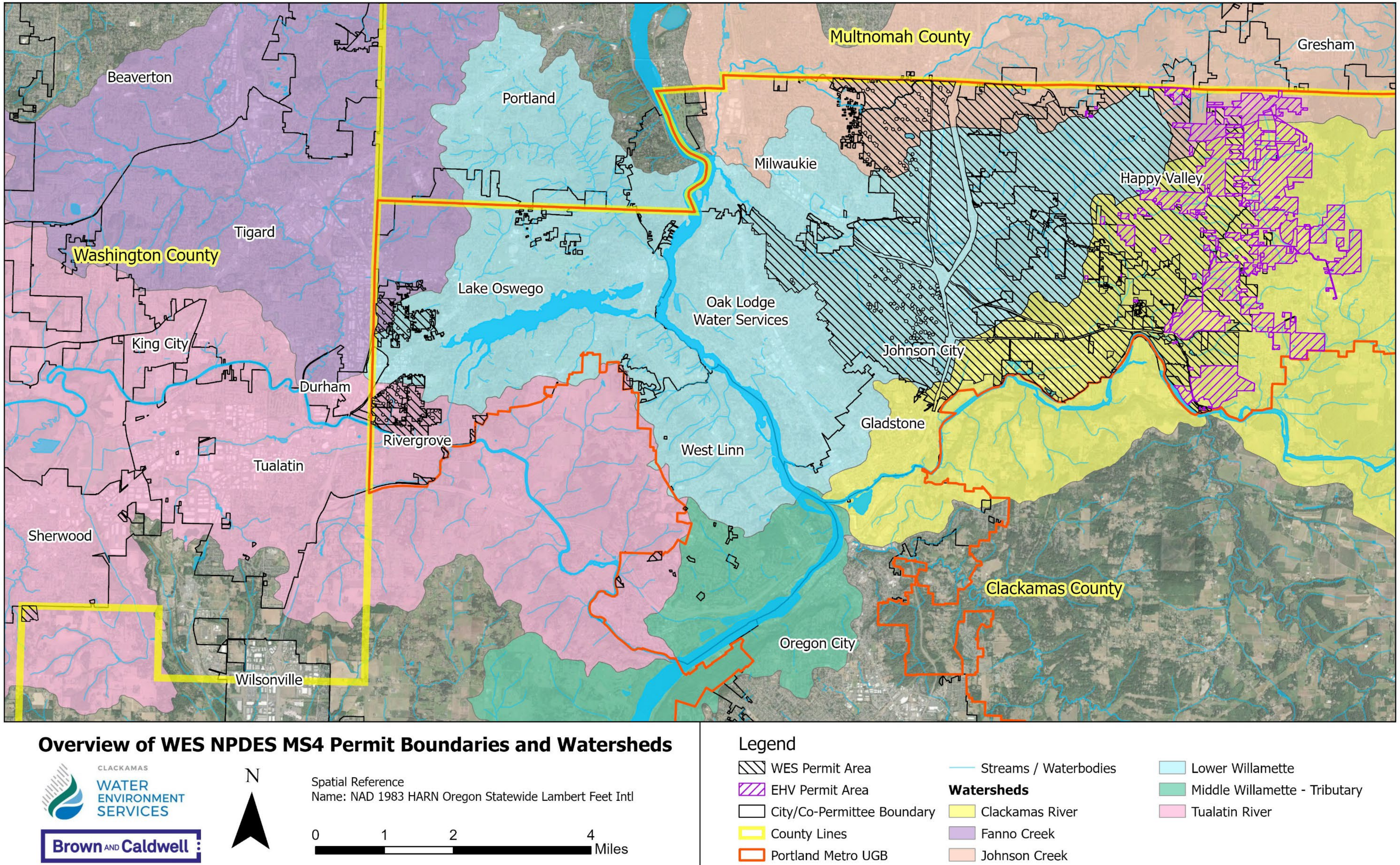

Figure 2-1. WES and EHV Stormwater Management Service Area Boundaries

2.2 Identification of Projected Service Area Expansions

This section summarizes how service area expansions were estimated and projected for the WES stormwater management service area and the City of Happy Valley (City) for the next permit term (through November 2031). As described previously, the portion of the City of Rivergrove located in Clackamas County is within WES' stormwater management service area and therefore is considered in WES' description below.

2.2.1 WES

Annexations to WES' stormwater management service area occur based on need from the surrounding communities and are typically development driven. At the present time, annexation into the WES stormwater management service area is almost exclusively the result of development activities that occur within the Happy Valley city limits, including the area within EHV.

Prior to 2020, parcels with over 5,000 square feet of impervious area that were not currently connected to sanitary sewer services were required to annex into WES to support redevelopment or new development. However, starting in 2020, single-family homes, accessory dwelling units (ADUs), and duplexes can now develop without annexation into the WES stormwater management service area, but the newly-developed parcel's septic system will need to be able to process and dispose of the parcel's wastewater, which limits the degree of development which can occur. As a result, land use approvals and the land use process are conducted by the City; however, WES still conducts development review for stormwater on behalf of the City, as stormwater management facilities located outside of WES' stormwater management service area are likely to be part of a future annexation into the WES stormwater management service area. Based on the recorded changes to WES' stormwater management service area over the last ten years, a total of 308 acres of the City's service area was annexed into the WES stormwater management service area.

Due to the variable nature of the land annexation process affecting WES, and the fact that annexations can involve service area transfers from one Clackamas co-permittee to another (e.g., WES to Lake Oswego or Happy Valley to WES), no projected service area expansions have been identified for WES' stormwater management service area.

2.2.2 Happy Valley

For the City of Happy Valley, annexations are typically voluntarily initiated by the applicant. The City's process for annexation and associated zoning changes is outlined in Section 16.67.070 of the City's Land Development Code. The City's Annexation Petition Policy (19-19), revised in July 2023, guides annexation approvals.

In accordance with Policy 19-19, support for annexation occurs in accordance with the following:

1. The property or properties are adjacent to the existing city limits; or,
2. The property or properties are along an existing "cherry stem annexation" established prior to 2019. Note that new cherry-stem annexations can occur within a reasonable distance to existing city limits or an existing cherry-stem depending on the condition of the roadway; or,
3. The property or properties that represent commercial, industrial or other high opportunity areas; or,
4. If a residential neighborhood should seek annexation, at least 75 percent of the property owners that are part of an HOA and for non-HOA developments, at least 75 percent of the property owners on the public ROW that makes up the cherry stem shall participate in the annexation request.

For property or properties in alignment with Policy 19-19, annexation to the City would occur as part of an expedited process, typically within 60-90 days. Annexations in the City typically fall under this expedited annexation process. Under the expedited process, annexations are heard and decided only by the City Council. This applies to annexation areas within the urban planning area (UPA) and includes no planned changes to zoning designations. Development is then subject to developer timelines and the availability of public facilities.

For properties identified as an exception to Policy 19-19, a non-expedited annexation process would occur. Non-expedited annexations require an evidentiary hearing before the City's Planning Commission and recommendation to City Council, followed by a City Council evidentiary hearing, where approval of the annexation requires a vote and majority approval by City Council. With approval, development would likely require adoption of an acknowledged Comprehensive Plan and extension of public facilities. Therefore, development is not considered immediate for these areas.

The City last updated their citywide Comprehensive Plan in 2017, and the Pleasant Valley/North Carver Comprehensive Plan was adopted in 2023. A future Comprehensive Plan update is anticipated with annexation of lands east of the Pleasant Valley/North Carver area and associated with the former city of Damascus. The timeline for the update is currently unknown but once initiated it is estimated to take approximately two years to complete.

In the City, future expansion areas anticipated over the next permit term (through 2031) were identified by reviewing documented publications of population growth projections in Clackamas County, historic annexation rates into the City, and proximity to future sanitary and water service lines (i.e., the Rock Creek Interceptor, sanitary trunkline installations off SE Troge Rd, etc.). Between November 2016 and November 2025, a total of 1,038 acres were annexed into the City, which is less than the 2,300 acres estimated for annexation as reflected in the 2017 MS4 permit renewal application submitted on behalf of the City of Happy Valley. Current trends in annexation to the City reflect the incorporation of area along the eastern city boundary, once part of the City of Damascus.

For purposes of this permit renewal effort, a total of approximately 47 acres have been identified for potential future annexation into the City over the next permit term, bringing the City's total anticipated MS4 permit service area to 2,773 acres.[2] This total anticipated service area does not reflect city area that is currently part of WES' stormwater management service area, nor area that would subsequently be annexed into WES (and removed from the City's NPDES MS4 permit area) in conjunction with development activities.

Areas identified as potential future annexations for the City are either included in the 2008 East Happy Valley Comprehensive Plan or the 2023 Pleasant Valley/North Carver Comprehensive Plan, as verified using publicly available GIS. City planning staff anticipate that the likelihood of annexation of these parcels in the next 5 years is high and consistent with the historic rate of annexation but ultimately will depend on the applicant's objectives. Annexation and development of area outside of these identified parcels would likely include areas already noted in the existing Comprehensive Plan area that would get access to public services, mainly sanitary sewer service from WES.

[2] In 2017 the City anticipated annexing approximately 2,300 acres to EHV, increasing the City's permit service area to 4,304 acres (excluding city area annexed into WES' stormwater management service area). This was based on historic annexation trends and the disincorporation of the City of Damascus. However, only approximately 1,038 acres were annexed into EHV between 2016-2025, resulting in the City's current permit area of 2,726 acres.

Because these potential future annexation areas are already in the City's Comprehensive Plans, City zoning is currently established. Future annexation areas include low density residential (R-7, R-10) representing 39% of anticipated future annexation area, medium density residential (R-5) representing 23% of anticipated future annexation area, high density residential (SFA - single-family attached residential) representing 32% of anticipated future annexation area, and mixed use residential – multifamily (MUR-M2) representing 6% of anticipated future annexation area.

Annexation into the City would not automatically extend or increase many of the public services that would support development, other than what is already provided. In addition, Happy Valley has only had one annexation since the City discontinued its policy to waive fees for property to annex in July 2024. Therefore, these proposed future annexation areas will likely remain rural residential until development pressure and associated sanitary sewer service from WES become available. These parcels are generally served by septic systems and drinking water wells, but some properties already receive potable water service from Sunrise Water Authority. With annexation, and in alignment with the Comprehensive Plans, these annexed areas would have the potential to subdivide and be developed in accordance with the City-approved zoning designations, and in conjunction with the extension of sanitary sewer services provided by WES.

Locations of anticipated service area expansions in the City are shown on the MS4 maps, included in the permit renewal application.

Section 3

Updated Estimate of Total Annual Pollutant Loads

This section outlines the modeling methods, assumptions, and results associated with developing an updated estimate of total annual stormwater pollutant loads.

Clackamas County co-permittees submitted their original estimate of total annual stormwater pollutant loads in Part 2 of the 1993 MS4 permit application. This annual load estimate included area now defined as the WES stormwater management service area. The WES stormwater management service area is the portion of Clackamas County Service District #1 (CCSD #1), which is located within the Portland metro area UGB, and the Surface Water Management Agency of Clackamas County (SWMACC), which includes the portion of the City of Rivergrove in Clackamas County. These service areas were collectively referred to as the “Districts” and are now combined as the WES stormwater management service area. For comparison with the previous NPDES MS4 permit renewal application, the term “Districts” will be maintained.

In 2008, the Districts provided an updated estimate of total annual pollutant loads with the MS4 permit renewal application. The total modeled MS4 permit area for the Districts in 2008 was 13,457 acres, which reflected the combined CCSD#1 and SWMACC service area and did not reflect any projected annexations. A spreadsheet loads model, using the U.S. Environmental Protection Agency (EPA) simple method equation was developed and used for the 2008 analysis.

The City of Happy Valley did not submit an estimate of total annual pollutant loads in 2008 for the rural, undeveloped portion of the City (i.e., EHV), which was not annexed into CCSD#1 at that time.

The total annual pollutant loads were again recalculated and submitted with the Districts,’ Clackamas County’s, and the cities’ permit renewal application in 2017. Modeling methods and assumptions were consistent with the 2008 analysis. Total annual pollutant loads were calculated for the Districts and the Cities projected MS4 service area, reflecting annexations anticipated to occur through the end of the permit term (estimated as 2022). The total, projected MS4-permitted service area for CCSD#1 was 13,415 acres, and for SWMACC was 703 acres (cumulatively 14,118 acres for the Districts), and 4,304 acres for EHV.

Modeling methods and assumptions used for this (2026) estimate of total annual pollutant loads are detailed below and are generally consistent with the approach used in 2008 and 2017. Total annual pollutant loads have been calculated and reported on separately for WES and EHV.

3.1 Modeling Methods and Assumptions

Total annual pollutant loads were calculated for WES and the City’s current MS4 service area and annexations anticipated to occur through the end of the next permit term (2031). The total modeled MS4 permit area is 14,393 acres for WES and 2,773 acres for EHV, consistent with the discussion of anticipated NPDES MS4 service area expansions outlined in Section 2.

Total annual pollutant loads are required to be calculated for TMDL pollutants, or applicable pollutant surrogates, and additional parameters as listed in Schedule B.4.d (nitrate, total phosphorus, ortho-phosphorus, copper, lead, and zinc). The Willamette Basin TMDL[3] (Lower and Middle Willamette subbasins, Johnson Creek subbasin, and Clackamas River subbasin) includes waste load allocations (WLAs) for bacteria (E. coli) and total mercury for WES and the cities, as well as DDT and dieldrin for the lands in the Johnson Creek watershed. The Tualatin Basin TMDL (including the Fanno Creek subbasin) includes WLAs for bacteria (E. coli), total phosphorus (as a surrogate for chlorophyll a and pH), and settleable volatile solids (SVS) (as a surrogate for dissolved oxygen [DO]).

Specific to the Willamette Basin TMDL and applications within the Tualatin River watershed, the mercury TMDL became effective in 2019; however, limited stormwater monitoring data is available for mercury (total or methyl) preventing a quantitative evaluation of mercury loading or the development of benchmarks for mercury (see Schedule D.3.b.iii of the MS4 permit). In addition, as described in the 2026 TMDL pollutant load reduction evaluation (PLRE), no current sources of DDT and dieldrin exist in the Johnson Creek watershed, and pollutant load reduction is reliant on controlling erosion of upland soils and on processes of natural degradation. With limited, relevant monitoring data to assess current DDT and dieldrin loading, these parameters are not included in the annual loads estimate. Specific to the Tualatin TMDL, as described in the 2026 PLRE, given the lack of data for SVS, the Tualatin Subbasin TMDL references total suspended solids (TSS) as a common parameter to evaluate instead of SVS. Therefore, bacteria (E. coli), total phosphorus, and TSS are the TMDL parameters included in this evaluation for the Tualatin River TMDLs.

A spreadsheet pollutant loads model using the EPA simple method was used for the pollutant load calculations. The spreadsheet loads model is consistent with the model used in 2008 and 2017 and contains baseline land use event mean concentrations (EMCs), which were developed in 2008 as part of a coordinated effort between the Oregon Association of Clean Water Agencies (ACWA) and Oregon Phase I jurisdictions. The land use EMCs were calculated as a range reflecting the upper and lower 95 percent confidence limit (UCL and LCL), and reflect general land use categories (commercial [COM], residential [RES], industrial [IND], parks and open space [POS]). Table 3-1 summarizes the land use EMCs that were used in the model.

The spreadsheet loads model and land use EMCs per Table 3-1 were also used to conduct the 2026 PLRE and calculate TMDL benchmarks.

Table 3-1. Land Use EMC Values used in the Total Annual Pollutant Load Estimate

Parameter	Land Use	Count[a]	Bootstrapped Values		
			95% LCL	Mean	95% UCL
TSS, mg/L	COM[b]	72	64	82	103
	IND	48	117	184	284
	POS	10	16	31	50
	RES[c]	65	44	66	99
E. coli, CFU/100 mL (geomean)	COM[b]	52	573	1,247	2,409

[3] The Willamette Basin TMDL also includes temperature; however, DEQ does not consider temperature to be a pollutant parameter associated with urban runoff in the Willamette Valley. Temperature is regulated by DEQ and addressed by individual NPDES wastewater discharge permits and nonpoint source TMDL implementation plans, but not under the MS4 permit.

Table 3-1. Land Use EMC Values used in the Total Annual Pollutant Load Estimate

Parameter	Land Use	Count[a]	Bootstrapped Values		
			95% LCL	Mean	95% UCL
	IND	58	154	438	1,004
	POS	9	57	87	124
	RES[c]	65	970	1,656	2,651
Nitrate, mg/L	COM[b]	46	0.27	0.38	0.53
	IND	22	0.18	0.24	0.31
	POS	263	1.36	1.51	1.66
	RES[c]	32	0.60	0.91	1.33
Total phosphorus, mg/L	COM[b]	26	0.280	0.380	0.500
	IND	25	0.400	0.510	0.640
	POS	8	0.095	0.120	0.150
	RES [c]	36	0.230	0.340	0.480
Dissolved phosphorus, mg/L	COM [b]	46	0.09	0.11	0.14
	IND	21	0.10	0.17	0.27
	POS	261	0.04	0.04	0.04
	RES [c]	30	0.08	0.11	0.15
Copper, total, µg/L	COM [b]	26	20.8	28.6	38.2
	IND	26	33.8	45.5	58
	POS	10	2.0	2.5	3.0
	RES [c]	33	10.5	13.4	17.1
Lead, total, µg/L	COM [b]	25	37.8	54.0	72.7
	IND	22	32.7	48.3	67.0
	POS	9	0.6	0.8	1.1
	RES [c]	28	11.0	17.7	27.6
Zinc, total, µg/L	COM [b]	28	130.0	170.0	217.0
	IND	24	283.0	674.0	1,353.0
	POS	9	6.3	7.8	9.5
	RES [c]	39	77.0	104.0	134.0

Note: Data range (+/- 95%) provided by the City of Portland; based on modified ACWA data set (see 2015 PLRE).

a. *Count refers to the number of samples used to calculate the land use EMC.*

b. *COM was used to simulate runoff concentrations from agriculture and public facility land use.*

c. *RES was used to simulate runoff concentrations from SFR, MFR, and rural residential land uses.*

Full buildout conditions (i.e., no remaining vacant lands) were simulated in the spreadsheet loads model, consistent with the 2008 and 2017 assumptions. As WES and the cities do not maintain a current condition land use coverage map, the modeled land use categories were based instead on zoning. Clackamas County zoning coverage was used to establish development conditions for WES and the cities. Zoning for future annexation areas into the City of Happy Valley are based on zoning defined in their 2018 and 2023 Comprehensive Plans. Zoning categories were reviewed and consolidated into those categories for which land use concentration information (see Table 3-1) exists.

WES and the cities maintained consistent land use categories as the 2017 PLRE and benchmark evaluation assumptions with the following exceptions (which are also reflected in the 2026 PLRE and TMDL benchmarks):

- Instead of defining a single-family residential zoning category to reflect lower density housing, a more general “residential” zoning category is used. This category reflects lower density residential development to align with statewide middle housing initiatives, which may not exclusively be single family residential development.
- This evaluation now includes a Public Facilities (PF) land use category which encompasses school campus and school district-owned lands. Due to the unique land use characteristics of school properties (often having large grassy fields but also large buildings and parking lots), this land use category was separately defined to apply a more representative impervious assumption for these areas.

Calculation of pollutant loads using the EPA simple method requires runoff coefficients reflective of each land use category. Consistent with assumptions and methodology described in the 2017 PLRE, the runoff coefficients were calculated from estimated impervious percentages for each land use category. These values are consistent with the 2008 assumptions, apart from PF which is a new category in this evaluation and was calculated in 2025 as part of this effort. Table 3-2 below summarizes the modeled area by service area, land use category, and associated impervious percentages used for this estimation of total annual pollutant loads.

Table 3-2. Modeled Area by Build-out Land Use Category and Impervious Percentage

Modeled Land Use Category	Modeled Impervious Percentage (%)	WES Service Area		EHV Service Area	
		Existing Service Area (ac)	Future Annexations (ac)	Existing Service Area (ac)	Future Annexations (ac)
Agricultural (AGR)	5	184.3	--	660.1	--
Industrial (IND)	70	1,818.2	--	216.3	--
Commercial (COM)	72	1,292.0	--	75.0	--
Open space (OSP)	7	1,521.7	--	113.7	--
Residential (RES)	42	7,743.0	--	681.7	29.0
Multi-family Residential (MFR)	61	1,356.2	--	260.1	18.4
Rural Residential (RUR)	10	119.1	--	714.2	--
Public Facilities (PF)	41	358.9	--	4.5	--
SUBTOTAL PROJECTED SERVICE AREAS		14,393.4	0	2,725.6	47.4
TOTAL PROJECTED SEVRICE AREA (2031)		14,393.4		2,773.0	

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The annual pollutant load estimates are based on an average annual rainfall depth of 40 inches, consistent with the rainfall depth assumed in the 2008 and 2017 MS4 permit renewal applications and 2026 PLRE and benchmarks evaluation.

3.2 Updated Estimate of Total Annual Pollutant Loads

Total annual pollutant loads—reflective of full-buildout conditions in the anticipated WES stormwater management service area and the City's permit area through the end of the permit term—are summarized in Table 3-3 and Table 3-4 for the applicable parameters. This updated estimate is presented in terms of a pollutant load range because of the inherent variability in stormwater runoff quality. Pollutant loads are shown in pounds (lb) per year, with the exception of *E. coli*, which is shown as total counts per year.

Table 3-3. Updated Annual Estimate of Pollutant Loads for WES

Pollutant Load Parameter	LCL (lb/Year Or Counts/Year)	Mean (lb/Year Or Counts/Year)	UCL (lb/Year Or Counts/Year)
TSS	3,249,006	4,846,886	7,181,379
E. coli (counts)	1.79E+14	3.24×10^{14}	5.49E+14
Nitrate	26,365	38,621	55,046
Total phosphorus	14,389	20,125	27,259
Dissolved phosphorus (i.e., ortho-phosphorus)	4,555	6,450	9,073
Copper, total	880	1,165	1,501
Lead, total	1,033	1,558	2,245
Zinc, total	6,602	11,811	20,088

Table 3-4. Updated Annual Estimate of Pollutant Loads for East Happy Valley

Pollutant Load Parameter	LCL (lb/Year Or Counts/Year)	Mean (lb/Year Or Counts/Year)	UCL (lb/Year Or Counts/Year)
TSS	408,825	610,808	907,088
E. coli (counts)	2.39E+13	4.29E+13	7.21E+13
Nitrate	3,420	5,062	7,268
Total phosphorus	1,832	2,576	3,504
Dissolved phosphorus (i.e., ortho-phosphorus)	584	827	1,163
Copper, total	110	145	186
Lead, total	127	192	279
Zinc, total	824	1,458	2,458

Note: The service area includes only the non-urbanized portions of the City of Happy Valley within city limits and future annexation areas.

Section 4

Qualitative Evaluation

This section provides a qualitative evaluation of the potential increases in area, intensity, and pollutant loads due to the projected service area expansions discussed in Section 2. This discussion is required per Schedule B.4.f of WES,' Clackamas County's, and the cities' MS4 permit.

Outcomes from this evaluation are intended to support DEQ's determination as to whether the permit renewal will involve a substantial modification or intensification of the permitted activity, as referenced in Oregon Administrative Rule (OAR) Chapter 340, Division 18 regarding completion of a Land Use Compatibility Statement (LUCS). Specifically, OAR 340-018-0050(2)(b), which states:

> *(b) An applicant's submittal of a LUCS is required for the renewal or modification of the permits identified in OAR 340-018-0030 if the Department determines the permit involves a substantial modification or intensification of the permitted activity.*

The City of Happy Valley expects to have only minor expansion of its service area during the next permit term (2026-2031) and concludes that the expansion will not result in substantial increases in permitted area, runoff intensity, or pollutant loads. The City of Rivergrove does not expect to significantly expand its service area in during the next MS4 permit period (i.e., by year 2031). WES does not expect to expand its stormwater management service area beyond area already covered by another MS4 co-permittee. Analysis provided in Sections 2 and 3 support these findings, as detailed in the subsections below.

4.1 Service Area Expansion

The City of Happy Valley expects to have only minor expansion, approximately 47 acres, during the next permit term (2026-2031). This service area expansion represents 1.7 percent of the City's MS4 permit area anticipated in the year 2031, which is not a substantial increase in service area.

WES does not anticipate any annexation during the next permit term. However, any expansion if it does occur would probably be transferred from one Phase 1 Clackamas County MS4 co-permittee (i.e., the City) and this area would likely already be accounted for in their current service area. Annexation is ultimately subject to the availability of public facilities and services to accommodate development.

At the present time, there is no proposed adjustment to the UGB near the cities or the WES stormwater management service area that would further promote annexation of area outside the current UGB.

4.2 Pollutant Load Discharge

With expansion of the service area, the pollutant load permitted under the City of Happy Valley's MS4 permit may increase with urbanization (existing rural land prior to annexation is also anticipated to have some level of pollutants in stormwater discharges). However, the incremental increase in pollutant load generation would be addressed and reduced by programmatic and structural stormwater best management practices implemented by the City. Additionally, the projected service area expansions identified in 2026 are less than accounted for in the total annual pollutant load estimates developed in 2017.

Proposed service area expansions for the City of Happy Valley are currently considered rural residential land use and zoned as residential or multi-family residential land use. However, these areas may not be developed to their full development potential immediately upon annexation. Thus, the increase in imperviousness (or "intensity" per the MS4 permit language) and associated pollutant load discharge may change based on development potential. It should be noted that with annexation, these future service area expansions would now be included under the City's MS4 permit coverage, and development activities in these annexation areas would be subject to additional stormwater controls and stormwater design standards that would not otherwise be implemented, and these controls are expected to include stormwater runoff volume reduction (via infiltration), stormwater detention, and stormwater pollution removal via treatment structures such as stormwater management ponds and stormwater planter boxes.

For WES, as described in Section 2.2.1, any potential service area expansions or annexations are development-driven in order to connect to WES' sanitary sewer system. These areas are most likely already in the City of Happy Valley city limits, and development/redevelopment is almost certain to accompany any annexation into WES. Such development would be expected to increase the imperviousness or intensity from the current land use, up to the imperviousness associated with the allowable zoning designation. The magnitude of change would ultimately vary depending on the nature of the current and proposed site usage. However, as discussed for the City of Happy Valley, development activities would be subject to WES' stormwater controls and stormwater design standards.

Since 1995, WES and the cities have adaptively managed their stormwater programs as most recently detailed in the 2024 MS4 Permit Shared SWMP Document (Shared SWMP Document) and through the process outlined in the maximum extent practicable (MEP) evaluation. The 2024 Shared SWMP Document includes a variety of operational and source control best management practices (BMPs) targeting typical stormwater pollutants of concern. Newly annexed properties to the City of Happy Valley or WES will be subject to BMPs outlined in the 2024 Shared SWMP Document if the property is served by an MS4

In October 2022, WES completed the Storm System Master Plan for the WES stormwater management service area, providing a framework and capital improvement projects targeted at improving water quality at a regional scale. WES also adopted updated Stormwater Standards and Rules and Regulations in April 2024 that promote stormwater retention and infiltration using a hierarchy of stormwater facilities for new or redevelopment projects. The 2024 Rules and Regulations update substantially increased WES' authority to inspect and correct storm maintenance deficiencies found within private storm systems that may impact discharges from WES' public storm sewer system.

Collectively, implementation of the 2024 Shared SWMP Document, 2022 Storm System Master Plan, and 2024 Stormwater Standards and Rules and Regulations will result in the ongoing, future installation of structural stormwater controls throughout existing development areas, redevelopment areas, and new development areas, including annexations. Typical stormwater facilities include filtration and infiltration planters and rain gardens, which are types of green infrastructure (GI) that, in addition to direct treatment of stormwater runoff, also promote infiltration of stormwater runoff and limit pollutant discharges through volume reduction.

As part of the 2026 PLRE, a water quality trends analysis was conducted to evaluate whether instream water quality conditions, as reflected through instream water quality monitoring efforts, were improving or degrading in conjunction with MS4 discharges. A trends analysis was last conducted in 2015. The most recent water quality trends indicate that instream water quality in WES' stormwater management service area is generally the same or improving, even in consideration of service area expansions that have historically occurred along with associated development and redevelopment activities. Most of the sites evaluated had either no observed trends or trends towards decreasing pollutant concentrations, indicating improved water quality.

Given the extensive efforts in implementing an effective stormwater program including source control and structural stormwater controls, pollutant loads are not anticipated to significantly increase as a result of service area expansions. Historical service area expansions and development have not resulted in significant impacts to instream water quality, as indicated through the water quality monitoring data and trends analysis.

4.3 Conclusion

At the present time, there are no anticipated annexations into WES' stormwater management service area that would result in an increase in the area, intensity, or pollutant loads permitted. Any annexation into WES' service area is anticipated to be limited to parcels that are currently part of the City of Happy Valley, which is also a co-permittee under the MS4 permit. The City of Rivergrove does not plan to annex property in the next permit term.

At the present time, future annexation into the City's service area is primarily located along the eastern city boundary (EHV). Annexations to the City are expected to minimally increase the overall permitted area. However, annexations are applicant-driven and would not be conducted directly in conjunction with development activities, as development will not be permissible until public facilities and services are available. Therefore, annexations for the upcoming permit term are not an indication of a direct increase in the intensity and pollutant load generation.

Development/redevelopment occurring with annexation may result in an increase in impervious area and pollutant load generation. However, WES and the City of Happy Valley implement an extensive stormwater program including requirements related to stormwater design standards for new and redevelopment, source controls, and non-structural/programmatic activities, which are expected to address additional pollutant loading from development activities related to service area expansion.

Appendix B

303(d) List Evaluation

Technical Memorandum

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Prepared for: Clackamas Water Environment Services

Project Title: MS4 Permit Renewal for WES, Clackamas County, Happy Valley and Rivergrove

Project No.: 203486

Technical Memorandum

Subject: 303(d) Evaluation

Date: May 12, 2026 (Final)

To: Andrew Swanson, Clackamas Water Environment Services

From: Angela Wieland, P.E., Brown and Caldwell

Prepared by: Shelby Gilmartin

Shelby Gilmartin, E.I.T.

Reviewed by: Angela Wieland

Angela Wieland, P.E.

Limitations:

This document was prepared solely for Clackamas County WES in accordance with professional standards at the time the services were performed and in accordance with the contract between City and Brown and Caldwell dated May 14, 2025. This document is governed by the specific scope of work authorized by the WES; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by WES and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
BMP	best management practice
CC	Clackamas County
CCSD#1	Clackamas County Service District No. 1
CCCSMP	Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DEQ	(Oregon) Department of Environmental Quality
Districts	CCSD#1 and SWMACC
DO	dissolved oxygen
DTD	(Clackamas County) Department of Transportation and Development
GI	green infrastructure
HABs	harmful algal blooms
HV	Happy Valley
L	liter(s)
LID	low-impact development
MCLs	maximum contaminant levels
MEP	maximum extent practicable
mg	milligram(s)
MS4	municipal separate storm sewer system
ng	nanograms
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rules
OC	organochlorine
ODOT	Oregon Department of Transportation
OLWS	Oak Lodge Water Services
PAH	Polycyclic Aromatic Hydrocarbons
PCB	polychlorinated biphenyl
PGA	Public and Government Affairs
SWMACC	Surface Water Management Agency of Clackamas County
SWMP	Stormwater Management Program
TCE	Trichloroethylene
TM	technical memorandum
TMDL	total maximum daily load
TSCA	Toxic Substances Control Act
TSS	total suspended solids
UGB	urban growth boundary
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WES	(Clackamas) Water Environment Services

Section 1: Introduction

This technical memorandum (TM) provides an evaluation of 303(d)-listed pollutant parameters as they relate to discharges from the municipal separate storm sewer system (MS4) within the Clackamas Water Environment Services (WES) stormwater management service area inside of the Portland Metro Area's urban growth boundary (UGB)[1], which includes Clackamas County, the City of Happy Valley, and the portion of the City of Rivergrove in Clackamas County.

These areas are regulated under the Phase I National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit. For purposes of this TM, these jurisdictions are collectively referred to as the "SWMP Document Participants" due to their collective stormwater management requirements detailed under their Shared Stormwater Management Program Document (Shared SWMP Document) [2], and their MS4 permit coverage is referred to as the "Permitted Area".

This TM includes the following information:

- An evaluation of whether there is a reasonable likelihood for stormwater from the MS4 to cause or contribute to water quality degradation of receiving waters related to specific 303(d) parameters
- An evaluation of whether the best management practices (BMPs) in the current 2024 Shared SWMP Document are effective in addressing and reducing applicable 303(d)-listed parameters
- An identification of potential stormwater management program revisions that may be considered to address and reduce the 303(d) pollutants to the maximum extent practicable (MEP)

1.1 Summary of Permit Requirements

The MS4 permits for Phase I communities require a qualitative review of the effective 303(d) list established for the jurisdiction's receiving waters. Pollutant parameters included on the 303(d) list are those that have been found to exceed water quality standards for a water body's established beneficial or designated uses.

In Oregon, the U.S. Environmental Protection Agency (USEPA) has delegated authority to the Department of Environmental Quality (DEQ) to conduct water quality assessments to determine the status of water bodies in the state with respect to established water quality standards. DEQ conducts the assessments approximately every 2 years and publishes findings in an Integrated Reported, which includes the effective 303(d) list.

Receiving waters that are placed on the 303(d) list do not yet have an established total maximum daily load (TMDL), including load or wasteload allocations for the pollutant parameters. TMDLs have been established for specific pollutant parameters in the Lower Willamette River and the Tualatin River watersheds, which includes the Permitted Area. The SWMP Document Participants are addressing requirements for TMDL parameters through a separate quantitative evaluation of pollutant loads and pollutant load reductions, which is not included in this document.

The SWMP Document Participants are four of the co-permittees on Clackamas County's NPDES MS4 Phase 1 Individual Permit (MS4 permit). Specific permit requirements in the 2021-2026 permit for the 303(d) evaluation are listed in Schedule D.2 of the permit, as follows:

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[1] Only the portion of Clackamas WES and Clackamas County that falls within the UGB is covered by the NPDES MS4 Permit. [2] Clackamas County, Clackamas Water Environment Services, City of Happy Valley, and City of Rivergrove collectively created the "2024 MS4 Permit Shared Stormwater Management Program Document" in July 2024. For ease of reference this TM will refer to the document as the 2024 Shared SWMP Document or Shared SWMP Document.

[2] Clackamas County, Clackamas Water Environment Services, City of Happy Valley, and City of Rivergrove collectively created the "2024 MS4 Permit Shared Stormwater Management Program Document" in July 2024. For ease of reference this TM will refer to the document as the 2024 Shared SWMP Document or Shared SWMP Document.

The co-permittee must:

i. Review the applicable pollutants that are on the 2018/2020 Integrated Report's 303(d) list, or the most recent USEPA list if approved within three years of the issuance date of this permit, that are relevant to the co-permittees' MS4 discharges with the MS4 Permit Renewal Application Package. Based on a review of the most current 303(d) list at the time, evaluate whether there is a reasonable likelihood for stormwater from the MS4 to cause or contribute to water quality degradation of receiving waters.

ii. Evaluate whether the BMPs in the existing SWMP Document are effective in addressing and reducing the 303(d) pollutants. If the co-permittee determines that the BMPs in the existing SWMP Document are ineffective in addressing and reducing the applicable 303(d) pollutants, the co-permittee must describe how the SWMP will be modified or updated to address and reduce these pollutants to the MEP.

iii. Submit a report with the MS4 Permit Renewal Application Package summarizing the results of the review and evaluation, and identify any modifications or updates to the SWMP Document that are necessary to reduce applicable 303(d) pollutants to the MEP.

During the previous MS4 permit term (2012-2017), the SWMP Document Participants submitted a 303(d) evaluation to DEQ in 2015. The 2015 evaluation has been referenced in developing this TM.

1.2 Summary of TM Organization

The purpose of this TM is to fulfill the MS4 permit requirements for a 303(d) evaluation as listed in Section 1.1.

Section 2 summarizes the 303(d)-listed parameters applicable to the SWMP Document Participants. Section 3 discusses each parameter or parameter category in additional detail, including:

- A summary of the relationship between regulated MS4 discharges and the listed parameter(s)
- An evaluation of current BMPs to address the listed parameter(s)
- A discussion of potential 2024 Shared SWMP Document adjustments for consideration, considered necessary, in order to further address 303(d) parameters

Section 4 provides a summary and conclusion regarding current BMPs and whether any modifications are needed to address the 303(d) pollutants.

1.3 Shared Stormwater Management Program Document

The Shared SWMP Document (July 2024)[3] outlines stormwater program activities, in the identified service areas and by responsible party, with respect to NPDES MS4 permit compliance. The Shared SWMP Document includes BMPs with measurable goals and tracking measures that the respective jurisdictions implement, or plans to implement within the current permit cycle, to address water quality in MS4 discharges. BMPs are generally implemented across the whole service area, unless specifically noted in the Shared SWMP Document.

[3] The Shared SWMP Document is reviewed annually in accordance with the SWMP Document Participants adaptive management process and is periodically updated, with the most recent update in July 2024, which is the version referred to in this evaluation (identified as the 2024 Shared SWMP Document in this TM).

The underlying compliance standard for the MS4 permit and the Shared SWMP Document under federal and Oregon law is that permittees are required to implement controls to reduce the discharge of the pollutants to the MEP. This means that the SWMP Document Participants are required to implement *reasonable and available* controls to reduce the discharge of pollutants. Neither USEPA nor DEQ provides a precise definition of MEP, acknowledging that MEP and the resulting activities will be different for each permittee based on a wide range of factors including watershed planning and local hydrology; local initiatives and concerns; climate; finances and operational capacity of each municipality; and beneficial uses of receiving waters.

Since the development of the Shared SWMP Document, the SWMP Document Participants have been continuously evaluating and adaptively managing their stormwater programs based on new data, technology, and review of BMPs. In this way, the current 2024 Shared SWMP Document reflects the best professional judgment regarding resource allocation and optimization to reduce or eliminate discharge of stormwater pollutants from the regulated MS4 to the MEP.

The Shared SWMP Document and associated BMPs are organized into nine major program categories, corresponding to the NPDES MS4 permit. The Shared SWMP Document categories and BMPs are listed in Table 1 below. Section 3 of this TM identifies BMPs in the 2024 Shared SWMP Document that are effective in addressing the 303(d)-listed pollutants. It should be noted that for each BMP, there are specific BMP activities numbered and further described in the Shared SWMP Document; responsibilities, measurable goals and tracking measures are listed by BMP activity as opposed to the primary BMP itself.

Table 1. 2024 Shared SWMP Document Summary

Shared SWMP Document Categories	BMPs
1. Education and Outreach (ED)	ED-1. Stormwater Public Education and Outreach Strategy ED-2. Outreach to Priority Audiences ED-3. Evaluation of Education and Outreach Activities
2. Public Participation (PP)	PP-1. Publicly Accessible Website PP-2. Public Stewardship PP-3. Evaluation of Public Participation Activities
3. Illicit Discharge Detection and Elimination (IDDE)	IDDE-1. Illicit Discharge Legal Authority IDDE-2. Illicit Discharge Response IDDE-3. Illicit Discharge Enforcement Procedures IDDE-4. Dry Weather Inspections IDDE-5. IDDE Staff Training IDDE-6. Evaluation of IDDE Activities
4. MS4 Mapping (MAP)	MAP-1. Develop Mapping Strategy MAP-2. Inventory and Map MS4 Infrastructure MAP-3. Track and Map Locations of Concern MAP-4. MS4 Mapping Evaluation
5. Construction Site Runoff Control (EPSC)	EPSC-1. Construction Site Runoff Legal Authority EPSC-2. EPSC Plan Review EPSC-3. EPSC Inspection and Enforcement EPSC-4. Construction Site Runoff Staff Training EPSC-5. Evaluation of Construction Site Runoff Control Activities
6. Post-Construction Site Runoff (POST)	POST-1. Post-Construction Legal Authority POST-2. Post-Construction Stormwater Standards POST-3. Stormwater Management (SWM) Plan Review

Table 1. 2024 Shared SWMP Document Summary	
Shared SWMP Document Categories	**BMPs**
	POST-4. Post-Construction Verification and Acceptance POST-5. Post-Construction Site Runoff Staff Training POST-6. Evaluation of Post-Construction Site Runoff Activities
7. Pollution Prevention for Municipal Operations (PREV)	PREV-1. Road Operations and Maintenance PREV-2. Winter Operations and Maintenance PREV-3. Landscape Maintenance and Vegetation Control PREV-4. Litter Control PREV-5. Municipal Facilities PREV-6. Control Sewage Infiltration PREV-7. Fire-Fighting Training PREV-8. Pollution Prevention Staff Training PREV-9. Evaluation of Pollution Prevention for Municipal Operations Activities
8. Industrial and Commercial Facilities (COMM)	COMM-1. Identify Industrial NPDES Permit Facilities COMM-2. Industrial/Commercial Stormwater Pollutant Prevention COMM-3. Industrial/Commercial Site Inspection Staff Training COMM-4. Evaluation of Industrial and Commercial Facilities Activities
9. Stormwater System Operation and Maintenance (MAINT)	MAINT-1. Operation and Maintenance Legal Authority MAINT-2. Implement Current Operations and Maintenance Strategy MAINT-3. Public Conveyance Cleaning and Maintenance MAINT-4. Regulated Private Storm System Inspection and Maintenance Program MAINT-5. Urgent Conditions / Storm Preparation and Response MAINT-6. Storm Sewer System Retrofit Program and Hydromodification Assessment MAINT-7. Stormwater Facility Maintenance Training MAINT-8. Evaluation of Stormwater System Operations and Maintenance Activities

Section 2: 303(d) Waterbodies and Parameters

Per the MS4 permit, jurisdictions must review the 2018/2020 303(d) list unless a more recent list has been approved by USEPA within three years of the issuance date of the permit (September 15, 2021).[4] DEQ's 2022 303(d) list was approved by USEPA in September 2022 and is the current list in effect. Therefore, the 2022 303(d) list is the effective 303(d) list for this evaluation. Applicable 303(d) parameters for the SWMP Document Participants pertain to the Lower Willamette River, Clackamas River, and Tualatin River subbasins, including tributaries. The applicable 303(d) parameters are identified in Table 2.

For the purposes of this evaluation, the evaluations of Chlordane, DDD 4,4', DDE 4,4', Endosulfan, Endrin Aldehyde, Dieldrin, polychlorinated biphenyls (PCBs) and Tetrachloroethylene have been combined in

[4] The original issuance date of the permit was September 15, 2021. DEQ released Modification #1 to the permit due to a major permit modification related to the monitoring required for pesticides in Schedule B.1. Therefore, the permit has an updated issuance date of May 4, 2023.

Section 3.5 Toxics (PCBs and OC Pesticides).Copper, iron (total), and zinc have been combined in Section 3.6 Heavy Metals.

Table 2. 2022 303(d) Parameters by Applicable Subbasin

Water Body	Parameter	Most Recent Assessment	Year Listed	Section Addressed in this TM
Lower Willamette Subbasin *(Clackamas County, Clackamas WES and Happy Valley)*				
Johnson Creek North Fork Johnson Creek to confluence with Willamette River	Biocriteria	2022	2010	3.1 Biocriteria
	Dissolved Oxygen (spawn)	2022	2022	3.2 Dissolved Oxygen
	Alkalinity	2022	2022	3.3 pH/Alkalinity
	PAHs	2002	2002	3.4 Polycyclic Aromatic Hydrocarbons (PAHs)
	PCBs	2022	2004	3.5 Toxics (PCBs and OC Pesticides)
	Chlordane	2022	2022	
	DDD 4,4'	2022	2022	
	DDE 4,4'	2022	2012	
	Endosulfan	2012	2012	
	Copper	2022	2022	3.6 Heavy Metals
	Iron (total)	2022	2018	
	Temperature (spawn) [a]	2022	2010	--
	Temperature (year-round) [a]	2022	2018	--
Unnamed Trib to Johnson Creek	Biocriteria	2010	2010	3.1 Biocriteria
	Zinc	2022	2022	3.6 Heavy Metals
	Temperature (year-round) [a]	2022	2018	--
Kellogg Creek	pH	2018	2018	3.3 pH/Alkalinity
Mitchell Creek	Temperature (year-round) [a]	2022	2010	--
Mount Scott Creek Phillips Creek to confluence with Willamette River	Dissolved Oxygen (spawn)	2018	2012	3.2 Dissolved Oxygen
	Endrin Aldehyde	2012	2012	3.5 Toxics (PCBs and OC Pesticides)
Clackamas River Subbasin *(Clackamas County, Clackamas WES and Happy Valley)*				
Cow Creek	Temperature (year-round) [a]	2010	2010	--
Clackamas River Wade Creek to confluence with Willamette River	Dissolved Oxygen (spawn)	2022	2012	3.2 Dissolved Oxygen
	Alkalinity	2022	2022	3.3 pH/Alkalinity
	Temperature (spawn) [a]	2022	2018	--
	Temperature (year-round) [a]	2022	2010	--
Unnamed Trib to Clackamas River	Dissolved Oxygen (spawn)	2018	2012	3.2 Dissolved Oxygen

Table 2. 2022 303(d) Parameters by Applicable Subbasin				
Water Body	Parameter	Most Recent Assessment	Year Listed	Section Addressed in this TM
Rock Creek	Dissolved Oxygen (spawn)	2022	2012	3.2 Dissolved Oxygen
Unnamed Trib to Rock Creek	Dissolved Oxygen (spawn)	2018	2012	3.2 Dissolved Oxygen
Tualatin River Subbasin *(Clackamas WES, Clackamas County, and City of Rivergrove)*				
Tualatin River McFee Creek to confluence with Willamette River	Biocriteria	2010	2010	3.1 Biocriteria
	Dissolved Oxygen (spawn)	2022	2022	3.2 Dissolved Oxygen
	Dieldrin	2022	2022	3.5 Toxics (PCBs and OC Pesticides)
	Iron (total)	2022	2012	3.6 Heavy Metals
	Harmful Algal Blooms	2010	2010	3.7 Harmful Algal Blooms
Cedar Creek Headwaters to confluence with Tualatin River	Biocriteria	2002	2002	3.1 Biocriteria
	Dissolved Oxygen (spawn)	2018	2012	3.2 Dissolved Oxygen
	Iron (total)	2022	2018	3.6 Heavy Metals
Fanno Creek Carter Creek to confluence with Tualatin River	Dissolved Oxygen (spawn)	2022	2012	3.2 Dissolved Oxygen
	Dieldrin	2018	2004	3.5 Toxics (PCBs and OC Pesticides)
	Tetrachloroethylene	2012	2012	
	Copper	2022	2012	3.6 Heavy Metals
	Iron (total)	2022	2012	

a. Temperature is addressed in the Lower Willamette and Tualatin River watersheds as a TMDL parameter and thus not addressed in this analysis. Additionally, temperature is not considered by DEQ to be a stormwater parameter as covered under the NPDES MS4 permit.

DDD = dichlorodiphenyldichloroethane

DDE = dichlorodiphenyldichloroethylene

PAHs = Polycyclic Aromatic Hydrocarbons

PCBs = polychlorinated biphenyls

-- = not applicable

Table 3 documents the changes (addition or removal) of 303(d) parameters between the 2010 303(d) list (used in the development of the jurisdictions 2015 303(d) evaluation) and the 2022 303(d) list. This table is intended as a quick review tool to track parameter changes over time.

Table 3. Changes to parameters from previous (2010) to current (2022) 303(d) list		
303(d) Waterbody	Parameter Added	Parameter Removed
Lower Willamette subbasin		
Johnson Creek North Fork Johnson Creek to confluence with Willamette River	• Alkalinity • Chlordane • Copper (dissolved fraction) • DDD 4,4' • DDE 4,4' • Endosulfan • Iron (total) • Temperature (spawn) [A] • Temperature (year-round) [A]	• pH
Unnamed Trib to Johnson Creek (ADDED)	• Biocriteria • Zinc (dissolved fraction) • Temperature (year-round) [A]	--
Kellogg Creek (ADDED)	• pH	--
Mitchell Creek (ADDED)	• Temperature (year-round) [A]	--
Mount Scott Creek (ADDED) Phillips Creek to confluence with Willamette River	• Dissolved Oxygen (spawn) • Endrin Aldehyde	--
Clackamas River subbasin		
Cow Creek (ADDED)	• Temperature (year-round) [A]	
Clackamas River Wade Creek to confluence with Willamette River	• Alkalinity • Temperature (spawn) [A] • Temperature (year-round) [A]	--
Unnamed Trib to Clackamas River (ADDED)	• Dissolved Oxygen (spawn)	--
Sieben Creek Drainage Area (REMOVED)	--	• Dissolved Oxygen (spawn)
Unnamed Trib to Rock Creek (ADDED)	• Dissolved Oxygen (spawn)	--
Tualatin River Subbasin		
Tualatin River McFee Creek to confluence with Willamette River	• Dieldrin • Harmful Algal Blooms	• Manganese
Chicken Creek (REMOVED)	--	• Dissolved Oxygen (spawn)
Cedar Creek (ADDED) Headwaters to confluence with Tualatin River	• Dissolved Oxygen (spawn) • Biocriteria • Iron (total)	--
Fanno Creek Carter Creek to confluence with Tualatin River	• Tetrachloroethylene • Iron (total) • Copper (dissolved fraction)	--

a. *Temperature is addressed in the Lower Willamette and Tualatin River watersheds as a TMDL parameter and thus not addressed in this analysis. Additionally, temperature is not considered by DEQ to be a stormwater parameter as covered under the NPDES MS4 permit.*

b. *Methylmercury is not addressed in this analysis as there is a TMDL for mercury for the Willamette River Basin.*

The previous 303(d) evaluation excluded the unnamed tributary streams while this evaluation includes those that are specifically 303(d)-listed within the Permitted Area, which increases the number of waterbodies listed. Additionally, Sieben Creek is no longer 303(d)-listed and has been removed accordingly.

Clackamas WES'/Clackamas County's and/or the City of Happy Valley's MS4 area includes drainage to several creeks that are not specifically included on the 303(d) list. These include Dean Creek and Philips Creek in the Kellogg Creek watershed (Lower Willamette Subbasin), and Carli Creek in the Clackamas River Subbasin.

WES' MS4 permit service area (which includes the City of Rivergrove) also includes drainage to several small, unnamed creeks in the Tualatin River Subbasin and the Middle Willamette Subbasin that are not included on the 303(d) list. Based on the current TMDL watershed boundaries and Permitted Area, Chicken Creek was removed from this evaluation as it does not appear to be near any Permitted Area that could be pollutant generating, while Cedar Creek was added as there is a small portion of Clackamas WES' boundary within the UGB by this stream that could contribute pollutants. Additionally, the TMDL watershed for Fanno Creek overlaps with a portion of Clackamas WES' boundary within the UGB, which is why this stream is included.

While 303(d) parameters vary by drainage basin, the 2024 Shared SWMP Document is implemented consistently throughout the Permitted Area. Therefore, the 303(d) evaluation in Section 3 has been conducted for all the Permitted Area.

Section 3: 303(d) Evaluation

This section provides an evaluation of the 303(d) parameters applicable to the SWMP Document Participants. The evaluation includes background and source information for each parameter and a description of the association between the parameter and MS4 discharges. In preparing the evaluation, the Shared 2024 SWMP Document was reviewed.

Table 4 summarizes the current BMPs in the Shared SWMP Document and indicates how each BMP is anticipated to prevent the 303(d) parameter from discharging into receiving waters by one or more of the following means:

1. Controlling of the ***source*** of a pollutant entering the regulated MS4,
2. Controlling or limiting the ***transport*** of a pollutant through the regulated MS4, or
3. Assumed pollutant reduction through ***indirect*** means (e.g., education, behaviors, funding, etc.).

Some BMPs support the MS4 permit efforts without direct or indirect impact on the identified pollutants, and these are noted in the table with a dash (--).

As the 2024 Shared SWMP Document details varying responsible parties based on BMP activity, some of the BMPs in Table 4 have been separated by unique BMP activity (those with numeric or alphanumeric designator, e.g., 2.2-a, 2.2-b, etc.). This is done to note a difference in responsible party or BMP pollution prevention mechanism (such as if one sub-activity has an indirect impact but another helps control the sources of a pollutant).

The "responsible party" designation includes WES, Happy Valley (HV), Clackamas County (CC) Department of Transportation and Development (DTD), CC Public and Government Affairs (PGA), CC Other Departments, and Rivergrove. Although Oak Lodge Water Services (OLWS) is consistently listed in the "General Responsibility" table at the beginning of each BMP it has a separate SWMP Document and is therefore not included in the summary of responsible parties. Responsible Parties in Table 4 includes an "Other" category to include any additional entities that are required to comply with the 2024 Shared SWMP Document but are not listed as a SWMP Document Participate (e.g., Code Enforcement). Responsibility is shown when the 2024 Shared SWMP Document identifies specific parties with general responsibility related to the management, actions, or enforcement of the BMP.

Variations to policies, activities, and practices between SWMP Document Participants are typically limited to implementation schedules and methods to set priority areas for implementing specific BMPs (e.g., setting priorities for construction site inspections). However, BMP implementation is not targeted at specific areas or watersheds to address 303(d)-listed pollutants. Rather, the SWMP Document Participants use best practices and adaptive management to formulate a stormwater program that targets a wide range of pollutants of concern in all the urban areas.

Table 4. Relationship between Current BMPs and Pollutants of Concern

S = control of the source of a pollutant entering the MS4
T = control of the transport mechanism of discharge
I = indirect pollutant reduction benefits
-- = not applicable

Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
1. Education and Outreach (ED)	ED-1. Stormwater Public Education and Outreach Strategy	ED-1.1 – Implement the Stormwater Public Education and Outreach Strategy	X	X	X	X	X	X	• ED-1.1-a: During the MS4 Permit term, include educational goals targeting audiences and topics in the Strategy. • ED-1.1-b: Each year complete at least 80% of planned written communication outputs (e.g., newsletters, websites, and pamphlets) described in the Strategy. • ED-1.1-c: Each year hold or co-sponsor at least three in-person public education opportunities (e.g., training, seminars, and kids' programs).	I	I	I	I	I	I	I
		ED-1.2 – Update the Stormwater Public Education and Outreach Strategy	X		X	X			• ED-1.2: Update the Strategy as needed.	I	I	I	I	I	I	I
	ED-2. Outreach to Priority Audiences	ED-2.1 – Erosion Control Outreach	X	X	X				• ED-2.1: Annually update erosion trainings on website.	I	I	I	I	I	I	I
		ED-2.2 – Private Stormwater Facility Operations and Maintenance Outreach	X		X	X			• ED-2.2-a: Create private stormwater facility maintenance handouts during the MS4 Permit term. • ED-2.2-b: Hold one maintenance workshop during the MS4 Permit term.	I	I	I	I	I	I	I
		ED-2.3 – Source Control Outreach and Technical Assistance	X		X				• ED-2.3: Incorporate spill prevention outreach into DTD RCSW.	I	I	I	I	I	I	I
		ED-2.4 – Pesticide, Herbicide, and Fertilizer Technical Assistance and Training	X						• ED-2.4: Hold one IPM check-in meeting for SWMP Document Participant staff during the MS4 Permit Term.	I	I	I	I	I	I	I
	ED-3. Evaluation of Education and Outreach Activities	ED-3.1 – Evaluation of Education and Outreach Activities	X	X	X	X	X	X	• ED-3.1: Evaluate the SWMP Document Participants' Education and Outreach activities by April 3, 2026.	--	--	--	--	--	--	--
2. Public Participation (PP)	PP-1. Publicly Accessible Website	PP-1.1 – Publicly Accessible Website	X	X	X	X	X	X	• PP-1.1-a: Post MS4 Permit renewal documents to WES website by April 3, 2026. • PP-1.1-b: Post MS4 Annual Report to each SWMP Document Participant's website by Dec. 5 each year. • PP-1.1-c: Post draft documents for public comment for at least 30 days. • PP-1.1-d: Consideration of comments received during public comments periods. • PP-1.1-e: Post reports, plans, and other documents to the website. • PP-1.1-f: Annual review of website for current information and accuracy.	--	--	--	--	--	--	--
		PP-1.2 – Facility Illicit Discharge Reporting				X			• PP-1.2: Conduct at least one IDDE reporting publicity campaign during the MS4 Permit term.	I	I	I	I	I	I	I
	PP-2. Public Stewardship	PP-2.1 - Public Stewardship	X			X			• PP-2.1-a: Each year budget for and award stewardship grants to community groups, businesses, and property owners to improve the health of watersheds in the Permit area. • PP-2.1-b: Each year hold or co-sponsor at least one volunteer activity with an education component.	I	I	I	I	I	I	I
	PP-3. Evaluation of Public Participation Activities	PP-3.1 - Evaluation of Public Participation Activities	X	X	X	X	X	X	• PP-3.1: Evaluate the SWMP Document Participants public participation activities by April 3, 2026.	--	--	--	--	--	--	--

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Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
3. Illicit Discharge Detection and Elimination (IDDE)	IDDE-1. Illicit Discharge Legal Authority	IDDE-1.1 - Illicit Discharge Legal Authority	X		X				• IDDE-1.1-a: Review and update legal authority as necessary to prohibit illicit discharges to County ROW by Dec. 1, 2024. • IDDE-1.1-b: Review and update legal authority as necessary to prohibit illicit discharges to MS4s in WES by Dec. 1, 2024.	I	I	I	I	I	I	I
3. Illicit Discharge Detection and Elimination (IDDE) *(continued)*	IDDE-2. Illicit Discharge Response	IDDE-2.1 – Response to Illicit Discharges (Including Spills)	X	X	X		X		• IDDE-2.1-a: Each year investigate and confirm 100% of reports of suspected illicit discharges within 24 hours. • IDDE-2.1-b: Each year evaluate removal of 100% confirmed illicit discharges within five working days of determining the source of the discharge. • IDDE-2.1-c: Each year halt 100% of illicit discharges within 15 working days after the source has been confirmed. • IDDE-2.1-d: Each year report 100% of reportable spills on public roadways or in the MS4 to state and federal authorities within required reporting timelines.	S	S	S	S	S	S	S
	IDDE-3. Illicit Discharge Enforcement Procedures	IDDE-3.1 - Illicit Discharge Enforcement Procedures	X	X	X		X		• IDDE-3.1: Track 100% of enforcement actions initiated in that MS4 Permit year and their resolution.	S	S	S	S	S	S	S
	IDDE-4. Dry Weather Inspections	IDDE-4.1 – Maintain and Update List of Priority Locations	X						• No measurable goals. BMP activities include: ○ All known MS4-Permitted storm sewer systems in the WES SWM service area shall be monitored once in 10 years. ○ Conduct dry weather field screening inspections in 10% of all of the known MS4-Permitted storm sewer systems in the WES SWM service area each July 1st to June 30th year.	I	I	I	I	I	I	I
		IDDE-4.2 – Inspections and Analysis	X						• IDDE-4.2-a: Each year, conduct an inspection at a Priority Location in 10% of the MS4-permitted MS4s in the WES SWM Service Area. • IDDE-4.2-b: Each year refer 100% of confirmed (and unconfirmed) illicit discharges discovered through dry weather inspection to WES Field Operations or WES Watershed Protection within one working day.	S	S	S	S	S	S	S
	IDDE-5. IDDE Staff Training	IDDE-5.1 – Determine Training Needs	X	X	X	X	X	X	• IDDE-5.1: Evaluate and document staff training and education needs one time during the MS4 Permit term.	I	I	I	I	I	I	I
		IDDE-5.2 – Conduct Training	X	X	X	X	X	X	• IDDE-5.2: Provide training documented in the staff training and education strategy.	I	I	I	I	I	I	I
	IDDE-6. Evaluation of IDDE Activities	IDDE-6.1 – Evaluation of IDDE Activities	X	X	X	X	X	X	• IDDE-6.1: Evaluate IDDE activities by April 3, 2026.	--	--	--	--	--	--	--
4. MS4 Mapping (MAP)	MAP-1. Develop Mapping Strategy	MAP-1.1 – Develop Mapping Strategy	X	X	X				• MAP-1.1: Develop MS4 Mapping Strategy by December 1, 2022.	--	--	--	--	--	--	--
	MAP-2. Inventory and Map MS4 Infrastructure	MAP-2.1 – Update Inventory and Map Existing Infrastructure	X	X	X				• MAP-2.1-a: MS4 Map and Digital Inventory submitted or access provided to DEQ by December 1, 2022. • MAP-2.1-a: 100% of existing public stormwater conveyances and stormwater facilities mapped by December 1, 2022. • MAP-2.1-b: 25% of existing private stormwater facilities mapped by December 1, 2022. • MAP-2.1-c: 100% of existing private stormwater facilities mapped by end of permit term.	--	--	--	--	--	--	--

Table 4. Relationship between Current BMPs and Pollutants of Concern

S = control of the source of a pollutant entering the MS4
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I = indirect pollutant reduction benefits
-- = not applicable

Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
		MAP-2.2 – Inventory and Map New Stormwater Conveyance Management	X	X	X				• MAP-2.2: 100% of new public stormwater conveyances and public and private stormwater facilities are mapped within 3 months of public acceptance and private final construction approval (see POST-4).	--	--	--	--	--	--	--
		MAP-2.3 – Map Priority Locations for IDDE Field Screening	X						• MAP-2.3: 100% of IDDE Priority Locations mapped by December 1, 2023.	--	--	--	--	--	--	--
	MAP-3. Track and Map Locations of Concern	MAP-3.1 – Map Chronic Illicit Discharges	X	X	X				• MAP-2.3: MS4 Map and Digital Inventory submitted or access provided to DEQ by December 1, 2022.	--	--	--	--	--	--	--
	MAP-4. MS4 Mapping Evaluation	MAP-4.1 – Evaluation of MS4 Mapping Activities	X	X	X				• MAP-4.1: Evaluate the MS4 mapping activities by April 3, 2026.	--	--	--	--	--	--	--
5. Construction Site Runoff Control (EPSC)	EPSC-1. Construction Site Runoff Legal Authority	EPSC-1.1 – Construction Site Runoff Legal Authority	X	X	X		X		• EPSC-1.1-a: Review, and update, if necessary, DTD's boilerplate contract terms to ensure EPSC plans are required in construction contracts by Dec. 1, 2024. • EPSC-1.1-b: Review, and update, if necessary, Happy Valley code to ensure alignment with the MS4 Permit Schedule A.3.d by Dec. 1, 2024. • EPSC-1.1-c: Review, and update, if necessary, WES Rules and Regulations to ensure alignment with MS4 Permit Schedule A.3.d by Dec. 1, 2024. • EPSC-1.1-d: Review, and update, if necessary, Clackamas County Code and Building and Development Ordinance to ensure alignment with MS4 Permit Schedule A.3.d by Dec. 1, 2024.	I	I	I	I	I	I	I
		EPSC-1.2 – Erosion and Sediment Control Plan Standards	X	X	X		X	X	• EPSC-1.2: Review, and update, if necessary, Erosion Prevention Planning and Design Manual once during the MS4 Permit Term.	S	S	S	S	S	S	S
	EPSC-2. EPSC Plan Review	EPSC-2.1 – EPSC Review of County CIPs			X				• EPSC-2.1: Internally review the EPSC plan of 100% of County CIPs going to construction in the Permitted Area each year. (DTD)	S	S	S	S	S	S	S
		EPSC-2.2 – EPSC Review in Happy Valley		X					• EPSC-2.2: Review EPSC plan of 100% of land use and building permit applications meeting threshold for erosion prevention and sedimentation control in Happy Valley each year. (Happy Valley)	S	S	S	S	S	S	S
		EPSC-2.3 – EPSC Review in WES' SWM Service Area	X		X				• EPSC-2.3-a: Review EPSC plan of 100% of land use reviews and building permit applications meeting threshold for erosion prevention and sediment control in WES Service Areas. • EPSC-2.3-b: Attend 80% of pre-construction meetings for projects meeting threshold for erosion prevention and sediment control in WES Service Areas.	S	S	S	S	S	S	S
	EPSC-3. EPSC Inspection and Enforcement	EPSC-3.1 – County Inspection and Enforcement			X				• EPSC-3.1: Conduct at least three EPSC inspections over the life of the project at 100% of County CIP construction sites within the Permitted Area that require EPSC review.	S	S	S	S	S	S	S
		EPSC-3.2 – Happy Valley Inspection and Enforcement		X					• EPSC-3.2-a: Each year conduct the initial EPSC inspection prior to construction at 100% of EPSC permitted sites in Happy Valley. • EPSC-3.2-b: Inspect 90% of EPSC permitted sites in Happy Valley at least three times over the life of the project. • EPSC-3.2-c: Inspect 100% of EPSC permitted sites in Happy Valley at least twice over the life of the project.	S	S	S	S	S	S	S

Table 4. Relationship between Current BMPs and Pollutants of Concern

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-- = not applicable

Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
		EPSC-3.3 – WES Inspection and Enforcement	X		X				• EPSC-3.3-a: Each year conduct the initial EPSC site inspection prior to construction at 100% of EPSC permitted sites in WES SWM Service Areas. • EPSC-3.3-b: Inspect 90% of EPSC permitted sites in WES at least three times over the life of the project.	S	S	S	S	S	S	S
		EPSC-3.4 – Adopt Construction Site Enforcement Procedures	X	X	X				• EPSC-3.4: Adopt construction site enforcement procedures by December 1, 2023 (WES, DTD, Happy Valley).	I	I	I	I	I	I	I
	EPSC-4. Construction Site Runoff Staff Training	EPSC-4.1 – Determine Training Needs	X	X	X				• EPSC-4.1: Evaluate and document staff training needs one time during the MS4 Permit term.	--	--	--	--	--	--	--
		EPSC-4.2 – Conduct EPSC Training	X	X	X				• EPSC-4.2: Conduct or procure training documented in the staff training and education strategy.	I	I	I	I	I	I	I
	EPSC-5. Evaluation of Construction Site Runoff Control Activities	EPSC-5.1 – Evaluation of Construction Site Runoff Control Activities	X	X	X				• EPSC-5.1: Happy Valley, DTD, and WES will evaluate their construction site runoff control activities by April 3, 2026.	--	--	--	--	--	--	--
6. Post-Construction Site Runoff (POST)	POST-1. Post-Construction Legal Authority	POST-1.1 – Maintain Current Post-Construction Legal Authority	X	X					• POST-1.1-a: Review, and update, if necessary, Happy Valley code to ensure alignment with the MS4 Permit Schedule A.3.e by December 1, 2024. • POST-1.1-b: Review, and update, if necessary, WES Rules and Regulations to ensure alignment with MS4 Permit Schedule A.3.e by December 1, 2024.	I	I	I	I	I	I	I
		POST-1.2 – Update Post-Constriction Runoff Ordinances and Standards	X	X	X			X	• No measurable goals. BMP activities include: • Review legal authority to require stormwater management facilities and controls and development and redevelopment sites one time during MS4 Permit terms. • By December 1, 2024, review and update rules and regulations to implement post-construction stormwater management requirements meeting the requirements of subsection A.3.a.e.iii of the permit or NSRR approach.	I	I	I	I	I	I	I
	POST-2. Post-Construction Stormwater Standards	POST-2.1 – Require Low Impact Development/Green Infrastructure (LID/GI) for Development and Redevelopment Projects	X	X	X	X	X	X	• POST-2.1: By Dec. 1, 2023, review and update or develop and begin a LID/GI strategy.	S	S	S	S	S	S	S
		POST-2.2 – Update Stormwater Standards Design Manual	X			X			• POST-2.2: Update the stormwater design manual (currently WES Stormwater Standards) by Dec. 1, 2024.	I	I	I	I	I	I	I
	POST-3. Stormwater Management (SWM) Plan Review	POST-3.1 – Stormwater Management Plan (SWM Plan) Review of Permittee CIPs	X	X	X			X	• POST-3.1: Review 100% of CIP SWM Plans that meet the minimum impervious surface threshold each year.	I	I	I	I	I	I	I
		POST-3.2 – SWM Plan Review for Single-Family (SFR) Building Permits	X		X				• POST-3.2: Review 100% of SFR SWM Plans received prior to signing off on building permit each year. (WES)	--	--	--	--	--	--	--
		POST-3.3 – SWM Plan Review for Land Use Applications	X	X	X			X	• POST-3.3-a: Attend 100% of pre-application meetings (WES) for land use applications (DTD/Happy Valley). • POST-3.3-b: Review and approve 100% of non-SFR SWM Plans for projects that meet the minimum impervious threshold each year. (WES)	--	--	--	--	--	--	--
	POST-4. Post-Construction Verification and Acceptance	POST-4.1 – Verify Single-Family Residential Building Site Stormwater Systems	X	X	X				• POST-4.1: Perform final SWM construction site inspection on 100% of residential development sites each year.	S	S	S	S	S	S	S

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Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
		POST-4.2 – Verify Subdivision/Partition Stormwater Systems	X	X	X				• POST-4.2: Perform final SWM construction site inspection on 100% of subdivision and partition sites each year.	S	S	S	S	S	S	S
		POST-4.3 – Verify Commercial Development Stormwater Systems	X	X	X				• POST-4.3: Perform final SWM construction site inspection on 100% of commercial development sites each year.	S	S	S	S	S	S	S
		POST – 4.4 – Verify SWMP Document Participant CIP Stormwater System	X	X	X			X	• POST-4.4: Inspect 100% of new stormwater facilities for completed County CIPs and Happy Valley CIPs in the WES SWM Service Areas prior to acceptance each year. (WES)	S	S	S	S	S	S	S
	POST-5. Post-Construction Site Runoff Staff Training	POST-5.1 – Determine Staff Training Needs	X	X	X	X	X	X	• POST-5.1: Evaluate and document staff training needs one time during the MS4 Permit term.	--	--	--	--	--	--	--
		POST-5.2 – Conduct Staff Training	X	X	X	X	X	X	• POST-5.2: Conduct or procure training documented in the staff training and education strategy.	I	I	I	I	I	I	I
	POST-6. Evaluation of Post-Construction Site Runoff Activities	POST-6.1 – Evaluation of Post Construction Site Runoff Activities	X	X	X	X	X	X	• POST-6.1: Evaluate the SWMP Document Participants post-construction site runoff activities by April 3, 2026.	--	--	--	--	--	--	--
7. Pollution Prevention for Municipal Operations (PREV)	PREV-1. Road Operations and Maintenance	PREV-1.1 – Street Sweeping		X	X				• PREV-1.1-a: Sweep curbed arterials four times per year (Happy Valley). • PREV-1.1-b: Sweep a minimum of 50% of County maintained curbed road and bike lane miles four times per year (DTD).	T	T	T	T	T	T	T
		PREV-1.2 – Continue to Conduct Pollution Prevention Activities Related to Road Operations	X	X	X				• PREV-1.2: Remove 90% of solid waste dumps in SWMP Document Participants' ROW within six weeks of notification or discovery.	S/T	S/T	S/T	S/T	S/T	S/T	S/T
	PREV-2. Winter Operations and Maintenance	PREV-2.1 – Winter Materials Management		X	X				• PREV-2.1: Maintain winter materials stockpile	T	T	T	T	T	T	T
		PREV-2.1 – Winter Maintenance Strategy		X	X				• PREV-2.2: Implement winter operations and maintenance activities if snow and/or ice events occur.	T	T	T	T	T	T	T
	PREV-3. Landscape Maintenance and Vegetation Control	PREV-3.1 – Continue to Conduct Pollutant Prevention Activities Related to Landscape Maintenance and Vegetation Control	X	X	X				• PREV-3.1: Clackamas County DTD shall adopt and implement the most recent Oregon Department of Transportation (ODOT) Guide or an approved alternative for vegetation maintenance in County-maintained ROW during the permit term.	I	I	I	I	S	I	I
	PREV-4. Litter Control	PREV-4.1 – Implement Litter Control Methods	X	X	X			X	• PREV-4.1-a: Encourage event organizers to implement recycling at events. • PREV-4.1-b: Respond to 100% of roadway litter reports each year.	S	S	S	S	S	S	S
	PREV-5. Municipal Facilities	PREV-5.1 – Continue to Conduct Pollution Prevention Activities Related to Municipal Waste Facilities	X	X	X				• PREV-5.1-a: Each year, inspect 100% of municipal waste facilities at least once. • PREV-5.1-b:Each year, document the number of emergency overflow events to the dry pond. (WES)	S/T	S/T	S/T	S/T	S/T	S/T	S/T
	PREV-6. Control Sewage Infiltration	PREV-6.1 – Inspect Sanitary Sewer Lines	X						• PREV-6.1-a: Each year complete 100% of scheduled TV inspections of the public sanitary sewer system. • PREV-6.1-b: Eliminate 100% of sanitary sewer discharges to the MS4 within five days of discovery each year.	S	S	S	S	S	S	S
		PREV-6.2 – Prevent Cross-Connections in New Development/Re-Development	X	X	X				• No measurable goals. BMP activities include: • WES will review development plans (see POST-3) for cross connections between sanitary and storm sewer systems. DTD Building Department will inspect new	S	S	S	S	S	S	S

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									constriction in unincorporated portions of WES Rate Zones #2 and #3. Happy Valley Building Division will inspect new construction in Happy Valley.							
	PREV-7. Fire-Fighting Training	PREV-7.1 – Pollution Prevention in Fire-Fighting Training	X						• PREV-7.1: Once during the MS4 Permit term, perform one site visit to CFD#1's training center to review the position of the diversion valve and offer verbal guidance if appropriate.	I	I	I	I	I	I	I
	PREV-8. Pollution Prevention Staff Training	PREV-8.1 – Determine Training Needs	X	X	X	X	X	X	• PREV-8.1: Evaluate and document staff training needs one time during the MS4 Permit term.	--	--	--	--	--	--	--
		PREV-8.2 – Conduct Pollution Prevention Training	X	X	X	X	X	X	• PREV-8.2: Conduct or procure training documented in the staff training and education strategy.	I	I	I	I	I	I	I
	PREV-9. Evaluation of Pollution Prevention for Municipal Operations Activities	PREV-9.1 – Evaluation of Pollution Prevention for Municipal Operations Activities	X	X	X	X	X	X	• PREV-9.1: Evaluate the SWMP Document Participants pollution prevention for municipal operations activities by April 3, 2026.	--	--	--	--	--	--	--
8. Industrial and Commercial Facilities (COMM)	COMM-1. Identify Industrial NPDES Permit Facilities	COMM-1.1 – Identify New Industrial Facilities Requiring NPDES Permits	X	X					• COMM-1.1-a: Review new industrial development applications for applicability of 1200-Z permit a minimum of one time each year. • COMM-1.1-b: Each year notify facility operator and DEQ of 100% of facilities newly identified as potentially needing a 1200-Z permit within 30 days of discovery.	I	I	I	I	I	I	I
		COMM-1.2 – Identify Existing Industrial Facilities Requiring a 1200-Z Permit	X	X					• COMM-1.2-a: Survey a subset of existing industrial facilities for 1200-Z permit applicability a minimum of one time each year. • COMM-1.2-b: Each year notify facility operator and DEQ of 100% of facilities newly identified as potentially needing a 1200-Z permit within 30 days of discovery.	I	I	I	I	I	I	I
	COMM-2. Industrial/Commercial Stormwater Pollutant Prevention	COMM-2.1 – Review and Update the Industrial/Commercial Facilities Strategy	X						• COMM-2.1: Update Industrial/Commercial Facilities Strategy by December 1, 2023.	I	I	I	I	I	I	I
		COMM-2.2 – Implement the Industrial/Commercial Facilities Strategy	X						• COMM-2.2: Each year, inspect 100% of sites referred through complaint or referral within ten business days.	S	S	S	S	S	S	S
	COMM-3. Industrial/Commercial Site Inspection Staff Training	COMM-3.1 – Determine Training Needs	X						• COMM-3.1: Evaluate and document staff training needs one time during the MS4 Permit term.	--	--	--	--	--	--	--
		COMM-3.2 – Conduct Training	X						• COMM-3.2: Conduct or procure training documented in the staff training and education strategy.	I	I	I	I	I	I	I
	COMM-4. Evaluation of Industrial and Commercial Facilities Activities	COMM-4.1 – Evaluation of Industrial and Commercial Facilities Activities	X						• COMM-4.1: Evaluate the SWMP Document Participants industrial and commercial facilities activities by April 3, 2026.	--	--	--	--	--	--	--
9. Stormwater System Operation and Maintenance (MAINT)	MAINT-1. Operation and Maintenance Legal Authority	MAINT-1.1 – Review of Operation and Maintenance Legal Authority	X						• MAINT-1.1: Review, and update, if necessary, legal authority in WES to require maintenance and inspect private storm systems (once during the MS4 Permit term) by Dec. 1, 2024.	I	I	I	I	I	I	I

Table 4. Relationship between Current BMPs and Pollutants of Concern

S = control of the source of a pollutant entering the MS4
T = control of the transport mechanism of discharge
I = indirect pollutant reduction benefits
-- = not applicable

Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
	MAINT-2. Implement Current Operations and Maintenance Strategy	MAINT-2.1 – Ongoing Facility Maintenance	X		X				• MAINT-2.1-a: Each year inspect the stormwater systems in 70% of subdivisions and other participants enrolled in WES' Residential Maintenance Agreement Program. (WES) • MAINT-2.1-b: Correct 100% of maintenance deficiencies discovered during a Residential Maintenance Agreement inspection within two years. (WES) • MAINT-2.1-c: Each year mow and/or cut brush and weeds from stormwater facilities within 100% of subdivisions and other participants enrolled in WES' Residential Maintenance Agreement Program. (WES) • MAINT-2.1-d: Each year remove sediment and trash from 20% of underground public water quality facilities operated by WES. (WES) • MAINT-2.1-e: Each year respond to 100% of non-emergency complaints and referrals for facility maintenance within 72 hours. (WES) • MAINT-2.1-f: Each year replace proprietary components in 100% of stormwater management structures operated by DTD in which a proprietary component needs replacement. (DTD) • MAINT-2.1-g: Each year respond to 100% of non-emergency complaints and referrals for facility maintenance within 72 hours. (DTD)	T	T	T	T	T	T	T
		MAINT-2.2 – Routine Catch Basin Cleaning	X		X		X		• MAINT-2.2-a: Clean 20% of catch basins and inlets (with sumps) under WES responsibility each year. • MAINT-2.2-b: Clean 20% of catch basins and inlets (with sumps) under DTD responsibility each year.	T	T	T	T	T	T	T
	MAINT-3. Public Conveyance Cleaning and Maintenance	MAINT-3.1 – Public Conveyance Cleaning and Maintenance	X	X	X				• MAINT-3.1: Complete 100% of scheduled conveyance system cleaning maintenance activities each year (WES, DTD, Happy Valley).	T	T	T	T	T	T	T
		MAINT-4.1 – Storm Drain Cleaning Assistance Program	X						• MAINT-4.1: Each year, implement SCAP.	T	T	T	T	T	T	T

Table 4. Relationship between Current BMPs and Pollutants of Concern

S = control of the source of a pollutant entering the MS4
T = control of the transport mechanism of discharge
I = indirect pollutant reduction benefits
-- = not applicable

Category	BMP	BMP Activities	Responsible Party(ies): WES	Happy Valley	CC DTD	CC PGA	CC Other Depts.	Rivergrove	Summary of Activities (Measurable Goals are numbered)	Biocriteria	Dissolved Oxygen (spawn)	pH/ Alkalinity	PAHs	Toxics PCBs and OC Pesticides	Heavy Metals Copper, Iron (total), Zinc	Harmful Algal Blooms
9. Stormwater System Operation and Maintenance (MAINT) *(continued)*	MAINT-4. Regulated Private Storm System Inspection and Maintenance Program	MAINT-4.2 – Regulated Storm Sewer Inspection and Enforcement	X						• MAINT-4.2-a: Inspect 20% of prioritized regulated private storm systems in WES each year. • MAINT-4.2-b: 50% of prioritized regulated private storm systems pass initial inspection each year. • MAINT-4.2-c: Provide technical assistance to 90% of prioritized regulated private storm systems found to have a maintenance deficiency within one year.	T	T	T	T	T	T	T
	MAINT-5. Urgent Conditions / Storm Preparation and Response	MAINT-5.1 – Urgent Conditions/Storm Preparation and Response	X	X	X		X		• There are no measurable goals. BMP activities include: • Mobilize and respond to flooding caused by public facilities and conveyance during storms and urgent conditions within any portion of the Permitted Area.	--	--	--	--	--	--	--
	MAINT-6. Storm Sewer System Retrofit Program and Hydromodification Assessment	MAINT-6.1 – Infrastructure Retrofit and Hydromodification Assessment Update	X						• MAINT-6.1: Assessment of outcomes related to the Hydromodification Assessment and Stormwater Retrofit Strategy reports by December 1, 2023.	I	I	I	I	I	I	I
	MAINT-7. Stormwater Facility Maintenance Training	MAINT-7.1 – Determine Training Needs	X	X	X		X		• MAINT-7.1: Evaluate and document staff training needs one time during the MS4 Permit term.	--	--	--	--	--	--	--
		MAINT-7.2 – Conduct Stormwater Management Facilities Maintenance Staff Training	X	X	X		X		• MAINT-7.2: Conduct or procure training documented in the staff training and education strategy.	I	I	I	I	I	I	I
	MAINT-8. Evaluation of Stormwater System Operations and Maintenance Activities	MAINT-8.1 – Evaluation of Stormwater System Maintenance Activities	X						• MAINT-8.1: Evaluate the SWMP Document Participants operations and maintenance activities by April 3, 2026.	--	--	--	--	--	--	--

3.1 303(d)-Listed Parameter: Biocriteria

Receiving Waters 2022 303(d)-listed:	• Johnson Creek (North Fork Johnson Creek to confluence with Willamette River) • Unnamed Trib to Johnson Creek • Tualatin River (McFee Creek to confluence with Willamette River) • Cedar Creek (Headwaters to confluence with Tualatin River)
Parameters included:	• Biocriteria

Oregon's narrative water quality standard related to biological criteria (biocriteria) is simply stated in Oregon Administrative Rules (OAR) 340-041-0011 as follows: "Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities." This protocol is based on biological community information for freshwater macroinvertebrates at reference sites. Freshwater macroinvertebrates include insects, crustaceans, snails, clams, worms, mites, etc. Currently, there are no numeric water quality criteria for biocriteria. Instead, the *Methodology for Oregon's 2022 Water Quality Report and List of Water Quality Limited Waters* includes a narrative assessment protocol (DEQ, 2022). The protocol is based on USEPA guidance that biological community assessments are an indicator of aquatic life beneficial-use support. The protocol uses numeric benchmarks to evaluate the health of biological communities (macroinvertebrates) but does not relate those benchmarks to specific pollutants causing impairment.

Macroinvertebrates play an important role in maintaining the health of the aquatic ecosystem by processing dead and decaying plant and animal life and converting these in-stream nutrients into higher levels of energy in the aquatic food web. They are also good indicators of overall watershed health, because the overall water and habitat quality determines which types of macroinvertebrates can survive in a body of water.

3.1.1 Relationship between MS4 Discharges and Biocriteria

Biological communities have long been impacted by historical land management activities, including land clearing, harvesting, agriculture, mining, and development activities. Current land development activities may impact stream and habitat conditions if proper controls are not in place to limit direct impacts to the receiving water and riparian corridor. Research has indicated that at a threshold of approximately 10% impervious area, a watershed can demonstrate loss of aquatic system function (Vogt et al., 2016). Because biological communities are a function of overall water and habitat quality and not one specific pollutant measurement, it is difficult to point to a causative pollutant discharge or specific source (activity) that has direct impacts on biological criteria. Rather it is the cumulative impacts (both positive and negative) throughout the watershed that may be reflected in macroinvertebrate counts in downstream areas. Because biological criteria are an indicator of cumulative water and habitat quality and not a specific pollutant, no established relationship exists between MS4 discharges and direct biological criteria response.

In addition, the long-term effects of natural events, such as floods, fires, and landslides, periodically alter ecosystems, adding another evaluation variable when trying to identify what might be expected for macroinvertebrate communities.

3.1.2 Current BMPs to Address Biocriteria

Without an exact, causative pollutant to target, it is difficult to identify specific BMPs that reduce the sources of biocriteria degradation. For example, DEQ's biocriteria TMDL for the Umpqua Basin in southern Oregon states that "…implementing the Waste Load Allocations and Load Allocations for other water quality-limiting parameters, as well as making improvements in habitat and flow conditions, should recover biological communities to expected compositions" (DEQ, 2006).

As shown in Table 4, nearly all of the 2024 Shared SWMP Document BMPs may be seen as a way to address biocriteria, either directly (through control of the source of the pollutant or through control of the transport mechanism of discharge) or indirectly.

BMPs from the 2024 Shared SWMP Document that are assumed to address biocriteria are summarized in Table 5. The table notes which SWMP Document Participants are responsible for implementing BMP activities for pollutant reduction/removal (any Clackamas County departments have been simplified to CC and any Rivergrove BMPs have been classified as WES in the table as the implementing party).

Table 5. BMPs that Address Biocriteria

BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs work to keep pollutants from directly discharging into the stream systems by reporting, investigating, and removing suspected spills and illicit discharge sources. Enforcement actions will be implemented as appropriate based on the investigation findings. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs work to reduce pollutants in runoff by requiring on-site erosion control procedures, site inspections, and enforcement help to reduce the transport and discharge of organic materials associated with nutrients in the MS4. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs work to limit pollutant transport from reaching the surface waters by installing stormwater facilities based on thresholds of impervious area change. Pollutant transport is also reduced by inspecting residential, subdivision, and commercial development sites per prescribed frequencies and procedures. (WES, HV, CC)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.
COMM-2.2	Implementation of the Strategy for the Industrial/Commercial Stormwater Program to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit pollutant transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps, and cleaning and maintaining conveyance system. (WES, HV, CC)

3.1.3 BMP Modifications to Address Biocriteria

The 2024 Shared SWMP Document is presumed to have sufficient controls in place to address biocriteria to the MEP. Biocriteria is an indicator of cumulative water and habitat quality. This is supported by DEQ's biocriteria TMDL for the Umpqua Basin referenced in Section 3.1.2.

In addition to addressing waste load allocations through the MS4 permit, the SWMP Document Participants similarly implement the "2023 Non-point Source Total Maximum Daily Load Implementation Plan for the Tualatin, Willamette, Molalla-Pudding, and Sandy River Watersheds", which includes activities targeted at temperature reduction as well as work towards reaching the load allocations for TMDL parameters. This IP is in effect in all of the Non-point Source geographic areas which are adjacent to, and in some instances, surrounded by the geographic areas which are regulated by the MS4 Permit.

WES also completed a hydromodification assessment in 2015 to evaluate whether current controls, design standards, and proposed projects address hydromodification issues in local streams. In 2023, they prepared an "Infrastructure Retrofit and Hydromodification Assessment Update". Implementing the recommendations from the hydromodification assessment, including prioritizing capital projects and updating stormwater design standards (completed in 2024), should further address biocriteria as well as other listed pollutants.

No additional changes to the SWMP are currently proposed to specifically address biocriteria.

3.2 303(d)-Listed Parameter: Dissolved Oxygen

Receiving Waters 2022 303(d)-listed:	• Johnson Creek (North Fork Johnson Creek to confluence with Willamette River) • Mount Scott Creek (Phillips Creek to confluence with Willamette River) • Clackamas River (Wade Creek to confluence with Willamette River) • Unnamed Trib to Clackamas River • Rock Creek (Clackamas River watershed) • Unnamed Trib to Rock Creek (Clackamas River watershed) • Tualatin River (McFee Creek to confluence with Willamette River) • Cedar Creek (Headwaters to confluence with Tualatin River) • Fanno Creek (Carter Creek to confluence with Tualatin River)
Parameters included:	• Dissolved Oxygen (spawn)

In Oregon, water quality standards for dissolved oxygen (DO) are established to ensure that water bodies provide critical habitat for salmonids and other aquatic species, particularly for spawning, rearing, and migration activities. Several factors contribute to fluctuating DO concentrations in a stream system including temperature, flow, organic material, and nutrients or fertilizer discharges. Elevated temperatures result in an increase in biologic activity (plant growth, respiration, and decomposition), which depletes oxygen from the system. Warmer waters also do not hold as much DO as cooler waters. Flow impacts DO in that flowing or turbulent waters have more exposure to, and mixing with, the atmosphere, and therefore more DO is present. Low-flow streams are typically warmer, further reducing DO concentrations. The discharge of oxygen demanding organic waste can also reduce DO concentrations through the process of decomposition. Animal waste (including that from wildlife and domestic pets) and nutrients (i.e., fertilizers containing nitrogen and phosphorus) feed aquatic plants and organisms, which require more oxygen for respiration, thus depleting oxygen when decomposing.

The current water quality standard for DO is based on the identified salmonid and aquatic life habitat for a water body. Within Clackamas County, certain water bodies have been identified as active salmonid spawning habitat. The DO concentration in those water bodies may not be less than 11.0 milligrams per liter (mg/L).

3.2.1 Relationship between MS4 Discharges and Dissolved Oxygen

Stormwater runoff entering the MS4 can be a contributor of organic material to receiving waters. Potential sources of organic materials in stormwater runoff include trash and debris, sediment (total and dissolved), landscaping chemicals (pesticides/fertilizers), illicit discharges dumping, and cross-connections between the sewer and stormwater systems. In addition, organic materials such as leaves, grass, and other plant materials are often conveyed with stormwater runoff through the MS4 system and discharged into receiving waters.

In addition to organic materials, changes in flow regime and elevated instream temperatures may impact DO levels. Development activities that add impervious surfaces can reduce the amount of rainfall that supports groundwater recharge. Groundwater is a source for cool water flows in summer months.

3.2.2 Current BMPs to Address Dissolved Oxygen

As shown in Table 4, the 2024 Shared SWMP Document includes several BMPs that address sources of organic waste to receiving waters and indirectly affect DO levels. The illicit discharge program aims to reduce or eliminate illicit discharges to the MS4 by identifying illicit connections and illegal dumping. Erosion and sediment control efforts reduce the transport of organic materials during construction activities, and post-construction inspection efforts help to ensure fully functioning stormwater treatment facilities. Street sweeping efforts and maintenance efforts also facilitate the removal of organic materials from roads before they can be discharged into catch basins, manholes, mainlines, drainage ditches, and stormwater management facilities.

BMPs from the 2024 Shared SWMP Document that are assumed to address dissolved oxygen are summarized Table 6.

Table 6. BMPs that Address Dissolved Oxygen

BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs work to reduce DO levels in the stream systems by monitoring MS4 permitted storm sewer systems and removing suspected spills and illicit discharges to prevent organics and nutrients from entering the stream systems through reporting, investigating/implementing enforcement actions if necessary, and removing suspected spills and illicit discharge sources. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs work to reduce sediment and other organic waste in runoff by requiring on-site erosion control procedures, site inspections, and enforcement to help reduce the transport and discharge of organic materials associated with nutrients in the MS4. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs work to reduce sediment and other pollutants in runoff by promoting retention and infiltration of stormwater through installation of stormwater facilities. Post-construction inspections ensure work was done in accordance with approved plans. (WES, HV, CC)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)

Table 6. BMPs that Address Dissolved Oxygen	
BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.
COMM-2.2	Implementation of the *Strategy for the Industrial/Commercial Stormwater Program* to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit pollutant transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps, and cleaning and maintaining conveyance system. (WES, HV, CC)

3.2.3 BMP Modifications to Address Dissolved Oxygen

The 2024 Shared SWMP Document is assumed to have sufficient controls in place to reduce discharges of organic wastes and material to the MEP. However, modifications to existing practices, as listed below, could be considered to improve efficiency. DO levels are typically a response to other pollutants such as nutrients, sediments, and elevated temperature. In the future, as expanded on in Section 4, the SWMP Document Participants plan to:

- Refine activities conducted under either Education and Outreach (BMP ED-1.1 – Implement the Stormwater Public Education and Outreach Strategy) or Public Participation (BMP PP-2.1 – Public Stewardship) to expand pet waste education and outreach activities, documenting measurable goals associated with those activities in the Shared SWMP Document.
- Continue to evaluate guidance for operation and maintenance of private and public structural stormwater control facilities
- Expand storm drain labeling to increase public awareness and reduce dumping and illicit discharges.
- Evaluate street sweeping and catch basin, manhole, mainline, and stormwater facility cleaning schedules, coverages, and frequencies to optimize pollutant removal activities (specifically organic waste) during times of highest potential discharge.
- Update education and outreach materials to further encourage natural landscaping methods that do not require use of fertilizers.

3.3 303(d)-Listed Parameter: pH/Alkalinity

Receiving Waters 2022 303(d)-listed:	• Johnson Creek (North Fork Johnson Creek to confluence with Willamette River) • Kellogg Creek • Clackamas River (Wade Creek to confluence with Willamette River)
Parameters included:	• pH • Alkalinity

pH is a measure of the acidity or alkalinity of a substance, or the measure of the amount of hydrogen ions in a solution. The pH scale ranges from 0 to 14, with a pH of 7 being neutral (equal ratio of hydrogen ions to hydroxide ions); a pH less than 7 has more hydrogen ions and is acidic; and a pH greater than 7 has fever hydrogen ions and is basic. Each whole incremental pH value is ten times stronger (or weaker) than the subsequent value.

The pH of most natural waters ranges between 6.5 and 8.5; this range is consistent with DEQ's water quality standard for the Willamette Basin that informs 303(d) listings. The pH of water determines the solubility (amount of a material that can be dissolved in the water) and biological availability of constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). In the case of heavy metals, the degree to which they are soluble also determines their toxicity. Metals tend to be more toxic at lower pH levels because they are more soluble (Michaud, 1991).

The greatest natural cause for change in pH in a receiving water is the seasonal and daily variation in photosynthesis. Photosynthesis, or the process by which plant species convert sunlight to a usable form of energy, consumes hydrogen molecules, which causes the concentration of hydrogen ions to decrease and therefore the pH increases. For this reason, pH is higher (more basic) during daylight hours and during the growing season, when photosynthesis is at its peak. In turn, respiration and decomposition processes lower pH (more acidic).

Alkalinity is a measure of a water body's ability to neutralize acids and bases, acting as a buffer to maintain a stable pH. This buffering capacity of water is primarily due to the presence of bicarbonates, carbonates, and hydroxides. As such, the alkalinity of a water body is influenced by the surrounding geology and land uses. For instance, a lake that receives much of its water from stormwater runoff within its watershed may have high alkalinity levels if the surrounding area contains limestone and the associated stormwater runoff has high calcium carbonate levels. Even in urban settings, ponds may exhibit high alkalinity due to runoff from lawns and buildings that use limestone materials (USGS, 2018). Alkalinity is crucial for the health of aquatic ecosystems. DEQ has defined the minimum freshwater chronic criteria for alkalinity at 20,000 µg/L (or 20 mg/L), meaning that waterbodies with alkalinity values below this level lack the buffering capacity to resist pH fluctuations, especially those caused by urbanization, and protect aquatic life.[5] This instability can harm aquatic organisms that rely on consistent water chemistry for survival (USGS, 2018).

3.3.1 Relationship between MS4 Discharges and pH/Alkalinity

Changes in pH can be caused by atmospheric deposition (acid rain), surrounding rock and geology, and certain wastewater/polluted discharges. Several urban sources can contribute to a change of pH in runoff. Activities that can increase acidity (lower pH) include but are not limited to industrial processes that discharge acidic wastewater, solutions used in metal plating operations, acidic chemicals used in printing and graphic art businesses, cement used in concrete products and concrete pavement, and chemical cleaners used in homes and businesses (King County, 2014). Activities that can increase the alkalinity (increase pH) include, but are not limited to asphalt production or disposal, oil and gas brines, industrial landfills, cement manufacturing, soap manufacturing, and runoff from limestone gravel roads (USEPA, 2025). These waste discharges are generally controlled through the wastewater and industrial permitting process. As such, the relationship between pH and stormwater runoff is generally limited to the contributions of organic matter, resulting in increased decomposition that lowers the pH of receiving waters.

[5] Oregon Administrative Rule 340-041-8033, Table 30: Aquatic Life Water Quality Criteria for Toxic Pollutants.

Potential sources of organic materials in stormwater runoff include trash and debris, sediment (total and dissolved), landscaping chemicals (pesticides/fertilizers), illicit discharges and dumping, and cross-connections between the sewer and stormwater systems. In addition, small amounts of organic materials such as leaves, grass, and other plant materials can be conveyed with stormwater runoff through the MS4 system and discharged into receiving waters.

3.3.2 Current BMPs to Address pH/Alkalinity

As shown in Table 4, the 2024 Shared SWMP Document includes several BMPs that may provide protection against pH impacts to the MS4 and downstream surface waters. The illicit discharge program aims to reduce non-stormwater discharges to the MS4 by identifying illicit connections and illegal dumping. Construction and erosion and sediment control efforts reduce the transport of organic materials during construction activities, and post-construction inspection efforts help to ensure fully functioning stormwater treatment facilities. Street sweeping efforts and maintenance efforts also facilitate the removal of organic materials from catch basins, manholes, mainlines, drainage ditches, and stormwater management facilities. Structural stormwater BMPs such as vegetated ponds and bioretention facilities can reduce the volume of stormwater discharged, and buffer the retained water into the healthy range of 6.5 to 8.5.

BMPs from the 2024 Shared SWMP Document that address pH are summarized in Table 7.

Table 7. BMPs that Address pH/Alkalinity

BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs to address acidity by monitoring MS4 permitted storm sewer systems and removing suspected spills and illicit discharges to prevent organics and nutrients from entering the stream systems. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs to reduce sediment and other organic waste that can affect runoff acidity by requiring on-site erosion control. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs to address acidity in runoff by promoting retention and infiltration of stormwater through installation of stormwater facilities, as well as inspecting residential, subdivision, and commercial development sites per prescribed frequencies and procedures. (WES, HV, CC)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.
COMM-2.2	Implementation of the *Strategy for the Industrial/Commercial Stormwater Program* to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit pollutant transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps, and cleaning and maintaining conveyance system. (WES, HV, CC)

3.3.3 BMP Modifications to Address pH/Alkalinity

Control of pH/alkalinity impacts from the stormwater system are focused primarily on reducing illicit discharges and cross-connections. The SWMP Document Participants currently have a robust illicit discharge program, including spill prevention and response, identifying and remedying cross-connections between the sanitary sewer and stormwater systems, and WES' industrial/commercial facility screening and inspections prevent and control illicit discharges. pH levels may also be impacted by the temperature or input of other pollutants, such as decaying organics, nutrients, etc. and during and after algae blooms. Therefore, the proposed Shared SWMP Document BMPs to address DO, as discussed in Section 3.2 address pH/alkalinity.

3.4 303(d)-Listed Parameter: Polycyclic Aromatic Hydrocarbons

Receiving Waters 2022 303(d)-listed:	Johnson Creek (North Fork Johnson Creek to confluence with Willamette River)
Parameters included:	Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a group of organic hydrocarbon compounds that each have two or more benzene rings. PAHs are typical components in asphalt, petroleum-based fuels, oils, and greases. They can also be generated as by-products when carbon compounds are not completely combusted (Zhang et al. 2022). PAHs are one of the most prominent groups of chemicals that are found in smoke, soot, and engine exhaust and can be released by a range of sources, including furnaces, automobile exhaust, fireplaces, cigarette smoke, coal- and oil-fired power plants, incinerators, forest fires, and volcanic eruptions (ATSDR 1995 and Patel et al. 2020).

When directly released to the atmosphere, PAHs may attach to small particles and be transported for considerable distances before falling back to earth as dust or in precipitation. PAHs can also enter surface water bodies if they are attached to particles that have been washed from upland soils or off impervious surfaces by stormwater (Berríos-Rolón et al. 2025). PAHs have been found in precipitation in pristine, undeveloped areas around the world (Baker and Hites, 2000). Although they are present in low concentrations virtually everywhere, PAHs can occasionally reach elevated concentrations because of certain industrial activities, such as in areas that are often downwind of an incinerator's gas plume. PAHs can also migrate from a material containing PAHs in high concentrations, such as a creosote-based wood preservative, or leachate from creosote-treated wood in utility poles, railway ties, bridges, and pilings into surface water, groundwater, and soil (ATSDR 1996).

Some PAHs degrade slowly in the environment, and sediments are a "sink" where these chemicals tend to concentrate (ATSDR 1996). PAHs that are dissolved in water can be "taken up" by plants and then re-released back into water or into soil when the plant dies and decomposes or is burned. Some PAHs can also accumulate in the tissues of certain organisms.

In the 1970s, the USEPA identified 16 PAHs which are frequently found in environmental monitoring samples, namely acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene, benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*ghi*]perylene, benzo[*a*]pyrene, chrysene, dibenz[*a,h*]anthracene, and indeno[1,2,3-*cd*]pyrene (Zelinkova and Wenzl, 2015).

As with other toxics, the water quality criterion for PAHs is designed to protect human health by limiting the amount present in consumable fish and thus have toxic effects on wildlife and humans. Studies have reported varying results regarding the bioaccumulation of PAHs in fish. This is largely due to the wide variability in environmental PAH concentrations and differences in their bioavailability (Honda et al., 2020).

3.4.1 Relationship between MS4 Discharges and PAHs

Stormwater runoff is a likely source of PAHs in local water bodies. Automotive exhaust, wood burning, oils, automotive fluids, and industrial activities are all potential sources of PAH contribution to either air or sediments. Rain and stormwater runoff can then carry pollutants downstream. City of Portland stormwater monitoring data from storms monitored between May 1991 and January 1993 found PAH concentrations exceeding maximum contaminant levels (MCLs) in all samples from urban land uses analyzed for PAHs, though the Portland samples were analyzed for total concentrations of 39 PAH compounds, as opposed to just the 16 that are applicable in evaluating Oregon's water quality standard for human consumption (WCC, 1993).

These results show that the MS4 system has the potential to transport PAHs that have been collected in stormwater runoff from the urban environment. While most PAHs may enter the MS4 as part of stormwater runoff, more significant contributions to the MS4 could be associated with spills and other types of illicit discharges.

3.4.2 Current BMPs to Address PAHs

As shown in Table 4, the 2024 Shared SWMP Document includes several spill prevention and response BMPs that may provide protection against the transport of a concentrated discharge of fuel (gasoline contains benzo(a)pyrene, for example), oil, or other substances containing PAHs to the MS4 and potentially downstream surface waters.

The spill prevention and illicit discharge detection and elimination programs and the commercial/industrial facility inspection program work to prevent spills, identify high-risk areas to prevent spills to the MS4, and provide education about proper disposal for hazardous materials. Street sweeping activities work to remove accumulated PAHs, if present, before they can reach the MS4 and maintenance activities such as cleaning facilitate the removal of oils and sediments from roads, catch basins, manholes, drainage ditches, and vegetated stormwater management facilities such as ponds.

BMPs from the 2024 Shared SWMP Document that address PAHs are summarized in Table 8.

Table 8. BMPs that Address PAHs

BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs work to keep pollutants from directly discharging into the stream systems by reporting, investigating, and removing suspected spills and illicit discharge sources. Enforcement actions will be implemented as appropriate based on the investigation findings. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs work to reduce pollutants in runoff by requiring on-site erosion control procedures, site inspections, and enforcement help to reduce the transport and discharge of organic materials associated with nutrients in the MS4. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs work to limit pollutant transport from reaching the surface waters by installing stormwater facilities based on thresholds of impervious area change. Pollutant transport is also reduced by inspecting residential, subdivision, and commercial development sites per prescribed frequency and procedures. (WES, HV, CC)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)

Table 8. BMPs that Address PAHs	
BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.
COMM-2.2	Implementation of the *Strategy for the Industrial/Commercial Stormwater Program* to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit pollutant transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps, and cleaning and maintaining conveyance system. (WES, HV, CC)

3.4.3 BMP Modifications to Address PAHs

The 2024 Shared SWMP Document is believed to have sufficient controls in place to reduce the discharges of PAHs to the MEP mainly through BMPs to identify and respond to water quality complaints, spills, and illicit discharges as well as BMPs to remove potential pollutants from roadways and the MS4 before they're discharged to a surface water body. Therefore, no modifications are recommended to the 2024 Shared SWMP Document to address PAHs.

While PAHs are a common component in stormwater runoff, SWMP Document Participants should pay particular attention to acute contributions of PAHs to the MS4 from spills of materials such as gasoline and other types of illicit discharges.

3.5 303(d)-Listed Parameter: Toxics (PCBs and OC Pesticides)

Receiving Waters 2022 303(d)-listed:	• Johnson Creek (North Fork Johnson Creek to confluence with Willamette River) • Mount Scott Creek (Phillips Creek to confluence with Willamette River) • Tualatin River (McFee Creek to confluence with Willamette River) • Fanno Creek (Carter Creek to confluence with Tualatin River)
Parameters included:	• PCBs • Chlordane • DDD 4,4' • DDE 4,4' • Endosulfan • Endrin Aldehyde • Dieldrin • Tetrachloroethylene

The "Toxics" subsection addresses a combination of polychlorinated biphenyls (PCBs) and organochlorine (OC) pesticides that were reported in the 2022 Integrated Report Assessment as "toxic substances – human health."

PCBs and OC pesticides in the aquatic food chain are now recognized as a widespread problem in streambed sediments (USGS, 1999).

One or more of these toxics - PCBs, dieldrin, chlordane, DDT and DDT metabolite (DDE and dichlorodiphenyldichloroethane [DDD]), endosulfan, endrin aldehyde, tetrachloroethylene - are on the 303(d) list for Johnson Creek, Mount Scott Creek, Tualatin River and/or Fanno Creek in the vicinity of the SWMP

Document Participants (see Table 2 for specific parameter by waterbody listing). A TMDL for DDT and dieldrin was approved in 2006 for Johnson Creek, but the TMDL did not cover DDD and DDE.

PCBs: PCBs are a family of chemicals with widespread industrial uses—for example, as insulators in electrical equipment, as hydraulic fluids, and as a component of carbonless copy paper—until their manufacturing was banned in the United States in 1977 because of their deleterious effects on wildlife and human health. A 1979 EPA regulation prohibited the manufacture, processing, distribution in commerce, and "non-enclosed" (open to the environment) uses of PCBs unless specifically authorized or exempted by EPA. "Totally enclosed" uses (i.e., those that are contained, and therefore exposure to PCBs is unlikely) were allowed to continue for the life of the equipment (USEPA, 2016). As such, PCB-containing equipment was aggressively retrofitted throughout the 1980s and 1990s to remove PCBs, so little equipment containing PCBs remains in use in the United States (ATSDR, 2014). However, PCBs may still be present in building materials, particularly in older institutional and industrial buildings. PCBs do not readily break down once in the environment and can remain for long periods cycling between air, water and soil.

OC Pesticides/ Toxics: OC pesticides cover a large category of pesticides that are persistent in the environment. OC pesticides in the aquatic food chain are recognized as a widespread problem in streambed sediments (USGS, 1999). The 303(d) list for the Lower Willamette River and tributaries including Johnson Creek, Mount Scott Creek, Tualatin River and Fanno Creek includes one or more of the following: dieldrin, chlordane, DDD 4,4', DDE 4,4', endosulfan, endrin aldehyde, tetrachloroethylene.

Aldrin and dieldrin are insecticides commonly used over the last 40 to 60 years to control pests in agricultural, residential, and/or commercial settings. Sunlight and bacteria change aldrin to dieldrin, so dieldrin is the form that is most commonly found in the environment. Dieldrin binds tightly to soil and is slow to break down in water or evaporate in the air. Aldrin and dieldrin are the common names of manufactured insecticides with similar chemical structures. Trade names and synonyms include Aldrec, Aldrex, Aldrex 30, Aldrite, Aldrosol, Altox, Compound 118, Drinox, Octalene, and Seedrin. Aldrin and dieldrin were widely used as insecticides on crops until the USEPA banned most uses in 1970 and all uses in 1987.

Chlordane was sold in the United States until 1988 as an insecticide for crops like corn and citrus, and for use on lawns and domestic gardens. Because of concerns about damage to the environment and harm to human health, USEPA banned all uses of chlordane in 1983, except for termite control. USEPA banned all uses of chlordane in 1988. USEPA added chlordane to the 2010 303(d) list for the Willamette River based on two exceedances from samples collected at the Portland Harbor cleanup site.

DDT was widely used as an insecticide, particularly for agricultural applications to control mosquito outbreaks. DDT was banned in 1972 after it was found to significantly impair eggshell development in birds exposed to DDT through the food chain (ATSDR, 2025). DDT metabolite, also referred to as DDD and DDE, is formed during the breakdown of DDT. DDE is particularly dangerous because it is fat-soluble like other OC compounds and is rarely excreted from the body. Concentrations of DDE tend to bioaccumulate and increase in organisms throughout their life cycle. In addition to DDD being formed via DDT, it was also manufactured and used as an insecticide to kill pests, but its use has also been banned (ATSDR, 2025).

Endosulfan and endrin aldehyde were widely used to control pests in the United States but have been banned due to toxic health and environmental effects. Endosulfan was used until 2016 specifically on crops with aphids, fruit worms and whiteflies and sold as a solid mixture of alpha and beta endosulfan (ATSDR, 2015). Endosulfan is known to pose serious health risks to human, especially field workers, and aquatic life. Endrin aldehyde is characterized as an odorless, white solid and was a byproduct of endrin, which was a pesticide used against insects, rodents and birds until 1986. Little is known about the properties of endrin aldehyde, however one rodent study suggests it may cause liver disease (ATSDR, 1996).

Tetrachloroethylene (also known TCE) is used as a dry cleaning and textile-processing solvent to remove oils from fabrics and for vapor degreasing in metal-cleaning operations. TCE has relatively low solubility in water and has medium-to-high mobility in soil, therefore the residence time in surface environments is not expected to be more than a couple of days, however it can persist in the atmosphere for several months and can last decades in groundwater (ATSDR, 2019). In December 2024, the USEPA issued a final risk-management rule which would prohibit all uses of TCE within the next year using phaseouts. The final rule included extended phaseouts or Toxic Substance Control Act (TSCA) section 6(g) exemptions to permit several uses to continue under workplace restrictions for longer periods (Federal Register, 2025). The USEPA received multiple petitions and filed motions with the U.S. Count of Appeals for the Fifth and Sixth Circuits (Federal Register, 2025). The EPA has extended the deadline several lines and is currently postponing the effective date for each of the TSCA section 6(g) exemption requirements until May 18, 2026 (USEPA, 2026).

PCBs and other OC pesticides have common properties that govern their fate and transport in the environment: they are highly persistent, they bioaccumulate in the food chain, and they are highly hydrophobic (i.e., partition out of water to sediment). Furthermore, they volatilize in sufficient quantities so that they are transported by air and deposited as wet or dry deposition on land, resulting in worldwide occurrence at trace levels. National water quality investigations by the USGS have found them to be widespread in streambed sediments (USGS, 1999). Water quality standards for these chemicals are designed to protect human health by limiting the amount present in the food chain of the Willamette River and tributaries, where they can eventually lodge in consumable fish and thus have toxic effects on wildlife and humans.

3.5.1 Relationship between MS4 Discharges and Toxics (PCBs and OC Pesticides)

PCBs: PCBs in the environment are found primarily in streambed sediments, which themselves have an upland (soil) source. PCBs in Willamette River sediments were measured in 1997 at 15 micrograms per kilogram (McCarthy and Gale, 1999) upstream of Portland Harbor.[6] Stormwater runoff is a primary pathway by which aerially deposited toxics, including PCBs, in the urban environment reach aquatic systems. Stormwater conveyance, whether in a piped or open-channel system, has traditionally been designed to drain stormwater quickly off impervious surfaces into downstream water bodies in the urban environment. MS4 systems may transport PCBs when older buildings are demolished for redevelopment activities. In addition, elevated urban peak flows can promote re-suspension of PCB-enriched streambed sediments, potentially contributing to water quality degradation downstream.

OC Pesticides: The OC Pesticides on the 303(d) list are no longer manufactured or approved for use in the United States, apart from some uses of TCE which is currently in process by the EPA. As such, urban stormwater runoff is not a potential source for new contributions of these pollutants. However, these OC pesticides continue to be present due to past uses, as they are persistent in the environment and hydrophobic (binding tightly to soil particles). Therefore, legacy sources of the pollutants may be contained in sediments which are eroded from upland soils and transported in urban runoff to the MS4.

[6] A 10-mile stretch of the Portland Harbor from the Broadway Bridge to the southern tip of Sauvie Island became a Federal Superfund Site in 2000. EPA released a final cleanup plan (Record of Decision) in January 2017 to address contamination in the sediment, surface water, and groundwater that poses an unacceptable risk to human health and the environment. As of June 2025, all of the acres designated for active in-water remediation at the Site are now in remedial design.

Due to the persistent and hydrophobic nature of these toxic pollutants, soil erosion can contribute to elevated PCBs and OC pesticides loading in the urban environment, particularly for MS4s with historical or upstream agricultural influences, as is the case of the MS4 Permitted Area. New development activity and stormwater runoff over other exposed soils which causes soil erosion that were previously used for agricultural purposes could result in the transport of these compounds in the MS4.

3.5.2 Current BMPs to Address Toxics (PCBs and OC Pesticides)

The 2024 SWMP Document Participants do not have control over the availability, sale, or use of products containing OC Pesticides. These jurisdictions also do not use any of the listed pesticides, nor are they available for public use.

Toxics (PCBs and OC pesticides) can be bound to sediment and introduced into the MS4 with stormwater runoff. Therefore, sediment-trapping BMPs are expected to be effective at capturing these compounds. BMPs that would be effective in reducing these loads include those that prevent soil erosion and reduce runoff volumes in a manner that limits peak flows that cause instream erosion and resuspension of sediments. This would include the implementation of stormwater design standards and erosion and sediment control requirements help to prevent the transport of sediment and associated legacy pollutants into the MS4 during ground-disturbing activities. In addition, structural BMPs that capture sediment, such as catch basins, water quality manholes, and vegetated stormwater ponds are presumed to capture these toxic pollutants along with the sediment, and the toxics are thus removed from the MS4 when the structure is cleaned.

BMPs from the 2024 Shared SWMP Document that are assumed to address toxics (PCBs and OC pesticides) are summarized in Table 9.

Table 9. BMPs that Address Toxics	
BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs work to keep pollutants from directly discharging into the stream systems by reporting, investigating, and removing suspected spills and illicit discharge sources. Enforcement actions will be implemented as appropriate based on the investigation findings. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs work to reduce pollutants in runoff by requiring on-site erosion control procedures, site inspections, and enforcement help to reduce the transport and discharge of organic materials associated with nutrients in the MS4. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs work to limit pollutant transport from reaching the surface waters by installing stormwater facilities based on thresholds of impervious area change. Pollutant transport is also reduced by inspecting residential, subdivision, and commercial development sites per prescribed frequencies and procedures. (WES, HV, CC)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)
PREV-3.1	Adoption and implementation of the most current version of the ODOT Integrated Pest Management (IPM) Plan for landscape management of all County owned/operated areas (CC) and for pest control activities in the Happy Valley ROW (HV). Mowing is a preferred use of vegetation management, with herbicide applied as needed in the ROW, per IPM Plan (HV) or Integrated Vegetation Management (IVM) Plan (CC) to reduce pollutants discharging into the stream systems. (HV, CC)
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.

Table 9. BMPs that Address Toxics	
BMPs	**How BMP(s) Impacts Pollutant Reduction/Removal**
COMM-2.2	Implementation of the *Strategy for the Industrial/Commercial Stormwater Program* to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit pollutant transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps, and cleaning and maintaining conveyance system. (WES, HV, CC)

3.5.3 BMP Modifications to Address Toxics (PCBs and OC Pesticides)

The 2024 Shared SWMP Document is presumed to have sufficient controls in place to reduce sediment discharges and total suspended solids (TSS), and hence PCBs and OC pesticides bound to the sediment/TSS, to the MEP. No new sources of PCBs or specific OC pesticides are being introduced into the environment.

Addressing PCBs is a matter of managing sediment from areas that may contain historical sources. The illicit discharge program includes identification and removal of illegal dump sites, which could be a potential source of older products that could contain PCBs.

In most cases, the primary removal mechanism to reduce OC pesticides such as aldrin, dieldrin, and DDD/DDE is degradation over time. For example, the Molalla-Pudding Subbasin TMDL (DEQ, 2008) for pesticides states that:

> *"DEQ expects that significant [TSS] reductions…and ongoing decay of dieldrin over time should result in the achievement of both aquatic health chronic toxicity and human health-based criteria for dieldrin."*

Therefore, no modifications to the 2024 Shared SWMP Document are proposed to address the PCBs and OC pesticides.

3.6 303(d)-Listed Parameter: Heavy Metals

Receiving Waters 2022 303(d)-listed:	• Johnson Creek (North Fork Johnson Creek to confluence with Willamette River) • Unnamed Trib to Johnson Creek • Tualatin River (McFee Creek to confluence with Willamette River) • Cedar Creek (Headwaters to confluence with Tualatin River) • Fanno Creek (Carter Creek to confluence with Tualatin River)
Parameters included:	• Copper (dissolved fraction) • Iron (total) • Zinc (dissolved fraction)

Heavy metals are among the most common pollutants found in urban runoff. Lead, zinc, and copper constitute about 90 percent of dissolved heavy metals and 90 to 98 percent of total metals loads in stormwater runoff (Harper, 1985). While these metals are naturally occurring, they are included in many anthropogenic products and processes and can be toxic to aquatic life and human health due to their relative solubility in natural waters and affinity for binding with naturally occurring organic matter, such as humic substances. At elevated concentrations heavy metals may bioaccumulate in biota and aquatic organisms (Strecker, 1994).

Copper occurs naturally throughout the environment, in rocks, soil, water, and air. Copper is an essential element in plants and animals (including humans) for life and must be absorbed from eating, drinking, and breathing (ATSDR, 2025). Copper is also used in many products exposed to precipitation and stormwater runoff including wire, plumbing pipes, and sheet metal. It is used as a preservative in wood, leather, and fabrics and commonly used in agriculture to treat plant diseases like mildew (ATSDR, 2025). Copper has historically been used as an additive for moss control on roofs, a notable issue in the Pacific Northwest; however, its use has more recently been discouraged due to the impacts of copper in stormwater runoff and toxicity for aquatic organisms, including salmon. The human health criterion for copper is 1,300 µg/L (water + organism).[7]

Iron is a fundamental component of soils and rocks with typical concentrations of 5 percent (i.e., 50,000 mg/kg) in the surficial geological materials of the Willamette River valley (Shacklette and Boerngen, 1984). This concentration is high compared to national averages due to the prevalence of volcanic or volcanic-derived geological materials. Soil concentrations of iron vary by soil horizon (i.e., they are typically concentrated in subsoils) and are relatively higher where soils are derived from basalts (e.g., Columbia River basalts, Troutdale gravels, etc.). Iron concentrations in streambed sediments of the Lower and Middle Willamette River (below Salem) range from 3.5 to 8.5 percent, and 7 percent is a typical value for the Lower Willamette River (Rice, 1999). These concentrations most likely reflect the influence of iron- enriched bedrock[8], although there may be some anthropogenic (human-related) contributions as well.

The instream iron concentrations on which the Tualatin River tributary 303(d) listings are based is measured as the total recoverable metal fraction. Therefore, some of the resulting exceedances of water quality criteria could be related to elevated suspended sediment concentrations. TSS concentrations as low as 5 mg/L could result in an exceedance of the iron criterion, assuming that the iron content of suspended sediment is equivalent to the iron content of streambed sediments. The freshwater chronic criterion for iron is 1 mg/L, but unlike copper and zinc, iron is not considered a human health criterion (DEQ, n.d., Table 30).

The numeric human-health water quality criterion for iron was withdrawn from Oregon's 2011 water quality standards. The withdrawal of numeric criteria was based on iron being a naturally occurring element. In addition, the previous numeric criteria for iron were based on USEPA's recommendations for taste and laundry staining effects, not on human-health effects. USEPA issued a letter of approval for the withdrawal of the standards on June 9, 2011, and Oregon's revised water quality standards for human-health criteria were approved in 2011. Despite the change in the water quality standard, the Tualatin River tributaries are still listed on the current 303(d) list for iron because the 2022 303(d) list includes iron (total) as a toxic substance for aquatic life.

[7] DEQ Table 40 Human Health Water Quality Criteria for Toxic Pollutants 340-041-8033, based on the Biotic Ligand Model (BLM), a predictive tool to assess bioavailability and toxicity of metals in the aquatic environment.

[8] Iron enrichment in sediments between Columbia River basalt lava flows was sufficient to support turn-of-the-century iron mining in Lake Oswego and Scappoose, for instance (Orr and Orr, 1999).

Zinc is one of the most common elements in the earth's crust. It is found in air, soil, and water, and is present in all foods (ATSDR, 2025). Zinc has many commercial uses and zinc compounds are widely used to make paint, rubber, dyes, wool preservatives, pennies, and ointments, and it is combined with other metals to make alloys (such as brass and bronze). Zinc is commonly released into the environment through mining, steel production, coal burning, and burning of wastes (ATSDR, 2025). Zinc coatings are common on metal roofs to limit rusting, which in turn results in discharges of zinc in roof runoff. The current criteria for zinc are based on dissolved concentrations in the water column. The human health criterion for zinc is 2.1 mg/L (water + organism) (DEQ, n.d., Table 40).

Partitioning of metals is largely dependent on the pH and alkalinity of rainfall (higher pH tends to result in partitioning toward the particulate bound phases) (Glenn et al., 2002). As such, partitioning is highly dependent on local rainfall and soil characteristics. All three heavy metals will persist in the environment attached to soil particles.

Oregon’s aquatic life water quality criteria for some metals are expressed as a function of hardness in the water column, so a single-value water quality standard is not available. Equations have been developed to calculate acute and chronic water quality standards based on hardness measurements.[9]

3.6.1 Relationship between MS4 Discharges and Heavy Metals

Heavy metal sources in urban runoff are generally associated with motor vehicles, roofing materials, products to kill moss on roofs[10], household pesticide use, direct fallout from the atmosphere, and the degradation of highway surfaces. Specifically, air pollution (exhaust from diesel and unleaded vehicles), tire wear, and brake pad wear are some of the most significant sources. Each of these sources may contribute pollutants to the environment when stormwater runoff flows over roadways and other impervious surfaces.

Given the lack of measured iron concentrations in urban stormwater in the Portland metropolitan area, the relationship between MS4 discharges and this listed pollutant cannot be quantified. However, qualitative relationships are possible based on gross observations of urban runoff processes. Stormwater conveyance systems have traditionally been designed to drain stormwater quickly off impervious surfaces to downstream receiving waters in the urban environment. This process provides efficient transport of eroded soil that could be deposited on impervious surfaces from air deposition or erosion of bare soil surfaces. Urban runoff can also contribute indirectly to elevated iron concentrations in the water column by quickly elevating stream flow volumes in receiving waters, resulting in either re-suspension of streambed sediments or accelerated erosion of stream banks.

As described above, iron concentrations can be elevated above ambient water quality criteria by natural concentrations of these parameters in soils due to typical values of suspended sediment in stormwater runoff and due to erosion of streambed sediments associated with increased runoff volumes.

[9] Equations for Hardness-Dependent Freshwater Metals Criteria and Conversion Factor Table are detailed in Table 30 and Endnote F of DEQ’s Aquatic Life Water Quality Criteria for Toxic Pollutants summary.

[10] The use of copper to kill moss on roofs was historically used but is now discouraged by many jurisdictions. However, it has not yet been banned from use.[11] Although 46 species of cyanobacteria have the potential to produce toxins, not all species do. Cyanobacteria are naturally occurring and provide key ecosystem functions that are links in aquatic food chains. They are an ancient form of photosynthetic bacteria found naturally in ocean, freshwater, and terrestrial environments (DEQ, 2011).

3.6.2 Current BMPs to Address Heavy Metals

The 2024 SWMP Document Participants do not have control over the availability, sale, and use of products containing heavy metals, like moss control pesticides or automotive components. Control of the source of heavy metals in MS4 discharge is limited to education related to its presence and use. The goal of stormwater BMPs designed to address heavy metals is to reduce the suspended sediment load in receiving waters and to moderate the effects of increased urban runoff volumes. Structural stormwater BMPs that would conceptually be most effective at reducing heavy metal loads would be those that collect and/or trap sediment and those that reduce flow volumes so that sediment transport capacity of the conveyance system is reduced.

As shown in Table 4, the 2024 Shared SWMP Document includes many BMPs that address the transport of heavy metals. Street sweeping aims to remove automotive and roadway waste before discharge into the MS4. Maintenance practices, such as cleaning catch basins, pollution control manholes, and other stormwater management facilities, and trash removal also remove pollutants before they can be discharged into surface waters. Non-structural BMPs such as public education aim to help prevent the introduction of sources of these metals to the MS4.

The distinction between particulate and dissolved forms of a metal is increasingly important when evaluating performance of structural stormwater facilities in removing pollutants. Particulate-based metals are effectively removed by stormwater management systems that use sedimentation, filtration, and vegetation uptake. However, dissolved metals are increasingly difficult to remove, and traditional structural stormwater treatment systems that use sedimentation as the primary unit removal process are not as effective. Dissolved metals are more effectively removed via infiltration and targeted stormwater filtration processes. The 2024 Shared SWMP Document has a BMP to require LID/GI for property development and redevelopment projects. Green infrastructure (GI) systems incorporate a variety of unit removal processes, with a focus on filtration and infiltration, and an emphasis on LID (low impact development) practices, such as installing less impervious surface, provides fewer opportunities for heavy metals to be introduced to the environment.

Surface infiltration through LID/GI facilities such as infiltrating rain gardens and stormwater planters, as well as subsurface infiltration via stormwater injection devices, are the preferred BMPs for treatment of stormwater which contains these heavy metals, assuming that concentrations of other stormwater pollutants are acceptable for discharge to groundwater. Constructed wetlands, wet ponds, and swales are all effective structural BMPs for treating TSS-rich stormwater because they retain sediment and provide some amount of flow attenuation. Detention ponds provide flow attenuation of the typical structural BMPs but may be prone to sediment re-suspension. Proper use and maintenance of erosion- and sediment-control BMPs are implemented during construction activities to reduce sediment entering the stormwater system. Maintenance activities that include the collection of sediments (e.g., street sweeping and catch basin cleaning) are also implemented to reduce the transport of sediment from the MS4 into downstream water bodies.

It should be noted that while stormwater BMPs can reduce the loads of iron (measured either directly or using TSS as a surrogate) ambient water quality concentrations may still be elevated due to naturally elevated levels of iron in local soils.

BMPs from the 2024 Shared SWMP Document that are assumed to address heavy metals are summarized in Table 10. WES' development and implementation of a strategy to require the use of LID/GI to the MEP (BMP POST-2.1) should improve the capture and removal of heavy metals from the MS4 through a reduction in impervious surfaces and better capture of runoff from new and redevelopment areas through infiltration.

Table 10. BMPs that Address Heavy Metals	
BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs work to keep pollutants from directly discharging into the stream systems by reporting, investigating, and removing suspected spills and illicit discharge sources. Enforcement actions will be implemented as appropriate based on the investigation findings. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs work to reduce pollutants in runoff by requiring on-site erosion control procedures, site inspections, and enforcement help to reduce the transport and discharge of organic materials associated with nutrients in the MS4. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs work to limit pollutant transport from reaching the surface waters by installing stormwater facilities based on thresholds of impervious area change. Pollutant transport is also reduced by inspecting residential, subdivision, and commercial development sites per prescribed frequencies and procedures. (WES, HV, CC) WES to develop and begin implementing a strategy to require LID/GI to the MEP for development and development projects. Use of LID/GI facilities will help minimize impervious areas and reduce the volume of stormwater runoff that could convey heavy metals to the stream systems. (WES)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.
COMM-2.2	Implementation of the *Strategy for the Industrial/Commercial Stormwater Program* to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit heavy metal transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps (physically removing collected heavy metals before they can runoff into the MS4), and cleaning and maintaining conveyance system. (WES, HV, CC)

3.6.3 BMP Modifications to Address Heavy Metals

The 2024 Shared SWMP Document has sufficient controls in place to reduce discharges of heavy metals to the MEP.

3.7 303(d)-Listed Parameter: Harmful Algal Blooms

Receiving Waters 2022 303(d)-listed:	Tualatin River (McFee Creek to confluence with Willamette River)
Parameters included:	Harmful Algal Blooms

Aquatic weeds and algae are natural components of aquatic ecosystems. In large quantities they can produce dense mats that can impede activities like swimming and fishing and may cause odor problems and oxygen depletion. When algae die, they decompose in a process that removes oxygen from the water. As described in Section 3.2, fish and other aquatic organisms cannot survive in water with low DO levels. Animal waste and nutrients (e.g., fertilizers containing nitrogen and phosphorus) feed aquatic plants and organisms, which in turn require more oxygen for respiration and deplete oxygen when they decompose. Elevated temperatures may also result in an increase in biologic activity (aquatic weeds/algae growth, respiration, and decomposition), which depletes oxygen from the system.

In addition, large quantities of algae (known as harmful algal blooms or HABs) can pose a significant threat to human and ecological health. HABs have occurred in several of Oregon's lakes, reservoirs and rivers. The blooms look different depending on local conditions, and can appear green, blue-green or reddish brown and form foam, slicks, scum or mats (DEQ, 2011). HABs consist of microorganisms known as cyanobacteria (or commonly referred to as blue-green algae), which have the potential to produce toxins that can contaminate waterways used for recreation and drinking water supply, thus causing adverse health effects on humans and animals (DEQ, 2011).[11] HABs may be exacerbated by drought conditions, which reduce water levels, lower flows, and increase water temperatures, particularly in summer months. When levels of nutrients, temperature, pH, and light are conducive to good growth, cyanobacteria can grow rapidly resulting in blooms where the cyanobacteria become the dominant form of life in their environment (DEQ, 2011).

The 2022 Integrated Report 303(d) list includes one report of a HAB in the Tualatin River (Record ID: 23209).

3.7.1 Relationship between MS4 Discharges and Harmful Algal Blooms

Aquatic weed plants include aquatic species on the Oregon Department of Agriculture Noxious Weed Policy or those covered by a quarantine in OAR 603-052-1200. These species are noted for their excessive growths of invasive, non-native aquatic plants that dominate the assemblage in a water body and have a harmful effect on fish or aquatic life or are injurious to health, recreation, or industry. Algae, including periphyton (attached algae) or phytoplankton (floating algae), are also documented to cause other standards to be exceeded (e.g., pH, chlorophyll a, DO) or to impair beneficial uses.

Increased levels of Chlorophyll a are indicators of higher algae production. Chlorophyll a is generally elevated due to excess nutrients in water bodies. A direct relationship exists between the amount of nutrients in a water body and the amount of algae growing in that water body; as nutrient levels increase, the amount of algae increases. Stormwater runoff discharged by the MS4 can be a contributor of nutrients, such as phosphorus, into receiving waters. Potential nutrient sources in stormwater runoff include landscaping fertilizer, pet waste, illicit discharges, and illegal solid waste dumping. In addition, landscaping waste such as bits of leaves, pieces of cut grass, etc. can provide another source of nutrients to receiving waters if transported there via the MS4.

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[11] Although 46 species of cyanobacteria have the potential to produce toxins, not all species do. Cyanobacteria are naturally occurring and provide key ecosystem functions that are links in aquatic food chains. They are an ancient form of photosynthetic bacteria found naturally in ocean, freshwater, and terrestrial environments (DEQ, 2011).

3.7.2 Current BMPs to Address Harmful Algal Blooms

As shown in Table 4, the 2024 Shared SWMP Document includes several BMPs that address sources of nutrients to receiving waters. The illicit discharge detection and elimination program aims to eliminate illicit discharges to the MS4. Activities include identifying/removing illicit connections and illicit discharges, spill response, and conducting commercial facility inspections to ensure that illicit discharge prevention and response procedures are implemented.

In addition, pollution prevention BMPs focused on reducing pollutants associated with the application of fertilizers and a BMP for street sweeping to collect and prevent organic waste from discharging to the MS4. The maintenance of public and private stormwater facilities and catch basins is also a key management practice to remove nutrients from the MS4 before they are discharged to downstream water bodies.

BMPs from the 2024 Shared SWMP Document that address harmful algal blooms are summarized in Table 11.

Table 11. BMPs that Address Harmful Algal Blooms

BMPs	How BMP(s) Impacts Pollutant Reduction/Removal
IDDE-2.1 IDDE-3.1 IDDE-4.2	Illicit discharge detection and elimination BMPs work to keep pollutants/nutrients from directly discharging into the stream systems by reporting, investigating, and removing suspected spills and illicit discharge sources. Enforcement actions will be implemented as appropriate based on the investigation findings. (WES, HV, and CC)
EPSC-1.2 EPSC-2.1, 2.2, 2.3 EPSC-3.1, 3.2, 3.3	Construction site runoff control BMPs work to reduce pollutants in runoff by requiring on-site erosion control procedures, site inspections, and enforcement help to reduce the transport and discharge of organic materials associated with nutrients in the MS4. (WES, HV, CC)
POST-2.1 POST-4.1, 4.2, 4.3, 4.4	Post-construction site runoff BMPs work to limit pollutant transport from reaching the surface waters by installing stormwater facilities based on thresholds of impervious area change. Pollutant transport is also reduced by inspecting residential, subdivision, and commercial development sites per prescribed frequencies and procedures. (WES, HV, CC)
PREV-1.1 PREV-2.1, 2.2	Street sweeping removes pollutants from roadways before they can enter the stream systems, and winter road maintenance practices prevent/reduces stormwater pollution through proper storage and application techniques, timely deicing/sand removal, and location specific material application (e.g., roadway salt is not used in locations that drain to vegetated stormwater facilities). (HV, CC)
PREV-1.2 PREV-4.1	Road maintenance activities (road repairs, ditching, removing solid waste dumps found within the ROW) and litter control to be conducted using appropriate BMPs to reduce trash, sediment, nutrients, and chemicals from discharging into surface waters. (HV, CC)
PREV-5.1 PREV-6.1, 6.2	Review development plans and inspect for cross connection between sanitary and storm sewer systems (WES, HV, and CC) and inspect sanitary sewer lines for leaks via CCTV (WES, CC), clean and maintain lines as needed to ensure no illicit discharges to surface waters.
COMM-2.2	Implementation of the *Strategy for the Industrial/Commercial Stormwater Program* to address stormwater pollution from industrial and commercial sites (WES). Including responding to complaints or referrals about potential stormwater contaminants which could include accidental mishandling, lack of good storage practices, or inappropriate operations to reduce/remove potential pollutants from entering waterways (WES, HV, CC).
MAINT-2.1, 2.2 MAINT-3.1 MAINT-4.1, 4.2	Stormwater system operation and maintenance BMPs to limit pollutant transport from entering the stormwater system by inspecting and maintaining public and private stormwater facilities, cleaning catch basin and inlets with sumps, and cleaning and maintaining conveyance system. (WES, HV, CC)

3.7.3 BMP Modifications to Address Harmful Algal Blooms

Aquatic weeds and algae production increases with an increase in nutrients and temperature and commonly results in the reduction of instream DO. The 2024 Shared SWMP Document implements BMPs to reduce nutrients in stormwater to the MEP. Therefore, no BMP modifications or additions are proposed to address harmful algal blooms. In addition, the SWMP Document Participants implement the "Non-point Source Total Maximum Daily Load Implementation Plan for the Tualatin, Willamette, Molalla-Pudding, and Sandy River Watersheds," which includes activities to reduce water temperature in the Tualatin River watershed, such as riparian area tree planting.

Section 4: Summary and Conclusions

Based on this analysis and review, the SWMP Document Participants are using reasonable, effective, and available controls to reduce the discharge of these 303(d)-listed pollutants to the MEP.

There are currently 48 BMPs with 82 BMP activities that each have unique measurable goals and activities. Based on this evaluation, 29 of the BMP activities are anticipated to reduce or prevent the 303(d) parameter from discharging into receiving waters either by control of the source of a pollutant or control/limitation of the transport of a pollutant through the regulated MS4.

As identified, there are several specific recommended modifications to the 2024 Shared SWMP Document as well as a few more general recommendations for BMP revisions. These proposed modifications are outlined in each of the sections below.

4.1 BMP Revisions to Address 303(d) Listed Parameters

- Operations and maintenance programs may consider adding a focused campaign of storm drain labeling to increase public awareness and reduce dumping and illicit discharges. There is mention of education markers for storm drains in BMP ED-2.3 but it is part of the DTD Resource Conservation and Solid Waste program's Leaders in Sustainability Certification, which is aimed at a small number of local businesses and likely not wholistically applied around the Permitted Area.
- Based on the outcome of the public education effectiveness evaluation (BMP ED-3.1), changes to the public outreach program could be made to emphasize the importance of managing pet waste correctly For example, updating the Education and Outreach BMP ED-1. ("Implement the Stormwater Public Education and Outreach Strategy") or Public Participation BMP PP-2.1 ("Public Stewardship") to include more pet waste education and outreach activities, as well as updating measurable goals and tracking measures in a revised Shared SWMP Document could have a direct impact on addressing DO and other 303(d) parameters.
- Optimize street sweeping/winter maintenance (PREV-1.1 and PREV-2.1); catch basin, pollution control manhole, and vegetated stormwater facility cleaning schedules and frequencies (PREV-6.1, PREV-6.2, MAINT-2.1, MAINT-2.2, MAINT-3.1, MAINT-4.1, MAINT-4.2, and MAINT-8.1) to promote additional pollutant removal activities.
- Continue to improve guidance for maintenance of private and public structural stormwater pollution control facilities to emphasize proper maintenance of plants and proper disposal of removed vegetation and sediment (PREV-3.1, MAINT-2.1).

4.2 Editorial/General Changes to the 2024 Shared SWMP Document and BMPs

Streamlining the number of BMPs and purpose of the BMP could result in easier activity tracking to ensure that the BMPs are meeting their objectives and deadlines, as well as making the intent of the BMP and impacts on pollutant removal clearer. The following changes may be considered with subsequent updates to the SWMP Document.

Examples of Potential BMP Consolidation

- ED-1.1 is "implement the stormwater public education and outreach strategy," ED-1.2 is "update the stormwater public education and outreach strategy," and ED-3.1 is "evaluate the education and outreach activities." BMPs ED-1.1 and ED-1.2 could be consolidated into one BMP with a defined process for updating the strategy included as a measurable goal which would remove the need for ED-1.2 being a standalone BMP. Similar logic could be applied throughout the Shared SWMP Document to simplify the number of BMPs and their purpose if that would enhance implementation and reporting.
- BMPs ED-2.4 "pesticide, herbicide, and fertilizer technical assistance and training" and PREV-3.1 "continue to conduct pollution prevention activities related to landscape maintenance and vegetation control". These BMP activities could be combined into a single BMP to outline current and proposed IPM/IVM Plan practices, and then training activities identified as measurable goals/tracking measures. The current ED-2.4 BMP does not offer a lot of information about what the one-time meeting (also called a check-in) is about. Stating more explicit intents of this meeting (training on new pesticides/practices, updates to the IPM Plan, issues/concerns, etc.) would make it easier to determine how exactly this effort was impacting pollutant reduction in the MS4.

BMP Editorial Changes

- Multiple BMPs reference measurable goal dates that have already passed (with completion dates in either 2024 or 2025). These BMPs include: IDDE-1.1, MAP-1.1, MAP-2.1, MAP-2.3, MAP-3.1, EPSC-1.1, POST-1.1, POST-1.2, POST-2.1, POST-2.2, COMM-2.1, MAINT-1.1, and MAINT-6.1. The BMPs need to be reviewed and either updated to reflect modifications/adoptions of new practices/documents from the BMP effort, or update the measurable to a future date if the activities have not been completed yet.
- The numbering of a few BMPs has typos that should be corrected for ease of reference.
  - BMP PREV-2.1 is listed for both "winter materials management" and "winter maintenance strategy." This either should be listed as PREV-2.1 and PREV-2.2, respectively, or combined into a single BMP.
  - BMP MAP-2.2 has two measurable goals with the ID "Map-2.1-a" that need to be adjusted to more easily measure and track the activities.

It is important to note that the 2024 Shared SWMP Document updates may be made at any time in accordance with the SWMP Document Participants adaptive management process. In conjunction with the collective permit renewal application[12], additional Shared SWMP Document changes may be proposed based on the MEP Evaluation and TMDL pollutant load reduction evaluation and benchmarks. SWMP Document Participants anticipate receiving additional feedback from DEQ regarding anticipated, future MS4 permit language changes, which may also prompt additional Shared SWMP Document modifications to be submitted to DEQ.

[12] In the process of drafting this 303(d) evaluation WES filed for and received an extension from DEQ for their permit renewal. The original due date was April 3, 2026, with the extension the new due date is September 29, 2026.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1996. Public Health Statement Endrin. https://www.atsdr.cdc.gov/ToxProfiles/tp89-c1-b.pdf, accessed May 2025.

ATSDR. 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. U.S. Department of Health and Human Services, Public Health Services. https://www.atsdr.cdc.gov/toxprofiles/tp69.pdf

ATSDR. 1996. Polycyclic Aromatic Hydrocarbons (PAHs). Agency for Toxic Substances and Disease Registry ToxFAQs. https://www.epa.gov/sites/default/files/2015-04/documents/walter_atsdr_pahs.pdf

ATSDR. 2002. Public Health Statement for Aldrin and Dieldrin. https://www.atsdr.cdc.gov/toxprofiles/tp1-c1-b.pdf, accessed March 2026.

ATSDR. 2015. Public Health Statement for Endosulfan. https://www.atsdr.cdc.gov/ToxProfiles/tp41-c1-b.pdf, accessed March 2026.

ATSDR. 2015. ATSDR Toxic Substances Portal. https://wwwn.cdc.gov/TSP/PHS/PHS.aspx?phsid=607&toxid=113, accessed May 2025.

ATSDR. 2019. "Toxicological Profile for Tetrachloroethylene," U.S. Department of Health and Human Services.

ATSDR, ATSDR Toxic Substances Portal, http://www.atsdr.cdc.gov/substances/index.asp, accessed September 2014 and August 2025.

Baker, J.I., and Hites, R.A, 2000. "Siskiwit Lake Revisited: Time Trends of Polychlorinated Dibenzo-p-dioxin and Dibenzofuran Deposition at Isle Royale," Michigan. *Environ. Sci. Technol*., 2000, 34 (14), pp 2887–2891

Berríos-Rolón PJ, M.C. Cotto, and F. Márquez. Polycyclic Aromatic Hydrocarbons (PAHs) in Freshwater Systems: A Comprehensive Review of Sources, Distribution, and Ecotoxicological Impacts. Toxics. 2025 Apr 20;13(4):321. doi: 10.3390/toxics13040321.

Choi H, Harrison R, Komulainen H, et al. Polycyclic aromatic hydrocarbons. WHO Guidelines for Indoor Air Quality: Selected Pollutants. Geneva: World Health Organization; 2010. 6. https://www.ncbi.nlm.nih.gov/books/NBK138709/

Clackamas County WES, NPDES MS4 Permit Stormwater Management Plan Interim Evaluation Report for Clackamas County Service District No. 1 and the City of Happy Valley, May 1, 2006.

Clackamas County WES, NPDES MS4 Permit Stormwater Management Plan for Clackamas County Service District No. 1 and the City of Happy Valley. September 21, 2010.

Clackamas County WES, NPDES MS4 Permit Stormwater Management Plan for Surface Water Management Agency of Clackamas County and the City of Rivergrove. September 21, 2010.

DEQ, Molalla-Pudding TMDL: Pesticides TMDL (Chapter 4), December 2008.

DEQ, NPDES MS4 Discharge Permit 101384, Issued to Clackamas County et al., March 16, 2012.

DEQ, Umpqua Basin TMDL: Biocriteria TMDL, October 2006.

DEQ, Oregon's 2022 Integrated Report – Assessment Database and 303(d) List, https://www.oregon.gov/deq/wq/pages/epaapprovedir.aspx, accessed October 2025.

Federal Register – National Archives. December 2025. 40 CFR Part 751. Perchloroethylene (PCE); Regulation Under the Toxic Substances Control Act (TSCA). https://www.govinfo.gov/content/pkg/FR-2024-12-18/pdf/2024-30117.pdf, accessed March 2026.

Federal Register – National Archives. November 2025. Extension of Postponement of Effectiveness for Certain Provisions of Trichloroethylene (TCE); Regulation Under the Toxic Substances Control Act (TSCA). https://www.federalregister.gov/documents/2025/11/14/2025-19887/extension-of-postponement-of-effectiveness-for-certain-provisions-of-trichloroethylene-tce, accessed March 2026.

Honda, M., & Suzuki, N. 2020. Toxicities of Polycyclic Aromatic Hydrocarbons for Aquatic Animals. International journal of environmental research and public health.

King County, The Science of Stormwater, http://www.kingcounty.gov/environment/waterandland/stormwater/introduction/science.aspx, accessed April 2014.

McCarthy, K.A. and R. W. Gale. 1999. Investigation of the distribution of organochlorine and polycyclic aromatic hydrocarbon compounds in the lower Columbia River using semipermeable membrane devices. USGS Water-Resources Investigations Report 99–4051.

Michaud, J. 1991. A Citizens' Guide to Understanding and Monitoring Lakes and Steams. Washington State Department of Ecology 94-149.

Orr, W.N, and E.L. Orr. 1999. Geology of Oregon. Kendall-Hunt Publishing. Dubuque, Iowa.

Patel, A. B., S. Shaikh, K.R. Jain, C. Desai & D. Madamwar. 2020. Polycyclic Aromatic Hydrocarbons: Sources, Toxicity, and Remediation Approaches. Frontiers in Microbiology (Volume 11 – 2020). https://doi.org/10.3389/fmicb.2020.562813

State of Oregon, Oregon Administrative Rules 340-041.

Strecker, E.W. (1994). "Constituents and Methods for Assessing BMPs." Proc. Engineering Foundations Conference on Stormwater Related Monitoring Needs, ASCE, New York.

United States Environmental Protection Agency (USEPA), Dissolved Oxygen and Biochemical Oxygen Demand, http://water.epa.gov/type/rsl/monitoring/vms52.cfm, accessed September 2014.

USEPA, 2016. EPA Bans PCB Manufacturer; Phases Out Uses, https://www.epa.gov/archive/epa/aboutepa/epa-bans-pcb-manufacture-phases-out-uses.html, accessed December 2025

USEPA, pH, https://www.epa.gov/caddis/ph, accessed December 2025.

USEPA. 2014. Water: After the Storm – Weather, http://water.epa.gov/action/weatherchannel/stormwater.cfm, accessed October 2014.

USEPA. 2025. pH, https://www.epa.gov/caddis/ph#high, accessed May 2025.

USEPA, February 2026. Risk Management for Trichloroethylene (TCE). https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-trichloroethylene-tce, accessed March 2026.

USEPA Region 10. Office of Water and Watersheds. EPA Approval of Oregon's Withdrawal of Numeric Human Health Criteria for Iron and Manganese (OAR 340-041-0033(2), Table 20) and Revisions to the Associated Footnote to Table 20. June 09 2011.

U.S. Geological Survey (USGS). 1999. "The quality of our nations' waters: nutrients and pesticides." USGS Circular 1225. US Geological Survey, Reston, Virginia.

USGS. 2018. Alkalinity and Water. https://www.usgs.gov/special-topics/water-science-school/science/alkalinity-and-water. accessed May 2025.

WCC. 1993. Final data report: data from storms monitored between May 1991 and January 1993. Prepared for Portland Bureau of Environmental Services. Woodward-Clyde Consultants, Portland, OR.

WCC. 1997. Analysis of Oregon urban runoff water quality monitoring data collected from 1990 to 1996. Prepared by Woodward-Clyde Consultants, Portland, Oregon. Prepared for the Association of Clean Water Agencies.

Vogt, R. J., P. C. Frost, S. Nienhuis, D. A. Woolnough, and M. A. Xenopoulos. 2016. The dual synchronizing influences of precipitation and land use on stream properties in a rapidly urbanizing watershed. Ecosphere7(9):e01427. 10.1002/ecs2.1427. https://doi.org/10.1002/ecs2.1427

Zhang H., X. Zhang, Y. Wang, P. Bai, K. Hayakawa, L. Zhang, and N. Tang. Characteristics and Influencing Factors of Polycyclic Aromatic Hydrocarbons Emitted from Open Burning and Stove Burning of Biomass: A Brief Review. Int J Environ Res Public Health. 2022 Mar 25;19(7):3944. doi: 10.3390/ijerph19073944.

Zelinkova, Z. and T. Wenzl. 2015. *The Occurrence of 16 EPA PAHs in Food – A Review.* National Library of Medicine. https://pmc.ncbi.nlm.nih.gov/articles/PMC4673601/#:~:text=EPA%20selected%2016%20PAHs%2C%20which,in%20the%201970s%20(12).

Appendix C

Proposed Monitoring Program Objectives Matrix and Monitoring Plan

Proposed Monitoring Program Changes

Permit Requirements

Schedule B.4: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the co-permittees' programs and stormwater control measures in reducing pollutants in discharges from the MS4 to the MEP, and the conclusions of the annual adaptive management process developed under this permit. The application package must contain:

e. A description of proposed changes to the monitoring plan in the form of a monitoring objectives matrix with accompanying narrative describing the rationales supporting such changes, to be developed based on ongoing discussions with DEQ over the course of the permit term regarding the monitoring needs for the next permit;

This section of the permit renewal application package provides a summary of the environmental monitoring program for four Co-Permittees – Clackamas WES, Clackamas County, the City of Happy Valley and the City of Rivergrove – as well as the narrative describing proposed changes to their program and an updated monitoring objectives matrix. Because these four Co-Permittees co-own and co-implement the same MS4 Permit SWMP Document, they will be referred to here as the SWMP Document Participants.

The SWMP Document Participants' environmental monitoring program, required per Schedule B.1 of the 2021-2026 MS4 permit, is detailed in the *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* (CCCSMP), dated May 2023. This version of the CCCSMP has been implemented continuously as of July 1, 2023. Implementation of the 2023 CCCSMP is a joint effort. In addition to the SWMP Document Participants, other participants include Oak Lodge Water Services (OLWS), and the cities of Gladstone, Milwaukie, Oregon City, West Linn, and Wilsonville.

Implementation of the 2023 CCCSMP is expected to extend to the end of the current permit term, which is September 30, 2026. All participants intend to continue implementation of the 2023 CCCSMP during the period when the MS4 permit has been administratively extended after it has expired, except for the pesticide monitoring requirements in Schedule B.1.b, which will conclude when the permit expires.

Per Schedule B.1.c of the NPDES MS4 permit, co-permittees may make modifications to their monitoring plan without DEQ approval if *A) the modifications do not reduce the minimum number of data points, which are a product of the number of monitoring locations, frequency, duration and pollutant parameters identified in Table 3, or B) if the modifications result from including elements of another permit such as a WPCF UIC permit.* Otherwise, modifications require co-permittees to provide DEQ with the proposed modification to the monitoring plan and receive written approval from DEQ prior to implementation of the proposed modification. Proposed monitoring program changes, as outlined below, include both those changes that can be authorized without DEQ approval, as well as changes that would require DEQ approval prior to implementation.

Participants in the 2023 CCCSMP implemented an adaptive management process to identify proposed changes to their respective environmental monitoring programs. Co-permittee meetings were conducted from June 2025 to February 2026 to discuss improvements and ensure consensus on proposed changes. Outcomes of the discussions are reflected below with a summary of proposed changes and the rationale for changes.

A monitoring objectives matrix is provided as Table 4-1, below. This matrix summarizes the environmental monitoring activities for the proposed, modified CCCSMP, including instream water quality, instream biological, instream physical condition, mercury, stormwater quality, and BMP effectiveness monitoring. The matrix describes how each monitoring activity addresses monitoring objectives per Schedule B.1.a of the NPDES MS4 permit. The matrix also highlights how proposed monitoring program changes will impact or influence adherence to the monitoring objectives.

4.1 General CCCSMP Proposed Changes

In accordance with the adaptive management process, CCCSMP participants reviewed sampling locations and sample collection methods as outlined in the 2023 CCCSMP. CCCSMP participants also reviewed their individual environmental monitoring results for field, conventional, nutrients and metals parameters over the permit term. Ultimately, no changes to monitoring locations were proposed. CCCSMP participants also concluded that even if samples were collected from a location where 90% or greater of the samples resulted in non-detects, while not required, sampling for that parameter in that location would continue to occur in conjunction with regular sampling activities. In most cases, discontinuation of a single parameter at a specific location is not efficient when employing staff to sample multiple locations for a range of parameters.

The following proposed CCCSMP changes are being requested with respect to sample collection methods:

- **Option to use auto-samplers to obtain flow composite stormwater samples in select locations.**
  - Participants of the CCCSMP have been conducting time-weighted composite sampling for stormwater – wet weather in accordance with the Technical Memorandum submitted to Benjamin Benninghoff, DEQ on November 19, 2010 "*Request to Conduct Time-Composite versus Flow-Weighted Composite Sampling Program for MS4 Communities*". Given the expense and technical oversight needed to employ automated samplers, use of time-composite grab sampling was proposed as an alternative sampling method to better align with resources amongst the Clackamas County co-permittees.
  - Given the staff training, limitations on identification of a viable storm event, and overall manual labor requirements to conduct time-composite sampling at multiple locations, select jurisdictions would like to have the option of using automated samplers for stormwater wet-weather monitoring. This proposed modification is not expected to require DEQ approval, as it was previously required and is currently in use by other Phase I jurisdictions, and it does not change the minimum number of data points that are collected.
- **Update the CCCSMP, Appendix A, SOP A-4 to remove use of the Winkler Titration Method for QA/QC of dissolved oxygen.**
  - In accordance with Standard Methods (SM) 4500-O-G (polargraphic electrode) and 4500-O-H (optical probe), both of which are the suggested analytical methods for field data collection of dissolved oxygen per Table 11 of the CCCSMP, use of the Winkler Titration Method as a QA/QC check is not required. In addition, implementation of the Winkler Titration Method is a resource intensive activity, requiring adherence to safety protocols, as well as the storage and purchase of reagents (i.e., sulfuric acid, preservatives, etc.). As such,

removal of reference to the Winkler Titration Method as a QA/QC check in the CCSMP is proposed. This modification is not expected to require DEQ approval.

- **Evaluate the current practice of conducting time-composite sampling, when applied to routine instream monitoring activities, and potentially discontinue its application.**
  - Instream monitoring activities are conducted to meet Monitoring Objective #4: Evaluate the status and long-term trends in receiving water quality associated with MS4 discharges, and Monitoring Objective #5: Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters. To address these objectives, jurisdictions record rainfall conditions (wet-conditions vs. dry-conditions) and evaluate instream water quality trends based on whether rainfall was occurring (wet-conditions) or not occurring (dry-conditions). However, neither monitoring objective nor the NPDES MS4 permit specifically requires a sampling approach that targets collection of instream samples in a receiving water throughout the duration of a storm event.
  - The CCCSMP itself states that a time-composite sampling procedure shall be followed for all instream monitoring activities if rainfall is occurring, to collect instream samples that are reflective of the storm hydrograph and the range of pollutant concentrations in runoff that may occur over the duration of a storm event. CCCSMP participants have followed this procedure over the last decade. In conducting time-composite sampling during instream monitoring activities, observations by CCCSMP participants have led to questions regarding the benefit(s) of this sampling approach. Specifically, it has been observed that local watershed conditions and storm conditions can influence whether the instream sample that is being collected is reflective of stormwater discharges. The timing of stormwater runoff entering receiving waters ultimately depends on upland hydrologic characteristics of the watershed.
  - Based on visual observations by CCCSMP participants, instream pollutant concentrations may not change significantly over the duration of a storm event, whether a single grab sample is collected instream or, specific to the time-composite sampling procedure, three time-spaced grab samples are collected instream a minimum of 30 minutes apart during a storm event (CCCSMP 2023).
  - Given the significant, additional time and materials required to collect time-composite samples versus individual grab samples, CCCSMP participants would like to investigate whether moving away from time-composite sampling methodology during routine instream monitoring will produce similar results. Although this change does not appear to require DEQ approval based on the current NPDES MS4 permit, CCCSMP participants anticipate submitting results of this investigation and a rationale regarding this proposed change to DEQ during permit negotiations.

4.2 Pesticide Monitoring

In August 2022, Clackamas co-permittees applied for and obtained a major NPDES MS4 permit modification that revised the pesticide monitoring requirements outlined in Table 3 of the Clackamas County NPDES MS4 permit. As a result of the permit modification, pesticide monitoring requirements were applied separately to nine Clackamas co-permittees, commensurate on whether the co-permittee had an existing stormwater-wet weather monitoring requirement in Table 3.

Each applicable co-permittee is required to collect a total of six data points (i.e., combination of monitoring location and sampling event) over the remainder of the permit term (approximately three years, from July 2023 to September 2026). Therefore, the Clackamas co-permittees are collectively required to collect 42 data points over three years, which exceeds the required number pesticide data points for other Phase I jurisdictions (i.e., Salem and Eugene).

To date (February 2026), Clackamas co-permittees have completed approximately 50% of the required pesticide stormwater sampling. Most samples have employed the multi-residue pesticide screen. Select co-permittees have also employed additional screening analyses including the Chlorinated Herbicides in Water, Sulfometuron-methyl in Water, and Glyphosate and AMPA in Water to address permit-listed pesticides. Pesticide monitoring efforts for Clackamas co-permittees are anticipated to exceed $60,000 for the permit term. Meanwhile, review of pesticide monitoring data results that have been collected to date indicates non-detects in over 90% of the samples. Of the samples with measurable concentrations, the majority are from residential and mixed-use areas. Pesticides detected consistently amongst jurisdictions include 2,4-D and triclopyr, which are commercially available herbicides.

Clackamas co-permittees will discontinue location-specific pesticide monitoring at the end of the permit term, consistent with the current NPDES MS4 permit language (Table 3) indicating a monitoring frequency of three or six events “over the permit term”.

With respect to the upcoming, reissued NPDES MS4 permit, if pesticide monitoring is again required, Clackamas co-permittees request that the permit provide co-permittees with flexibility in defining the monitoring locations and dates for the pesticide monitoring events, or revert to the 2012 NPDES MS4 permit language *“Conduct or contribute to a pesticide stormwater characterization monitoring or instream pesticide monitoring project/task”,* which will allow for targeted sampling to build on what was learned from the 2015 USGS study. Most Clackamas co-permittees participate in the Coordinated Clackamas County Monitoring Plan (CCCSMP), which promotes the collective use and sharing of information. The identification of the presence of commercially-available pesticides in stormwater runoff is not considered to be a cost-effective strategy to reduce discharge of these parameters. Instead, the cost of sampling could be more effectively applied towards more detailed technical investigations such as the compilation of sales data/purchase history trends on various pesticides or conducting efforts to educate and inform behavioral changes regarding pesticide use.

4.3 Instream Mercury Monitoring

Mercury monitoring requirements for Clackamas County MS4 co-permittees (collectively) are outlined in Table 3 of the Clackamas County group’s MS4 permit. Instream and stormwater-wet weather sampling locations for mercury were selected by Clackamas co-permittees, as detailed in Tables 8 and 9 of the CCCSMP. To ensure consistency in sample collection procedures, equitable cost distribution amongst co-permittees, and assurance that samples collected would be submitted to DEQ consistently in conjunction with permit obligations, an intergovernmental agreement (IGA) between WES and each co-permittee was established. WES conducts all mercury monitoring to meet MS4 permit requirements on behalf of Clackamas-co permittees.

Whereas the benefits and information gained related to stormwater-wet weather mercury monitoring are understood and are directly applicable to the MS4 permit, instream monitoring results are less conclusive regarding sources and contribution from stormwater runoff. As described in Chapter 4 of the Willamette Basin Mercury Total Maximum Daily Load (2021), atmospheric deposition of mercury from global sources is presented as the dominant source of mercury in the Willamette River Basin. Additional non-point sources of mercury identified include runoff from forestry and agricultural land management practices; background/anthropogenic sources in groundwater due to local geology; and naturally occurring sediment-bound mercury that is eroded and transported to streams. Point sources such as municipal stormwater are also referenced as a potential source, but mercury in urban stormwater is believed to be predominantly associated with atmospheric deposition and/or active erosion or transport of sediment in stormwater runoff, which is addressed by existing stormwater BMPs. Creeks and other surface water bodies which drain urban areas in the WES SWM service area also typically receive a substantial amount of flow and water pollution from privately owned storm sewer systems which outfall directly to the creek; these are Non-Point Sources of pollution which are not regulated by the MS4 Permit. Municipal stormwater management programs implement multiple source control, structural, and programmatic BMPs targeting sediment. Paired mercury and TSS data appears to agree with literature, indicating that TSS concentrations generally correspond to mercury concentrations; therefore, reducing TSS reduces mercury.

Initial analysis of instream mercury concentrations for Clackamas County MS4 co-permittees are provided in Figure 4-1. Results show a relatively consistent range of total mercury concentrations instream, and particularly amongst the locations within the same watershed.

Due to the consistency in concentrations, Clackamas County MS4 co-permittees are requesting a reduction in instream mercury monitoring requirements to one location in each of the four watersheds, defined in accordance with the MS4 permit.

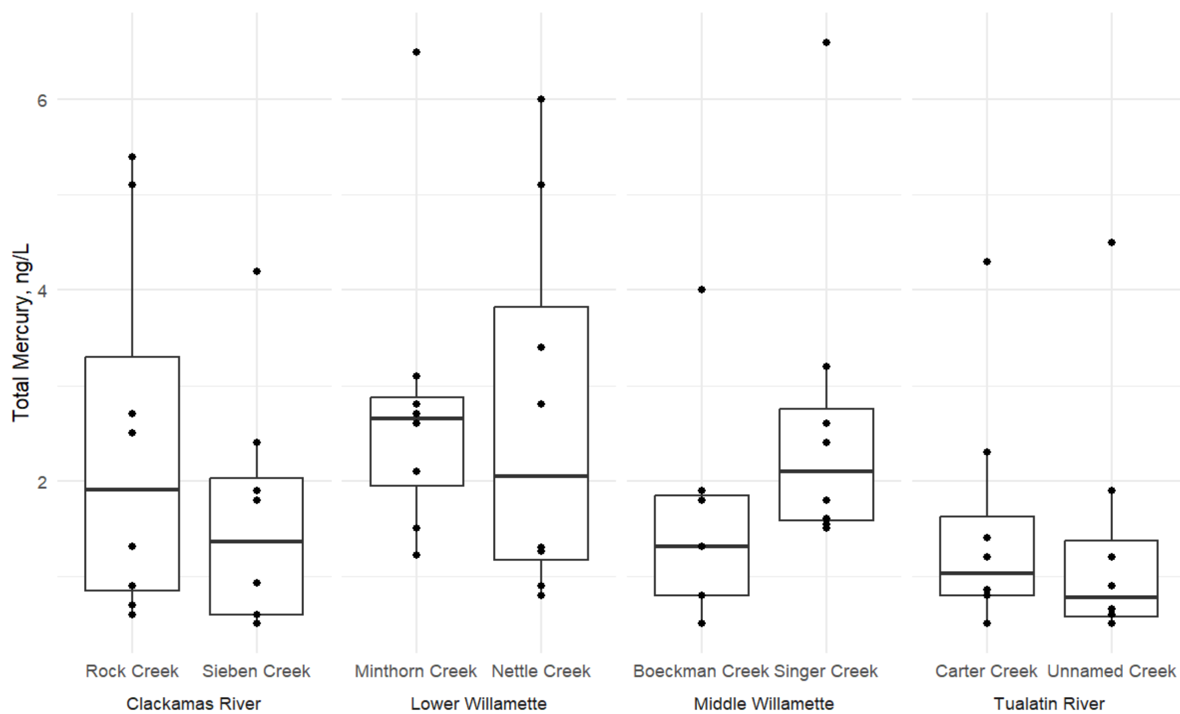


Figure 4-1. Total mercury concentrations by watershed and receiving water (2023-2025)

4.4 Monitoring Objectives Matrix

Table 4-1 presents the six monitoring objectives outlined in Schedule B.1.a of the MS4 permit. Monitoring activities outlined in the CCCSMP are highlighted according to each monitoring objective addressed. Proposed monitoring plan changes, as described in Sections 4.1 through 4.3, are listed as related to respective monitoring activities, and impact (if any) in addressing the respective monitoring objectives. In summary, proposed changes to the CCCSMP are not expected to limit or prevent Clackamas County MS4 co-permittees from addressing the monitoring objectives.

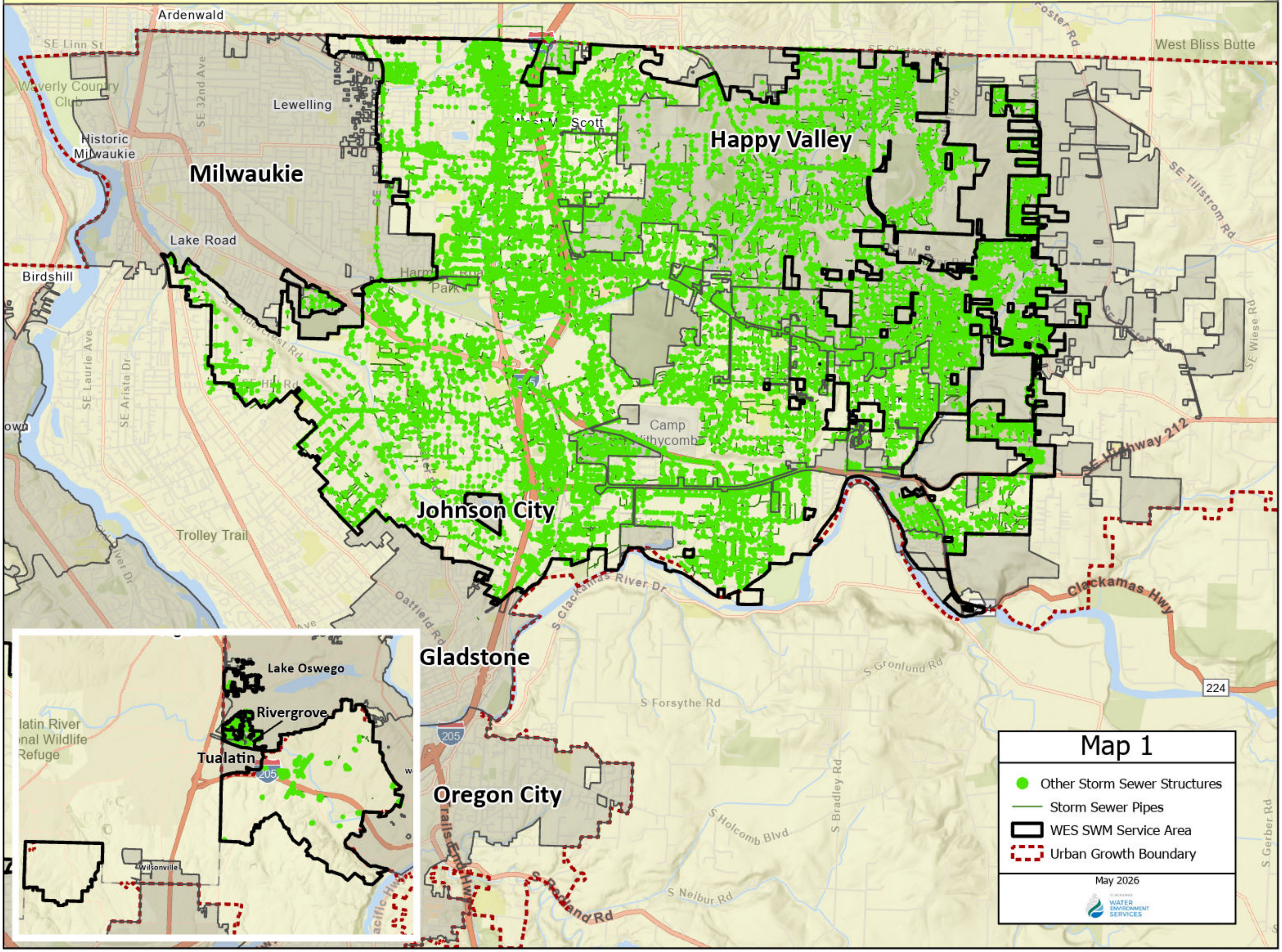
Table 4-1. Monitoring Objective Matrix								
			DEQ MS4 Monitoring Objectives					
NPDES MS4 Monitoring Activity/Program	2023 CCCSMP Monitoring Activity	Proposed CCCSMP Changes	Evaluate the sources and means for reducing pollutants of concern, including 2018/2020 303(d) listed pollutants, as applicable.	Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities.	Characterize stormwater based on land use, seasonality, geography or other catchment characteristics.	Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges.	Assess the chemical, biological, and physical effects of MS4 discharges on receiving waters.	Assess progress towards reducing TMDL pollutant loads.
Environmental Monitoring Activities								
Instream Water Quality	• 20 instream monitoring locations using storm targeted or routine instream monitoring procedure. • Between 3 and 9 monitoring events per year, resulting in 102 data points annually. • Single grab samples or time-composite samples during wet weather events. • Field and lab parameters are monitored.	**Section 4.1:** Potential removal of time-composite sampling procedure for routine instream monitoring. **Section 4.1:** Removal of Winkler method for QAQC of dissolved oxygen samples.	N/A	• Effectiveness of overall stormwater program implementation (BMPs) may be assessed by comparing instream samples collected from the same location during dry and wet weather conditions. • No impacts assumed due to proposed CCCSMP changes. The evaluation of time-composite sampling procedure will include comparison of wet-weather samples collected via single grab and time-composite, to confirm consistency in results.	N/A	• Trends assessed by comparing instream sampling results over time. • No impacts assumed due to proposed CCCSMP changes. Instream data will still be collected at each monitoring location identified in the 2023 CCCSMP and used to inform trends for wet and dry conditions.	• Chemical effects of MS4 discharges may be assessed by comparing dry season and wet weather monitoring results. • No impacts assumed due to proposed CCCSMP changes. Instream data will still be collected at each monitoring location identified in the 2023 CCCSMP and used to inform trends.	N/A
Instream Water Quality (Mercury-total recoverable)	• As part of collective effort with Clackamas co-permittees, 8 instream monitoring locations (2 locations in each of the Clackamas, L Willamette, Tualatin and Middle Willamette watersheds) using routine instream monitoring procedure (50% samples collected during wet weather season September 1 to April 30). • Four monitoring events per year, resulting in 32 data points annually. • Single grab samples following clean hands-dirty hands procedures.	**Section 4.3:** Reduction (8 to 4) of instream mercury monitoring locations. Monitoring activities will continue in each of 4 watersheds defined in the permit.	N/A	• Effectiveness of overall stormwater program implementation (BMPs) may be assessed by comparing mercury instream samples collected from the same location during dry and wet weather conditions. • No impacts assumed due to proposed CCCSMP changes. Watershed-specific instream total mercury will still be evaluated. No changes proposed to sample collection procedure.	N/A	• Trends assessed by comparing instream sampling results over time. • No impacts assumed due to proposed CCCSMP changes. Trends are currently unable to be assessed for mercury due to data limitations. Mercury data will continue to be collected to inform future trends; however, noted differences in trends between wet and dry conditions may not fully be related to MS4 stormwater discharges, as mercury sources instream can vary widely.	• Chemical effects of MS4 discharges may be assessed by comparing dry season and wet season results. • No impacts assumed due to proposed CCCSMP changes. Instream data will still be collected and used to inform trends. However, noted differences in trends between wet and dry conditions may not be entirely related to MS4 stormwater discharges, as mercury sources instream can vary widely.	N/A
In-Stream Biological	• 20 locations. One sample and field assessment per site once per permit term, at a minimum (2004, 2009, 2013, 2018).	No changes proposed.	N/A	N/A	N/A	• Trends assessed by comparing results of macroinvertebrate monitoring over time. Trends are also assessed for geomorphological indicators.	• Biological effects assessed by comparing results of invertebrate monitoring over time with respect to monitoring location (by MS4 outfall location). • Physical condition information compiled with biological monitoring. • •	N/A

Table 4-1. Monitoring Objective Matrix								
			DEQ MS4 Monitoring Objectives					
NPDES MS4 Monitoring Activity/Program	2023 CCCSMP Monitoring Activity	Proposed CCCSMP Changes	Evaluate the sources and means for reducing pollutants of concern, including 2018/2020 303(d) listed pollutants, as applicable.	Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities.	Characterize stormwater based on land use, seasonality, geography or other catchment characteristics.	Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges.	Assess the chemical, biological, and physical effects of MS4 discharges on receiving waters.	Assess progress towards reducing TMDL pollutant loads.
Environmental Monitoring Activities								
Stormwater - Wet Weather Water Quality	• 11 locations featuring representative land use (residential, commercial, mixed use, and industrial land use). • Between 3 and 12 monitoring events per year, resulting in 33 data points annually. • Time-composite sampling (with grabs for E. coli). Field and lab parameters monitored and rainfall determined/ flow estimated. • Pesticide monitoring is conducted at 11 locations, between 3 and 6 events over the permit term, for screening level analyses.	**Section 4.1:** Allowance of automated samplers to collect flow-composite stormwater samples. **Section 4.2:** Allowance of a collective pesticide monitoring effort instead of jurisdiction-specific pesticide monitoring.	Bacteria (TMDL) and pesticides, heavy metals, and nutrients (303(d)) are monitored.	• Effectiveness of overall stormwater program implementation (BMPs) may be assessed by comparing stormwater samples collected from the same location over time. • No impacts assumed due to proposed CCCSMP changes. Automated samplers should result in consistent if not better sampling results as compared to collection of time-composite grab samples. • Pesticide monitoring will still occur, and increased flexibility of permit language will allow jurisdictions build on to past efforts, informing parameters and/or sources requiring targeted outreach or retrofit.	• Will be used to characterize the runoff quality for the respective contributing land use categories and catchment areas. • No impacts assumed due to proposed CCCSMP changes. Automated samplers should result in consistent if not better if not better sampling results as compared to collection of time-composite grab samples. • Pesticide monitoring will still occur, and increased flexibility will allow jurisdictions build on to past efforts, informing parameters and/or sources requiring targeted outreach or retrofit.	N/A	• Chemical effects assessed by comparing wet-weather results with instream concentrations. • No impacts assumed due to proposed CCCSMP changes. Automated samplers should result in consistent if not better if not better sampling results as compared to collection of time-composite grab samples. • No instream pesticide monitoring currently conducted for comparison with stormwater sampling results. Instream pesticide sampling was historically conducted, and with additional flexibility in the permit, pesticide sampling efforts could be expanded to include comparative efforts.	• Comparisons between monitoring data for various land use categories and land use EMC data used in the benchmark pollutant loads model will be made to evaluate whether updates to the EMCs are needed. • No impacts assumed due to proposed CCCSMP changes. Automated samplers should result in consistent if not better if not better sampling results as compared to collection of time-composite grab samples.
Stormwater-Wet Weather (Mercury-total recoverable)	• As part of collective effort with Clackamas co-permittees, 4 stormwater monitoring locations (representing residential, commercial, mixed use, and industrial land use). • Three monitoring events per year, resulting in 12 data points annually. • Single grab samples only following clean hands-dirty hands procedures.	No changes proposed.	Mercury is a new TMDL parameter.	• Effectiveness of overall stormwater program and BMPs may be assessed by comparing stormwater-wet weather samples collected from the same location over time.	• As mercury stormwater samples are collected, data will be used to characterize the runoff quality for the respective contributing land use categories and catchment areas.	N/A	• Chemical effects assessed by comparing wet-weather results with instream concentrations.	• Comparisons between monitoring data collected at various land use categories and land use EMC data provided in literature can be used to inform future pollutant load reduction benchmarks. • If TSS can be used as a surrogate, matched pair sampling results can be used to anticipate mercury load reduction as part of future pollutant load reduction benchmarks.

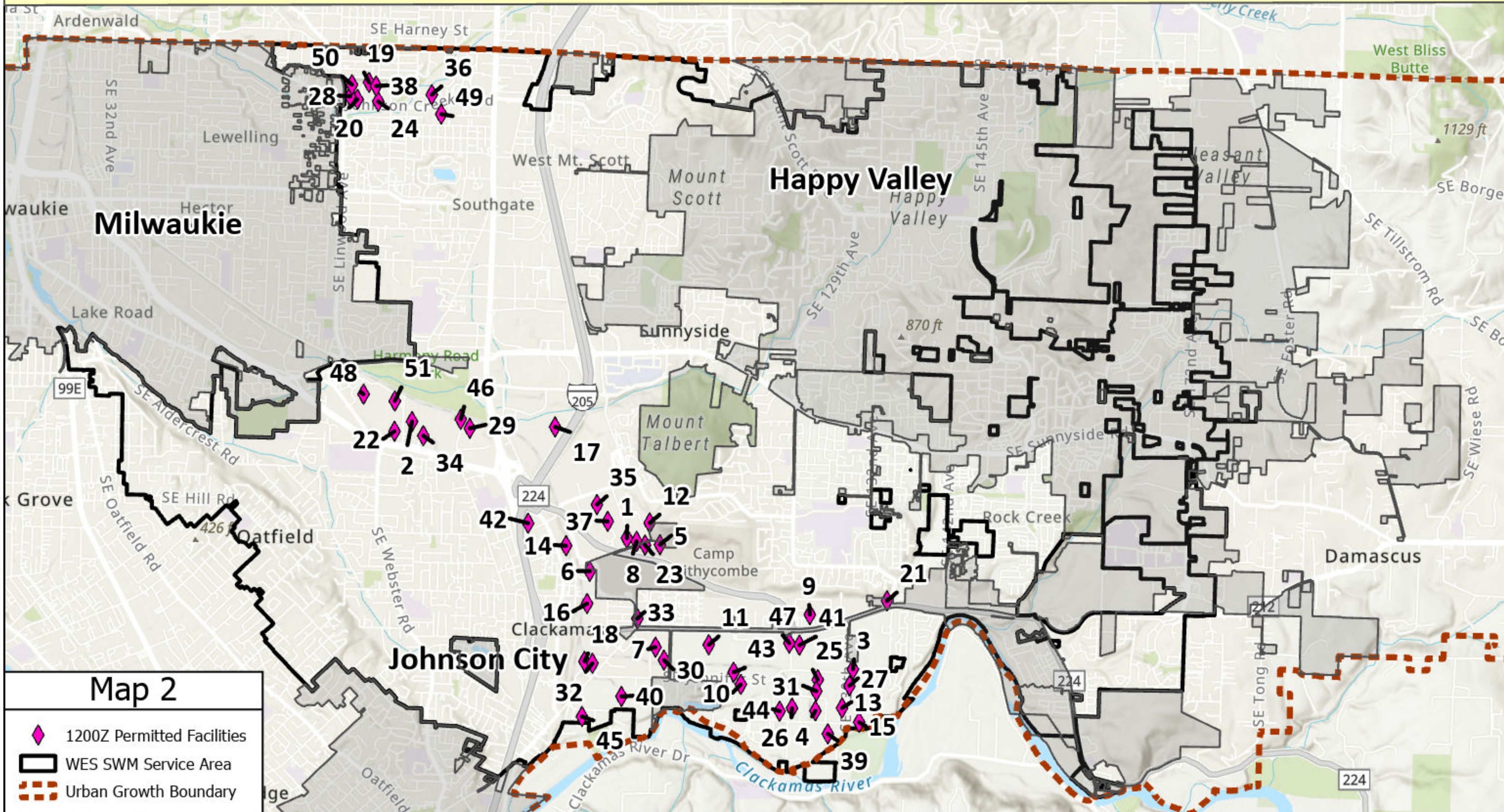
Appendix D

Maps for Permit Schedule B(4)(h)

2026 MS4 Permit Renewal Application Submittal - WES Storm Sewer System



2026 MS4 Permit Renewal Application Submittal - 1200Z Permitted Businesses

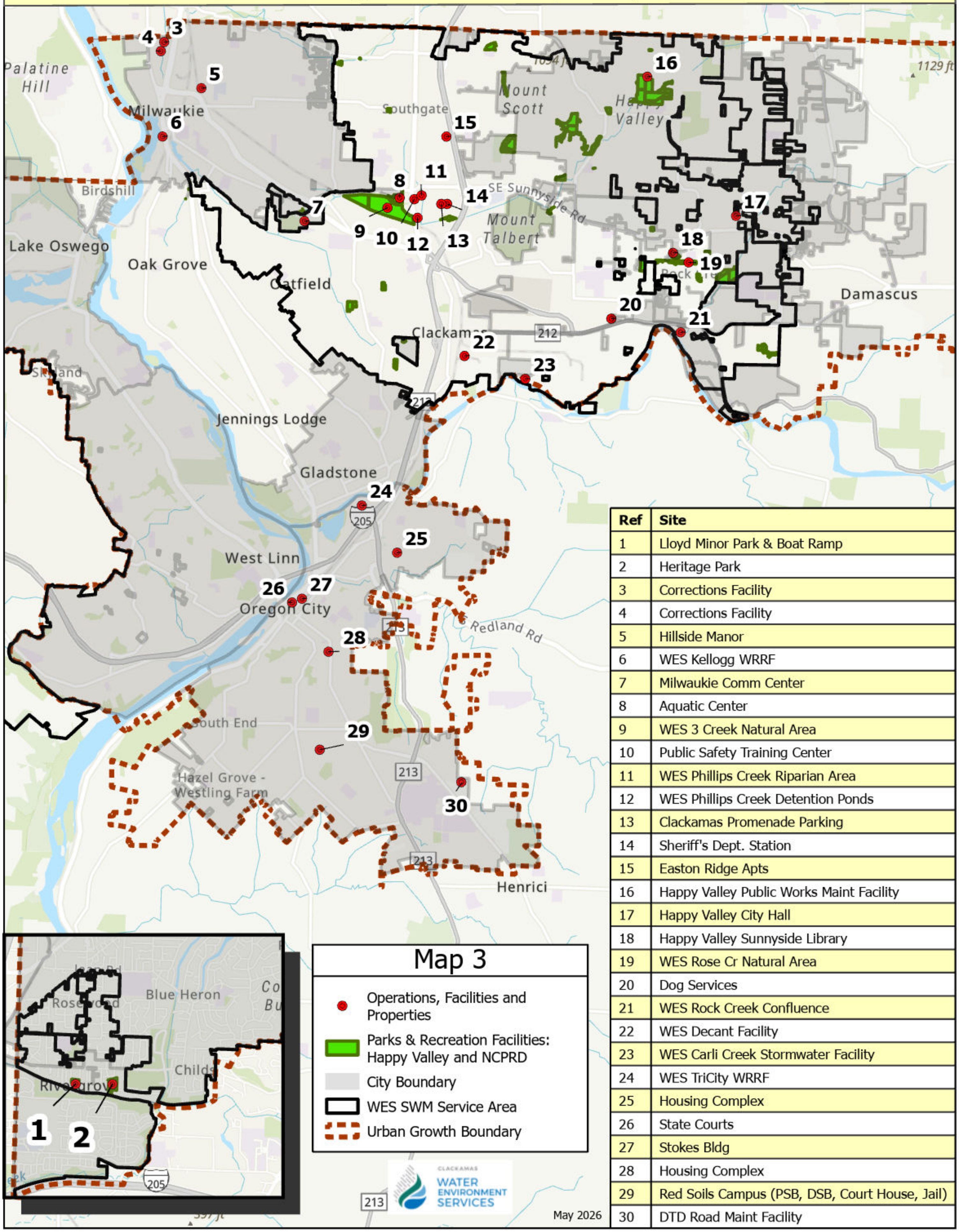


Ref	Business
1	Columbia Body Manufacturing
2	Warn Automotive LLC
3	P & A Metal Fab
4	Wymore Transfer
5	Euro-American Design
6	Conveyco Mfg
7	Consolidated Metco, Inc
8	R.S. Davis Recycling, Inc
9	Met-Tek Inc
10	Precision Truss & Lumber
11	Fred Meyer Distribution Center
12	Mannex Corportation
13	Pacific Seafood
14	Columbia Rubber Mills
15	Alpenrose
16	K.B. Recycling
17	PCC Structurals, Inc. - Operations
18	Interstate Meat Distributors
19	PCC Structurals, Inc.-Machine Shop
20	Oregon Screw Machine Products
21	Trans-Lite, Inc.
22	Bob's Red Mill
23	Temco Metal Products
24	PCC Structurals, Inc. LSBS I & II
25	Wilbur Ellis Feed Llc
26	J&D Refrigerated Services
27	Safety-Kleen Systems, Inc.
28	Skutt Ceramic Products
29	PCC Structurals, Inc.-Deer Creek
30	Q B Fabrication & Welding
31	Thermo Fluids, Inc.
32	General Sheet Metal Works
33	Transportation Services
34	PCC Structurals, Inc. - Milwaukie
35	Vigor Works LLC
36	Wright Manufacturing
37	Recon Craft
38	PCC Structurals, Inc. - LSBS III
39	Warn Industries Inc.
40	Forum Clackamas Campus
41	Estes Express Clackamas
42	Boydstun Equipment Manufacturing
43	Miles Fiberglass & Composites
44	Pioneer Recycling
45	Albertsons Companies
46	Mcfarlane's Bark, Inc.
47	Agrinos
48	6433 SE Lake I LLC
49	Rapid Response Bio-Clean
50	PCC Structurals, Inc. - Titanium
51	C&S Wholesale Grocers

Clackamas Water Environment Services

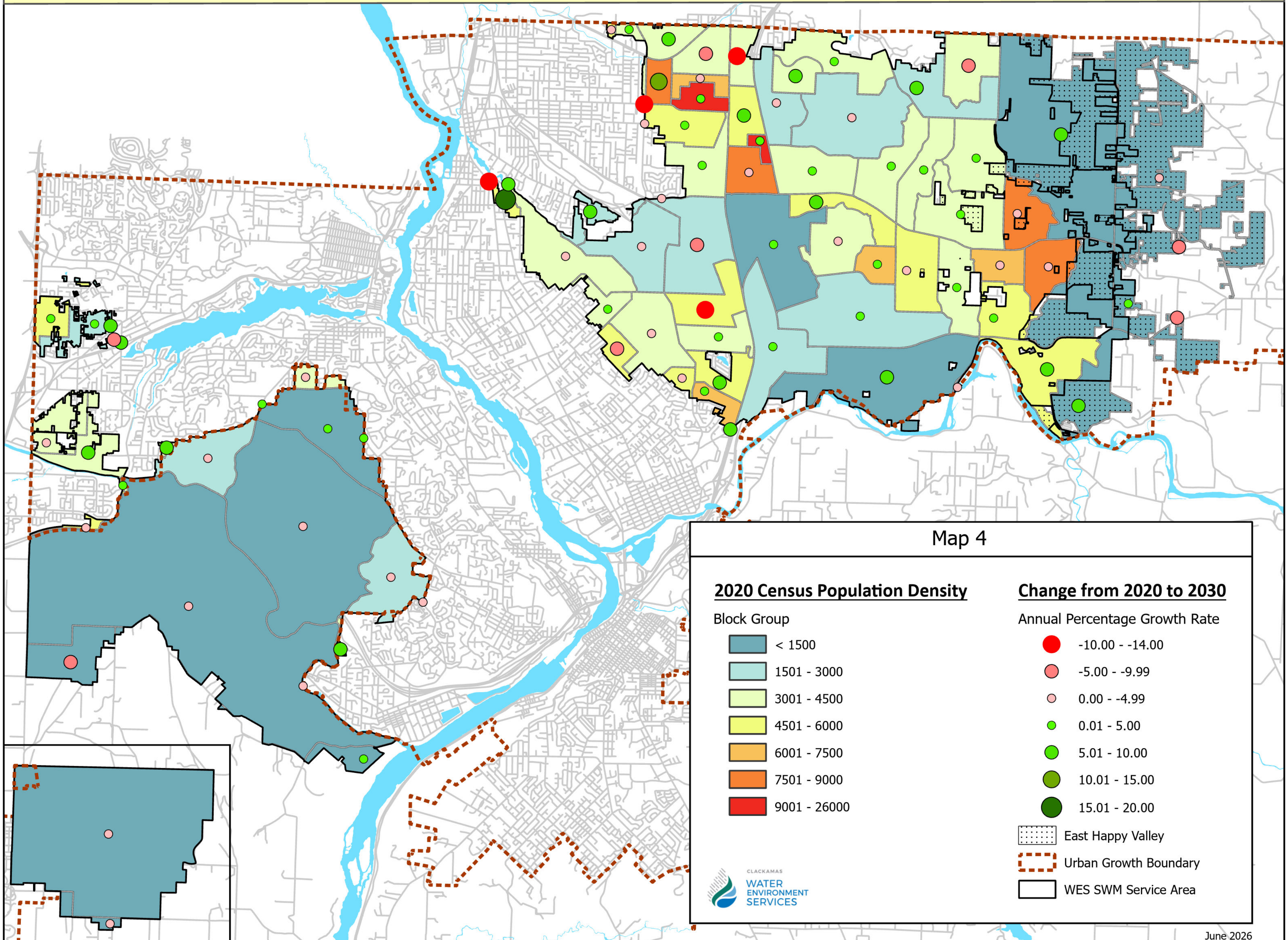
May 2026

2026 MS4 Permit Renewal Application Submittal - Operations, Facilities and Properties

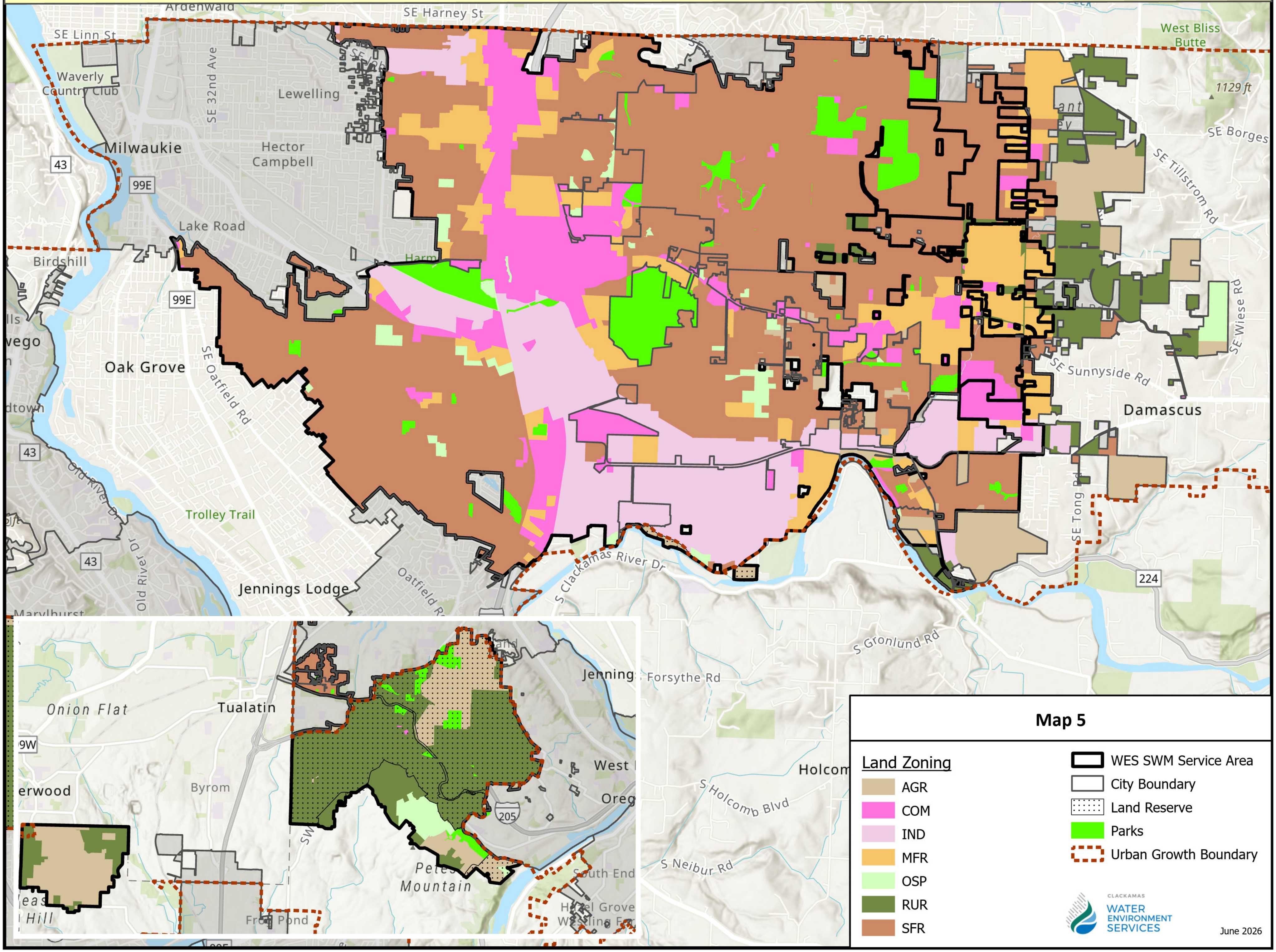


Ref	Site
1	Lloyd Minor Park & Boat Ramp
2	Heritage Park
3	Corrections Facility
4	Corrections Facility
5	Hillside Manor
6	WES Kellogg WRRF
7	Milwaukie Comm Center
8	Aquatic Center
9	WES 3 Creek Natural Area
10	Public Safety Training Center
11	WES Phillips Creek Riparian Area
12	WES Phillips Creek Detention Ponds
13	Clackamas Promenade Parking
14	Sheriff's Dept. Station
15	Easton Ridge Apts
16	Happy Valley Public Works Maint Facility
17	Happy Valley City Hall
18	Happy Valley Sunnyside Library
19	WES Rose Cr Natural Area
20	Dog Services
21	WES Rock Creek Confluence
22	WES Decant Facility
23	WES Carli Creek Stormwater Facility
24	WES TriCity WRRF
25	Housing Complex
26	State Courts
27	Stokes Bldg
28	Housing Complex
29	Red Soils Campus (PSB, DSB, Court House, Jail)
30	DTD Road Maint Facility

2026 MS4 Permit Renewal Application Submittal - Population and Projected Growth



2026 MS4 Permit Renewal Application Submittal - Landuse



Appendix E

TMDL Pollutant Load Reduction Evaluation and Benchmarks

TMDL Pollutant Load Reduction Evaluation and Benchmarks

Prepared for

Clackamas Water Environmental Services, Clackamas County
City of Happy Valley, Oregon
City of Rivergrove, Oregon

June 2026

FINAL

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List of Abbreviations

ac	acre(s)
ACWA	(Oregon) Association of Clean Water Agencies
AGR	agricultural
ASCE	American Society of Civil Engineers
BMP	best management practice
CCSD #1	Clackamas County Service District #1
CFU	colony forming unit(s)
cities	City of Happy Valley and City of Rivergrove
COM	commercial
DDT	dichlorodiphenyltrichloroethane
DEQ	(Oregon) Department of Environmental Quality
Districts	CCSD #1 and SWMACC (including Rivergrove)
DO	dissolved oxygen
EHV	East Happy Valley
EMC	event mean concentration
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
HUC	hydrologic unit code
IND	industrial
LA	load allocation
LCL	lower confidence limit
MFR	multifamily residential
mg/L	milligram(s) per liter
mL	milliliter(s)
MS4	Municipal Separate Storm Sewer System
ng/L	nanogram(s) per liter
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
PLRE	pollutant load reduction evaluation
POS	parks and open space
RES	residential
RUR	rural residential
SOD	sediment oxygen demand
SVS	settleable volatile solids
SWMACC	Surface Water Management Agency of Clackamas County
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence limit
UGB	urban growth boundary
UIC	underground injection control
USGS	U.S. Geological Survey
VAC	vacant
VBA	visual basic for applications
WES	Water Environment Services
WLA	waste load allocation
WPCF	water pollution control facility
WTM	Watershed Treatment Model
WWTP	wastewater treatment plant

Definitions

Load Allocation (LA)	The portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. [OAR 340-041-0002(30)]. [1]
Pollutant Load Reduction Benchmark (Benchmark)	A future pollutant load reduction estimate for a parameter or surrogate, where applicable, for which a waste load allocation (WLA) is established. The benchmark is used to establish anticipated future progress toward achieving the WLA over an implementation period (typically 5 years).
Pollutant Load Reduction Evaluation	An evaluation of current pollutant load generation and pollutant load reduction associated with BMP implementation for a parameter or surrogate where a WLA is established. The pollutant load reduction evaluation (PLRE) is used to measure progress toward achieving a WLA or previously established benchmark.
Total Maximum Daily Load (TMDL)	The sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and background. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. [OAR 340-041-002(65)]. [1]
Wasteload Allocation (WLA)	The portion of a receiving water's loading capacity allocated to one of its existing or future sources of pollution. WLAs constitute a type of water quality-based effluent limitation [OAR 340-041-0002(67)]. [1]

[1] Definitions are from the May 2025 Oregon Administration Rules (OARs) Chapter 340, Division 41, Number 0002. https://oregon.public.law/rules/oar_340-041-0002

Section 1

Introduction

This report presents the total maximum daily load (TMDL) pollutant load reduction evaluation (PLRE) and the TMDL pollutant load reduction benchmarks for Clackamas Water Environment Services (WES), Clackamas County, and the cities of Happy Valley and Rivergrove, hereby referred to as the "cities." WES, Clackamas County, and the cities are co-permittees on the Clackamas County National Pollutant Discharge Elimination System (NPDES) Phase I municipal separate storm sewer system (MS4) permit. The MS4 permit coverage extends to the MS4 permit area of WES within the Portland Metro Area's Urban Growth Boundary (UGB) and the service boundaries of the incorporated cities within the UGB.

WES' MS4 permit area includes the portion of the city of Rivergrove within Clackamas County, as well as portions of the city of Happy Valley. There is a portion of the city of Happy Valley located outside WES' MS4 permit area but within the UGB. This area is referred to as East Happy Valley (EHV) and is covered by the Clackamas County NPDES MS4 permit. Clackamas County's MS4 Permit area also includes the Oak Lodge Water Services (OLWS), but a separate PLRE and TMDL benchmark evaluation was conducted and submitted to DEQ for this area. Therefore, WES and EHV collectively are the two "service areas" evaluated for this PLRE and TMDL benchmark analysis.

WES and EHV service areas are subject to TMDLs for three TMDL subbasins: the Lower Willamette, the Middle Willamette, and the Tualatin. Each TMDL subbasin covers various waterbodies/ TMDL watersheds and pollutant parameters referenced in the TMDL documents.

As required by the Clackamas County MS4 permit, the PLRE includes:

- An evaluation of the estimated pollutant loading based on current land use, without considering best management practice (BMP) implementation, from WES and EHV's MS4 permit areas (i.e., NPDES MS4 permit coverage area).
- An evaluation of the pollutant load reduction based on WES' and EHV's current land use and current use of structural stormwater controls or BMPs[1].
- A comparison of the current (2025[2]) pollutant load reduction to TMDL wasteload allocations (WLAs) and TMDL pollutant load reduction benchmarks established as part of the NPDES MS4 permit renewal application in 2017.
- A description of the estimated effectiveness of structural and non-structural BMPs and the rationale for the selected approach.

[1] *Structural* stormwater controls or BMPs consist of specific stormwater facilities such as detention ponds, treatment wetlands, stormwater planters, rain gardens, or stormwater filters. These are distinguished from *non-structural* BMPs such as maintenance activities, street sweeping, and/or education and outreach activities.

[2] The Geographic Information System (GIS) data was baselined for November 2025. Although this technical report was completed in 2026, the term "current" in this document refers to 2025.

The PLRE results presented in Section 5 and Appendix B (titled "summary of loads") show that the WES and EHV service areas are meeting WLAs for DDT in the Lower Willamette TMDL Subbasin, and bacteria in the Tualatin TMDL Subbasin. WES is meeting the previously established quantitative pollutant load reduction benchmarks for *E. coli* in select TMDL watersheds in the Lower Willamette TMDL Subbasin. However, significant additional pollutant reduction would be needed to achieve the WLAs defined in the TMDL, specifically for bacteria in the Lower Willamette and Middle Willamette TMDL Subbasins. This additional reduction could come from additional structural BMPs, or non-structural BMPs such as source controls and programmatic activities.

As part of the NPDES MS4 permit renewal application, new pollutant load reduction benchmarks are required for TMDL parameters where WLAs are not currently estimated as being achieved. The benchmark development includes:

- Identification of additional or modified BMPs anticipated over the next permit term (assumed through 2031).
- An evaluation of the estimated pollutant loading and pollutant load reduction based on WES' and EHV's current and anticipated future use of BMPs.

Updated benchmarks for WES and EHV for applicable TMDL watersheds are presented in Section 6 and Appendix B.

To accompany and support the PLRE and TMDL benchmark analyses, this report also includes an analysis of long-term trends in receiving water quality based on in-stream monitoring data as well as a qualitative evaluation of mercury reduction as required by the permit.

1.1 Permit Requirements

WES, Clackamas County, and the cities of Rivergrove and Happy Valley (cities) are co-permittees on the Clackamas County NPDES MS4 permit or MS4 permit. The MS4 permit coverage extends to the MS4 permit areas of WES within the Portland Metro Area's Urban Growth Boundary (UGB) and the service boundaries of the incorporated cities within the UGB.

The Oregon Department of Environmental Quality (DEQ) initially issued the current Clackamas MS4 permit (Permit No. 101348) on September 15, 2021, which was updated under Modification #1 with an updated issuance date of May 4, 2023. The requirements to evaluate pollutant load reductions are listed in Schedule D.3.a of the Clackamas County NPDES MS4 permit as follows:

> *a.* ***Applicability:*** *…The requirements of this section apply to the co-permittees' MS4 discharges to receiving waters with established TMDLs or to receiving waters with new or modified TMDLs approved or issued by EPA within three years of the issuance date of this permit. Established TMDLs are noted on page 1 of this permit. Pollutant discharges for those parameters listed in the TMDL with applicable WLAs must be reduced to the maximum extent practicable through the implementation of BMPs and an adaptive management process.*

The following two subsections (1.1.1 and 1.1.2) provide more detail regarding the TMDL pollutant evaluation requirements from the permit, specifically for the PLRE and benchmarks. Section 1.1.3 summarizes the pollutant load evaluation submittal timeframes applicable to this evaluation.

1.1.1 PLRE Requirements

Per Schedule D.3.c of the MS4 permit, WES, Clackamas County, and the cities must complete a PLRE for submittal with the MS4 Permit Renewal Application Package. WES received an extension from Oregon Department of Environmental Quality (DEQ) on January 20, 2026, allowing the MS4 Permit Renewal Application to be submitted no later than permit expiration (September 29, 2026). The PLRE must include the following:

i. *The rationale and methodology used to evaluate progress towards reducing TMDL pollutant loads.*

ii. *An estimate of current pollutant loadings without considering BMP implementation, and an estimate of current pollutant loadings considering BMP implementation for each TMDL parameter with an established WLA. The difference between these two estimated loads is the pollutant load reduction.*

iii. *A comparison of the estimated pollutant loading with and without BMP implementation to the applicable TMDL WLA.*

iv. *A comparison of the estimated pollutant load reduction to the estimated TMDL pollutant load reduction benchmark established for the permit term, if applicable.*

v. *A description of the estimated effectiveness of structural BMPs.*

vi. *A description of the estimated effectiveness of non-structural BMPs, if applicable, and the rationale for the selected approach.*

vii. *A water quality trend analysis, as sufficient data are available, and the relationship to stormwater discharges for receiving water bodies within the co-permittees' jurisdictional area with an approved TMDL. If sufficient data to conduct a water quality trend analysis is unavailable for a receiving waterbody, the co-permittees must describe the data limitations. The collection of sufficient data must be prioritized and reflected as part of the monitoring project/task proposal required in Schedule B.4.e.*

viii. *A narrative summarizing progress towards applicable TMDL WLAs and existing TMDL benchmarks, if applicable. If a co-permittee estimates that an existing TMDL benchmark was not achieved during the permit term, the co-permittee must apply their adaptive management process to reassess the SWMP and current BMP implementation in order to address TMDL pollutant load reduction over the next permit term; and,*

ix. *If a co-permittee estimates that TMDL WLAs are achieved with existing BMP implementation, the co-permittee must provide a statement supporting this conclusion.*

1.1.2 Benchmark Requirements

Per Schedule D.3.d of the Clackamas MS4 permit, WES, Clackamas County, and the cities must develop TMDL pollutant load reduction benchmarks for the next permit term for each applicable TMDL parameter where existing BMP implementation is not achieving the WLA. The TMDL benchmarks must be submitted with the permit renewal application. Per Schedule D.3.d.i, the TMDL pollutant load reduction benchmark must reflect the following:

(A) *Additional pollutant load reduction necessary to achieve the benchmark estimated for the permit term, if not achieved per Schedule D.3.c.iv; and,*

(B) *The pollutant load reduction proposed to achieve additional progress towards the TMDL WLA during the next permit term.*

Per Schedule D.3.d.ii, the TMDL pollutant load reduction benchmark submittal must include the following:

(A) *An explanation of the relationship between the TMDL waste load allocations and the TMDL benchmark for each applicable TMDL parameter;*

(B) *A description of how SWMP implementation contributes to the overall reduction of the TMDL pollutants during the next permit term;*

(C) *Identification of additional or modified BMPs that will result in further reductions in the discharge of the applicable TMDL pollutants, including the rationale for proposing the BMPs; and*

(D) *An estimate of current pollutant loadings that reflect the implementation of the current BMPs and the BMPs proposed to be implemented during the next permit term.*

1.1.3 Submittal Timeframes

Development of this PLRE and benchmark evaluation is intended to build on and provide comparisons with the previous (2017) PLRE and Benchmark Evaluation. Due to the variable timeframes and assumptions associated with each analysis, Table 1-1 summarizes the submittal dates and basis of the analyses associated with the previous analysis.

Table 1-1. Timeline Summary for Pollutant Load Evaluations

Evaluation	Permit Schedule Reference	Submittal Date	Date Basis for PLRE	Date Basis for Benchmarks
Clackamas County Co-Permittee NPDES MS4 permit issuance (2012)				
PLRE	Schedule D.3.c	2015	2015	N/A
PLRE and Benchmark Evaluation [a]	Schedule D.3.d	2017	2015	2022
Clackamas County Co-Permittee NPDES MS4 permit issuance (2021, modified 2023)				
PLRE and Benchmark Evaluation	Schedule D.3.c and d	2026	2025	2031

a. *This PLRE and Benchmark Evaluation amended the 2015 PLRE submittal.*

1.2 Service Area Overview

WES administers stormwater and sanitary sewer services in portions of the City of Happy Valley and unincorporated Clackamas County area within the Portland Metro urban growth boundary (UGB), both east and west of the Willamette River.

WES' MS4 permit area is defined as the area for which WES has responsibility for implementing a stormwater management program, which is also regulated by their MS4 permit. With the previous (2017) PLRE and Benchmark Evaluation, two service districts: the Clackamas County Service District #1 (CCSD#1) and the Stormwater Management Agency of Clackamas County (SWMACC) represented WES' MS4 permit area. As such, the 2017 PLRE and Benchmark Evaluation results were presented for CCSD#1 and SWMACC separately. With this 2026 PLRE and Benchmark Evaluation, results are presented collectively for the overall WES MS4 permit area as those Districts have been consolidated.

East of the Willamette River:

- WES' MS4 permit area is bordered by incorporated cities including Gladstone and Milwaukie. The city of Happy Valley is located along the eastern WES MS4 permit area boundary. WES provides stormwater and sanitary services for developed areas of the city of Happy Valley.
- The portion of Happy Valley not included within WES' MS4 permit area is referred to as East Happy Valley (EHV) and for purposes of the PLRE and benchmarks, pollutant loads and benchmarks are calculated for this area separately from WES.
- Clackamas County's MS4 Permit area extends into OLWS, but a separate PLRE and benchmark evaluation was created and submitted to DEQ for OLWS.

West of the Willamette River, WES' MS4 permit area subject to PLRE and benchmark requirements is limited to a small amount of rural Clackamas County land within the UGB. Most of the area is rural and includes small, disconnected unincorporated tax lots as well as the portion of the city of Rivergrove located in Clackamas County. WES' MS4 permit area continually fluctuates in conjunction with annexations to neighboring cities (Lake Oswego, for example). Thus, the areas subject to the PLRE and benchmark requirements will vary over time. Review and update of the WES service area boundary will be necessary with future submittals.

1.3 TMDL Pollutant Summary

TMDLs are developed to determine the maximum pollutant load capacity that can be directed to a particular water body without exceeding water quality standards. TMDLs may be developed for pollutants with direct links to stormwater runoff (e.g., metals, nutrients) or for pollutants not typically associated with urban stormwater runoff in the Willamette Valley (e.g., temperature).

TMDLs relevant to stormwater discharges from the WES and EHV MS4 permit areas include the Willamette Basin TMDL, which includes the Lower Willamette and Middle Willamette TMDL Subbasins, and the Tualatin Basin TMDL. The Willamette Basin TMDL was approved for bacteria and DDT/dieldrin on September 29, 2006, by the U.S. Environmental Protection Agency (EPA) and then updated to include mercury waste load allocations in 2019 (approved/reissued by EPA in 2021). The temperature portion of the TMDL was updated on May 8, 2025. The Tualatin Subbasin TMDL was approved by the EPA on August 7, 2001, and amended on August 28, 2012.

The Willamette Basin TMDL addresses the following tributary waterbodies/ TMDL watersheds applicable to WES and EHV: the Clackamas River (including the Rock Creek tributary), Johnson Creek, unspecified tributary discharges to the Lower Willamette River (e.g., Kellogg-Mt. Scott Creek) and unspecified tributary discharges to the Middle Willamette River (e.g., Tanner Creek). The Tualatin Subbasin TMDL addresses urban stormwater runoff to Fanno Creek and direct and unspecified tributary discharges to the Lower Tualatin River within the WES service area.

Additional detail regarding TMDL parameters and WLAs are provided in Section 2. Refer to Figure 4-1 and Figure 4-2 for the location of WES and EHV service areas with respect to the TMDL watersheds.

1.4 Document Organization

This technical report was prepared to fulfill requirements related to the development of a PLRE, as required per Schedule D.3.c of the NPDES MS4 permit, as well as the requirements related to development of TMDL benchmarks, as required per Schedule D.3.d of the NPDES MS4 permit. This report outlines the data assumptions, methods, and results of the PLRE and updated benchmarks for WES and EHV service areas.

Following this introductory section, this report is organized according to the following sections:

Section 2 Review of the Willamette Basin TMDL, Tualatin Subbasin TMDL, and applicable pollutant wasteload allocations.

Section 3 Description of the process for developing pollutant load reduction estimates and benchmarks.

Section 4 Pollutant load modeling methods and assumptions.

Section 5 PLRE, including comparison of results to WLAs and comparison of results to the 2017 pollutant load reduction benchmarks. This section also includes a qualitative evaluation of mercury load reduction as required by the permit.

Section 6 TMDL Pollutant Load Reduction Benchmarks for the upcoming permit term.

This report also includes an analysis of long-term trends in receiving water quality based on in-stream monitoring data, as documented in Appendix A and a summary of loads related to the PLRE and benchmarks, as documented in Appendix B.

Section 2

TMDL Applicability

TMDLs are developed to document the projected maximum pollutant load capacity of a water body that should be met so as not to exceed water quality standards. They may be developed for pollutants with direct links to stormwater runoff (e.g., metals, nutrients) and for pollutants not typically associated with urban stormwater runoff in the Willamette Valley (temperature).

To translate a TMDL into guidelines for NPDES-permitted entities (municipalities, industries, wastewater treatment plants [WWTPs]), WLAs are developed to regulate discharges from defined point sources of pollution that operate under an NPDES discharge permit. Load allocations (LAs) are developed to allocate pollutant discharges from nonpoint sources that generally do not operate under an NPDES discharge permit (e.g., agriculture and forestry).

With the implementation of NPDES MS4 permit requirements (considered to be point source discharge permits), by definition, WLAs would typically be used to regulate discharges from urban stormwater runoff for areas covered by the permits. However, depending on the language of the TMDL, MS4 sources have sometimes been undefined or excluded from the WLA or instead mistakenly covered under the LAs. As such, interpretation of TMDL requirements for MS4 sources can be confusing.

The Willamette Basin TMDL uses LAs to define pollutant load discharges from urban land use including from the WES and EHV MS4 permit areas (i.e., NPDES MS4 permit area). The Tualatin Subbasin TMDL uses WLAs to define pollutant load discharges from designated jurisdictions with an NPDES MS4 permit (including areas in the WES MS4 permit area). Because pollutant load discharges within the WES and EHV MS4 permit areas are managed through implementation of the NPDES MS4 permit, for purposes of this report, it is assumed that the LAs referenced in the Willamette Basin TMDL are WLAs. The term WLA is used in this report.

2.1 Willamette Basin TMDL

The Willamette Basin TMDL addresses elevated in-stream temperatures, bacteria (*E. coli*), and mercury for the Willamette River and tributaries (i.e., Johnson Creek, Clackamas River, etc.). Specific for Johnson Creek, a TMDL is also in place for DDT (dichlorodiphenyltrichloroethane) and dieldrin.

2.1.1 TMDL Overview

Temperature can be considered both a point and nonpoint source pollutant, but DEQ does not consider it to be a pollutant parameter associated with urban stormwater runoff in the Willamette Valley. Temperature is regulated by DEQ and addressed by individual NPDES Wastewater Discharge permits and TMDL Implementation Plans, but not under NPDES MS4 permits.

Bacteria are considered a pollutant with direct ties to stormwater runoff; thus, bacteria are regulated under the MS4 permits as a point source pollutant. Therefore, WES and EHV are required to conduct a PLRE and, as necessary, develop new benchmarks for bacteria in the Lower and Middle Willamette TMDL Subbasins.

While mercury is also an applicable TMDL parameter with direct ties to stormwater, per Schedule D.3.b. of the permit, mercury pollutant load reductions and benchmarks are not applicable in the first permit cycle after the TMDL is issued. Instead, an analysis of the effectiveness of BMPs, along with a description of other actions taken and qualitative pollutant load reductions achieved are required with the Permit Renewal Application Package. This qualitative evaluation for mercury is provided in Section 5.5 of this document.

In Johnson Creek, a TMDL was developed for toxics because of measured high levels of the pesticides DDT and dieldrin. DDT and dieldrin are both legacy pollutants, used historically as agricultural insecticides, and use of the compounds was banned in 1972 (DDT) and 1983 (dieldrin). However, the historical use of the compounds still results in exceedances of the aquatic and human-health water quality standards because of their persistence in the environment and low solubility (i.e., tendency to bind to soil particles). Stormwater collection systems provide a transport mechanism for contaminated soil, so a WLA was established for MS4 discharge and a pollutant load reduction estimate is required. Because DDT and dieldrin are legacy pollutants and ongoing degradation is occurring, a PLRE is conducted but new benchmarks have not been developed for toxics.

2.1.2 Wasteload Allocations

The WLAs for bacteria (*E. coli*) and DDT in the Willamette Basin TMDL are calculated as a percent load reduction based on land use (e.g., urban, agricultural, etc.). In the Willamette Basin TMDL, specific MS4 contributions (by jurisdiction) are not defined, so the MS4 WLA is assumed to equate to the LA associated with urban land use.

As described in the Willamette Basin TMDL, the water quality criterion for bacteria (monthly log mean concentration of 126 *E. coli* per 100 milliliters [mL]) was used to establish the required bacteria WLAs. For DDT, a WLA of 77 percent (annual reduction) was established for urban stormwater, based on the 90th percentile concentration of DDT in stormwater versus instream samples. It should be noted that stormwater samples used to establish the WLA were based on a limited number of samples (10 samples) collected from two locations in 2002.

WLAs for the Willamette Basin TMDL by TMDL waterbody and parameter are listed in Table 2-1.

Table 2-1. Willamette Basin TMDL WLAs

TMDL Document	TMDL Waterbody	Service Area		Parameter	WLA
		WES	EHV		
Willamette Basin TMDL/ Lower Willamette Subbasin (2006)	Clackamas River	X	X	Bacteria *(E. coli)*	78% reduction (annual)
	Lower Willamette (via tributaries)	X	X	Bacteria *(E. coli)*	78% reduction (annual)
	Johnson Creek	X	X	Bacteria *(E. coli)*	78% reduction (annual)
		X	X	DDT	77% (annual reduction)
Willamette Basin TMDL/ Middle Willamette Subbasin (2006)	Middle Willamette (via tributaries)	X		Bacteria *(E. coli)*	88% reduction (summer seasonal)
					75% reduction (fall, winter, spring seasonal)

2.2 Tualatin Subbasin TMDL

The Tualatin Subbasin TMDL addresses elevated in-stream temperatures, bacteria (*E. coli*), chlorophyll a and pH (total phosphorus as a surrogate measure), and DO (ammonia and SVS as a surrogate measure) for the Tualatin River and tributaries (i.e., Fanno Creek).

2.2.1 TMDL Overview

As described for the Willamette Basin TMDL, DEQ does not consider temperature to be a pollutant parameter associated with urban stormwater runoff in the Willamette Valley. Therefore, no WLA was established for temperature, and temperature is not evaluated in this PLRE.

Bacteria are considered a pollutant with direct ties to stormwater runoff, so bacteria are regulated under the MS4 permits as a point source pollutant. Therefore, WES is required to conduct a PLRE for bacteria and, as necessary, develop new benchmarks for bacteria in the Tualatin TMDL Subbasin.

DO, pH, and Chlorophyll a are not independently considered to be pollutants, but rather an effect of elevated temperature, low flows, and the discharge of pollutants such as nutrients that exacerbate the growth of algae and other autotrophs. These factors can result in changes to pH levels and DO concentrations. Low DO concentrations and variable pH levels can impact aquatic health. DO and pH levels are related to stormwater runoff when considering impacts of pollutants such as nutrients (i.e., total phosphorus) and sediment on receiving waters. Total phosphorus and settleable volatile solids (SVS) are often used as surrogates for DO, chlorophyll a, and pH. Given the lack of data for SVS, the Tualatin Subbasin TMDL references total suspended solids (TSS) as a common parameter to represent SVS. Therefore, WES is required to conduct a PLRE for total phosphorus and TSS and, as necessary, develop associated benchmarks.

2.2.2 Wasteload Allocations

The WLAs for bacteria (E. coli) were established as a general (not water-body-specific) WLA for urban runoff in the Tualatin TMDL. The WLAs are presented as an event mean concentration (EMC) of stormwater runoff and are calculated separately for a summer storm event of 0.11 inch/24 hours and a winter storm event of 1.96 inches/96 hours. The WLAs were established based on a calibrated loadings model and the ability to achieve a target in-stream *E. coli* concentration of 126 counts/100 mL.

The WLAs for total phosphorus (as a surrogate for pH and chlorophyll a) were established as a median concentration of stormwater runoff for the summer season (May to October). The TMDL assigns WLAs for point source discharges (excluding WWTPs) according to the location of discharges along the Tualatin River. Dischargers to tributaries have lower WLAs than dischargers to the mainstem Tualatin River. Point source WLAs for total phosphorus were based on maintaining an in-stream total phosphorus concentration below 0.15 mg/L, which is considered natural background conditions. Therefore, specific TMDL watersheds have unique phosphorus concentration targets to achieve natural background conditions.

The WLA for TSS (as a surrogate for SVS) is calculated based on the necessary reduction in sediment oxygen demand (SOD) required to meet various DO criteria along the mainstem and tributaries of the Tualatin River. SOD reduction for runoff sources (i.e., MS4 runoff) is addressed through the allocation of SVS and total phosphorus (see pH and chlorophyll a TMDL). Because the current (or background) SVS load is unknown, the WLAs are presented as unique percent reduction estimates for specific TMDL watersheds and management efforts are expected to incorporate TSS (as opposed to SVS) as a target parameter.

WLAs by service area, TMDL waterbody, and parameter are listed in Table 2-2.

Table 2-2. Tualatin Basin TMDL WLAs

TMDL Document	TMDL Waterbody	Service Area		Parameter	WLA
		WES	EHV		
Tualatin Subbasin TMDL (2012)	Fanno Creek	X		Bacteria *(E. coli)*	12,000 count/100 mL (summer storm event)
					5,000 count/100 mL (winter storm event)
		X		TSS (surrogate measure for SVS and DO)	50% (summer seasonal reduction)
		X		Total phosphorus (surrogate measure for pH and Chlorophyll a)	0.13 mg/L (summer seasonal)
	Tualatin River (via tributaries)	X		Bacteria *(E. coli)*	12,000 count/100 mL (summer storm event)
					5,000 count/100 mL (winter storm event)
		X		TSS (surrogate measure for SVS and SOD)	20% (summer seasonal reduction)
		X		Total phosphorus (surrogate measure for pH and chlorophyll a)	0.14 mg/L (summer seasonal)

Section 3

PLRE and Benchmark Process and Methodology

Conducting a PLRE and developing benchmarks relies on the use of a pollutant loading model to calculate pollutant loads for select parameters and select scenarios, under select development conditions.

In accordance with Schedule D.3.c of the MS4 permit, jurisdictions are required to conduct a PLRE for all applicable TMDL parameters. The PLRE must reflect current (2025[4]) development conditions. The PLRE must include estimates of current pollutant loading both without and with BMP implementation. Results of the PLRE must be compared to previously established pollutant load reduction benchmarks and applicable WLAs. The PLRE is used to estimate the effectiveness of stormwater management facilities and show how BMPs are making progress toward achieving pollutant load reductions.

For TMDL parameters where the PLRE indicates that a WLA is not being met, development of a new pollutant load reduction benchmark is required. A benchmark is an estimate of pollutant load reduction for an applicable TMDL pollutant at the end of the next 5-year NPDES MS4 permit term. Benchmarks account for current BMP implementation and additional BMP implementation anticipated during the next five-year permit term (i.e., estimated as 2026 through 2031).

3.1 PLRE and Benchmark Process

Figure 3-1 below identifies the overall process for conducting the PLRE and the relationship to the pollutant load reduction benchmarks. Steps 1 through 6 are associated with the PLRE and include review of TMDL assumptions, data compilation, pollutant load calculations, and comparison of pollutant loads to WLAs and benchmarks previously established for the current permit period. Step 7 includes development of new pollutant load reduction benchmarks for the upcoming permit period.

This overall process is based on the process collectively developed through the Oregon Association of Clean Water Agencies (ACWA) in 2005 to conduct pollutant loads modeling for TMDL compliance.

As shown on Figure 3-1 three general categories of BMPs are considered in the process:

1. Structural BMP systems for which pollutant removal can be reported quantitatively and are based on the results of scientific research (i.e., effluent concentrations). These BMPs include traditional ponds, swales, infiltration facilities, proprietary treatment systems, and wetlands.
2. Structural and/or source control BMP applications or practices where pollutant removal potentially could be reported in objective, quantitative terms, but effectiveness information is generally limited or unavailable. These BMPs (particularly source control BMPs) may be reflected in the modeling effort by simulating their specific coverage area with adjusted model assumptions (impervious area, land use EMCs, etc.). These source control BMPs may include downspout disconnection programs, street sweeping, and catch basin cleaning.

[4] The date bases for GIS data used for the PLRE is November 2025. Therefore, current development conditions are considered to represent 2025.

3. Non-structural/source control BMP applications where pollutant removals are not likely to be reported in objective, quantitative terms. These BMPs could include public education, illicit discharge detection programs, and spill prevention.

This process results in a conservative estimate of pollutant removal because it considers only those BMPs with quantitative pollutant removal effectiveness information (Category 1) and selected structural/source control BMPs under Category 2 to provide a relative picture as to how close or far the stormwater program is with regards to meeting the WLAs. Implementation of non-structural or non-quantifiable BMPs (Category 3) have the potential to reduce pollutant loads further than is reflected in this evaluation.

3.2 Model Description

The PLRE and development of benchmarks were conducted using a spreadsheet loads model developed based on the EPA simple method for pollutant load calculations. The model was originally developed in 2008 for multiple Oregon Phase I NPDES MS4 jurisdictions including the Clackamas County co-permittees to calculate pollutant loads and develop TMDL benchmarks. Minor refinements were made in 2014 to account for new land use and BMP categories.

The same spreadsheet loads model was used for this effort with the following modifications:

- The model itself was updated to automate data processing and visualization and to prevent input errors. This was done using a Visual Basic for Applications (VBA) script to perform pollutant load calculations within the original spreadsheet loads model structure and a Python script to generate box and whisker plots of the results.
  - The VBA script transfers user inputs from a new *Input Parameters* worksheet into the calculation worksheets; runs the pollutant-load computations using the established Excel formula structure; and then summarizes results to the *Summary of Loads* worksheet. This updated workflow preserves consistency with the formula-based approach used in prior pollutant load evaluation analyses while streamlining the data input and processing steps.
  - The Python script automatically creates a scaled box and whisker plot and corresponding legend, defining the mean, upper confidence limit (UCL), lower confidence limit (LCL), and WLA for each pollutant load.
- A new land use category (Public Facilities/Schools) was added, and a new impervious percentage calculated by WES to represent area covered by schools and other public property (not parks and open space or vacant lands).

3.3 Model Methodology

To use the spreadsheet loads model, rainfall, land use coverage information (areas), and structural BMP coverage information (areas) are entered into the model. Using established land use event mean concentrations (EMCs) and BMP effluent concentrations, the annual, seasonal, and design-storm-specific pollutant loads are calculated. Pollutant load and pollutant load reduction calculations reflect resulting pounds (lbs.) of phosphorus and TSS and counts of bacteria (*E. coli)*. Pollutant loads and load reduction were calculated for each TMDL watershed for each parameter shown in Table 2-1 and Table 2-2.

Land use EMCs and BMP effluent concentrations for use in the model were established through a joint effort between Oregon Phase I NPDES permittees. The statewide coordination process was facilitated through the Oregon ACWA Stormwater Committee, producing summary tables of qualified values to use in the PLRE and benchmark development.

Pollutant concentrations by land use, referred to in this report as “EMCs,” (event mean concentrations) were originally developed in 2005 and updated in 2008. Land use EMC data were based on published, statistically verified national data, and data obtained by local jurisdictions. Data were *bootstrapped*, a statistical method to estimate upper and lower confidence intervals, and the upper confidence limit (UCL), mean/median, and lower confidence limit (LCL) were used to calculate pollutant loading by land use (ACWA 2014). Land use EMCs used in this effort are summarized in Section 4.4.

BMP effluent concentration data were originally developed in 2005, updated in 2008, and updated again in 2014 to reflect additional BMP categories and local BMP monitoring results. BMP effluent concentrations were used to calculate pollutant removal due to the implementation of structural BMPs in each TMDL subbasin for applicable pollutant parameters. BMP effluent concentrations are summarized in Section 4.4.

Most structural BMPs are not designed to treat all runoff that enters a facility in any given year. Generally, BMPs are designed to treat a proportion of the total annual rainfall/runoff that occurs. WES’ Stormwater Design Standards (2023) require stormwater management facilities to “capture and treat 80 percent of the average annual runoff volume, to the maximum extent practicable with the goal of 80 percent total suspended solids removal” (WES, 2023). Thus, structural BMPs included in the model were assumed to capture and treat 80 percent of the average annual rainfall and bypass additional runoff. This was the assumption for TMDLs that are based on a reduction of the annual pollutant load. As an exception, the Tualatin Subbasin TMDL was established based on reducing bacteria loads from a summer and winter design storm event. The identified summer and winter design storm event is, on average, smaller than WES’ design storm event. As a result, it was assumed that total treatment of the summer and winter design storms would occur and BMP bypass was not accounted for in the pollutant load modeling for bacteria in the Tualatin Subbasin.

Model simulations are conducted for each PLRE scenario (a current no-BMP scenario and a current with-BMP scenario). Pollutant loads and pollutant load removals are calculated for the UCL, mean (or geometric mean for bacteria; median for total phosphorus), and LCL, to yield a range in the resulting loads. The UCL and LCL represent the 95 percent confidence limits for the data used in establishing the land use EMCs.

Quantitative data are not currently available to assess the effectiveness of source control or non-structural BMPs for the WES and EHV MS4 permit areas. Therefore, effectiveness of source control and non-structural BMPs is not included in the model but is qualitatively incorporated in the PLRE and new benchmarks based on best professional judgment and as summarized in Section 5.

3.4 Model Output and Load Comparisons

Based on the modeling results, the current no-BMP pollutant load range (LCL to UCL) and the current with-BMP pollutant load range (LCL to UCL) were first documented for each TMDL pollutant in each TMDL watershed and for each analysis period.

The estimated pollutant load reduction is calculated as the difference between the current no-BMP and current with-BMP pollutant loads. Because loads are presented as a range, the pollutant load reduction is also identified as a range, using the results from the LCL and UCL calculations.

This current no-BMP load is the starting point for WLA comparisons and TMDL benchmark development.

3.4.1 Calculation of WLAs for Comparison with Pollutant Load Estimates

For WES and EHV, the calculations of loads associated with the WLA, in order to compare with calculated pollutant loadings, was conducted as follows:

- The WLAs for bacteria in the Lower Willamette Subbasin TMDL were defined as an annual percent reduction. The WLAs (as loads) were calculated as the percent load reduction from the current no-BMP, mean pollutant load based on annual rainfall.
- The WLAs for DDT and dieldrin in the Lower Willamette Subbasin TMDL were defined as an annual percent reduction. The WLAs (as loads) were calculated as the percent load reduction from the 2008 no-BMP, mean pollutant load, reflecting the date with which source DDT data was collected.
- The WLAs for bacteria in the Middle Willamette Subbasin TMDL are defined as both an annual percent reduction (for direct discharges to the Middle Willamette River) and a seasonal percent reduction (for discharges to unspecified tributaries to the Middle Willamette River). WES MS4 permit area discharges to Tanner Creek, an unspecified tributary to the Middle Willamette River, and as such, the WLAs (as loads) were calculated as the percent load reduction from the current no-BMP, mean pollutant load based on seasonal rainfall.

For WES, the applicable WLAs for the Tualatin TMDL Subbasin were calculated as follows:

- The WLAs for total phosphorus and bacteria in the Tualatin Subbasin TMDL are defined as concentrations. For both parameters, the WLAs (as loads) were calculated based on the total seasonal or event runoff volume and the target pollutant concentration listed in Table 2-2.
- The WLAs for TSS in the Tualatin Subbasin TMDL are based on a seasonal percent reduction. The WLAs (as loads) were calculated as the percent load reduction from the current no-BMP, mean pollutant load based on seasonal rainfall.

3.4.2 Pollutant Load Estimates

For graphic representation, the current no-BMP and current with-BMP loads are both shown as a range. The WLA is shown as a single value, based on the mean value calculations.

The estimated pollutant load reduction reflective of the PLRE was calculated as the difference between the current no-BMP and current with-BMP pollutant loads. This pollutant load reduction is identified as a range, using the results from the LCL and UCL calculations. This pollutant load reduction (as a percentage or back calculated as a concentration) was directly compared with the WLA. Resulting graphs and discussion related to the PLRE and comparison with WLAs are included in Section 5. Where the WLA falls within the current with-BMP load range, WES or EHV is assumed to be meeting the WLA.

For DDT, because it is a legacy pollutant with no new pollutant sources, the process for calculating pollutant loads and estimated pollutant load reduction is based on a combination of natural degradation and projected removal associated with structural BMP implementation. In 2008, a methodology was developed to assess DDT loading, given a lack of land use EMC and BMP effluent concentration data. Using local stormwater data collected around 2008, all land use categories were estimated to contribute a consistent DDT concentration of 2.96 nanograms per liter (ng/L). Literature values suggest a natural attenuation rate equivalent to a 10-year half-life. Therefore, to reflect current loading conditions, the 2008 baseline concentration and a 10-year half-life was used to calculate a revised 2025 concentration and develop a current no-BMP load (in pounds). Then, current structural BMP implementation was used to account for a relative reduction (as a percentage) of TSS as a surrogate parameter. Because DDT is a legacy pollutant, pollutant load reduction was evaluated based on 2008 (baseline), no-BMP conditions and the current (2025) with

BMP conditions. Like other parameters, where the WLA falls within the current with-BMP load range, the City is assumed to be meeting the WLA.

3.4.3 Comparing Pollutant Loads to Previous Benchmarks

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously established benchmarks (Schedule D.3.c.iv of the NPDES MS4 permit). WES previously developed TMDL benchmarks and submitted them as part of the MS4 Permit Renewal Submittal in February 2017. The 2017 TMDL benchmarks are presented as a pollutant load reduction range and are directly comparable with the current PLRE results. For purposes of the benchmark comparison effort, the following guidelines apply:

- Where the mean/median current pollutant load reduction estimate falls within the benchmark range, the benchmarks are interpreted to be met
- Where the UCL of the current pollutant load reduction estimate falls within the 2017 benchmark range, the benchmarks are interpreted as likely met.

Figure 3-1 identifies the points in the PLRE and benchmark development process where current model assumptions and model results should be reviewed in conjunction with the comparison to previously established benchmarks. For WES and EHV, model area and modeling assumptions may change so documentation of changes is necessary to accurately review and interpret model results.

3.4.4 Calculating New Benchmarks

By definition, a pollutant load reduction benchmark is a pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established. The benchmark is used to measure the overall effectiveness of the stormwater management program and progress towards achieving the WLA over an implementation period (typically 5 years). Thus, benchmarks are pollutant load reduction estimates for the future. They are used as a tool and a goal for guiding adaptive management activities and are not considered a numeric effluent limit.

New benchmarks are calculated as the difference between the current no-BMP and a future with-BMP pollutant loads. As with the PLRE, the benchmarks are identified as a range, using the results from the LCL and UCL calculations. Results and discussion related to development of TMDL benchmarks are included in Section 6.

Pollutant loads are tabulated in Appendix B for all modeled scenarios.

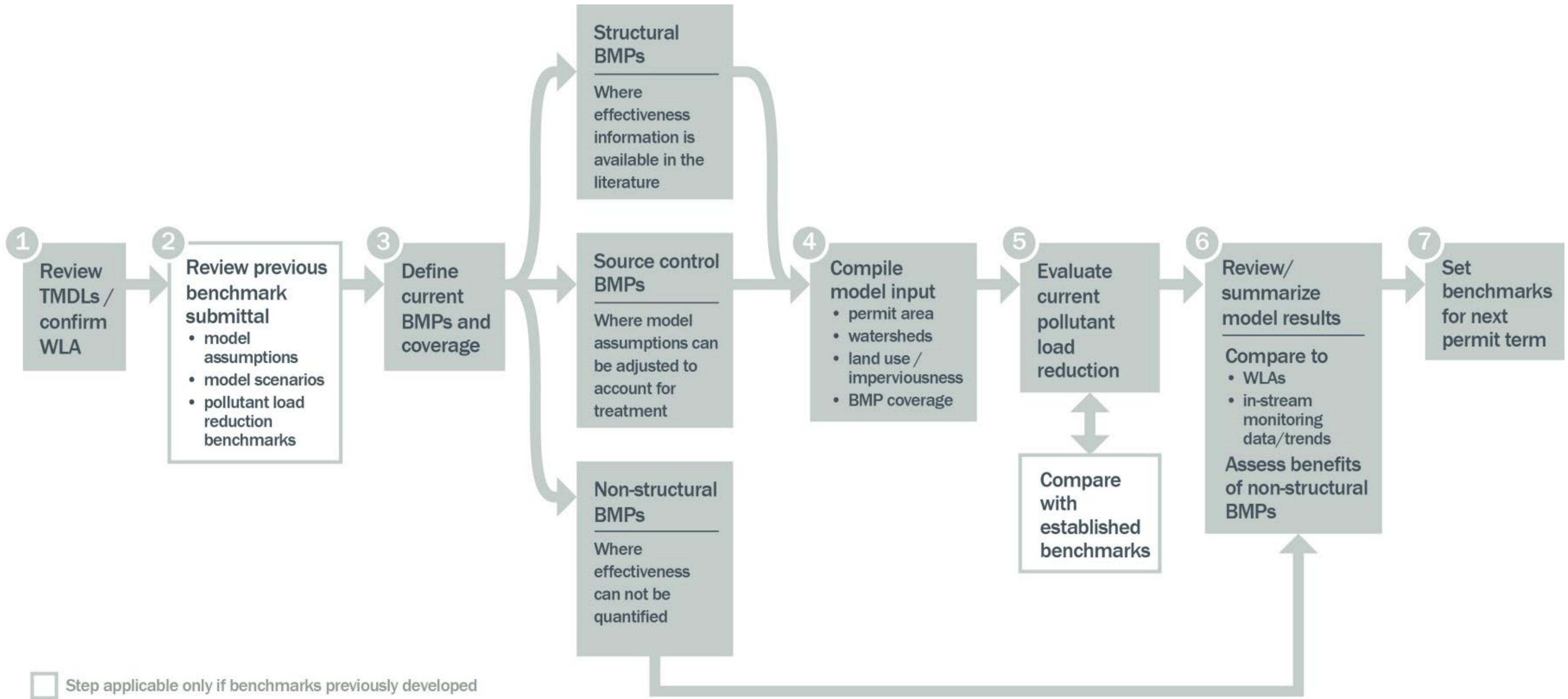

Figure 3-1. Pollutant load reduction evaluation and benchmark development

Section 4

Modeling Methods and Assumptions

This section describes the modeling methods and assumptions associated with the 2026 PLRE and benchmark development. As applicable, modeling assumptions associated with the previous (2017) PLRE and benchmark development effort are provided for comparison. Model input data were developed using updated geographic information system (GIS) data sets maintained by WES.

The total model area and land use coverage for WES and EHV reflect notable changes from previous efforts. Annexation of area from EHV to WES' MS4 permit area between 2015 to 2025 resulted in an additional 308 acres of area accounted for in the Clackamas River, Lower Willamette and Johnson Creek TMDL watersheds for WES.

Structural BMP coverage also significantly changed from the previous efforts. BMP categories have been expanded to align with WES' current stormwater design standards and allowable facility types; BMP drainage areas were reviewed in detail in accordance with WES' current process for mapping BMPs. In all, BMP coverage in WES' MS4 permit area increased by nearly 220 acres; however, BMP coverage decreased in EHV, as areas with existing BMPs were annexed into WES' MS4 permit area. Area annexed into EHV from 2015 to 2025 is composed of rural and undeveloped areas with no BMP coverage.

The subsections below include information regarding modeled areas, land use and impervious area assumptions, BMP coverage, rainfall and design storms, runoff concentrations, and BMP effluent data. Maps showing model input data including land use, exclusion areas, and current and projected BMP coverage are included as Figure 4-1 and Figure 4-2.

4.1 Model Area

As described in Section 1, WES' MS4 permit area reflects its MS4 permit coverage, extending across the service boundaries of the city of Rivergrove and city of Happy Valley within the Portland Metro UGB. The portion of the city of Happy Valley located outside WES' MS4 permit area but within the UGB is referred to as EHV and is covered by the Clackamas County NPDES MS4 permit, thereby requiring evaluation as part of this PLRE and benchmark effort. The WES and EHV MS4 permit areas reflect the modeled area for this PLRE and benchmark analysis.

The WES and EHV MS4 permit areas reflect conditions as of November 2025. Annexations continuously occur within unincorporated Clackamas County; therefore, significant differences exist between the modeled areas in 2015 and current (2025) modeled areas. As portions of the city of Happy Valley develop, these areas are incorporated into WES' service area, which results in an increase in the WES modeled area and a decrease in EHV's modeled area. The city of Happy Valley annexed approximately 1,038 acres between 2016 and 2025, increasing the service area for both WES and EHV.

Areas within WES and EHV's MS4 permit areas that are the responsibility of the Oregon Department of Transportation (ODOT) were reviewed and omitted from the modeled area as ODOT is covered by their own separate NPDES MS4 permit. This includes the Interstate 205 (I-205) corridor, the Oregon Highway 212/224 corridor, the Oregon Highway 213 corridor (including SE 82nd Avenue), and Oregon Highway 99E. ODOT ROW coverage was sources from Portland Metro's Regional Land Information System (RLIS) dataset.

Large water bodies (as delineated through available polygon GIS layers) and areas that discharge to public underground injection controls (UICs) regulated under WES' water pollution control facility (WPCF) permit for UIC systems were also excluded from the modeled area. Such exclusions were also reflected in the previous analyses. For UICs, WES has limited information about the actual drainage area that discharges to an individual, public UIC. Therefore, a 1-acre drainage area per UIC was assumed and in turn excluded from the modeled area. A total of 205 public UICs were accounted for and thereby excluded from the model area for this PLRE effort, resulting in an increase in exclusion area from previous modeling assumptions.

Table 4-1 compares the 2025 WES and EHV total modeled area by TMDL subbasin to the 2015 total modeled area.[5] It should be noted that the total modeled area includes land that drains directly into the MS4 system, but also includes a substantial amount of land which is served by privately owned storm sewer systems that are not connected to the MS4, and which instead discharge directly to a creek or other public surface water body, so this modeling exercise overestimates the amount of pollution which is discharged from the MS4.

Table 4-1. Modeled Areas

TMDL Subbasin	TMDL Watersheds	2025 Total Modeled Area (ac)[a]			2015 Total Modeled Area (ac)[a]		
		WES	EHV	Total	WES	EHV	Total
Lower Willamette River	Clackamas River	4,521	2,377	6,898	4,031	1,371	5,402
	Johnson Creek	1,632	345	1,977	1,478	387	1,865
	Lower Willamette (direct or via unspecified tributaries)	7,758	3	7,761	7,781	9	7,790
Middle Willamette River	Middle Willamette (via unspecified tributaries)	0.5	N/A	0.5	2	N/A	2
Tualatin River	Fanno Creek	73	N/A	73	76	N/A	76
	Tualatin River (direct or via unspecified tributaries)	409	N/A	409	429	N/A	429

a. *The total modeled area reflects the NPDES MS4 permit area boundary (by service area) minus ODOT right-of-way, UIC drainage area, and water bodies.*

[5] In the 2015 PLRE, the jurisdictions were represented as Clackamas County Service District No. 1 (CCSD #1), Surface Water Management Agency of Clackamas County (SWMACC), and EHV. CCSD #1 and SWMACC are now included under WES' MS4 permit area. As such, these jurisdictions are added together for the comparison of WES' stormwater management services area between 2025 and 2015.

4.2 Land Use and Impervious Area

Land use coverage for both WES' and EHV's stormwater management service areas were created by WES specifically for this PLRE and benchmark effort using Clackamas County zoning coverage (dated 2025), Metro's 2025 Outdoor Recreation & Conservation Areas (ORCA)[6] coverage, and Metro's RLIS GIS layer for "Vacant Land".

Zoning categories were initially reviewed and consolidated into land use categories, consistent with the 2015 PLRE. Table 4-2 provides a summary of the zoning category consolidation. After zoning coverage was consolidated into land use categories, WES overlayed the Metro ORCA coverage, which includes parks and natural areas, cemeteries, golf courses, Homeowner Association areas, and school lands. All these METRO ORCA areas, except for school lands, were categorized as Parks and Open Space (since they are all considered undevelopable areas) and merged with the land use coverage; school lands was categorized as a new land use category called Public Facilities/Schools.

Table 4-2. WES and EHV Zoning Consolidation to Modeled Land Use Categories

Model Land Use Category[a]	2025 Clackamas County Zoning (Abbreviation)
Agricultural (AGR)	AGF, EFU, FF10, FU10, RF
Commercial (COM)	C1, C2, C3, CC, CG, CL, GC, IPU, MUC, MUE, NC, OA, OC, PF, PMU, PMU1, PMU2, PMU3, PMU6, RC, RCC, RCMU, RCO, RTL, SCMU, VC, VCS, VO, WLG OC, WLG RM
Industrial (IND)	BI, BP, GI, IC, IG2, IP, LI, M, RC-ME, RI
Residential (RES)	R0, R10, R15, R2, R2.1, R2.5, R20, R20CC, R3, R30, R4.5, R40, R5, R7, R7.2, R7.5, R8.5, R-DD, RL, RMD, R-MD, RMH, SFA, SFR, VR-4/5, VR-5/7, WLGR25
Multifamily Residential (MFR)	CCC, EC, HDR, MCC, MR1, MR2, MU, MURA, MURM1, MURM2, MURS, MURX, PMD, RCHDR, SHD, VA, VTH
Open Space and Parks (OSP)	OS, OSM, PNA, TBR
Rural Residential (RUR)	R1, RA1, RA2, RRFF5, RRFU

Vacant land is defined as undeveloped area with five percent or less impervious surface that is intended to develop, and it does not include parks/open space which are assumed to never be developed. Vacant land coverage is based on the 2025 Metro RLIS GIS layer for "Vacant Land". The 2025 vacant lands coverage was compared with current aerial imagery and 2015 vacant lands coverage (from the previous PLRE and benchmark effort) to project whether development potential exists. Lands already developed or reflecting a portion of a developed parcel were manually removed by WES GIS staff from the vacant lands coverage and moved to a more appropriate land use. The final vacant lands coverage was merged with the land use coverage, noting the underlying developed land use category projected for the future development of each vacant parcel.

Impervious percentages by land use that were used in the previous analyses were maintained for this effort, with the addition of the new Public Facilities/Schools (PF) land use category. To develop a unique impervious percentage for the Public Facilities/School land use category, WES used aerial imagery to selectively digitize in GIS the impervious area for each identified Public Facilities/ Schools

[6] In August 2012, the Outdoor Recreation and Conservation Areas (ORCA) feature class replaced RLIS Parks as a considerably richer dataset with more attributes and finer granularity of the features.

parcel and calculate a representative percent impervious. All other impervious percentages are based on Table A-2 of the Clackamas County Master Plan (2005).

The EPA formula was used to translate between percent impervious and a runoff coefficient, for use in the pollutant loads model:

Runoff coefficient = 0.05 + 0.009 (percent impervious)

Table 4-3 summarizes WES and EHV's modeled area by land use and summarizes the percent impervious values by modeled land use category.

Table 4-3. Summary of Model Input Parameters (Land Use and Impervious)													
MS4 permit area	TMDL Subbasin	TMDL Watershed	Total Modeled Area (ac)	Land Use Breakdown (ac)									
				Agriculture	Commercial	Industrial	Residential	Rural Residential	Multifamily Residential	Vacant	Open Space and Parks	Public Facilities/Schools
			Impervious (%)	*5*	*72*	*70*	*42*	*10*	*61*	*5*	*7*	*41*
WES	Willamette Basin/ Lower Willamette River	Clackamas River	4,521	57	219	921	1,331	59	644	791	346	153
		Johnson Creek	1,632	0	139	89	851	0	134	211	190	18
		Lower Willamette River (direct or via unspecified tributaries)	7,758	0	813	436	4,083	2	397	864	975	188
	Willamette Basin/ Middle Willamette River	Middle Willamette River (via unspecified tributaries)	0.493	0.491	0	0	0	0	0	0	0.002	0
	Tualatin Subbasin/ Tualatin River	Fanno Creek	73	0	0	0	71	0	0	3	0	0
		Tualatin River (direct or via unspecified tributaries)	409	14	0	0	283	16	0	85	10	0
EHV	Willamette Basin/ Lower Willamette River	Clackamas River	2,377	38	19	20	162	167	43	1,810	114	5
		Johnson Creek	345	2	0	0	40	10	9	285	0	0
		Lower Willamette River (direct or via unspecified tributaries)	3.2	0	0	0	0.5	2.6	0	0	0	0

[a] *The land use EMC data listed in Table 4-2 do not include all the modeled land use categories. Therefore, some land use categories were modeled using concentration data from a comparable land use category. This occurred for the residential and multi-family residential land use categories (modeled using residential concentration data); public facilities (PF) (modeled using commercial concentration data); and the VAC category (modeled using open space concentration data).*

4.3 BMP Coverage

WES maintains a GIS inventory of public and private structural stormwater facilities (BMPs), which is continually updated from as-builts to accurately reflect current facilities and associated treatment areas. Since 2017, new BMP categories have been added to the GIS inventory, including infiltration-related BMPs.

This PLRE modeling effort included a detailed review and categorization of public and private BMPs mapped in GIS to confirm a representative BMP category for modeling. BMP drainage area delineations from the 2015 PLRE were initially refined, as it was noted by WES that some of the drainage areas were overestimated and/or the drainage pattern needed to be revised based on local topography. WES used stormwater collection system mapping to evaluate contributing drainage areas and to develop new drainage areas.

Throughout the WES and EHV service areas, there are instances where multiple structural BMPs work together in series to achieve pollutant removal. Generally, these "treatment trains" consist of a sedimentation-type device upstream of a pond or bioswale, resulting in overlapping drainage areas to a single BMP. When BMP drainage areas overlapped, the structural BMP that appeared to be farthest downstream and provide better overall treatment was generally selected as the representative BMP for the drainage area. This method does not give credit for additional load removal likely achieved with BMPs that perform in series.

It is assumed that there may be structural BMPs in the WES MS4 permit area that are not captured in GIS. These BMPs were therefore not included in the model. Not accounting for these structural BMPs is a conservative assumption as these BMPs are also providing some level of pollutant load reduction.

Table 4-4 and Table 4-5 summarize the structural BMP categories and drainage areas included in the modeling effort. Modeled BMP categories reflect BMP types with available BMP effluent concentrations, as described in Section 4.4. In some cases, the GIS classification of a BMP differed from the modeled BMP categories, requiring WES to review as-builts to determine an appropriate modeled BMP category.

Figure 4-1 and Figure 4-2 show the land use and structural BMP coverage for WES' MS4 permit area and EHV, respectively. Anticipated future BMP coverage used to develop benchmarks is also shown in the figures and discussed in further detail in Section 6.

Table 4-4. Structural BMP Categories Used in WES' and EHV's Pollutant Loads Model

Structural BMP Category	2025 Modeled BMP Category
Cartridge Filter	Media Filter (sand filter, StormFilter)
Detention Pond Settling Pond	Dry, detention pond
Wet Pond	Wet, retention pond
Basic Biofiltration Swale (no underdrain) Wet Biofiltration Swale	Biofiltration Swale/ Vegetated Filter Strip
Stormwater Treatment Wetland	Wetland
Pollution Control Manhole Sedimentation Manhole StormGate Separator (Contech device similar to an oil-water separator)	Sedimentation Manhole

Table 4-4. Structural BMP Categories Used in WES' and EHV's Pollutant Loads Model	
Structural BMP Category	**2025 Modeled BMP Category**
Hydrodynamic Separator	Hydrodynamic Device (CDS, Stormceptor)/ Vortex Separator
Combined Pipe Infiltration Pond Infiltration Vault Rain Garden	Soakage Trench/ Infiltration Raingarden/ Porous Pavement
Bioretention Cell (underdrain no concrete curb) Bioretention Planter (underdrain with concrete curb)	Lined Planter/ Filtration Raingarden with Underdrain
Injection Well Drywell	Drywell

Table 4-5. Summary of Model Input Parameters (2025 BMP Coverage)													
				BMP Coverage (ac)									
Service Area	TMDL Subbasin	TMDL Watershed	BMP Coverage Area (% model area)	Media Filter	Dry, Detention Pond	Wet, Retention Pond	Biofiltration Swale/ Vegetated Filter Strip	Sedimentation Manhole	Hydrodynamic Device	Soakage Trench/ Infiltration Raingarden	Lined Planter/ Filtration Raingarden with Underdrain	UIC
WES	Lower Willamette River	Clackamas River	44%	65	1271	11	244	27	189	102	62	19
		Johnson Creek	30%	1	321	0	5	16	69	27	12	34
		Lower Willamette River (direct or via unspecified tributaries)	25%	36	1218	21	182	116	275	62	18	40
	Middle Willamette River	Middle Willamette River (via unspecified tributaries)	0%	0	0	0	0	0	0	0	0	0
	Tualatin	Fanno Creek	0%	0	0	0	0	0	0	0	0	0
		Tualatin River (direct or via unspecified tributaries)	5%	0	8	0	4	0	0	6	0	1
EHV	Lower Willamette River	Clackamas River	0.3%	0	3	0	2	0	0	0	2	0
		Johnson Creek	11.2%	0	5	0	0	0	0	0	33	0
		Lower Willamette River (direct or via unspecified tributaries)	0%	0	0	0	0	0	0	0	0	0

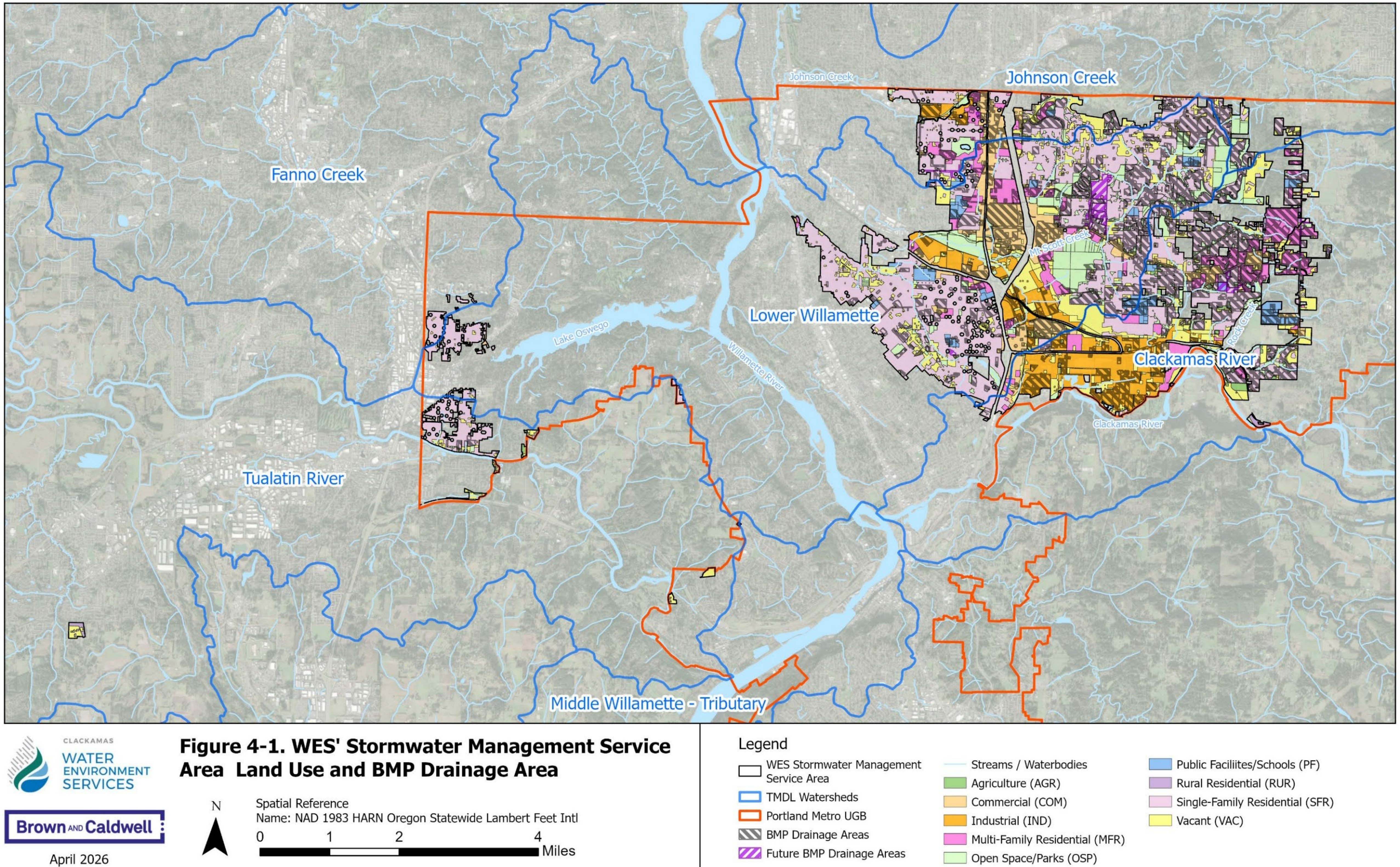

Figure 4-1. WES' MS4 permit area, Land Use, and BMP Drainage Area

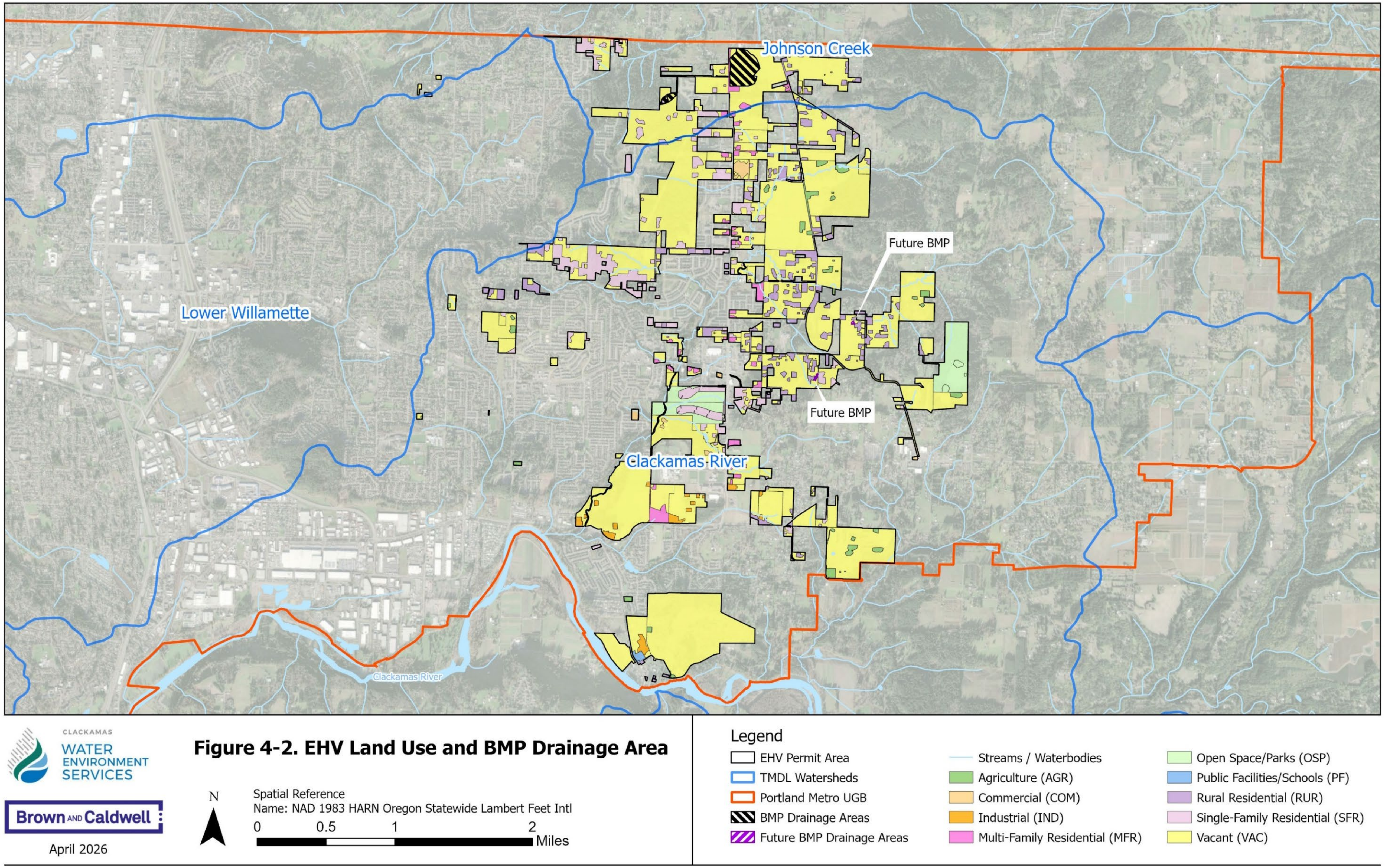

Figure 4-2. EHV's Land Use and BMP Drainage Area

4.4 Land Use and BMP Effluent Data

As described in Section 3, in 2014 Phase I MS4 jurisdictions worked to review land use EMC data, BMP categories, and BMP effluent concentration data for use in the PLRE and benchmark evaluations. For this 2025 effort, these values were collectively reviewed and confirmed by the ACWA Stormwater Committee, and no changes were made. Thus, source data assumptions are consistent with those from the previous analysis.

Land use concentration data, including the upper and lower confidence intervals, are provided in Table 4-6. The mean and median BMP effluent concentration values are provided in Table 4-7. In 2014, BMP categories and BMP effluent concentrations were updated from values originally assumed in 2008, based on additional information contained in the American Society of Civil Engineers (ASCE) BMP database and locally obtained data. New BMP categories included lined planters/filtration rain gardens, ecoroofs, and porous pavement as options in the pollutant loads model.

For purposes of pollutant load calculations, analysis of *E. coli* is conducted via use of a geomean land use EMC. Analysis of total phosphorus is conducted via use of the median land use EMC and median BMP effluent concentrations because the Tualatin Subbasin TMDL load capacity analysis and calculation of WLAs for total phosphorus was based on median concentration data.

Table 4-6. Land Use-Based Pollutant Load Concentration Values Used in the PLRE and Benchmark Analysis					
			Bootstrapped Mean		
Parameter	Land Use	Count[d]	95% Lower Confidence Level	Mean	95% Upper Confidence Level
Total suspended solids (TSS) (mg/L)	Commercial[c]	72	64	82	103
	Industrial	48	117	184	284
	Open space[a]	10	16	31	50
	Residential[b]	65	44	66	99
			Bootstrapped median		
Parameter	Land use	Count[c]	95% lower confidence level	Median	95% upper confidence level
Total phosphorus (mg/L)	Commercial[c]	26	0.23	0.28	0.31
	Industrial	25	0.36	0.47	0.65
	Open space[a]	9	0.08	0.09	0.09
	Residential[b]	36	0.16	0.21	0.23
			Bootstrapped geomean		
Parameter	Land use	Count	95% lower confidence level	Geomean	95% upper confidence level
E. coli, CFU/100 mL (geomean)	Commercial[c]	52	573	1,247	2,409
	Industrial	58	154	438	1,004
	Open space[a]	9	57	87	124
	Residential[b]	65	970	1,656	2,651

Data range (+/- 95%) provided by the city of Portland. Based on modified ACWA data set (2008).

a. *Land use EMCs for open space are used to simulate vacant land use.*

b. *Land use EMCs for residential are used to simulate rural residential, single-family residential and multifamily residential land use.*

c. *Land use EMCs for commercial are used to simulate agricultural and public facilities land use.*

d. *Reflects the sample size for the source land use concentration data.*

Table 4-7. BMP Effluent Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Units	Centrifugal Separator Hydrodynamic Devices	Filters (Leaf/Sand/Other)	Ponds: Dry Vegetated Detention Ponds	Ponds: Wet Retention Basin	Swales: Vegetated Filter Strips	Water Quality Wetlands	Sedimentation Manhole	Green Roofs	Porous Pavement/UIC	Soakage Trenches/ Infiltration Rain Gardens	Lined Planters/ Filtration Rain Gardens
		Mean										
TSS	mg/L	115	42	44	41	24	25	66	5.4	N/A	N/A	42
E. coli	CFU/100 mL	5,587	91	1,922	499	1,922	499	5,587	20	N/A	N/A	91
Flow reduction	%	0%	0%	23%	5%	29%	0%	0%	50%	100%	100%	30%
Parameter	Units	Median										
Total phosphorus	mg/L	0.14	0.12	0.29	0.14	0.22	0.08	0.14	0.35	N/A	N/A	0.12

Notes:

Effluent concentrations shown as N/A represent BMP facilities that achieve 100% flow reduction, as no effluent is generated.

4.5 Annual and Seasonal Rainfall

WLAs calculated for the Willamette Basin and Tualatin Subbasin TMDLs reflect varying assumptions related to rainfall depths.

In the Lower Willamette Subbasin, TMDL watershed-specific WLAs for bacteria and, for Johnson Creek toxics (DDT) are identified as a single percent load reduction and, for purposes of this evaluation, are evaluated on an annual basis. An annual rainfall of 40 inches was used in the model to simulate annual pollutant loading, consistent with assumptions from the 2017 PLRE and benchmark development.

In the Middle Willamette Subbasin, varying WLAs for bacteria are identified depending on whether the discharge is to a tributary or direct to the Willamette River. A small (less than one acre) portion of WES' MS4 permit area is within the Middle Willamette Subbasin that discharges to Tanner Creek (a tributary) prior to discharging to the Willamette River. As such, the bacteria WLA is identified as a seasonal percent reduction. A summer seasonal rainfall depth of 6.82 inches (reflecting rainfall between May 1 and October 31) and a winter seasonal rainfall depth of 33.18 inches (reflecting rainfall between November 1 and April 30) was used in the model to simulate seasonal pollutant loading, consistent with assumptions from the 2017 PLRE and benchmark development.

In the Tualatin Subbasin TMDL, tributary-specific WLAs for bacteria, total phosphorus (as a surrogate for pH and chlorophyll a), and TSS (as a surrogate for SVS and SOD, associated with reduced DO) are identified. A portion of WES' MS4 permit area has contributing area within the Tualatin Subbasin that discharges runoff to Fanno Creek (a specified tributary with separate WLAs) and unspecified tributaries to the Tualatin River. Bacteria WLAs are identified as a concentration applicable for a specified (in the TMDL) seasonal design storm. The summer seasonal design storm is 0.11 inch/24 hours, and the winter seasonal storm event is 1.96 inches/96 hours. The total phosphorus WLA is identified as a summer seasonal concentration and was evaluated based on a summer seasonal rainfall of 6.82 inches (consistent with the Middle Willamette assumptions). The TSS WLA is identified as a summer seasonal percent reduction and uses the summer seasonal rainfall. Rainfall depths used are all consistent with 2017 assumptions.

4.6 Model Input Files

WES generated GIS shapefiles to populate the pollutant loads model with areal information reflecting modeled areas, modeled land uses, and BMP coverage. WES provided source GIS shapefiles for WES' and EHV's MS4 permit areas. The EHV GIS was supplemented by additional shapefiles from the city of Happy Valley for existing and future BMPs.

The final source GIS shapefiles were provided primarily in the WES_TMDL_data_v5.gdb as either WES or EHV layers, but there were several other geodatabases provided with relevant source data as well. The information was provided as a combined dataset for all service areas, with TMDL watershed information included by line item in each attribute table (not separated as individual layers). These attribute tables were queried to calculate information specific to each TMDL watershed.

An overview of the WES shapefiles is provided below. Note – all provided shapefiles had ODOT ROWs, waterbodies (those with available GIS polygons, such as the rivers and lakes), and public UICs (covered by the WPCF permit) clipped out, and as they were consistently removed from each layer, information related to model area exclusions is not noted in each individual description below.

- **WES_Bndry_watershe_Intersect:** this shapefile outlines the current (as of November 2025) land use categories, with vacant lands and watersheds identified by line item in the attribute table. If a parcel was tagged as both Open Space and Vacant the Open Space land use designation was used for area calculations.
- **WES_BMP_Landuse:** this shapefile outlines the current public BMP coverage with facility categorization, land use categories, and watersheds.
- **WES_BMP_Future_LU:** this shapefile outlines the additional, future public BMP coverage (by BMP type) anticipated in the next 5-years (by 2031) for use in developing TMDL benchmarks.
- **UIC_2025_Private_115_dissolve:** this shapefile creates a 1-acre buffer area around each private UIC, these areas are counted towards existing BMPs (whereas the public UICs are clipped from the NPDES MS4 permit area since they are covered by the WPCF permit). This layer combined each of the buffer areas into a single polygon layer so that overlapping areas are not double counted. The polygon was clipped to each watershed independently.

Section 5

Pollutant Load Reduction Evaluation Results

Pollutant load modeling results, including comparison of model results to WLAs and comparison of model results to the benchmarks established in 2017, are described below.

Sections 5.1 to 5.3 present a numeric estimate of current (2025) pollutant loading and pollutant load reduction by TMDL watershed, including comparison of current pollutant load reduction to the WLAs (Schedule D.3.c.ii and D.3.c.iii). Section 5.4 provides a comparison of current pollutant load reduction to established (2017) benchmarks (Schedule D.3.c.iv and Schedule D.3.c.viii). Section 5.5 provides an evaluation of model results with respect to non-structural BMP effectiveness, results from the water quality trends analysis (Schedule D.3.c.vii), as well as a qualitative evaluation of mercury reduction, as required under Schedule D.3.b.iii.

It should be emphasized that the pollutant load model results portray the incremental improvements that are estimated with the implementation of structural BMPs. These pollutant load model results are not reflective of full implementation of WES' stormwater design standards and infiltration requirements. Therefore, model results are assumed to be conservative. A significant number of non-structural BMP activities are also required under the current NPDES MS4 permit but are not directly reflected in the model results. Therefore, modeling results are assumed to underestimate the pollutant removal achieved through the respective stormwater management programs.

5.1 Lower Willamette Subbasin

A pollutant load reduction evaluation (PLRE) was conducted for the three TMDL watersheds within the Lower Willamette Subbasin with specified WLAs. The TMDL watersheds are the Clackamas River, Johnson Creek, and the Lower Willamette River (via unspecified tributaries).

Pollutant loads are calculated on an annual basis. Model results, provided by TMDL watershed in the subsections below, reflect model assumptions and simulations as described in Section 4.

The results of the PLRE show that significant additional load reduction would be needed beyond the current structural BMP implementation to achieve the bacteria WLAs for both WES and EHV. Although non-structural BMPs are implemented in this subbasin (and not directly considered in the pollutant load reduction estimate), it is unlikely that the additional pollutant removal achieved would result in meeting the WLAs. The WLAs are ultimate discharge goals.

Results of the PLRE are described in the following sections for each TMDL watershed and service area.

5.1.1 Clackamas River

Figure 5-1 shows the WES bacteria pollutant load estimates for the Clackamas River TMDL watershed. Figure 5-2 shows the EHV bacteria pollutant load estimates for the Clackamas River TMDL watershed. The Clackamas River TMDL watershed is the largest TMDL watershed in both the WES and EHV service areas. Both the no-BMP and with-BMP load estimates are shown. The pollutant load reduction estimate is highlighted.

The bacteria WLA for the Clackamas River is a 78 percent reduction.

WES shows a mean load reduction of approximately 1.03 x 10^{13} bacterial counts (approximately a 12.9 percent reduction) when comparing conditions with and without BMPs. EHV shows a mean load reduction of approximately 6.71 x 10^{10} counts (approximately a 0.8 percent reduction).

For WES, structural BMP implementation is widespread (structural BMP coverage is approximately 44 percent), which is greater than 2015 PLRE estimates. For EHV, structural BMP implementation is much more limited (structural BMP coverage of about 0.3 percent, reduced from 4.6 percent in 2015). At present time, EHV reflects rural residential and vacant lands with limited potential for development, so limited structural BMP coverage is expected unless properties annex and redevelop. Structural BMP coverage was reduced from 2015 conditions, as properties with structural BMP coverage in 2015 have now annexed to WES.

Structural BMPs implemented in the Clackamas River TMDL watershed include swales, dry detention ponds, and hydrodynamic separators, which generally show limited effectiveness for bacteria removal. Generally, the most effective bacteria reduction associated with structural BMPs is due to volume reduction achieved through the structural BMP (i.e., infiltration) rather than actual removal of the bacteria itself.

Figure 5-1 and Figure 5-2 indicate that WES and EHV are not currently estimated to be meeting the WLA for bacteria in the Clackamas River watershed. Significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. Although source control and non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), it is unlikely that the additional pollutant removal being achieved would result in meeting the WLA. The WLA is an ultimate discharge goal.

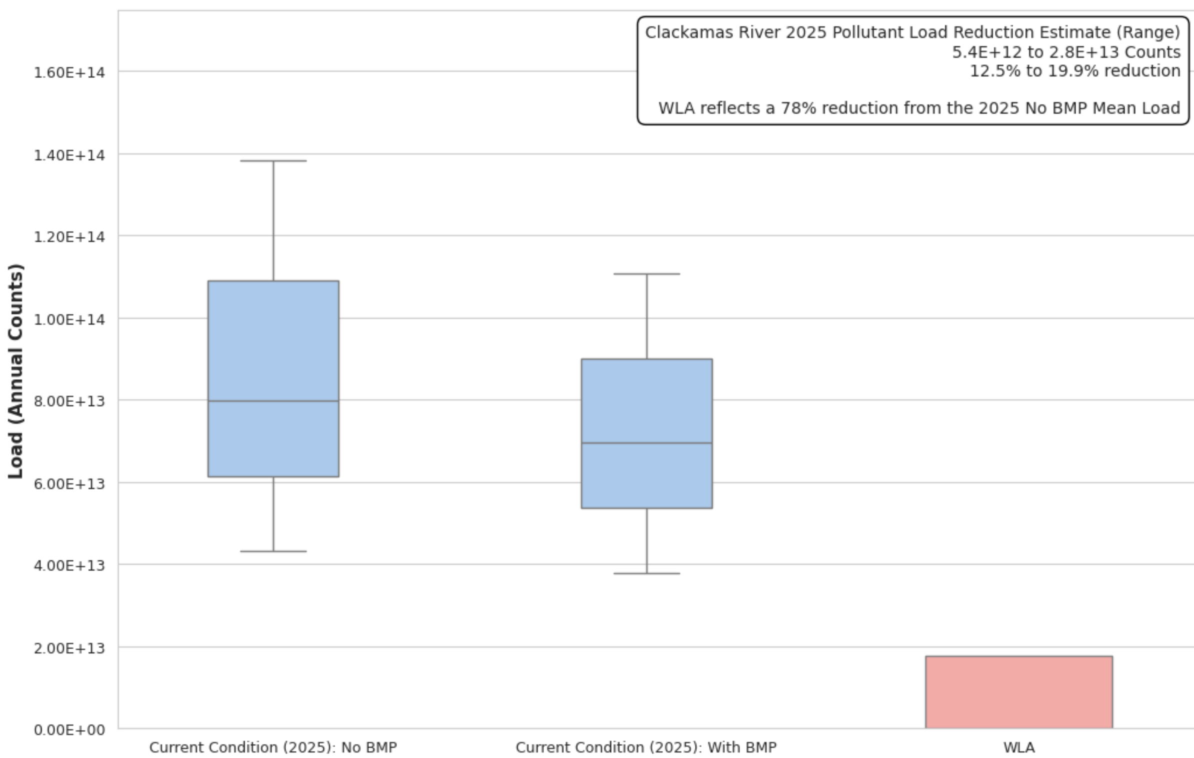

Figure 5-1. WES: *E. coli* PLRE results—Clackamas River TMDL watershed

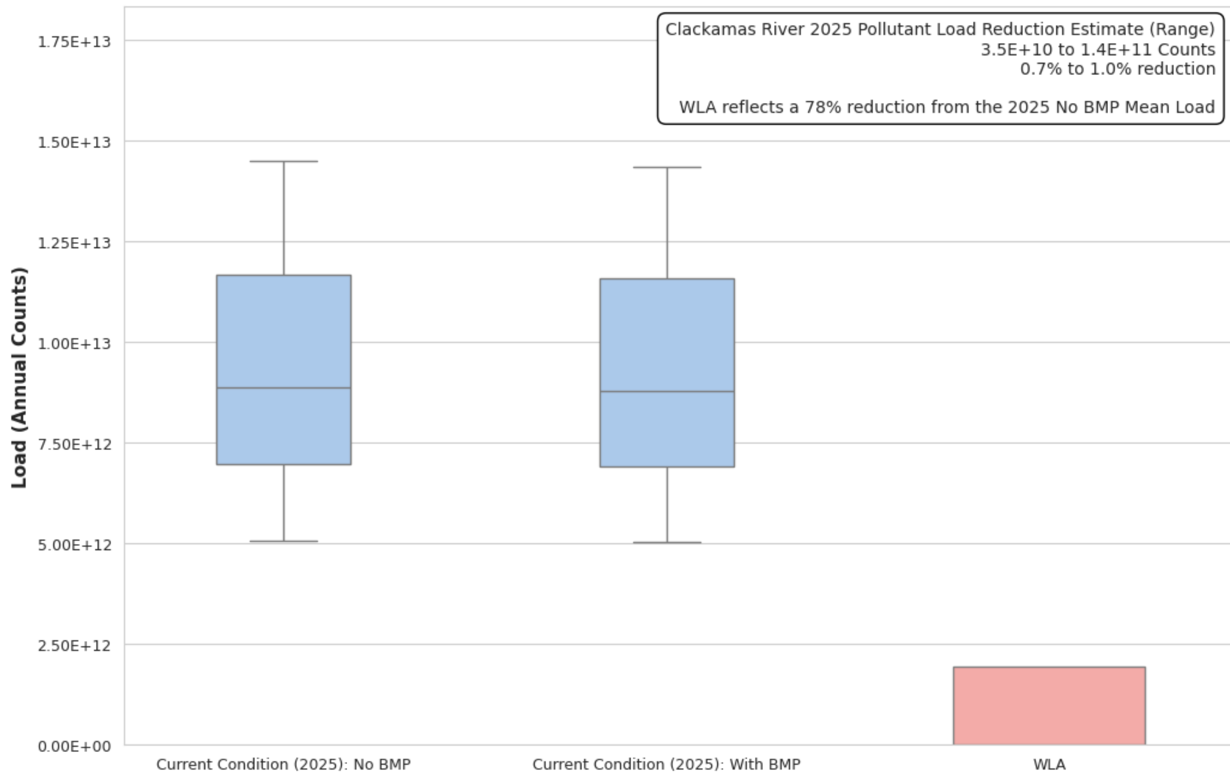

Figure 5-2. EHV: *E. coli* PLRE results—Clackamas River TMDL watershed

5.1.2 Johnson Creek

Figure 5-3 and Figure 5-4 show bacteria pollutant load estimates for the Johnson Creek TMDL watershed for WES and EHV, respectively. Figures 5-5 and 5-6 show DDT pollutant load estimates for WES and EHV, respectively. Both the no-BMP and with-BMP load estimates are shown. The pollutant load reduction estimate is highlighted.

The bacteria WLA for Johnson Creek is a 78 percent load reduction. The DDT WLA for Johnson Creek is a 77 percent reduction, using a baseline date of 2008 in accordance with the methodology described in Section 3.4.2.

For bacteria, WES shows a mean load decrease of approximately 3.36 x 10^{12} bacterial counts (approximately a 10.1 percent reduction) when comparing conditions with and without BMPs. EHV shows a mean bacteria load decrease of approximately 4.59 x 10^{10} counts (approximately a 3.0 percent reduction).

For DDT, WES shows a mean load decrease of approximately 0.012 pounds (approximately a 76 percent reduction from 2008 baseline conditions). EHV shows a mean load decrease of approximately 0.001 pounds (approximately a 78 percent reduction from 2008 baseline conditions). This reduction accounts for natural degradation and additional pollutant removal with structural BMPs (using TSS as a surrogate parameter).

Structural BMP implementation is slightly less prevalent in this watershed, as compared with the Clackamas River watershed. For WES, structural BMP implementation is more widespread (structural BMP coverage is approximately 29.7 percent), which is greater than 2015 estimates. For EHV, structural BMP implementation increased from 2015 PLRE assumptions (structural BMP coverage is about 11.2 percent, compared with 0.2 percent in 2015), and reflects a large filtration planter installation at Mr. Tree, Inc. (at 8560 172nd Ave, Happy Valley) in 2021. The structural BMP categories implemented by WES in this watershed are primarily detention ponds and hydrodynamic separators, consistent with those in the Clackamas River watershed. For EHV, except for the lined planter/ filtration raingarden facilities treating 30+ acres, the remaining structural BMP coverage area is reflective of detention ponds and swales that are affiliated with structural BMPs actually installed in WES' service area but which drain portions of the EHV drainage area.

Figure 5-3 and Figure 5-4 indicate that WES and EHV are not estimated to meet the WLA for bacteria in the Johnson Creek TMDL watershed when comparing the mean pollutant load estimate with BMPs to the mean WLA. Significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading.

Figure 5-5 and Figure 5-6 indicate that WES and EHV are estimated to be meeting the WLA for DDT in the Johnson Creek TMDL watershed, as the WLA falls within the current with-BMP load range. Most of the pollutant load reduction has been achieved through the natural degradation process as opposed to BMP implementation. Because the pollutant load reduction estimate reflects degradation and structural BMP implementation alone, non-structural and source control BMP implementation (as implied by the range in pollutant loading) may further reduce pollutant loads to meet the WLA.

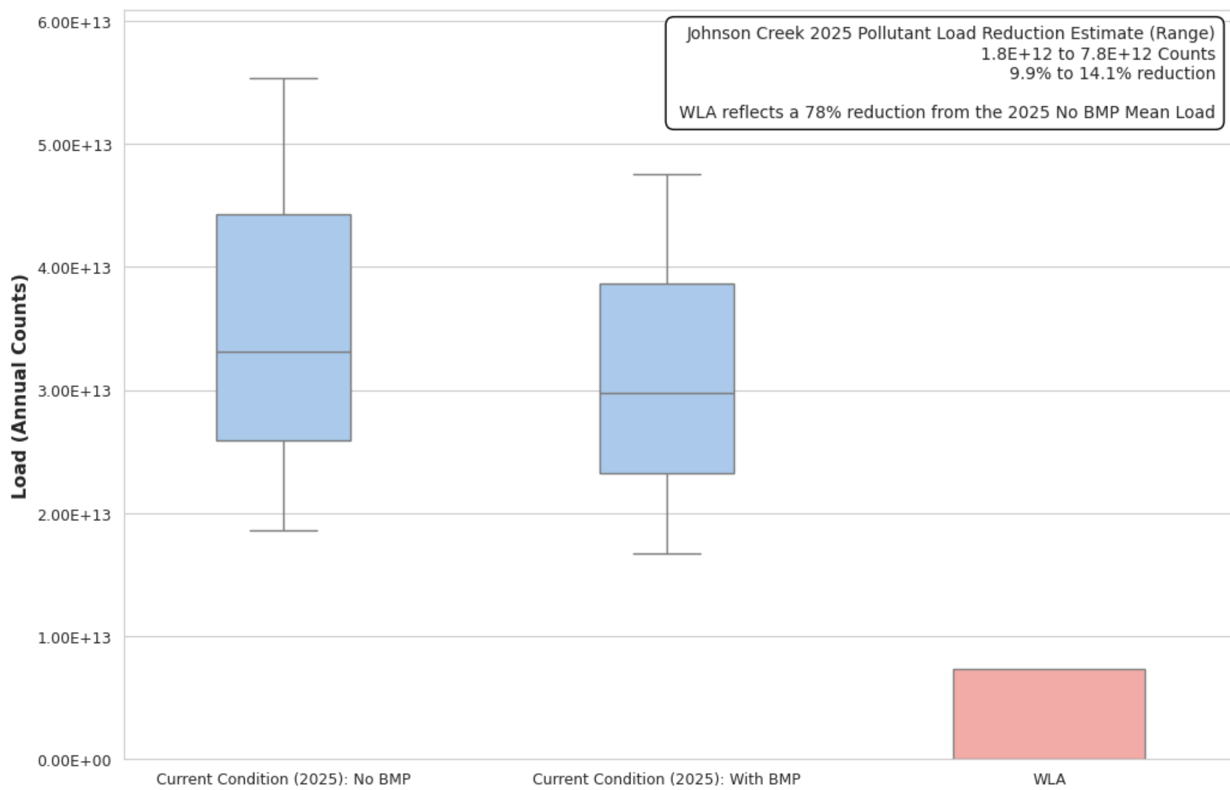

Figure 5-3. WES: *E. coli* PLRE results—Johnson Creek TMDL watershed

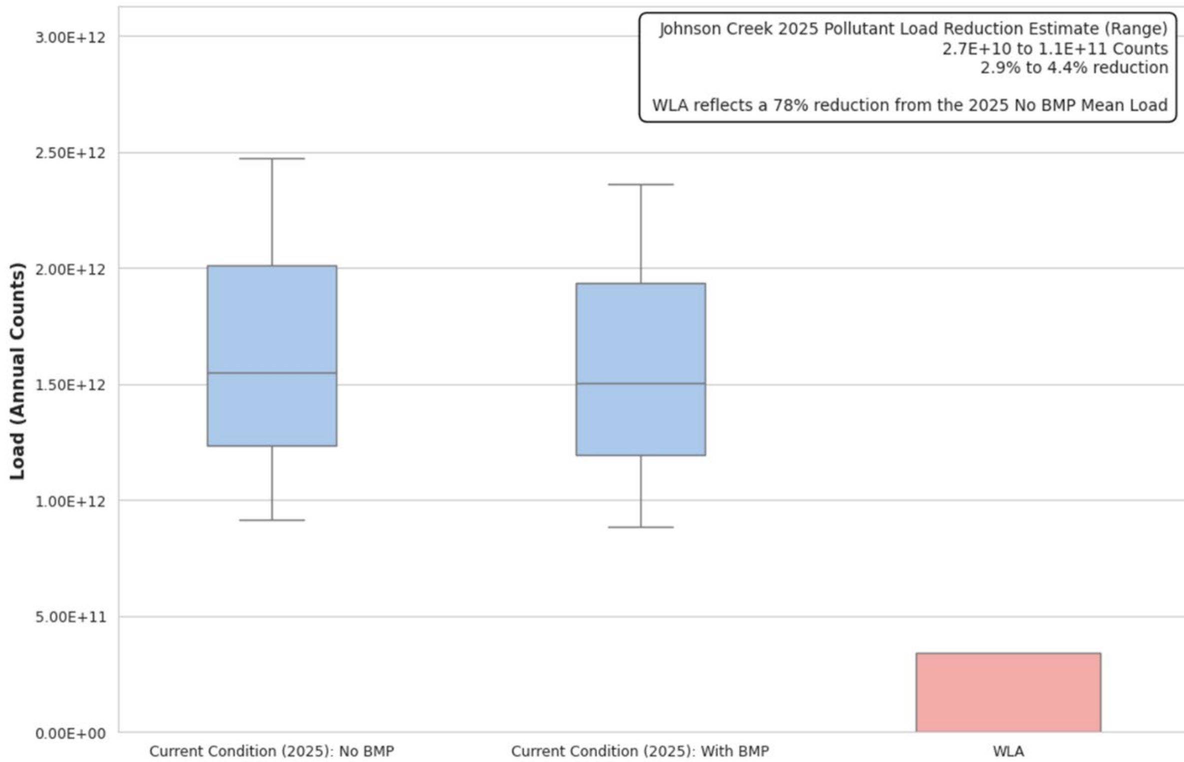

Figure 5-4. EHV: *E. coli* PLRE results—Johnson Creek TMDL watershed

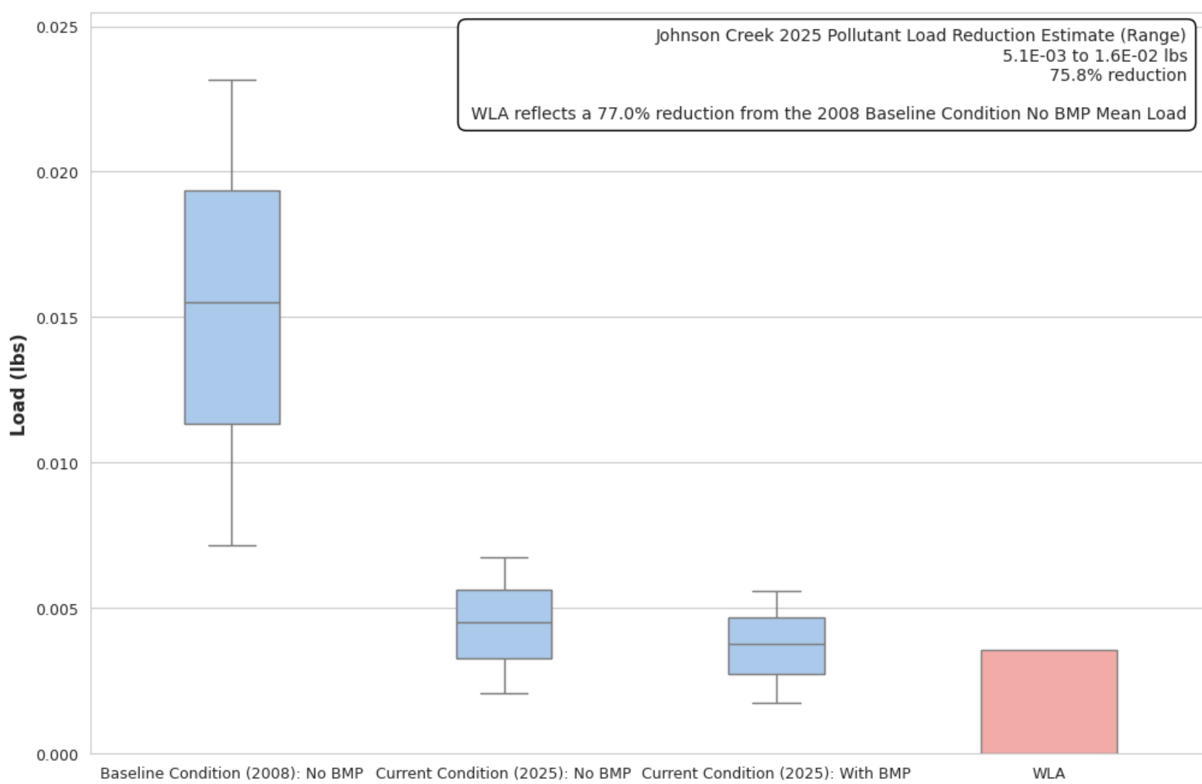

Figure 5-5. WES: DDT PLRE results—Johnson Creek TMDL watershed

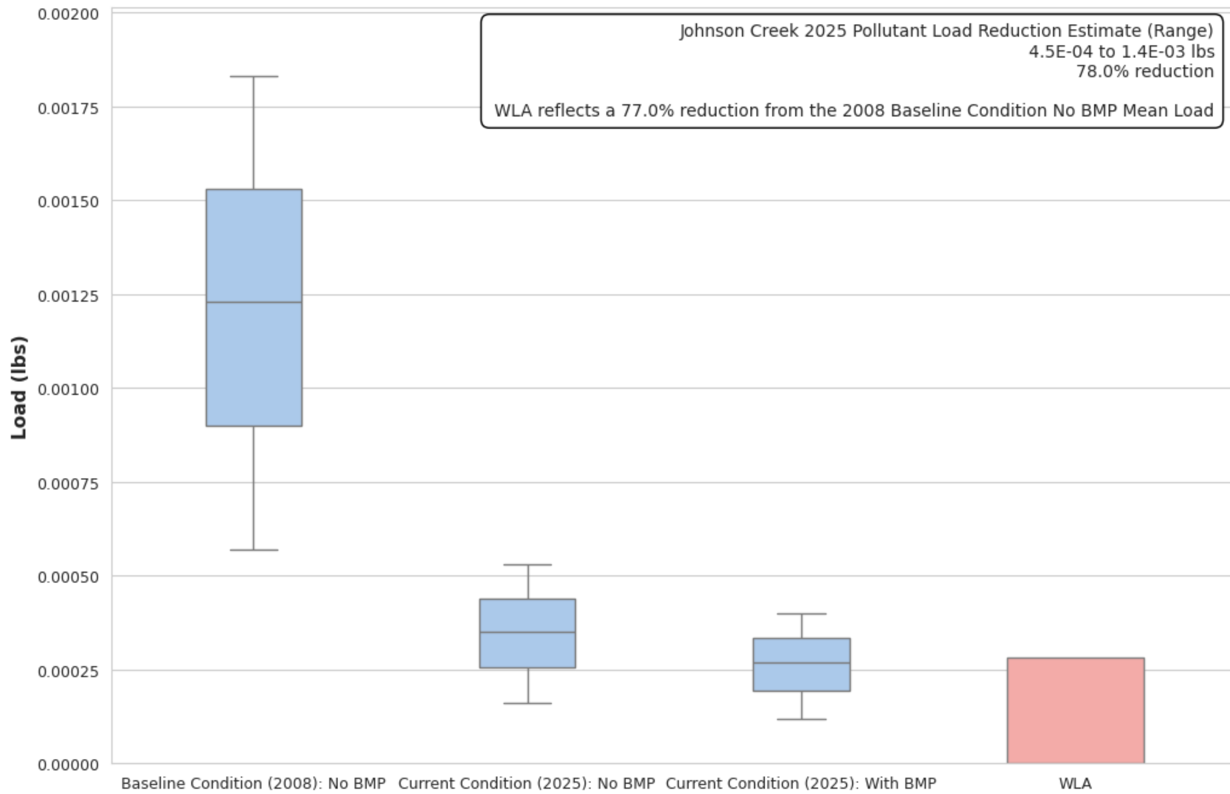

Figure 5-6. EHV: DDT PLRE results—Johnson Creek TMDL watershed

5.1.3 Lower Willamette River

Figure 5-7 and Figure 5-8 show the bacteria pollutant load estimates for the Lower Willamette River TMDL watershed for WES and EHV, respectively. Both the no-BMP and with-BMP load estimates are shown. The pollutant load reduction estimate is highlighted.

The bacteria WLA for the Lower Willamette River (direct and via unspecified tributaries) is a 78 percent load reduction.

WES shows a mean load decrease of approximately 9.69 x 10^{12} counts (approximately a 6.2 percent reduction) when comparing conditions with and without BMPs. EHV shows no anticipated load reduction, because no BMPs are currently identified and tracked in EHV in this watershed. The Lower Willamette TMDL watershed only encompasses about three acres in EHV, which is a very small geographic area, reflecting a model area reduction from 2015 PLRE assumptions.

Structural BMP implementation in WES' service area is substantive in this watershed (over 25 percent coverage) but reduced BMP coverage from the 2015 PLRE assumptions is noted due to GIS refinement of BMP drainage areas. In addition, in this TMDL watershed there is greater coverage of parks and open space area that was incorrectly identified as a BMP drainage area in 2015. Dry detention ponds are still the dominant BMP category, with swales and hydrodynamic separators also prevalent. Sedimentation-based systems like dry detention ponds and hydrodynamic systems show limited effectiveness for bacteria removal, so although the percent coverage of structural BMPs is significant, the relative bacteria load reduction is not optimal.

Figure 5-7 and Figure 5-8 indicate that WES and EHV are not estimated to be meeting the WLA for bacteria in the Lower Willamette River watershed, when comparing the mean pollutant load estimate with BMPs to the mean WLA. Significant additional load reduction would be needed beyond the current structural BMP implementation reflected in the range of loading. Although source control and non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), it is unlikely that the additional pollutant removal being achieved would result in meeting the WLA. The WLA is an ultimate discharge goal.

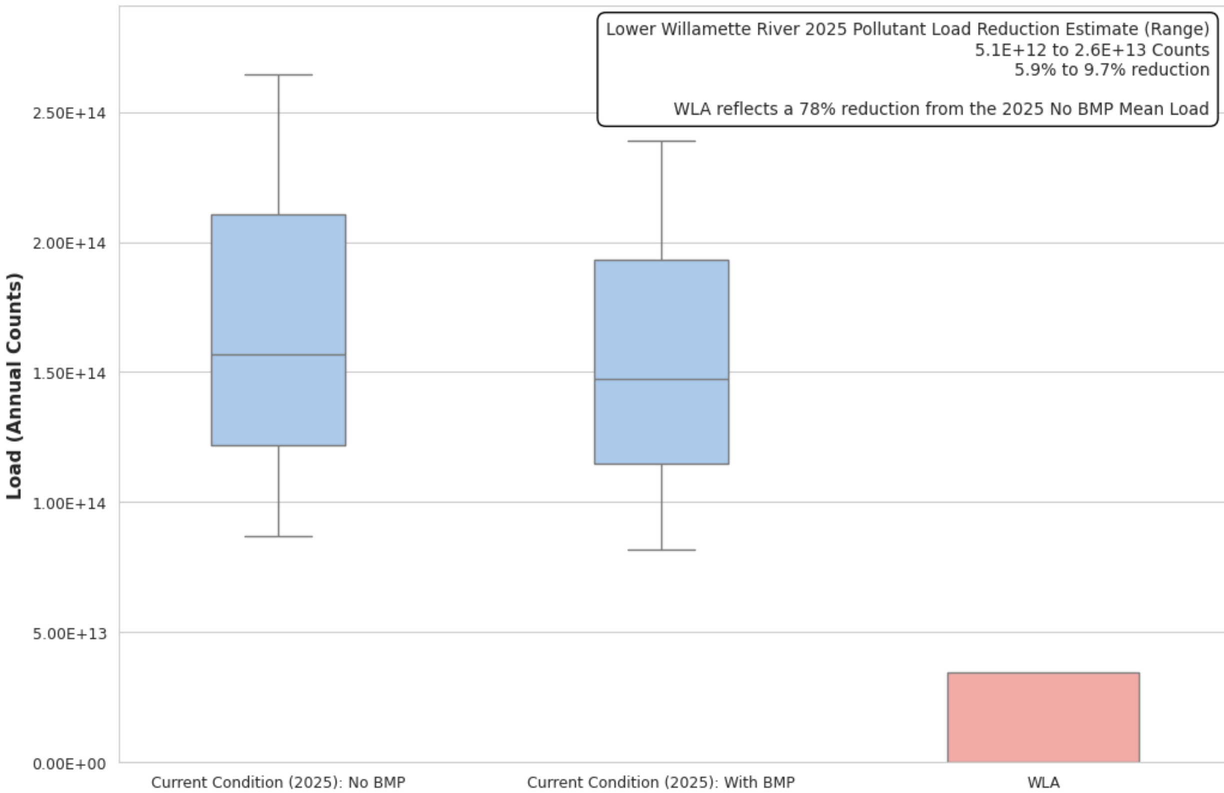

Figure 5-7. WES: *E. coli* PLRE results—Lower Willamette River TMDL watershed

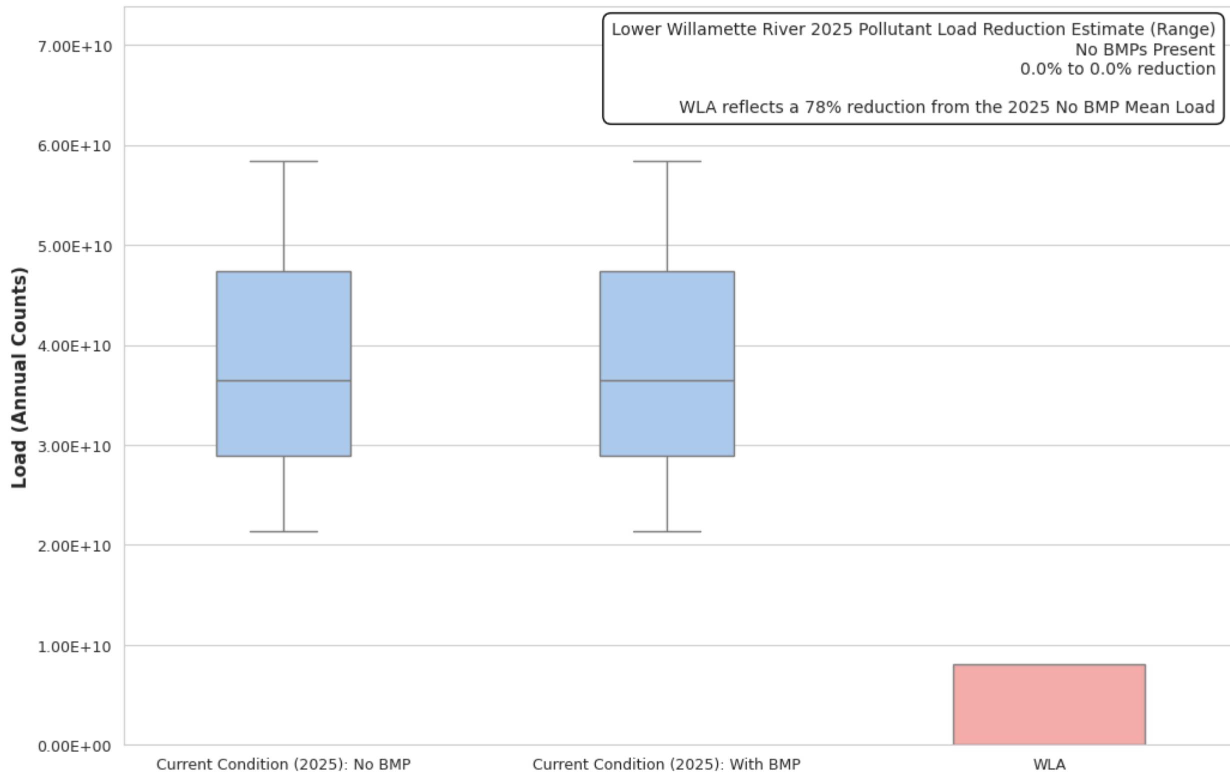

Figure 5-8. EHV: E. coli PLRE results—Lower Willamette River TMDL watershed

5.2 Middle Willamette Subbasin

Pollutant loads were calculated for the relatively small (0.5 acres total) WES service area within the Middle Willamette Subbasin. The area discharges to Tanner Creek, a tributary to the Willamette River within the Middle Willamette Subbasin. Because the area discharges to a tributary as opposed to the Willamette River directly, the TMDL specifies separate seasonal WLAs.

Pollutant loads are calculated for the summer season and the winter season, based on rainfall depths described in Section 4.5. As with the Lower Willamette Subbasin, model results include a numeric estimate of the current pollutant load reduction range (Schedule D.3.c.ii), a comparison of the current pollutant loading to the WLA (Schedule D.3.c.iii), and a narrative summarizing progress toward existing WLAs (Schedules D.3.c.viii and D.3.c.ix).

The bacteria WLA is shown for each model simulation. For the fall, winter, and spring seasons, the WLA is a 75 percent load reduction. For the summer season, the WLA is an 88 percent load reduction. The bacteria WLA is calculated as a load, based on the required load reduction applied to the no-BMP pollutant load range.

Figure 5-9 and Figure 5-10 show WES' bacteria pollutant load estimates for the Middle Willamette River TMDL watershed. Both the no-BMP and with-BMP load estimates are shown, although no structural BMPs are currently inventoried or tracked in this area. Therefore, no pollutant load reduction estimate is provided.

WES is not currently estimated to be meeting the WLA for bacteria in the Middle Willamette Subbasin when comparing the mean pollutant load estimate with BMPs to the mean WLA. However, given the small (single tax lot) area within this watershed, the inability of WES to meet its WLAs would be based on retrofit potential. Source control and non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), so additional load reduction not specifically observed through the pollutant load modeling is likely achieved.

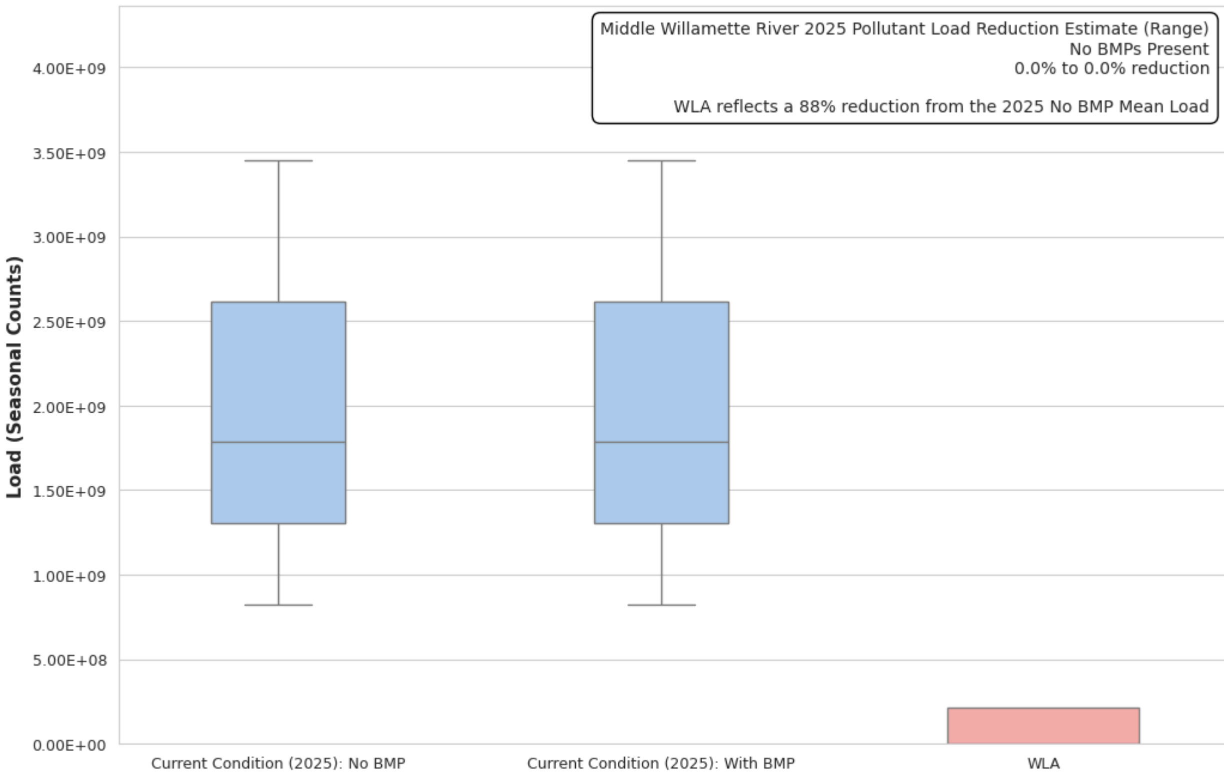

Figure 5-9.WES: *E. coli* PLRE results—Middle Willamette River TMDL watershed (fall, winter, spring seasons)

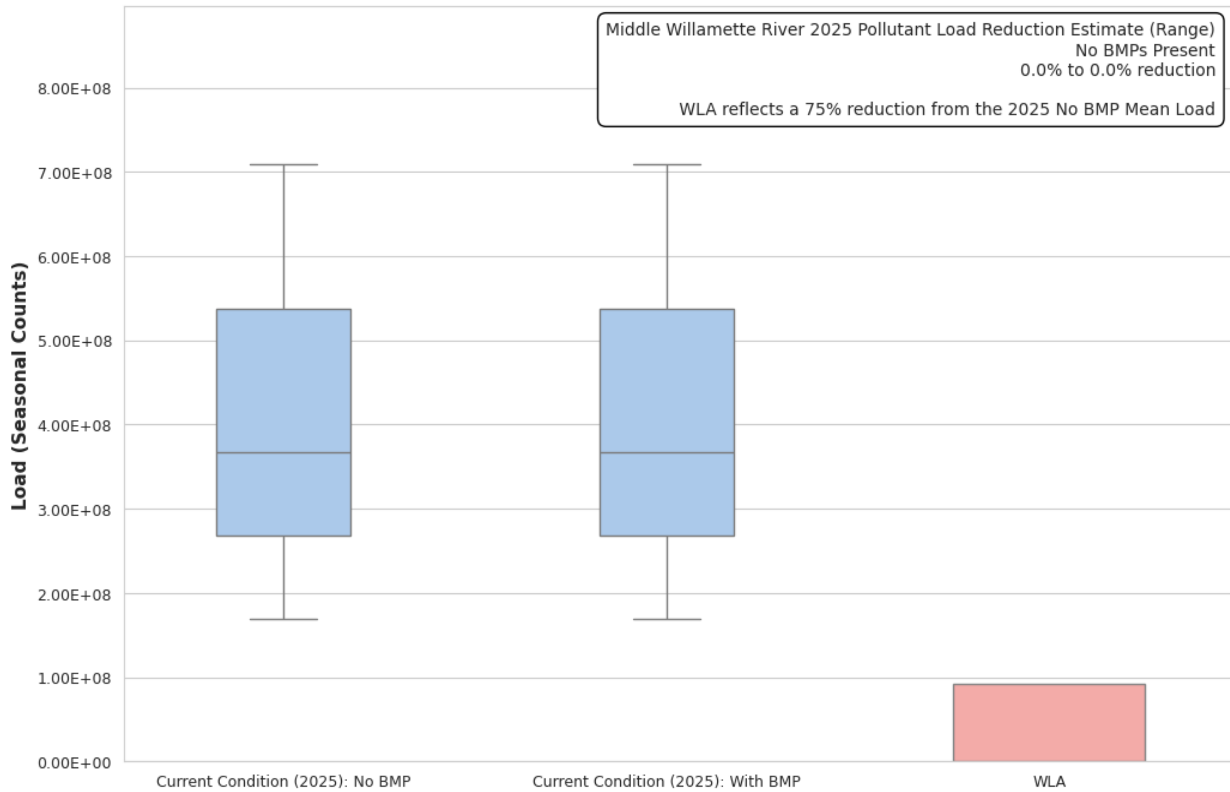

Figure 5-10. WES: *E. coli* PLRE results—Middle Willamette River TMDL watershed (summer season)

5.3 Tualatin Subbasin

Pollutant loads were calculated for two TMDL watersheds within the Tualatin Subbasin with specified WLAs. The TMDL watersheds are Fanno Creek and the Tualatin River (direct or via unspecified tributaries). WES' MS4 permit area extends into the Tualatin Subbasin.

Depending on the pollutant parameter, pollutant loads are calculated either on a seasonal basis or for a specific storm event. Model results, provided by TMDL watershed in the subsections below, reflect model assumptions and simulations as described in Section 4. Model results include a numeric estimate of the current pollutant loadings and pollutant load reduction range (Schedule D.3.c.ii), a comparison of the current pollutant loading to the WLA (Schedule D.3.c.iii), and a narrative summarizing progress toward existing WLAs (Schedules D.3.c.viii and D.3.c.ix).

The WLA is shown for each model simulation. As described in Section 3.3, the WLA (as a load) is either calculated based on the required load reduction applied to the no-BMP pollutant load range (for TSS) or based on the required concentration and associated runoff volume for the no-BMP model simulation (for bacteria and total phosphorus).

5.3.1 Fanno Creek

Figure 5-11, Figure 5-12, Figure 5-13, and Figure 5-14 show WES' pollutant load and pollutant load reduction estimates in the Fanno Creek TMDL watershed.

The bacteria WLAs for Fanno Creek are a concentration of 12,000 counts per 100 mL during a summer storm event and 5,000 counts per 100 mL during a winter storm event. The TSS (as a surrogate for SVS) WLA is a 50 percent load reduction. The total phosphorus (as a surrogate for pH and chlorophyll a) WLA is a concentration of 0.13 mg/L.

Figure 5-11 and Figure 5-12 show WES' bacteria pollutant load estimates for the Fanno Creek TMDL watershed for the winter and summer storm event, respectively. Both the no-BMP and with-BMP load estimates are shown, although no structural BMPs are currently inventoried or tracked in this area. Therefore, no pollutant load reduction estimate is provided. However, the pollutant load estimates reflect a discharge concentration range between 962 and 2631 counts per 100 mL, which is lower than the WLAs. <u>Therefore, in the Fanno Creek TMDL watershed, WES is estimated to be meeting its WLA for bacteria.</u>

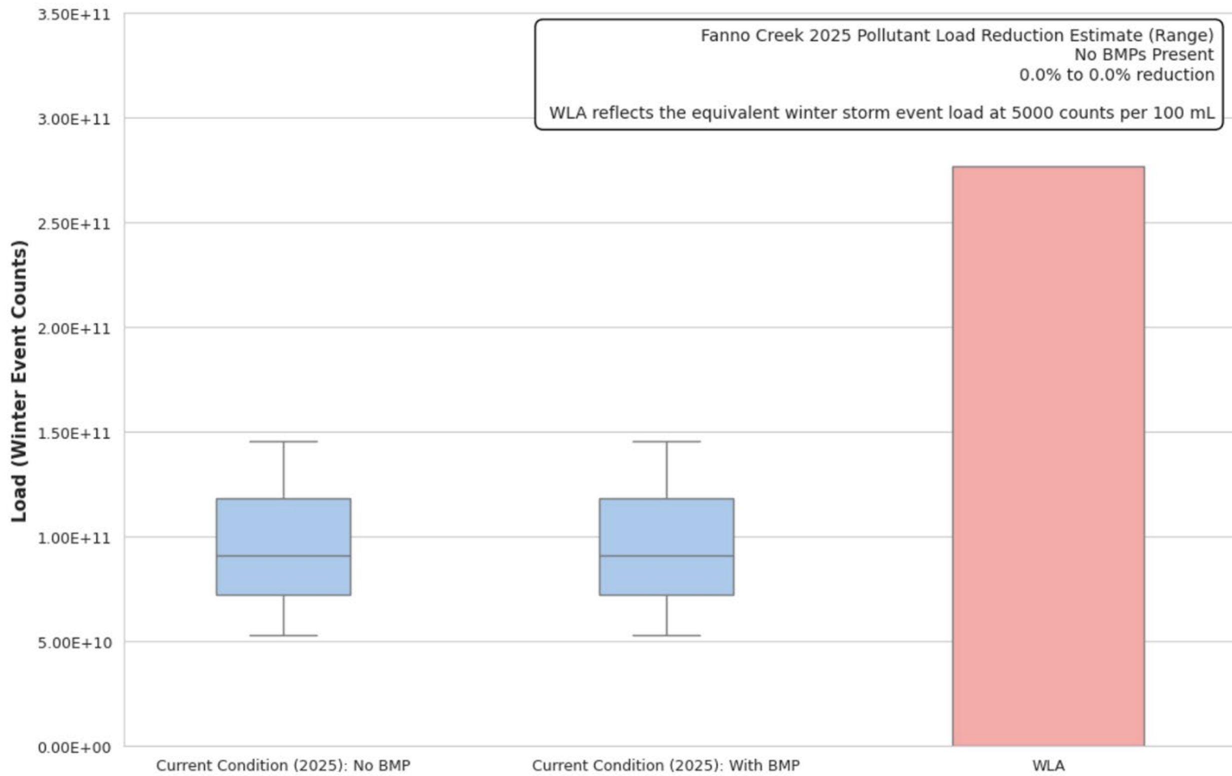

Figure 5-11. WES: *E. coli* PLRE results—Fanno Creek TMDL watershed (winter storm event)

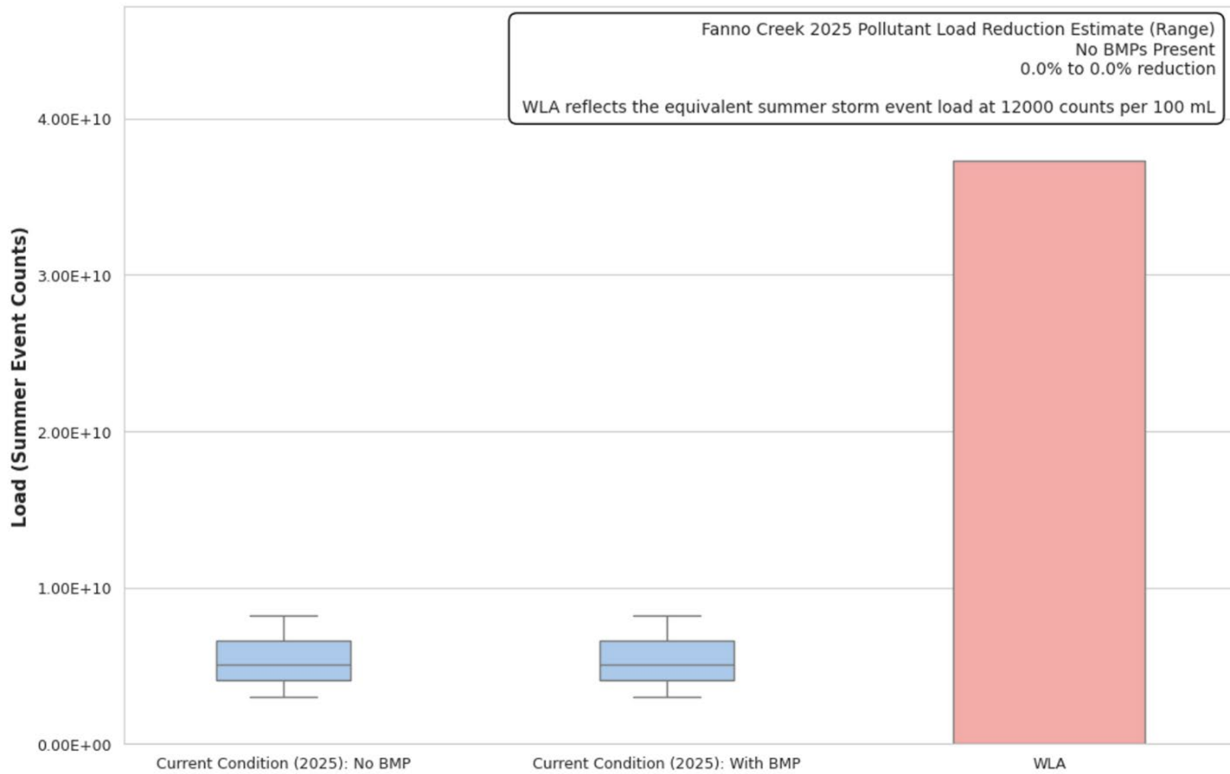

Figure 5-12. WES: *E. coli* PLRE results—Fanno Creek TMDL watershed (summer storm event)

Figure 5-13 and Figure 5-14 show WES' TSS and total phosphorus pollutant load estimates, respectively, for the Fanno Creek TMDL watershed. As with bacteria, both the no-BMP and with-BMP load estimates are shown, although no structural BMPs are currently inventoried or tracked in this area. Therefore, no pollutant load reduction estimate is provided. WES is not currently estimated to be meeting the WLA for TSS or total phosphorus in the Fanno Creek TMDL watershed when comparing the mean (for TSS) or median (for total phosphorus) pollutant load estimate to the WLAs. For total phosphorus, the pollutant load estimates reflect a discharge concentration range between 0.16 and 0.23 mg/L, which is greater than the WLA of 0.13 mg/L.

The WES NPDES MS4 permit area is relatively small in this watershed (approximately 75 acres) and composed primarily of older single-family residential development. Therefore, the opportunity for retroactive structural BMP implementation is limited. Source control and non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), so some load reduction not specifically observed through the pollutant load modeling is likely achieved.

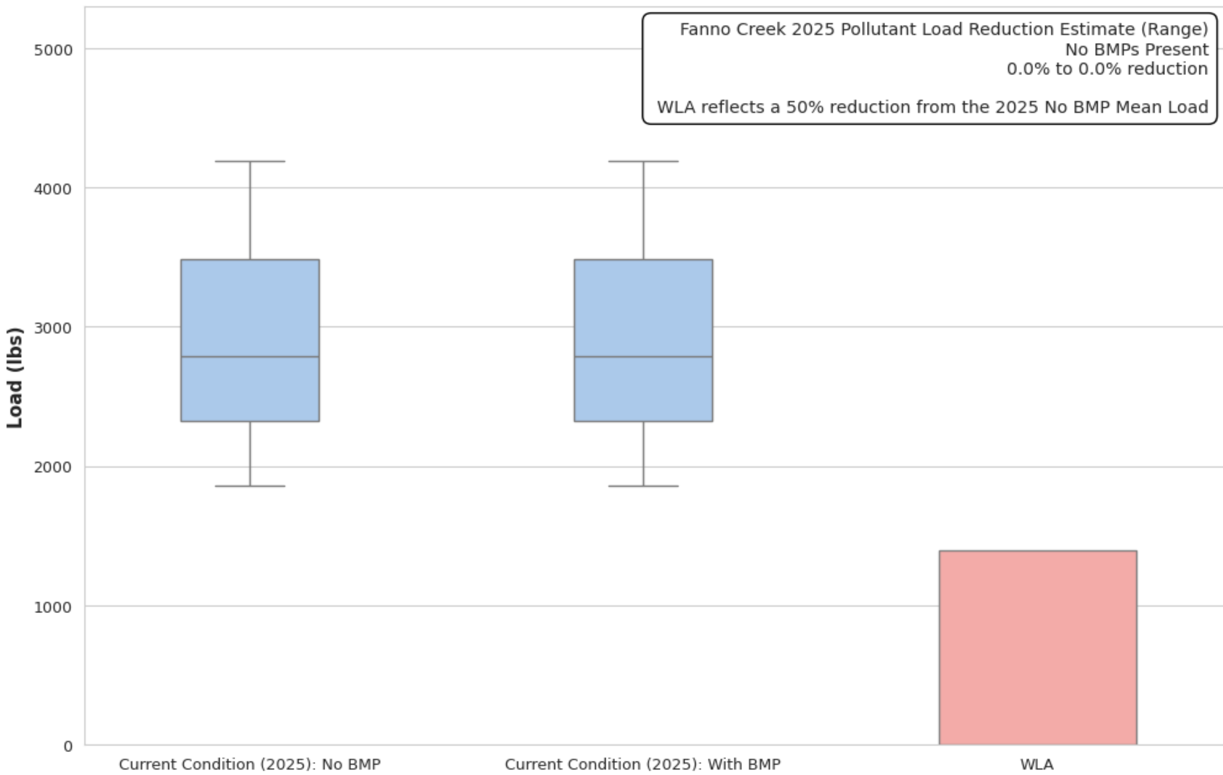

Figure 5-13. WES: TSS PLRE results—Fanno Creek TMDL watershed (summer season)

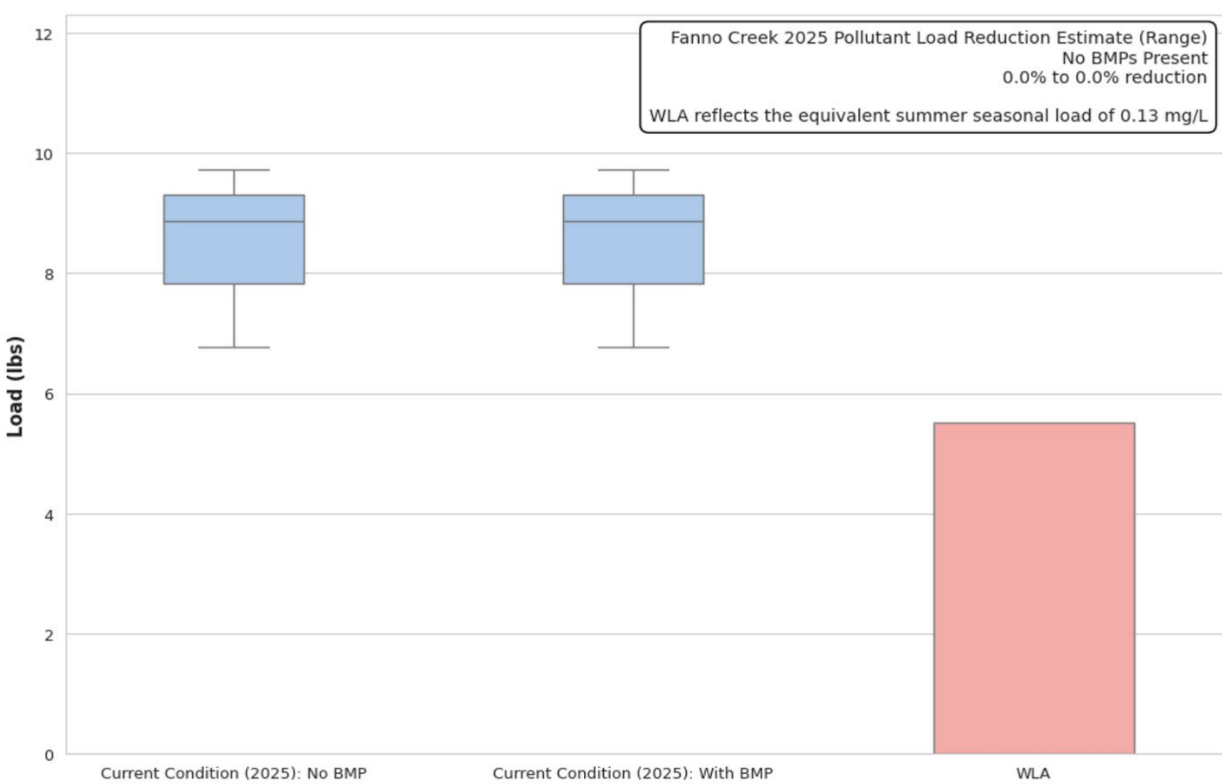

Figure 5-14. WES: total phosphorus PLRE results—Fanno Creek TMDL watershed (summer season)

5.3.2 Tualatin River (direct and via unspecified tributaries)

The portion of the City of Rivergrove in Clackamas County is in this TMDL subbasin.

Figure 5-15, Figure 5-16, Figure 5-17, and Figure 5-18, show WES' pollutant load estimates in the Tualatin River TMDL watershed. Both the no-BMP and with-BMP load estimates are shown for each pollutant parameter. The pollutant load reduction estimate is highlighted.

As in the Fanno Creek TMDL watershed, the bacteria WLAs for the Tualatin River (via direct or unspecified tributary) are a concentration of 12,000 counts per 100 mL during a summer storm event and 5,000 counts per 100 mL during a winter storm event. Specific to the Tualatin River TMDL watershed, the TSS (as a surrogate for SVS) WLA is a 20 percent load reduction. The total phosphorus (as a surrogate for pH and chlorophyll a) WLA is a concentration of 0.14 mg/L.

Figure 5-15 and Figure 5-16 show WES' bacteria pollutant load estimates for the Tualatin River TMDL watershed. WES shows a mean load reduction of approximately 1.24 x 10^{10} counts for the winter storm event when comparing conditions with and without BMPs. WES shows a mean load reduction of approximately 6.94 x 10^{8} counts for a summer storm event when comparing conditions with and without BMPs. The pollutant load estimates reflect a discharge concentration range between 872 and 2374 counts per 100 mL, which is lower than the WLAs. Therefore, in the Tualatin River TMDL watershed, WES is estimated to be meeting its WLA.

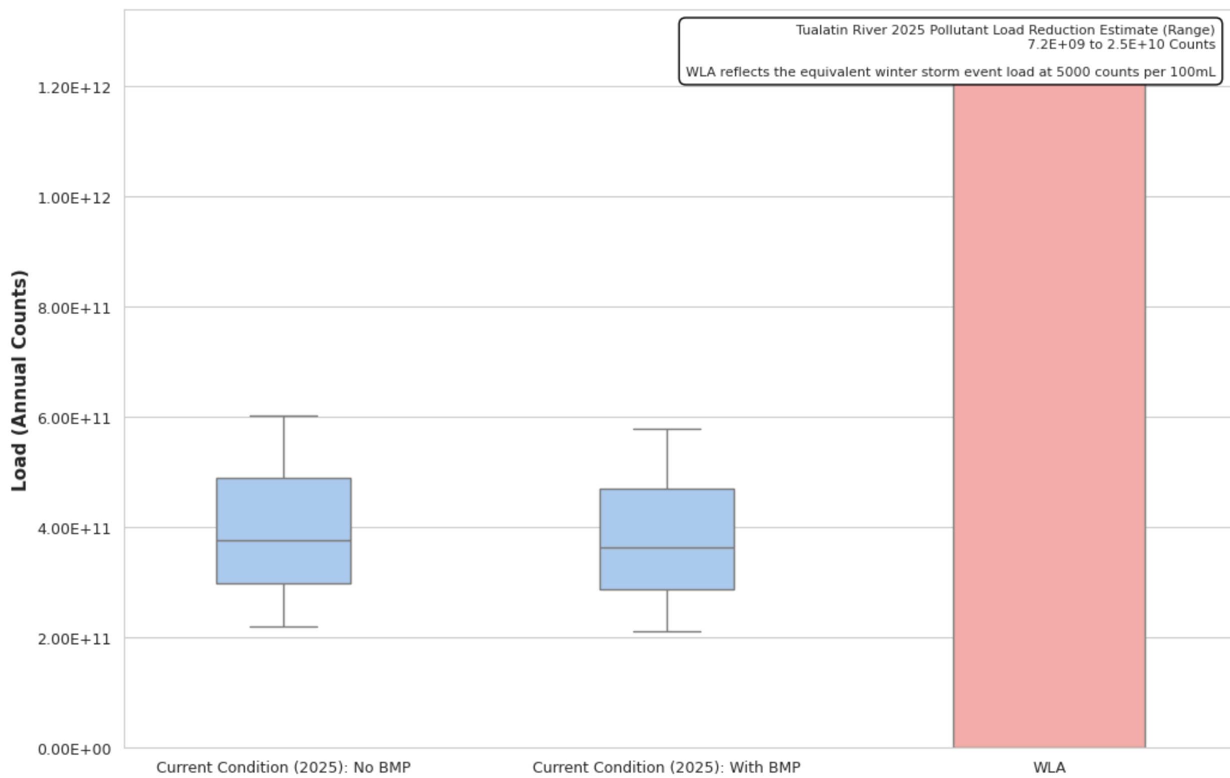

Figure 5-15. WES: *E. coli* PLRE results—Tualatin River TMDL watershed (winter storm event)

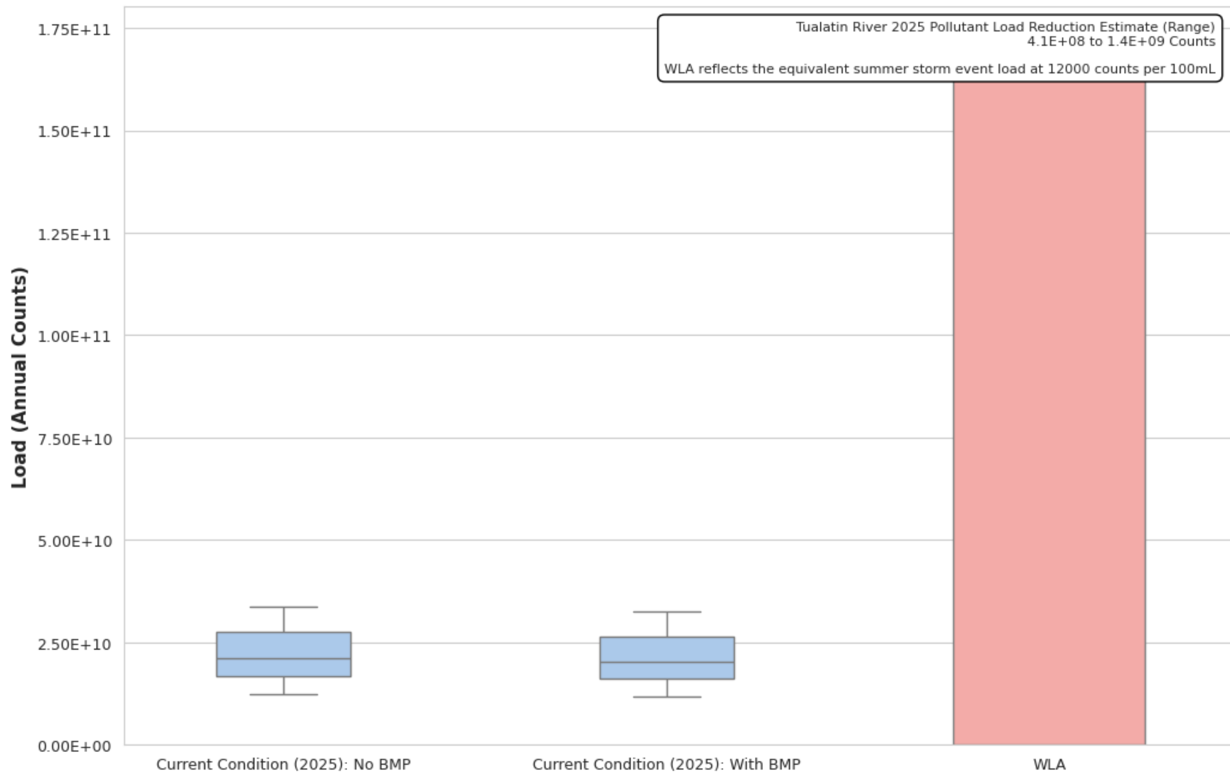

Figure 5-16. WES: *E. coli* PLRE results—Tualatin River TMDL watershed (summer storm event)

Figure 5-17 shows WES' TSS pollutant load estimates for the Tualatin River TMDL watershed. For TSS, WES shows a mean load reduction of 415 pounds (approximately a 3.5 percent reduction) when comparing conditions with and without BMPs.

Figure 5-18 shows WES' total phosphorus pollutant load estimates. For total phosphorus, WES shows a median load reduction of 1.1 pounds. The pollutant load estimates with BMPs reflect a discharge concentration range between 0.15 and 0.22 mg/L, which is slightly above the WLA of 0.14 mg/L.

Structural BMP implementation is observed but not widespread in this watershed. Structural BMP coverage is currently estimated at 4.6 percent, which is a slight reduction from 2015 PLRE estimates. This difference is likely due to the annexation of land into Lake Oswego (and removal from the WES MS4 permit area) of approximately 20 acres of WES service area in this TMDL watershed which included structural BMPs. Of the inventoried and mapped structural BMPs, detention ponds and infiltration raingardens/planters are the most common BMP category. Source control and non-structural BMPs are implemented in this watershed (and not directly considered in the pollutant load reduction estimate), so additional load reduction not specifically observed through the pollutant load modeling is likely achieved.

Figure 5-17 and Figure 5-18 indicate that WES is not estimated to be meeting the WLAs for TSS or total phosphorus, respectively, in the Tualatin River TMDL watershed, when comparing the mean pollutant load reduction estimate with BMPs to the mean WLA (for TSS) or when comparing the equivalent, with BMP pollutant concentration to the WLA (for total phosphorus). Additional load reduction would be needed beyond the current structural BMP implementation that is reflected in the current model results. However, particularly for total phosphorus, the pollutant load ranges are not significantly greater than the WLA.

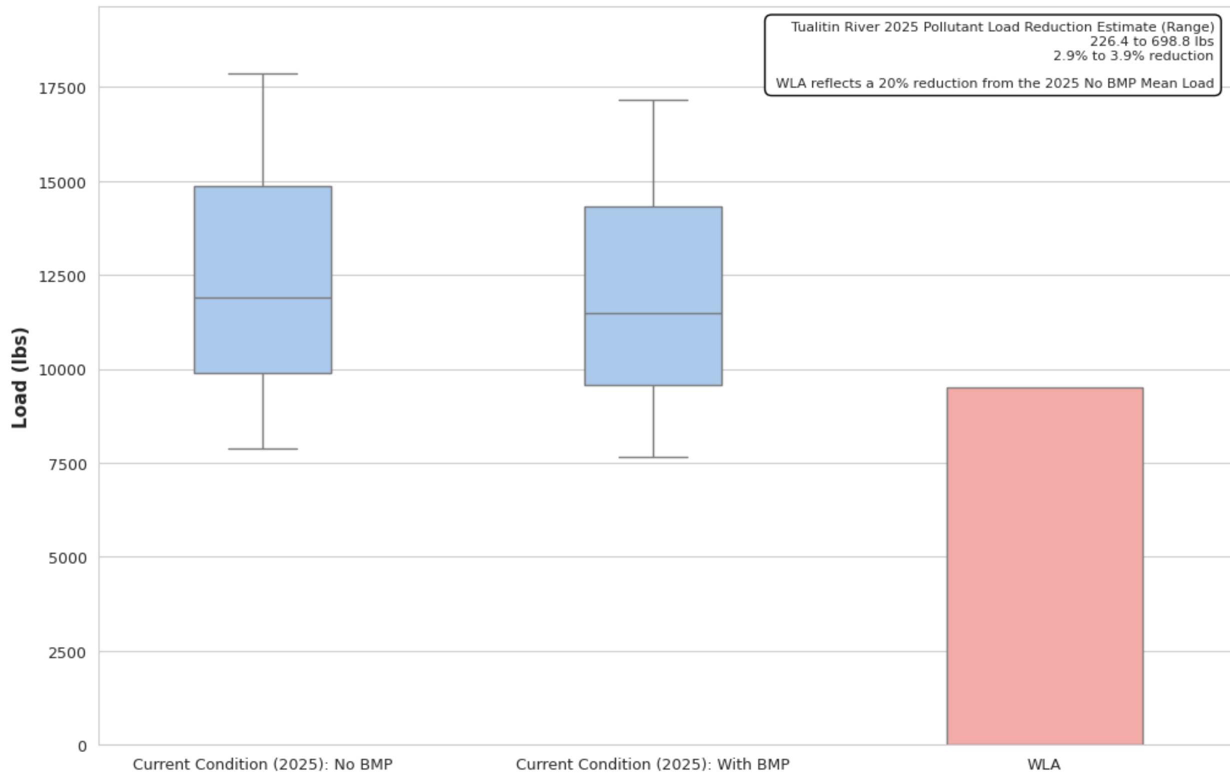

Figure 5-17. WES: TSS PLRE results—Tualatin River TMDL watershed (summer season)

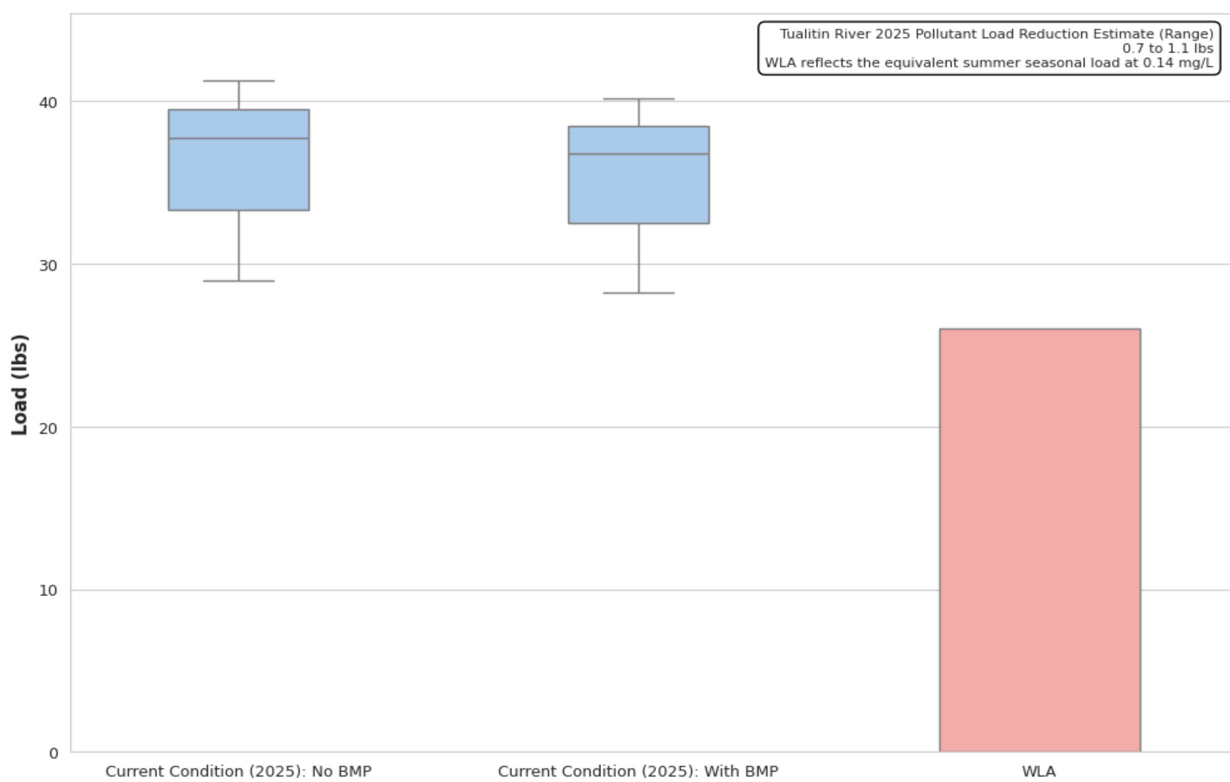

Figure 5-18. WES: total phosphorus PLRE results—Tualatin River TMDL watershed (summer season)

5.4 Benchmark Comparison

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously established pollutant load reduction benchmarks as applicable (Schedule D.3.c.iv).

The previously established pollutant load reduction benchmarks were developed in 2017, representing BMP implementation five years in the future, or 2022. Quantitative TMDL benchmarks were only developed for CCSD#1 for the Clackamas River TMDL watershed. Because of the fluctuating nature and relatively limited anticipated development in EHV, no future BMP installations were projected. Therefore, no TMDL benchmarks were developed for EHV. Similarly, because of the limited contributing area and lack of development activities/retrofit potential, no future BMP installations and TMDL pollutant load reduction benchmarks were established for SWMACC in the Tualatin or Middle Willamette Subbasins.

Table 5-1 shows the difference in model area and BMP coverage areas between the 2017 PLRE and benchmark evaluation and this 2025 PLRE. Such differences in assumptions affect the PLRE results and comparison to the 2015 PLRE and 2017 benchmarks.

Table 5-1. 2017 and 2026 Benchmark Assumptions Comparison

Service Area	TMDL Watershed	Assumption	2017 PLRE and Benchmark Effort		2025 PLRE (actual)
			2015 PLRE (actual)	2022 TMDL Benchmarks (projected)	
WES	Clackamas River	Model area (ac)	4,031.0	4,031.0	4,520.8
		BMP coverage (%)	35.7	42.5	44.0
	Johnson Creek	Model area (ac)	1,478.1	1,478.1	1,631.7
		BMP coverage (%)	28.7	28.7	29.7
	Lower Willamette[a]	Model area (ac)	7,781.3	7,781.3	7,758.0
		BMP coverage (%)	30.3	30.3	25.4
	Middle Willamette	Model area (ac)	1.7	1.7	0.5
		BMP coverage (%)	0.0	N/A	0.0
	Lower Tualatin River	Model area (ac)	428.8	428.8	409.5
		BMP coverage (%)	5.1	5.1	4.6
	Fanno Creek	Model area (ac)	75.7	75.7	73.3
		BMP coverage (%)	0.0	0.0	0.0
EHV	Clackamas River	Model area (ac)	1,370.5	1,370.5	2,377.1
		BMP coverage (%)	4.6	N/A	0.3
	Johnson Creek	Model area (ac)	386.7	386.7	345.3
		BMP coverage (%)	0.2	N/A	11.2
	Lower Willamette	Model area (ac)	8.5	8.5	3.2
		BMP coverage (%)	6.2	N/A	0.0

a. *For the 2017 PLRE and benchmark effort, the Lower Willamette River TMDL watershed was modeled for the separate CCSD #1 and SWMACC contributing areas. As such, model area and BMP coverage is reflective of the combined service areas.*

Table 5-2 summarizes the results of the PLRE and comparison to 2017 benchmarks. As described in Section 3.3, when the mean or median 2025 pollutant load reduction estimate falls within the benchmark range, the benchmarks are interpreted to be met. As described in Sections 5.1 and 5.3, PLRE results indicate the WLAs are achieved for bacteria in the Fanno Creek and Tualatin River TMDL watersheds as well as for DDT in the Johnson Creek TMDL watershed, so these parameters are not presented in Table 5-2.

Table 5-2. WLA and Benchmark Comparison

Service Area	TMDL Watershed	Parameter (units)	2025 Pollutant Load Reduction Estimate[a]			2017 Benchmarks (counts or pounds), Depicted as a Range Based on Projected 2022 Conditions	Met Benchmarks (Y/N)[b]
			LCL	Mean or Median	UCL		
WES	Clackamas River	Bacteria (counts)	5.41 x 1012	1.03 x 1013	2.75 x 1013	3.6 x 1012 to 2.3 x 1013	Y
	Johnson Creek	Bacteria (counts)	1.84 x 1012	3.36 x 1012	7.79 x 1012	N/A	N/A
	Lower Willamette River	Bacteria (counts)	5.14 x 1012	9.69 x 1012	2.55 x 1013	N/A	N/A
	Middle Willamette River[c]	Bacteria (counts), winter season	0	0	0	N/A	N/A
		Bacteria (counts), summer season	0	0	0	N/A	N/A
	Fanno Creekc	Total phosphorus (pounds)	0	0	0	N/A	N/A
		TSS (pounds)	0	0	0	N/A	N/A
	Tualatin River	Total phosphorus (pounds)	0.73	0.96	1.07	N/A	N/A
		TSS (pounds)	226	415	699	N/A	N/A
EHV	Clackamas River	Bacteria (counts)	3.49 x 1010	6.53 x 1010	1.43 x 1011	N/A	N/A
	Johnson Creek	Bacteria (counts)	5.21 x 1012	9.89 x 1012	2.65 x 1013	N/A	N/A
	Lower Willamette River[c]	Bacteria (counts)	0	0	0	N/A	N/A

a. *The pollutant load reduction estimate is based on the difference between the no-BMP and with-BMP pollutant loads. The UCL pollutant load reduction range is the difference between the no-BMP and with-BMP pollutant loads for the UCL; the mean pollutant load reduction range is the difference between the no-BMP and with-BMP pollutant loads for the mean load; the LCL pollutant load reduction range is the difference between the no-BMP and with-BMP pollutant loads for the LCL.*

b. *This column is provided to comply with a permit requirement. Quantitative benchmarks were only established for the Clackamas River TMDL watershed for WES in 2017.*

c. *Due to small area and/or limited development potential, no structural BMPs are currently located in this TMDL watershed and the pollutant load reduction estimate associated with structural BMP implementation is 0.*

Because benchmarks are pollutant load reduction estimates for estimated future conditions, they are used as a tool and a goal for guiding adaptive management activities and are not considered a numeric effluent limit.

5.5 Pollutant Load Reduction Evaluation Summary

The pollutant load reduction benchmarks comparison presented in Table 5-2 show that previously established quantitative benchmarks are met for bacteria in the Clackamas River TMDL watershed.

WLAs were previously (2015) met for bacteria in the Lower Tualatin and Fanno Creek TMDL watersheds, and current pollutant load reduction estimates continue to show that the WLA for bacteria is met in these TMDL watersheds. Specific for this PLRE, WLAs for DDT/dieldrin are estimated to be met for in the Johnson Creek watershed.

Significant additional load reduction will be needed beyond the current structural BMP implementation to meet WLAs for bacteria in the Lower Willamette River, Middle Willamette River, Clackamas River, and Johnson Creek TMDL watersheds. Additional reductions are also needed to achieve the WLAs for total phosphorus and TSS in the Lower Tualatin River and Fanno Creek TMDL watersheds, although progress is noted in the Lower Tualatin River TMDL watershed as current pollutant load estimates for phosphorus are close to WLAs.

Due to the variable nature of stormwater runoff and the variety of undefined sources contributing to stormwater pollutant discharges, there are inherent difficulties in applying WLAs to MS4 discharges and quantitatively tracking pollutant load discharges to ensure that progress toward the WLA is being made. WES, Clackamas County and EHV have chosen a conservative approach to avoid overestimating the effectiveness of their programs. The pollutant load reduction estimates reflect the maximum extent practicable standard defined by WES and the cities and implemented with structural BMPs. With adaptive management efforts, implementation of stormwater retrofits, ongoing implementation of stormwater development standards for new development and re-development that promote infiltration, and the potential for new information and/or new, more cost-effective technologies in the future, it is expected that pollutant load reductions will continue to increase.

In addition, greater reductions are likely achieved with implementation of non-structural BMPs. WES, Clackamas County, and the cities conduct a variety of programmatic activities that are directly attributable to bacteria, total phosphorus, and TSS reduction. Such activities include erosion control, riparian vegetated buffer protection and enhancement, illicit discharge detection and elimination, street sweeping, catch basin cleaning, facility maintenance, operations and maintenance, pet waste programs, and public education. While numeric values for non-structural and source-control BMP effectiveness were not specifically accounted for in the pollutant loads models, pollutant loads are presented as a range, and this range reflects the variable nature of stormwater runoff and may potentially account for non-structural and source-control practices implemented upstream.

5.5.1 Water Quality Trends Analysis

In accordance with Schedule D.3.c.vii of the MS4 permit, this PLRE includes a water quality trends analysis. WES conducts water quality monitoring on behalf of Clackamas County and the cities. Therefore, the trends analysis is relevant to the pollutant loads modeling conducted for WES and EHV.

WES' overall monitoring program includes in-stream (ambient) water quality monitoring, MS4 (stormwater) monitoring, biological monitoring, and physical condition monitoring. Specific to this permit term, pesticide (stormwater) and mercury (instream and stormwater) monitoring is also conducted. For the water quality trends analysis, WES evaluated in-stream monitoring data collected at their four active MS4 instream monitoring sites over the current permit term (through July 2025) along with historical monitoring data to assess long-term trends in receiving water quality. In addition, five discontinued MS4 instream monitoring sites were also evaluated for long-term trends in receiving stream water quality. Up to 30 years' worth of instream water quality data were available for analysis.

Ambient water quality trends were calculated for the nine WES instream monitoring locations, based on the monitoring locations identified in the Comprehensive Clackamas County Stormwater Monitoring Plan (2023). The following pollutant parameters were included in the analysis:

- total suspended solids
- E. coli
- total phosphorus
- total and dissolved copper
- total and dissolved zinc
- nitrate-nitrite
- nitrate
- mercury (total)

Each parameter was analyzed at each sampling site. Ambient water quality data was sorted into dry weather and wet weather conditions to help assess the potential influence of MS4 discharges on receiving water quality. Of the 154 datasets (a combination of parameter, weather condition and location), 126 datasets met data quality requirements for a trends analysis. Datasets with less than five years of observation data and datasets with greater than 50 percent non-detect observations were not suitable for trends analyses.

The Mann-Kendall test was used for analysis on data sets. The Mann-Kendall test is particularly well-suited for analyzing environmental data because (1) it allows for missing values and unevenly spaced measurements, (2) there are no distributional assumptions, (3) outliers have minimal effect, and (4) some non-detects can be present in the data.

Table 5-3 summarizes results of the 2025 in-stream water quality trends evaluation for waterbodies and parameters where observed trends are noted. Full documentation is included in Appendix A.

Table 5-3. Summary of Seasonal Kendall Water Quality Trends Analysis

Monitoring Location	Improving Trends (decreasing concentration trends)		Deteriorating Trends (increasing concentration trends)	
	No Rain	Rain	No Rain	Rain
Active WES Instream Monitoring Locations				
Phillips Creek (CC-11)	TSS Total phosphorus	Total phosphorus Copper (dissolved)	Zinc (total and dissolved)	Zinc (total and dissolved)
Mt Scott Creek (CC-15)	TSS Total phosphorus Copper (dissolved)	Total phosphorus Copper (dissolved)	Zinc (total)	Zinc (total and dissolved)
Rock Creek (CC-16)	TSS E. coli	TSS	None	None

Table 5-3. Summary of Seasonal Kendall Water Quality Trends Analysis				
	Improving Trends (decreasing concentration trends)		Deteriorating Trends (increasing concentration trends)	
Monitoring Location	No Rain	Rain	No Rain	Rain
	Total phosphorus Copper (total)			
Lower Kellogg Creek (CC-27)	TSS Copper (total)	TSS *E. coli* Copper (total and dissolved)	Total phosphorus	None
Discontinued WES instream monitoring locations				
Carli Creek (CC-05)	Total phosphorus Copper (total and dissolved Zinc (dissolved)	Total phosphorus Copper (dissolved)	None	None
Sieben Creek (CC-07)	Total phosphorus	TSS Total phosphorus	Zinc (total and dissolved)	Zinc (total and dissolved)
Upper Kellogg Creek (CC-14)	Copper (dissolved)	TSS E. coli Copper (total and dissolved)	Zinc (total)	Zinc (total)
Cow Creek (CC-24)	TSS Total phosphorus Copper (total) Zinc (total and dissolved)	TSS Total phosphorus Copper (total) Zinc (total and dissolved)	None	None
Pecan Creek (SW-11)	Total phosphorus	Total phosphorus	TSS *E. coli*	Zinc (dissolved)

Note: Based on a significance level up to 10 percent.

Results from the trends analysis indicate a mixture of improving and deteriorating trends. Most of the deteriorating trends (for dry or wet weather) occurred for total and dissolved zinc. Approximately 36 percent of trends analyses conducted (45 of the 126 datasets) reflected improving trends during dry or wet weather for TSS and total phosphorus.

As mentioned previously, no trend was observed for approximately half of the data sets evaluated (64 of the 126 datasets). Since 1994 (start of the monitoring data period of record), Clackamas County grew in population by approximately 115,000. Given that level of population grown and the potential impacts associated with the resulting development, seeing no trend in water quality is a positive result. The results of this trends analysis are not a definitive statement of the overall quality of sampled streams, but rather one piece of information to be considered within the larger watershed context.

5.5.2 Qualitative Evaluation of Mercury Reduction

Mercury is a TMDL parameter in the Willamette Basin with direct ties to stormwater runoff; however, mercury loading was not evaluated for this pollutant load evaluation and TMDL benchmark development effort.[7]

In accordance with Schedule D.3.b.iii of the NPDES MS4 permit, instead, the following is required for mercury:

[7] Per Schedule D.3.b.v of the NPDES MS4 permit, given the lack of sufficient mercury data, pollutant load reduction evaluations, benchmark and wasteload allocation attainment analyses for mercury will not be required this permit cycle.

> *"An analysis of the effectiveness of the best management practices and any other actions taken and qualitative pollutant load reductions achieved are required with the Permit Renewal Application Package."*

Per Chapter 4 of the Willamette Basin Mercury Total Maximum Daily Load (2021), a summary of mercury sources is provided. Atmospheric deposition of mercury from global sources is presented as the dominant source of mercury in the Willamette River Basin. Additional non-point sources of mercury identified include runoff from forestry and agricultural land management practices; background/anthropogenic sources in groundwater due to local geology; and naturally occurring sediment-bound mercury that is eroded and transported to streams. Point sources such as municipal waste discharges, industrial discharges, suction dredge mining and stormwater are also referenced. Mercury in urban stormwater is believed to be predominantly associated with atmospheric deposition and active erosion or transport of sediment in stormwater runoff. As a result, stormwater BMPs implemented by NPDES MS4 permittees are focused on reducing the discharge of sediment as the primary method of reducing discharges of mercury.

The prevention and reduction of sediment in runoff is a continued focus of WES, Clackamas County and the cities' stormwater management programs. The 2024 MS4 Permit Shared Stormwater Management Program Document (SWMP Document) includes measurable goals and tracking measures for several sediment-reducing BMPs.

Per Schedule D.3.b.i, of the Clackamas NPDES MS4 permit, a mercury minimization assessment was submitted with the NPDES MS4 annual report in December 2022 for WES and the cities. The assessment detailed current actions and stormwater BMPs per the SWMP Document that reduce sediment and mercury discharged into and from the permitted MS4 system. In short, nearly every program activity (or BMP) supports the prevention and reduction of sediment, and hence mercury. The mercury minimization assessment concluded that mercury and sediment reducing BMPs were fully incorporated into the SWMPs in effect at that time. Since then, each MS4 Permit annual report submitted to DEQ by WES, Clackamas County and the cities has affirmed that effective mercury and sediment reducing BMPs were fully incorporated into 2022 SWMP Document, and later, into the effective 2024 SWMP Document.

Structural BMP implementation in the WES MS4 permit area, as required by the WES Stormwater Standards (2023), supports the use of infiltration and filtration-based treatment systems that directly address sediment and thus mercury. Effectiveness of approved structural BMPs for TSS, assumed for this pollutant load reduction evaluation and TMDL benchmarks, is detailed in Section 3.4 and was compiled in part from the American Society of Civil Engineers International Stormwater Best Management Practices (ASCE BMP) Database, a Water Research Foundation tool. Per the latest (2020) ASCE BMP Database status report, BMP effectiveness for fourteen structural stormwater BMPs validates statistically significant reductions of TSS. The best performing structural BMPs include bioretention facilities (i.e., planters, raingardens, swales), which are structural stormwater facilities used in the WES MS4 permit area.

To ensure continued improvements are made to reduce mercury and sediment in stormwater, WES, Clackamas County and the cities adaptively manage non-structural/programmatic stormwater BMPs listed in their SWMP Document as new knowledge is gained regarding the effectiveness and efficiency of these practices. Results of this annual adaptive management process are outlined in annual reports, and a more detailed adaptive management process to define SWMP Document changes is reflected in the 2026 NPDES MS4 permit renewal application. In addition, the Non-point Source TMDL Implementation Plan for the Tualatin, Willamette, Molalla-Pudding, and Sandy River Watersheds, dated October 2023, details additional activities, specific to non-point source areas of the WES, Clackamas County, and EHV service areas, intended to address, control and reduce discharges of mercury.

Section 6

Pollutant Load Reduction Benchmarks

Benchmarks are a pollutant load reduction estimate for each parameter or surrogate, for which a WLA is established. The benchmark is used to measure the overall effectiveness of the stormwater management program and progress towards achieving the WLA over an implementation period. Thus, benchmarks are pollutant load reduction estimates for the future. They are used as a tool and a goal for guiding adaptive management activities and are not considered a numeric effluent limit.

The proposed benchmarks presented in this section are based on projected structural BMP implementation at the end of the next NPDES MS4 permit term (anticipated to be 2031).

6.1 TMDL Benchmark Development

Benchmarks are required for TMDL parameters where current BMP implementation does not meet WLAs established in the permit.

Based on results of the pollutant load reduction evaluation (Sections 5.1, 5.2, and 5.3), benchmarks are required for bacteria in the Clackamas River, Johnson Creek, Lower Willamette, and Middle Willamette tributary TMDL watersheds. Benchmarks are required for total phosphorus and TSS in the Tualatin River and Fanno Creek TMDL watersheds. In accordance with Schedule D.3.d.i of the MS4 permit, each benchmark must reflect the pollutant load reduction necessary to achieve the previously established benchmarks for the current permit term if not already met (2017 benchmark), and additional progress toward the TMDL WLA during the next permit term.

Benchmarks are developed by identifying structural stormwater BMPs likely to be installed before the end of the next permit term. Given uncertainties with the timing and selection of stormwater BMPs installed with private development activities, benchmark development for WES and EHV is focused on public facility installations or private facility installations that are already identified and therefore considered more certain.

WES staff identified a total of seven public structural BMPs covering a total of 134 acres of area, proposed for installation by 2031. Proposed BMPs are in the Clackamas River, Johnson Creek, and Lower Willamette TMDL watersheds. The drainage areas for these future BMPs is shown in Figure 4-1. In addition, the city of Happy Valley staff identified two future private structural BMP installations covering approximately 0.6 acres in the Clackamas River TMDL watershed.

Table 6-1 summarizes the project names and future BMP categories assumed in the development of benchmarks for WES' and EHV's service areas. New structural BMP installations are not proposed for the Middle Willamette, Tualatin River and Fanno Creek TMDL watersheds due to the limited resources available in the WES stormwater service area. New structural BMP installations for the EHV service area are also not proposed for the Johnson Creek and Lower Willamette TMDL watersheds, due to the characteristics of the property (vacant, agricultural, or rural residential) and the fact that with proposed development, EHV service area will ultimately annex into WES' service area and significant structural stormwater controls will be installed as a condition of development

Additional public and private stormwater facility installations beyond those outlined in Table 6-1 are likely but have not been projected with certainty. This conservative assumption is again due to the variable schedules, location and proposed facilities associated with private development activities and the unknown content and issuance date for the reissued NPDES MS4 permit and potential requirements influencing installation of .

Table 6-1. Projected Stormwater Facilities and Drainage Areas for 2026 Benchmarks

Service Area	TMDL Watershed	TMDL Parameter to be Addressed	2026 TMDL Benchmark Development		
			Future Project Name	Projected BMP Type	Estimated Additional Future BMP Drainage Area (ac)
WES	Clackamas River	Bacteria (counts)	172nd Avenue Retrofit	Lined Planter/ Filtration Raingarden	7.8
			152nd Retrofit	Detention Pond	25.5
	Johnson Creek	Bacteria (counts)	DTD Traffic Light at 76th and Johnson Creek Blvd.	Infiltration Raingarden	1.4
			Monroe Storm Improvements	Lined Planter/ Filtration Raingarden	6.5
	Lower Willamette River	Bacteria (counts)	Bilquist Elementary School Sidewalks	Hydrodynamic Separator	3.3
			78th Avenue Storm	Media Filter	0.5
			Valley View Terrace Storm	Detention Pond	89.1
EHV	Clackamas River	Bacteria (counts)	Winston Property	Lined Planter/ Filtration Raingarden	0.2
			Vogel Road	Lined Planter/ Filtration Raingarden	0.4

6.2 TMDL Benchmark Results

The spreadsheet loads model used for the PLRE was used to simulate future BMP implementation in accordance with modeling methods and assumptions described in Section 4 and as reflected in Table 6-1. The Clackamas River, Lower Willamette and Johnson Creek TMDL watersheds are the only watersheds with a future BMP installation proposed.

The benchmarks are calculated as the difference between the modeled loads associated with the current no-BMP scenario and the future with-BMP scenario. Due to the variability in stormwater quality data, pollutant loads themselves are typically calculated and presented as a range. Pollutant load estimates reflecting the current no-BMP, current with-BMP, and future with-BMP scenarios are provided in Appendix B. Pollutant load reduction estimates associated with the current scenario (PLRE) and future scenario (benchmarks) are also provided in Appendix B. For TMDL watersheds without future BMPs proposed, the benchmarks are set as the current pollutant load reduction estimate.

Table 6-2 shows the new bacteria TMDL benchmarks for WES and EHV in the Clackamas River TMDL watershed, as well as the new bacteria TMDL benchmarks for WES in the Johnson Creek and Lower Willamette TMDL watersheds. Benchmarks are presented as both a load reduction and percentage load reduction.

Table 6-2. TMDL Benchmarks for WES for Bacteria (2026–2031)

Service Area	TMDL Watershed	Time Frame	Pollutant (units)	WLA (% reduction)	TMDL Benchmarks (load reduction)[a], Range	TMDL Benchmarks (% load reduction)[a], Range
WES	Clackamas River	Annual	Bacteria (counts)	78%	5.50×10^{12} to 2.79×10^{13}	12.8 to 20.2
	Johnson Creek	Annual	Bacteria (counts)	78%	1.93×10^{12} to 8.07×10^{12}	10.4 to 14.6
	Lower Willamette	Annual	Bacteria (counts)	78%	5.36×10^{12} to 2.67×10^{13}	6.2 to 10.1
EHV	Clackamas River	Annual	Bacteria (counts)	78%	3.56×10^{10} to 1.45×10^{11}	0.7 to 1.0

a. *The TMDL benchmarks are a load reduction, calculated as the difference between the current no-BMP scenario load and the future with-BMP scenario load. The benchmarks have also been calculated as a percent reduction for direct comparison with the WLA.*

6.3 Discussion and Application of SWMP Implementation

WES benchmarks reflect the projected installation of seven new structural BMPs treating approximately 134 acres of previously untreated drainage area.

While the projected BMP coverage area and resulting bacteria load reductions are significant, the resulting pollutant load reduction is estimated to fall short of achieving the WLAs. Large areas of the WES and EHV MS4 permit area have already developed without structural BMPs and structural stormwater BMPs are not 100 percent effective in removing bacteria or other TMDL parameters. WES, Clackamas County and the cities prepared a WLA attainment assessment for DEQ in October 2015, which indicated that achieving the WLAs would require construction of facilities and associated maintenance costs that far exceed the MS4 Permit definition of maximum extent practicable. Progress toward the WLA, and not achievement of the WLA, is the goal in setting benchmarks. Such progress is reflected in Table 6-2 and Appendix B.

The proposed benchmarks are conservative estimates of the pollutant load reduction anticipated during the next permit term with the use of structural BMPs alone. The load reduction estimates do not account for:

1. Non-structural BMPs, as described in Section 5.5.
2. Additional structural BMPs installed in conjunction with future development and redevelopment projects that have not yet submitted land use applications.
3. Targeted capital improvement projects and retrofit applications not yet reflected in the WES, Clackamas County, and the city of Happy Valley budget estimates.

Each of these efforts is expected to further reduce the TMDL pollutant loads in runoff to below the levels indicated in these benchmark projections.

Section 7

References

Association of Clean Water Agencies, Stormwater Committee. BMP Effluent Data Bootstrapping Results. 2014.

Caraco, D., Watershed Treatment Model (WTM) 2010 Users Guide, Prepared for U.S. EPA Office of Wetlands Oceans and Watersheds, Altria Foundation, and Cooperative Institute for Coastal and Estuarine Environmental Technology, Center for Watershed Protection, Ellicott City, Maryland, 2010.

Center for Watershed Protection, A Survey of Residential Nutrient Behavior in the Chesapeake Bay, Prepared for Chesapeake Bay Research Consortium, 1999.

Clackamas County, MS4 Permit Shared Stormwater Management Program Document for Clackamas County, WES, city of Happy Valley and city of Rivergrove. 2024.

Clackamas County WES, Permit Renewal Application Packet for CCSD #1, SWMACC, the city of Happy Valley, and the city of Rivergrove, September 2008.

Clackamas County WES, Permit Renewal Application Packet for CCSD #1, SWMACC, the city of Happy Valley, and the city of Rivergrove, February 2017. https://www.oregon.gov/deq/wq/Documents/ms4ClacksubmittalR.pdf

Comprehensive Clackamas County Stormwater Monitoring Plan (CCCSMP). Updated December 2022, updated 2023.

DEQ, Tualatin Subbasin Total Maximum Daily Load, August 2001, amendments August 2012.

DEQ, Willamette River Total Maximum Daily Load, September 2006, amendments May 2021 and 2025.

DEQ, NPDES MS4 Discharge Permit 101384, Issued to Clackamas County et al., May 5, 2023.

Oregon Administrative Rules (OARs), Definitions (OAR 340-041-0002), May 26, 2025. https://oregon.public.law/rules/oar_340-041-0002

Pitt, R., A. Maestre, and R. Morquecho, The National Stormwater Quality Database (NSQD), Version 1.0, Water Environment Federation Technical Exposition and Conference, Los Angeles, 2003.

Winer, R., National Pollutant Removal Performance Database for Stormwater Treatment Practices: 2nd Edition, Center for Watershed Protection, Ellicott City, MD, 2000.

U.S. Environmental Protection Agency, 2014, http://toxics.usgs.gov/definitions/tmdl.html. Accessed November 17, 2014.

Water Environment Services Stormwater Standards, accessed June 24, 2026.

Appendix A: Water Quality Trends Analysis

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Technical Memorandum

Prepared for: Clackamas Water Environment Services

Project Title: WES NPDES MS4 Permit Renewal

Project No.: 203486

Technical Memorandum

Subject: 2025 Instream Water Quality Trends Analyses

Date: December 8, 2025

To: Chris Desiderati, Environmental Services Supervisor

Andrew Swanson, WES Project Manager

From: Angela Wieland, P.E., Project Manager, Brown and Caldwell

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Summary

The purpose of this technical memorandum (TM) is to provide a summary of the review and analysis of instream water quality monitoring data for Clackamas Water Environment Services (WES). WES conducts water quality monitoring on behalf of Clackamas County (County) and the cities of Rivergrove and Happy Valley. The cities of Happy Valley and Rivergrove are collectively referred to as Cities for purposes of this TM. This review and analysis were conducted to meet the requirements of the Cities', Clackamas County's, and WES' National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit issued on September 15, 2021.

The Cities, the County, and WES are co-permittees on the Clackamas County group's NPDES MS4 Phase 1 Individual permit along with several other local governments and service districts in Clackamas County, Oregon. As required by the NPDES MS4 permit, co-permittees must evaluate the overall effectiveness of their stormwater management programs by conducting a pollutant load reduction evaluation (Schedule D.3 of the permit). This includes performing an instream water quality trends analysis (Schedule D.3.c.vii) to summarize the relationship of identified trends to stormwater discharges. WES has been collecting instream water quality monitoring data for various pollutants since 1994. The most recent Water Quality Trends analysis (BC 2015) was completed in 2015 in support of the 2012 NPDES MS4 Permit requirements and 2017 NPDES MS4 permit renewal application, reflecting data collected through 2015. In addition, WES periodically evaluated historic trends against current water quality monitoring data from 2017 to 2020 and submitted those comparisons in an annual monitoring report with their NPDES MS4 annual compliance reports.

Brown and Caldwell (BC) was retained to review, compile, and analyze instream environmental monitoring data to support the Cities', the County's, and WES' 2021 NPDES MS4 permit requirement and permit renewal application. Please note that while referenced in this memo as the 2021 NPDES MS4 Permit, the permit was modified and reissued in 2023. This TM presents a summary of the data review and processing, an overview of the Mann-Kendall statistical analysis, and a summary of the trends results.

Section 1: Data Review and Pre-Processing

This section describes data requested, data quality criteria, and data pre-processing that BC conducted on the water quality monitoring data provided.

1.1 Data Request

The 2021 NPDES MS4 Permit requires instream monitoring for specific parameters. These parameters vary by jurisdiction and receiving water, but generally include total suspended solids (TSS), dissolved organic carbon, nutrients (total phosphorus [TP], ortho-phosphorus, nitrate, and ammonia nitrogen), heavy metals (total recoverable and dissolved copper, lead and zinc), and bacteria (*E. coli*). The 2021 Permit additionally requires Clackamas County co-permittees to conduct instream mercury monitoring.

For Clackamas County co-permittees, the number of instream monitoring locations and sampling frequency is dictated by the 2021 NPDES MS4 Permit. Description of instream monitoring locations and sampling methods are detailed in the 2023 Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan (2023 Monitoring Plan). Per the 2023 Monitoring Plan, WES conducts routine instream monitoring at four sites (Phillips Creek, Mt Scott Creek, Rock Creek and Kellogg Creek) on behalf of WES, Clackamas County and the Cities. In addition to those sites required per the 2023 Monitoring Plan, prior to 2023, WES also monitored five additional sites (a 2nd upstream Kellogg Creek site, Cow Creek, Pecan Creek, Carli Creek, and Sieben Creek), but discontinued monitoring at these sites beginning in July 2023.

The 2021 NPDES MS4 Permit and 2023 Monitoring Plan do not specify which parameters are required for the water quality trends analysis. A 2007 draft guidance document developed by the Oregon Association of Clean Water Agencies (ACWA) Phase I stormwater committee recommends that trends analyses be performed for TSS, TP, total recoverable and dissolved copper and zinc, and *E. coli* if adequate data are available to perform a statistically valid water quality trends analysis (ACWA 2007). In addition to the seven key water quality parameters recommended by the 2007 draft guidance, BC requested instream monitoring data for mercury and other relevant nutrients (e.g., nitrate), if available.

1.2 Data Quality Criteria

Recommendations for data quality criteria for water quality trends analysis are provided in the 2007 ACWA guidance document. This guidance recommends using a non-parametric Mann-Kendall trends analysis statistical test on datasets with at least 5 years of data and at least 30 observations. A "dataset" represents all the observations collected for a single water quality parameter at a single site during wet days (wet conditions) or dry days (dry conditions).

Refined criteria were applied in 2015 to allow for analysis of more parameters (i.e., those with 10 or more data points but less than the 30 recommended per the 2007 ACWA guidance). Limiting the analysis based on the detection limit also provides more rigorous and statistically valid trends analyses. For consistency with the 2015 Trends Analysis methods, BC used the same refined criteria for this 2025 Trends Analysis. BC did not conduct quality assurance/quality control (QA/QC) review of individual samples as it was assumed that the QA/QC was already completed by WES. The 2025 Trends Analysis applied refined/updated ACWA criteria as summarized in Table 1.

Table 1. Data Quality Criteria

Criteria	2007 ACWA Criteria	Refined Criteria
Wet vs. dry-day datasets	Analyzed separately	Analyzed separately
Minimum duration of data collection	5 years	5 years
Minimum number of observations	30	10
Minimum percent of detected observations	N/A	50%

1.3 Data Pre-Processing

BC compiled, summarized, and pre-processed the monitoring data received to identify which datasets were sufficient to perform a statistically valid water quality trends analysis. BC assessed a total of 154 datasets for trends analysis suitability. The datasets, provided by WES on August 8th, 2025, included eight water quality parameters reflecting two rainfall conditions (wet-day, dry-day) across the nine sites. At several sites, Nitrate and Mercury samples were also collected starting in 2023. Data pre-processing for trends analysis suitability included a review of the following for each monitoring site and parameter, documenting:

- Total number of samples.
- Total number of samples during wet-day conditions (record marked "Y" for rainfall greater than or equal to 0.1 inch during the sampling event) or dry-day conditions (record marked "N" for no rainfall).
- Number of detected and non-detected samples during wet-day and dry-day conditions.

Table 2 and Table 3 provide a summary of the monitoring sites and parameter statistics and shows a check mark (✓) for each dataset that met the project criteria for conducting a Mann-Kendall trends analysis. Of the 154 total datasets provided, 126 met the data quality requirements for trends analysis. A total of 28 datasets contained insufficient data for trends analysis, with each site having less than 5 years of observation data for Nitrate (8 datasets), Mercury (2 datasets), and Nitrate-Nitrite (18 datasets). Therefore, a total of 126 trends analyses were conducted, which include 63 trends analyses for the dry season (i.e., 9 sites x 7 parameters), and 63 trends analyses for the wet season (i.e., 9 sites x 7 parameters).

Table 2. Instream Monitoring Sites and Dataset Statistics

Parameter	Monitoring Period (years)	No Rain (Dry Conditions)		Rain (Wet Conditions)	
		# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]
Phillips Creek (CC-11)					
TSS	1999-2025 (26)	199 (192/7)	✓	87 (87/0)	✓
E. coli 2	1994-2025 (31)	225 (218/7)	✓	95 (92/3)	✓
TP	1994-2025 (31)	231 (220/11)	✓	94 (94/0)	✓
Copper	1994-2025 (31)	170 (163/7)	✓	74 (72/2)	✓
Copper (diss.)	2007-2025 (18)	120 (116/4)	✓	66 (66/0)	✓
Zinc	1994-2025 (31)	169 (166/3) + 2	✓	74 (74/0)	✓
Zinc (diss.)	2007-2025 (18)	118 (118/0) + 2	✓	66 (66/0)	✓
Nitrate-Nitrite	2021-2025 (4)	39 (39/0)		15 (15/0)	
Nitrate	2023-2025 (2)	18 (18/0)		6 (6/0)	
Mt. Scott Creek (CC-15)					
TSS	1999-2025 (26)	200 (198/2)	✓	87 (87/0)	✓
E. coli[2]	1994-2025 (31)	226 (219/7)	✓	95 (91/4)	✓
TP	1994-2025 (31)	232 (227/5)	✓	96 (95/1)	✓
Copper	1994-2025 (31)	170 (149/21)	✓	74 (69/5)	✓
Copper (diss.)	2007-2025 (18)	120 (117/3)	✓	65 (65/0)	✓
Zinc	1994-2025 (31)	167 (158/9) + 5	✓	73 (73/0)	✓
Zinc (diss.)	2007-2025 (18)	117 (117/0) + 5	✓	65 (65/0)	✓
Nitrate-Nitrite	2021-2025 (4)	39 (39/0)		15 (15/0)	
Nitrate	2023-2025 (2)	18 (18/0)		6 (6/0)	
Rock Creek (CC-16)					
TSS	1999-2025 (26)	212 (201/11)	✓	80 (80/0)	✓
E. coli[2]	1998-2025 (27)	196 (191/5)	✓	79 (77/2)	✓
TP	1998-2025 (27)	209 (197/12)	✓	76 (74/2)	✓
Copper	1998-2025 (28)	158 (134/24) + 3	✓	66 (61/5)	✓
Copper (diss.)	2007-2025 (18)	121 (119/2) + 3	✓	61 (61/0)	✓
Zinc	1994-2025 (31)	159 (134/25) + 1	✓	64 (59/5) + 2	✓

Table 2. Instream Monitoring Sites and Dataset Statistics					
		No Rain (Dry Conditions)		Rain (Wet Conditions)	
Parameter	Monitoring Period (years)	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]
Zinc (diss.)	2007-2025 (18)	123 (120/3) + 1	✓	59 (59/0) + 2	✓
Nitrate-Nitrite	2021-2025 (4)	39 (39/0)		15 (15/0)	
Nitrate	2023-2025 (2)	18 (18/0)		6 (6/0)	
Mercury	2023-2025 (2)	8 (8/0)		0 (0/0)	
Lower Kellogg Creek (CC-27):at Rowe Middle School					
TSS	2012-2025 (13)	101 (101/0)	✓	39 (38/1)	✓
E. coli[2]	2012-2025 (13)	101 (101/0)	✓	39 (37/2)	✓
TP	2012-2025 (13)	100 (100/0)	✓	39 (39/0)	✓
Copper	2012-2025 (13)	100 (99/1) + 1	✓	39 (39/0)	✓
Copper (diss.)	2012-2025 (13)	100 (96/4) + 1	✓	39 (39/0)	✓
Zinc	2012-2025 (13)	96 (96/0) + 5	✓	39 (39/0)	✓
Zinc (diss.)	2012-2025 (13)	96 (96/0) + 5	✓	39 (39/0)	✓
Nitrate-Nitrite	2021-2025 (4)	39 (39/0)		15 (15/0)	
Nitrate	2023-2025 (2)	18 (18/0)		6 (6/0)	

1 Data quality criteria: dataset has 5+ years of data, 10+ observations, and 50%+ detected values

2 E. Coli samples above the upper detection limit (marked with ">") are included in non-detected sample counts.

3 Censored data: several metals samples (total and dissolved) omitted due to possible dissolved filter contamination issue; these are not included in the sample counts and are quantified separately in Table 2.

Table 3. Discontinued Monitoring Sites Dataset Statistics					
		No Rain (Dry Conditions)		Rain (Wet Conditions)	
Parameter	Monitoring Period (years)	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]
Cow Creek (CC-24)					
TSS	2001-2023 (22)	101 (100/1)	✓	79 (78/1)	✓
E. coli[2]	2001-2023 (22)	93 (90/3)	✓	78 (75/3)	✓
TP	2001-2023 (22)	99 (94/5)	✓	77 (77/0)	✓
Copper	2001-2023 (22)	82 (74/8)	✓	68 (65/3)	✓
Copper (diss.)	2007-2023 (16)	71 (71/0)	✓	65 (65/0)	✓
Zinc	2002-2023 (21)	82 (82/0)	✓	68 (68/0)	✓
Zinc (diss.)	2007-2023 (16)	71 (71/0)	✓	65 (65/0)	✓
Nitrate-Nitrite	2021-2023 (2)	11 (11/0)		9 (9/0)	
Pecan Creek (SW-11)					
TSS	1996-2023 (27)	225 (217/8)	✓	118 (117/1)	✓
E. coli 2	1996-2023 (27)	224 (222/2)	✓	117 (116/1)	✓

Table 3. Discontinued Monitoring Sites Dataset Statistics					
		No Rain (Dry Conditions)		Rain (Wet Conditions)	
Parameter	Monitoring Period (years)	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]	# Samples (detected/ non-detected) + Censored [3]	Meet Refined Data Quality Criteria[1]
TP	1996-2023 (27)	218 (211/7)	✓	112 (112/0)	✓
Copper	2007-2023 (16)	109 (109/0)	✓	96 (96/0)	✓
Copper (diss.)	2007-2023 (16)	109 (109/0)	✓	95 (95/0)	✓
Zinc	2007-2023 (16)	108 (102/6) + 1	✓	96 (96/0)	✓
Zinc (diss.)	2007-2023 (16)	108 (107/1) + 1	✓	95 (95/0)	✓
Nitrate-Nitrite	2021-2023 (2)	21 (21/0)		9 (9/0)	
Carli Creek (CC-05)					
TSS	1999-2023 (24)	183 (179/4)	✓	78 (77/1)	✓
E. coli[2]	1994-2023 (29)	210 (199/11)	✓	86 (83/3)	✓
TP	1994-2023 (29)	216 (212/4)	✓	87 (85/2)	✓
Copper	1994-2023 (29)	153 (136/17) + 1	✓	68 (65/3)	✓
Copper (diss.)	2007-2023 (16)	99 (99/0) + 1	✓	61 (61/0)	✓
Zinc	1994-2023 (29)	154 (151/3)	✓	68 (68/0)	✓
Zinc (diss.)	2007-2023 (16)	99 (99/0)	✓	61 (61/0)	✓
Nitrate-Nitrite	2021-2023 (2)	21 (21/0)		8 (8/0)	
Upper Kellogg Creek (CC-14) near SE Rusk Road					
TSS	1999-2025 (26)	186 (183/3)	✓	78 (78/0)	✓
E. coli[2]	1994-2025 (31)	214 (207/7)	✓	85 (83/2)	✓
TP	1994-2025 (31)	221 (221/0)	✓	83 (81/2)	✓
Copper	1994-2025 (31)	158 (138/20)	✓	66 (62/4)	✓
Copper (diss.)	2007-2025 (18)	109 (109/0)	✓	57 (57/0)	✓
Zinc	1994-2025 (31)	156 (145/11) + 2	✓	66 (66/0)	✓
Zinc (diss.)	2007-2025 (18)	107 (107/0) + 2	✓	57 (57/0)	✓
Nitrate-Nitrite	2021-2025 (4)	24 (24/0)		9 (9/0)	
Sieben Creek (CC-07)					
TSS	1999-2025 (26)	192 (175/17)	✓	75 (75/0)	✓
E. coli[2]	1994-2023 (29)	213 (207/6)	✓	84 (81/3)	✓
TP	1994-2023 (29)	219 (216/3)	✓	81 (80/1)	✓
Copper	1994-2023 (29)	156 (133/23)	✓	65 (60/5)	✓
Copper (diss.)	2007-2023 (16)	103 (103/0)	✓	58 (58/0)	✓
Zinc	1994-2023 (29)	156 (141/15)	✓	65 (65/0)	✓
Zinc (diss.)	2007-2023 (16)	103 (103/0)	✓	58 (58/0)	✓
Nitrate-Nitrite	2021-2023 (2)	21 (21/0)		9 (9/0)	
Mercury	2023-2025 (2)	8 (8/0)		0 (0/0)	

1 Data quality criteria: dataset has 5+ years of data, 10+ observations, and 50%+ detected values

2 E. Coli samples above the upper detection limit (marked with “>”) are included in non-detected sample counts.

3 Censored data: several metals samples (total and dissolved) omitted due to possible dissolved filter contamination issue; these are not included in the sample counts and are quantified separately in Table 3

Section 2: Trends Analysis and Results

Temporal trends in water quality were evaluated using the Mann-Kendall test, a non-parametric method that is used for identifying consistently increasing or decreasing trends (monotonic trends).

2.1 Mann-Kendall Test

The Mann-Kendall test is particularly well-suited for analyzing environmental data over time because: (1) it allows for missing values and unevenly spaced measurements, (2) it does not require assumptions about the data’s underlying distribution (i.e., data does not have to meet the assumption of normality), (3) it is minimally impacted by outliers, and (4) some non-detects can be present in the data.

However, data used in the Mann-Kendall test must not exhibit autocorrelation issues that can arise with data that are seasonally varying. Water quality parameter concentrations are often affected by seasonal factors like rainfall. The seasonal Mann-Kendall test (Hirsch et al., 1982) removes the effects of seasonality but requires data that spans longer time periods (10 or more years). Therefore, applying the Mann-Kendall test separately to wet-day and dry-day datasets helps to address the seasonal variation without requiring such extensive monitoring periods. The Mann-Kendall test is described in a number of references including Gibbons (1994), Gilbert (1987), Hollander and Wolfe (1973), and U.S. EPA (2006).

The null and alternative hypotheses for the Mann-Kendall test are:

Ho: slope = 0 (null) Ha: slope $\neq$ 0 (alternative)

The null hypothesis (Ho) of “no trend” is rejected if the absolute value of the test statistic (p-value) exceeded the critical p-value. The critical p-value depends on the number of observations and the desired significance level of the results. Significance levels of both 5 and 10 percent were selected for this analysis (i.e., there is at most a 5 or 10 percent chance that the trend observed is not actually a trend but due to variability of the data). P-values less than 5 percent were assumed to demonstrate a statistically significant trend. P-values between 5 and 10 percent were assumed to demonstrate a marginally significant trend. P-values corresponded to a two-sided analysis where there is interest in both upward and downward trends.

A rejection of the null hypothesis, Ho, indicates a high likelihood of a temporal trend in the data. If Ho is <u>not</u> rejected, it cannot be concluded that there is a temporal trend in the data. The Mann-Kendall trend test compares each observation in a time series with all previous observations, tallying a point when the observation is larger than a previous observation, and subtracting a point when the observation is smaller than a previous observation. The total tally is the Kendall Score, and its sign determines the direction of the trend. A negative value indicates a downward trend with time and a positive value indicates an upward trend.

Mann-Kendall tests for trends were conducted using the Python programming language library “pymannkendall”. Python is an open-source language and integrated suite of software applications that can be efficiently used for statistical computing, with scientifically peer-reviewed statistical packages available through the Python Package Index. The "pymannkendall” package is the Python implementation of the non-parametric Mann-Kendall trend analysis. For this analysis, BC applied the original Mann-Kendall test (which does not consider seasonal effects) to the wet-day and dry-day datasets separately. Results of the Mann-Kendall trends analysis in Python produced a table of values including two-sided p-values and Kendall

Scores. BC processed all datasets using Python, resulting in a table of Mann-Kendall trends analysis values for each parameter evaluated for the site. Non-detected samples were included in the trends analysis by assuming a value equal to the detection limit for that parameter. Censored values were removed from the analysis.

To provide quality assurance on the automated processing using Python, the Mann-Kendall test was also conducted in ProUCL for select datasets. ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency (EPA) for analysis of environmental data (U.S. EPA, 2013). Because of the inability to automate the processing of datasets in ProUCL, this software was used solely to spot-check selected results from the Python package. The Kendall Scores and p-values from the ProUCL Mann-Kendall trend analyses were compared with the Kendall Scores and p-values from Python. In all spot-checked cases, the results of the two software packages were consistent, providing confidence in the results from all datasets processed through Python.

2.2 Statistical Test Results

As described above, trends analyses were conducted on all wet-day and dry-day datasets that had at least 5 years of monitoring data, at least 10 observations, and at least 50 percent detected values.

Table 4. Legend for Summary of Trends

No Rain (Dry)	< 0.1 inch of rainfall in the 24 hours prior to sampling
Rain (Wet)	>= 0.1 inch of rainfall in the 24 hours prior to sampling
↑	Declining water quality; upward trend in concentrations.
O	No trend detected
↓	Improving water quality; downward trend in concentrations.
N/A	Dataset does not meet data quality requirements

A legend for the Mann-Kendall results is shown in Table 4. Based on the selected data criteria for performing the trends analyses, trends were evaluated for both the 5 percent and 10 percent significance levels (i.e., alpha of 0.05 and 0.10). The significance levels associated with a trend are indicated with ** for p-value <= 0.05 (alpha of 0.05), indicating a significant trend, and * for p-value <= 0.10 (alpha of 0.10), indicating a marginally significant trend. Upward trends indicate a deterioration of the water quality parameter, while downward trends indicate an improvement in the water quality parameter.

Table 5 and Table 6 summarize the results of the 2025 Trends Analysis.

Table 5. Instream Water Quality Trend Analysis Results

WQ Parameter	Monitoring Period (years)	No Rain (Dry)		Rain (Wet)	
		n[1]	Trend[2]	n[1]	Trend[2]
Phillips Creek (CC-11)					
TSS	1999-2025 (26)	199	↓**	87	○
E. coli	1994-2025 (31)	225	○	95	○
TP	1994-2025 (31)	231	↓**	94	↓**
Total Copper	1994-2025 (31)	170	○	74	○
Copper (Diss.)	2007-2025 (18)	120	○	66	↓*
Total Zinc	1994-2025 (31)	169	↑**	74	↑**
Zinc (Diss.)	2007-2025 (18)	118	↑**	66	↑**
Nitrate-Nitrite	2021-2025 (4)	39	N/A	15	N/A
Nitrate	2023-2025 (2)	18	N/A	6	N/A
Mt. Scott Creek (CC-15)					
TSS	1999-2025 (26)	200	↓*	87	○
E. coli	1994-2025 (31)	226	○	95	○
TP	1994-2025 (31)	232	↓**	96	↓**
Total Copper	1994-2025 (31)	170	○	74	○
Copper (Diss.)	2007-2025 (18)	120	↓**	65	↓**
Total Zinc	1994-2025 (31)	167	↑**	73	↑**
Zinc (Diss.)	2007-2025 (18)	117	○	65	↑**
Nitrate-Nitrite	2021-2025 (4)	39	N/A	15	N/A
Nitrate	2023-2025 (2)	18	N/A	6	N/A
Rock Creek (CC-16)					
TSS	1999-2025 (26)	212	↓**	80	↓*
E. coli	1998-2025 (27)	196	↓**	79	○
TP	1998-2025 (27)	209	↓**	76	○
Copper	1998-2025 (27)	158	↓*	66	○
Copper (diss.)	2007-2025 (18)	121	○	61	○
Zinc	1998-2025 (27)	159	○	64	○
Zinc (diss.)	2007-2025 (18)	123	○	59	○
Nitrate-Nitrite	2021-2025 (4)	39	N/A	15	N/A
Nitrate	2023-2025 (2)	18	N/A	6	N/A
Mercury	2023-2025 (2)	8	N/A	0	N/A
Lower Kellogg Creek (CC-27) at Rowe Middle School					
TSS	2012-2025 (13)	101	↓*	39	↓*
E. coli	2012-2025 (13)	101	○	39	↓*
TP	2012-2025 (13)	100	↑**	39	○
Total Copper	2012-2025 (13)	100	↓**	39	↓**

Table 5. Instream Water Quality Trend Analysis Results					
WQ Parameter	Monitoring Period (years)	No Rain (Dry)		Rain (Wet)	
		n[1]	Trend[2]	n[1]	Trend[2]
Copper (Diss.)	2012-2025 (13)	100	○	39	↓**
Total Zinc	2012-2025 (13)	96	○	39	○
Zinc (Diss.)	2012-2025 (13)	96	○	39	○
Nitrate-Nitrite	2021-2025 (4)	39	N/A	15	N/A
Nitrate	2023-2025 (2)	18	N/A	6	N/A

1 n represents total samples used in trends analysis, including both detected and non-detected samples. Non-detected samples assumed a value equal to the detection limit for that parameter.

*2 Significance of upward or downward trend: *p ≤ 0.1, **p ≤ 0.05. Refer to Table 3 legend for description of trends symbols.*

Table 6. Discontinued Sites Instream Water Quality Trend Analysis Results					
WQ Parameter	Monitoring Period (years)	No Rain (Dry)		Rain (Wet)	
		n[1]	Trend[2]	n[1]	Trend[2]
Cow Creek (CC-24) at SE Last Road					
TSS	2001-2023 (22)	101	↓**	79	↓**
E. coli	2001-2023 (22)	93	○	78	○
TP	2001-2023 (22)	99	↓**	77	↓**
Total Copper	2001-2023 (22)	82	↓**	68	○
Copper (Diss.)	2007-2023 (16)	71	○	65	↓**
Total Zinc	2002-2023 (21)	82	↓**	68	○
Zinc (Diss.)	2007-2023 (16)	71	↓**	65	↓**
Nitrate-Nitrite	2021-2023 (2)	11	N/A	9	N/A
Pecan Creek (SW-11) at SW Mossy Brae Road					
TSS	1996-2023 (27)	225	↑**	118	○
E. coli	1996-2023 (27)	224	↑**	117	○
TP	1996-2023 (27)	218	↓**	112	↓**
Total Copper	2007-2023 (16)	109	○	96	○
Copper (Diss.)	2007-2023 (16)	109	○	95	○
Total Zinc	2007-2023 (16)	108	○	96	○
Zinc (Diss.)	2007-2023 (16)	108	○	95	↑**
Nitrate-Nitrite	2021-2023 (2)	21	N/A	9	N/A
Carli Creek (CC-05)					
TSS	1999-2023 (24)	183	○	78	○
E. coli	1994-2023 (29)	210	○	86	○
TP	1994-2023 (29)	216	↓**	87	↓**
Copper	1994-2023 (29)	153	↓**	68	○
Copper (diss.)	2007-2023 (16)	99	↓**	61	↓**

Table 6. Discontinued Sites Instream Water Quality Trend Analysis Results					
WQ Parameter	Monitoring Period (years)	No Rain (Dry)		Rain (Wet)	
		n[1]	Trend[2]	n[1]	Trend[2]
Zinc	1994-2023 (29)	154	○	68	○
Zinc (diss.)	2007-2023 (16)	99	↓**	61	○
Nitrate-Nitrite	2021-2023 (2)	21	N/A	8	N/A
Upper Kellogg Creek (CC-14) near SE Rusk Road					
TSS	1999-2025 (26)	186	○	78	↓**
E. coli	1994-2025 (31)	214	○	85	↓*
TP	1994-2025 (31)	221	○	83	○
Total Copper	1994-2025 (31)	158	○	66	↓**
Copper (Diss.)	2007-2025 (18)	109	↓**	57	↓**
Total Zinc	1994-2025 (31)	156	↑**	66	↑**
Zinc (Diss.)	2007-2025 (18)	107	○	57	○
Nitrate-Nitrite	2021-2025 (4)	24	N/A	9	N/A
Sieben Creek (CC-07)					
TSS	1999-2025 (26)	192	○	75	↓**
E. coli	1994-2023 (29)	213	○	84	○
TP	1994-2023 (29)	219	↓**	81	↓**
Total Copper	1994-2023 (29)	156	○	65	○
Copper (Diss.)	2007-2023 (16)	103	○	58	○
Total Zinc	1994-2023 (29)	156	↑**	65	↑**
Zinc (Diss.)	2007-2023 (16)	103	↑**	58	↑**
Nitrate-Nitrite	2021-2023 (2)	21	N/A	9	N/A
Mercury	2023-2025 (2)	8	N/A	0	N/A

1 n represents total samples used in trends analysis, including both detected and non-detected samples. Non-detected samples assumed a value equal to the detection limit for that parameter.

*2 Significance of upward or downward trend: *p ≤ 0.1, **p ≤ 0.05. Refer to Table 4 legend for description of trends symbols.*

Section 3: Summary and Conclusions

A summary of 2025 Trends Analysis results based on Table 5 and Table 6 are as follows:

- Trends analyses were conducted on 126 out of the 152 total datasets. As described above, Nitrate, Mercury, and Nitrate-Nitrite datasets did not have sufficient data for analyses (less than 5 years). For context, the 2015 trends analysis was performed on 126 datasets.
- Approximately 51 percent of all trend analyses conducted (64 out of 126) did not show any statistically significant increasing or decreasing trends.
- Approximately 36 percent of the trends analyses conducted (45 out of 126) showed **improving** water quality (decreasing trends in pollutant concentrations). TSS, TP, and Copper (Total and Dissolved) accounted for a large fraction of the improving trends across all sites.

   - All sites except Lower Kellogg Creek at Rowe Middle School (CC-27) and Upper Kellogg Creek near SE Rusk Road (CC-14) showed reductions in TP concentrations during either dry or wet-day conditions.
   - Three sites (CC-16, CC-27, CC-24) showed reductions in TSS for both dry and wet-day conditions, and several others (CC-11, CC-15, CC-14, and CC-07) showed reductions in TSS for either wet or dry-day conditions.
   - For Total Copper, four sites (CC-16, CC-27, CC-24, and CC-05) showed improving water quality for dry-day conditions, and two sites (CC-27, CC-14) showed improvements for wet-day conditions. For Dissolved Copper, three sites (CC-15, CC-15, and CC-14) showed improvements during dry-day conditions, and six sites (CC-11, CC-15, CC-27, CC-24, CC-05, and CC-14) improved during wet-day conditions. Notably, none of the sites showed *declining* water quality for dry or wet-day Total or Dissolved Copper; all were improving or had no trend.
   - Cow Creek at SE Last Road (CC-24) showed the greatest water quality improvements, with nine datasets showing improving water quality conditions and zero datasets showing declining water quality conditions, followed by Carli Creek (CC-05) and Kellogg Creek at Rowe Middle School (CC-27), which each had six improving trends.
- Approximately 13 percent of all trends analyses conducted (17 out of 126) showed **declining** water quality (increasing trends in pollutant concentration).
   - Zinc (Total and Dissolved) accounts for most of the increasing trends. Four sites (CC-11, CC-15, CC-14, and CC-07) showed increasing concentrations of Total Zinc during both dry and wet-day conditions. Two sites (CC-11, CC-07) showed increasing Dissolved Zinc concentrations during dry-day conditions, and four sites (CC-11, CC-07, CC-15, and SW-11) showed increasing Dissolved Zinc concentrations during wet-day conditions. However, it should be noted that while many sites show increasing Zinc trends (reflecting declining water quality), overall, there are fewer increasing Zinc trends in 2025 (14 total and dissolved Zinc trends) compared to the 2015 WQ Trends analysis (23 total and dissolved Zinc trends).
   - Dry-day TSS and E. Coli showed increasing concentrations at Pecan Creek (SW-11), and dry weather TP showed increasing concentrations in Kellogg Creek at Rowe Middle School (CC-27).

These trends results should be evaluated in the context of where samples are collected, specific weather, and watershed conditions that affect water quality at each sampling site. Interpretation should also consider dataset suitability and quality, such as the length of the monitoring record and the number of sampling events available for analysis.

The observed trends reflect a period when Clackamas County grew in population by approximately 38 percent (from 309,000 people in 1994, to 426,000 in 2024) and the Clackamas NPDES MS4 Permit area became even more densely developed with increasing impervious areas per square mile on average overall. Given that growth, and the potential adverse stormwater quality impacts associated with the resulting development and re-development, even seeing no trend in water quality is a positive result.

Water quality data from grab samples represent conditions during a specific snapshot in time and the results can be influenced by many factors. Although there is evidence that stormwater management activities can have a measurable impact on reducing pollutants in stormwater, correlating data from instream and outfall water quality sampling with stormwater management activities is a challenging task because of many other influences on water quality.

The current trends analysis addressed seasonality by evaluating wet-day and dry-day datasets separately. However, because routine instream sampling is not explicitly targeted to storm events, a potential future analysis could evaluate trends based on season (e.g., wet season versus dry season), rather than rainfall occurrence alone. Comparing the trends based on seasonality with those based on rainfall would allow for an assessment of the consistency and robustness of trends across these different methods. This comparison could also help determine whether routine sample collection efforts, when evaluated using season-based methods, can directly inform status and long-term trends of receiving waters associated with MS4 discharges.

The results of the trends analyses presented here are not a definitive statement of the overall quality of the sampled streams, but rather one piece of information to be considered within the larger watershed context. Both the number of data points in a dataset and the scatter of the data affect the results of the Mann-Kendall trends analysis. Datasets with more data may be more likely to exhibit a trend (if the data are not widely scattered) than datasets with fewer data points (McBride et al., 1993).

Finally, a statistically significant result is not necessarily practically significant. Other factors such as the magnitude and range of reported values compared to various instream water quality criteria can also be more practically significant, as well as longer-term indicators of watershed health such as benthic macroinvertebrate survey results. The results of the trends analyses are one piece of an overall evaluation of water quality.

Section 4: References

ACWA, 2007. Phase 1 Permit Renewal Coordination Subcommittee (Phase 1 Committee) Trend Analysis Sub-subcommittee Memo. October 26, 2007.

Brown and Caldwell (BC), 2015. Instream Water Quality Trends Analyses. Prepared for Clackamas Water Environment Services. October 26, 2015.

Brown and Caldwell (BC), 2023. Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan. Prepared for Clackamas County co-permittees. May 2023.

Hirsch, R. M., Slack, J. R., & Smith, R. A. 1982. Techniques of trend analysis for monthly water quality data. Water Resources Research, 18(1), 107–121.

Gibbons, R.D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons, Inc., New York, N.Y., 286 pages.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company, New York, N.Y.

Hollander, M. and D.A. Wolfe. 1973. Nonparametric Statistical Methods. John Wiley and Sons, New York, N.Y.

McBride, G. et al. 1993. What Do Significance Tests Really Tell Us About the Environment? Environmental Management. 17:423–432.

McLeod, A.I. 2011. Kendall rank correlation and Mann-Kendall trend test. Package “Kendall” version 2.2.

U.S. EPA. 2013. ProUCL Statistical Support Software for Site Investigation and Evaluation. Office of Research and Development, United States Environmental Protection Agency, Washington, D.C. March 2013. Accessed October 2015: < http://www2.epa.gov/sites/production/files/2015-03/documents/proucl_one_page_fact_sheet.final_.pdf >

U.S. EPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners EPA QA/G-9S. Office of Environmental Information, United States Environmental Protection Agency, Washington, D.C. February 2006. Document number EPA/240/B-06/003.

Appendix B: Summary of Loads

Table B-1. WES Pollutant Load Summary for the Willamette Basin TMDL and Tualatin TMDL (for use with the PLRE and TMDL Benchmarks)

			Pollutant Loading Estimate									Pollutant Load Reduction Estimate[c]								
			Current, no BMPs (counts or pounds)[a]			Current, with BMPs (counts or pounds)[a]			Future, with BMPs (counts or pounds)[b]			Current Conditions (counts or pounds)[d, f]			Future Conditions (counts or pounds)[e]			Future Conditions (% reduction or concentration)[e]		
TMDL Watershed	Season	WLA (% reduction or concentration)	Upper Confidence Limit (UCL)	Mean	Lower confidence limit (LCL)	Upper confidence limit (UCL)	Mean	Lower confidence limit (LCL)	Upper Confidence limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)
Bacteria (counts)																				
Clackamas River	annual	78%	1.38×10^{14}	7.99×10^{13}	4.31×10^{13}	1.11×10^{14}	6.95×10^{13}	3.77×10^{13}	1.10×10^{14}	6.94×10^{13}	3.77×10^{13}	2.75×10^{13}	1.03×10^{13}	5.41×10^{12}	2.79×10^{13}	1.05×10^{13}	5.50×10^{12}	20.2%	13.1%	12.8%
Lower Willamette via tributaries)	annual	78%	2.64×10^{14}	1.57×10^{14}	8.70×10^{13}	2.39×10^{14}	1.47×10^{14}	8.19×10^{13}	2.38×10^{14}	1.47×10^{14}	8.17×10^{13}	2.55×10^{13}	9.69×10^{12}	5.14×10^{12}	2.67×10^{13}	1.01×10^{13}	5.36×10^{12}	10.1%	6.4%	6.2%
Johnson Creek	annual	78%	5.53×10^{13}	3.31×10^{13}	1.86×10^{13}	4.75×10^{13}	2.98×10^{13}	1.67×10^{13}	4.72×10^{13}	2.96×10^{13}	1.66×10^{13}	7.79×10^{12}	3.36×10^{12}	1.84×10^{12}	8.07×10^{12}	3.53×10^{12}	1.93×10^{12}	14.6%	10.7%	10.4%
Middle Willamette	Summer Season	88%	7.09×10^{9}	3.67×10^{8}	1.69×10^{8}	Same as current, no BMPs			Same as current, no BMPs			0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0
	Winter Season	75%	3.45×10^{9}	1.79×10^{9}	8.20×10^{8}	Same as current, no BMPs			Same as current, no BMPs			0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0
Lower Tualatin	Summer Event	12,000 counts/ 100 mL	3.38×10^{10}	2.11×10^{10}	1.23×10^{10}	3.24×10^{10}	2.04×10^{10}	1.19×10^{10}	N/A – WLA is met			1.38×10^{9}	6.94×10^{8}	4.06×10^{8}	N/A – WLA is met			N/A – WLA is met		
	Winter Event	5,000 counts/ 100 mL	6.02×10^{11}	3.76×10^{11}	2.20×10^{11}	5.78×10^{11}	3.63×10^{11}	2.12×10^{11}	N/A – WLA is met			2.45×10^{10}	1.24×10^{10}	7.24×10^{9}	N/A – WLA is met			N/A – WLA is met		
Fanno Creek	Summer Event	12,000 counts/ 100 mL	8.17×10^{9}	5.11×10^{9}	2.99×10^{9}	Same as current, no BMPs			N/A – WLA is met			0.00	0.00	0.00	N/A – WLA is met			N/A – WLA is met		
	Winter Event	5,000 counts/ 100 mL	1.46×10^{11}	9.10×10^{10}	5.33×10^{10}	Same as current, no BMPs			N/A – WLA is met			0.00	0.00	0.00	N/A – WLA is met			N/A – WLA is met		
DDT (pounds)[g]																				
Johnson Creek	annual	77%	0.007	0.005	0.002	0.006	0.004	0.002	N/A – WLA is met			0.0175	0.0118	0.0054	N/A – WLA is met			N/A – WLA is met		
Total Phosphorus (pounds)																				
Lower Tualatin	Summer Season	0.14 mg/L	41.30	37.76	28.98	40.23	36.80	28.24	Same as Current, with BMPs			1.07	0.96	0.73	1.07	0.96	0.73	0.22 mg/L	0.20 mg/L	0.15 mg/L
Fanno Creek	Summer Season	0.13 mg/L	9.72	8.88	6.77	Same as current, no BMPs			Same as current, no BMPs			0.00	0.00	0.00	0.00	0.00	0.00	0.23 mg/L	0.21 mg/L	0.16 mg/L
TSS (pounds)																				
Lower Tualatin	Summer Season	20%	17,864	11,907	7,897	17,166	11,492	7,671	Same as Current, with BMPs			699	415	226	699	415	226	3.9%	3.5%	2.9%
Fanno Creek	Summer Season	50%	4,188	2,791	1,859	Same as current, no BMPs			Same as current, no BMPs			0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0

a. *The current (2026) no-BMP and with-BMP load estimates are presented in graphical form in Figure 5-1 through Figure 5-18*

b. *The future (2031) with-BMP load estimate is required per Schedule D.3.d.ii.4 of the NPDES MS4 permit. This load estimate provides the basis for development of the TMDL Benchmarks.*

c. *The pollutant load reduction estimate is calculated as the difference between the no-BMP and the with-BMP loads. The pollutant load reduction estimate is presented as a range, consistent with the pollutant loading estimate.*

d. *The current condition pollutant load reduction estimate (PLRE) is reflected in Section 5 in graphical and tabular form.*

e. *The future condition pollutant load reduction estimate is the TMDL Benchmark, as described in Section 6 The TMDL Benchmarks have been calculated as a load reduction and as a percentage load reduction or concentration, to allow for comparison to the WLA (defined as a percent load reduction or a concentration) and future PLREs (defined as a load reduction).*

f. *For DDT, the current condition pollutant load reduction estimate is based on the difference between the baseline condition (2008) no-BMP load and the current with-BMP load, based on current land use conditions. This accounts for natural degradation and removal via BMPs. The current condition pollutant load reduction estimate equates to a reduction of 75.8% from 2008 conditions, which is within the range for meeting the WLA.*

Table B-2. EHV Pollutant Load Summary for the Willamette Basin TMDL (for use with the PLRE and TMDL Benchmarks)

			Pollutant Loading Estimate									Pollutant Load Reduction Estimate[c]								
			Current, no BMPs (counts or pounds)[a]			Current, with BMPs (counts or pounds)[a]			Future, with BMPs (counts or pounds)[b]			Current Conditions (counts or pounds)[d, f]			Future Conditions (counts or pounds)[e]			Future Conditions (% reduction or concentration)[e]		
Waterbody	Season	WLA (% reduction or concentration)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)	Upper Confidence Limit (UCL)	Mean	Lower Confidence Limit (LCL)
Bacteria (counts)																				
Clackamas River	annual	78%	1.45×10^{13}	8.86×10^{12}	5.08×10^{12}	1.43×10^{13}	8.79×10^{12}	5.04×10^{12}	1.43×10^{13}	8.79×10^{12}	5.04×10^{12}	1.43×10^{11}	6.53×10^{10}	3.49×10^{10}	1.45×10^{11}	6.65×10^{10}	3.56×10^{10}	1.0%	0.8%	0.7%
Lower Willamette (via tributaries)	annual	78%	5.84×10^{10}	3.65×10^{10}	2.13×10^{10}	Same as Current, no BMPs			Same as Current, no BMPs			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Johnson Creek	annual	78%	2.47×10^{12}	1.55×10^{12}	9.13×10^{11}	2.36×10^{12}	1.51×10^{12}	8.87×10^{11}	Same as Current, with BMPs			1.08×10^{11}	4.59×10^{10}	2.66×10^{10}	1.08×10^{11}	4.59×10^{10}	2.66×10^{10}	4.4%	3.0%	2.9%
DDT (pounds)[g]																				
Johnson Creek	annual	77%	0.00053	0.00035	0.00016	0.00040	0.00027	0.00012	N/A – WLA is met			0.0014	0.0010	0.0005	N/A – WLA is met			N/A – WLA is met		

a. *The current (2026) no-BMP and with-BMP load estimates are presented in graphical form in Figure 5-1 through Figure 5-18.*

b. *The future (2031) with-BMP load estimate is required per Schedule D.3.d.ii.4 of the NPDES MS4 permit. This load estimate provides the basis for development of the TMDL Benchmarks.*

c. *The pollutant load reduction estimate is calculated as the difference between the no-BMP and the with-BMP loads. The pollutant load reduction estimate is presented as a range, consistent with the pollutant loading estimate.*

d. *The current condition pollutant load reduction estimate (PLRE) is reflected in Section 5 in graphical and tabular form.*

e. *The future condition pollutant load reduction estimate is the TMDL Benchmark, as described in Section 6. The TMDL Benchmarks have been calculated as a load reduction and as a percentage load reduction or concentration, to allow for comparison to the WLA (defined as a percent load reduction or a concentration) and future PLREs (defined as a load reduction).*

f. *For DDT, the current condition pollutant load reduction estimate is based on the difference between the baseline condition (2008) no-BMP load and the current with-BMP load, based on current land use conditions. This accounts for natural degradation and removal via BMPs. The current condition pollutant load reduction estimate equates to a reduction of 78% from 2008 conditions, which is within the range for meeting the WLA.*