CITY OF West Linn

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National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit Renewal Application

PERMIT NO.: 101348

FILE NO.: 108016

February 28, 2017

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City of West Linn

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

February 28, 2017

The undersigned hereby submits this permit renewal application package in accordance with NPDES Permit Number 101348. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my 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 my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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Lance Calvert
Public Works Director
City of West Linn Public Works

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Section 1 Introduction

In the early 1990s, the Federal Clean Water Act required municipalities with populations greater than 100,000 to apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit for their stormwater discharges. In Oregon, this program was delegated to the Oregon Department of Environmental Quality (DEQ). As a result, DEQ directed six Oregon jurisdictions and associated co-permittees to apply for and obtain an NPDES Municipal Separate Storm Sewer System (MS4) permit. Clackamas County was one of the jurisdictions required to obtain an NPDES MS4 permit, and the City of West Linn (City) is one of the 13 co-permittees on the Clackamas County NPDES MS4 permit.

1.1 Permit Overview

For Part 1 of the original NPDES MS4 permit application (1993), Clackamas County and its co-permittees performed a review of their stormwater systems including mapping, outfall inventories, monitoring of stormwater quality, etc. The second part of the application (1995) required the development of Stormwater Management Plans (SWMP), which included a number of Best Management Practices (BMPs) to address specific sources of pollutants. However, the requirements did not specify the number or type of BMPs that should be implemented. Instead, the requirement states that BMPs should be implemented to reduce the discharge of pollutants to the “maximum extent practicable”. The City received their first NPDES MS4 permit from DEQ in 1995.

The permit period for the 1995 NPDES MS4 permit was five years during which time jurisdictions were responsible for implementation of their SWMPs. The 1995 NPDES MS4 permit required renewal at the end of the five-year permit period. In March 2004, the NPDES MS4 permits were reissued to the six larger Oregon jurisdictions, including Clackamas County and its co-permittees. The 2004 NPDES MS4 permit included some additional requirements that were not in the earlier permit including requirements to evaluate and refine the SWMPs, to incorporate more specific monitoring elements, and to include additional information with the annual reports.

Third-party groups requested DEQ to reconsider the 2004 permit to address Total Maximum Daily Load (TMDL) obligations. DEQ agreed to reconsider the permit, and as a result, some additional changes were made. The changes included more specific reporting of SWMP commitments, additional public involvement, and a six-month extension for developing the revised SWMP.

In 2008, the City submitted its permit renewal application to DEQ for the third permit term. The City and other Clackamas co-permittees received their third (current) NPDES MS4 permit on March 16, 2012. This permit expires on March 1, 2017. During this permit period, the City’s SWMP has been updated and improved through adaptive management and remains as the central element of the permit.

This document represents City’s NPDES MS4 permit renewal application for the next permit term. It is being submitted to DEQ in accordance with Schedule F, Section A.4 of the current NPDES MS4 permit.

1.2 Description of Permit Area and Co-Permittees

The following section outlines the City's NPDES MS4 permit area and describes the City's coordination and responsibilities as a co-permittee with other Clackamas County jurisdictions.

1.2.1 Description of the City of West Linn's Permit Area

The city of West Linn is located in Clackamas County and covers approximately seven square miles. The City is bounded on the north by the City of Lake Oswego, on the west by unincorporated Clackamas County, on the east by the Willamette River, and on the south by the Tualatin River. West Linn has a population of approximately 24,200 (City of West Linn website - http://westlinnoregon.gov/communications/facts-figures). The City is primarily a residential community with three commercial centers: one along the Oregon Highway 43 corridor, one in the Willamette area, and one referred to as Cascade Commercial Center which is located on the top of Salamo hill off of Salamo Rd.

The City is drained by a number of perennial streams that ultimately discharge to the Willamette or Tualatin Rivers. Tanner Creek, Trillium Creek, and multiple other smaller tributaries drain approximately 87% of the city area to the Willamette River. The remainder of City area discharges to the Tualatin River through small tributaries including Fritchie Creek and Stevens Creeks. The Tualatin River has a TMDL in place for phosphorous, dissolved oxygen, bacteria, and temperature, and the Willamette River has a basin-wide TMDL for temperature, bacteria, and mercury.

1.2.2 Summary of City Coordination with Co-Permittees

The City of West Linn is a co-permittee on the Clackamas County permit, along with the cities of Oregon City, Milwaukie, Lake Oswego, Gladstone, Wilsonville, Happy Valley, Johnson City, and Rivergrove, as well the Clackamas County Department of Transportation and Development (DTD), and three utility districts: Oak Lodge Water Services District (OLWSD), Clackamas County Service District #1 (CCSD#1), and the Surface Water Management Agency of Clackamas County (SWMACC).

Per the Clackamas County NPDES MS4 permit, the co-permittees are responsible for meeting the same permit requirements as other individual Phase 1 jurisdictions (e.g., the City of Portland, the City of Salem, etc.). However, with the limited resources, it is unlikely that even the most ambitious co-permittee will be able to match efforts of the larger Phase 1 jurisdictions. Therefore, when possible, Clackamas County co-permittees coordinate selected efforts through intergovernmental agreements and comprehensive programs to meet the permit objectives. Coordinated efforts include the development and implementation of a comprehensive stormwater monitoring plan, implementation of consistent erosion and sediment control standards, and public outreach and education. The City plans to continue this coordinated effort throughout the new permit period.

1.2.3 Organization of Document

Table 1-1 summarizes the permit renewal submittal requirements as outlined in Schedule B.6. of the permit and provides the corresponding component's location within this document.

Table 1-1. Permit Renewal Submittal Components		
Submittal component	**Permit requirement**	**Permit application section**
Introduction	-	Section 1.0
MEP Evaluation Information and analysis related to: • How the City's existing program addressed requirements of the 2012 permit. • How the City's proposed program will meet maximum extent practicable (MEP) criteria.	B.6.b	Section 2.0
Proposed SWMP Modifications Narrative summary of proposed SWMP revisions and measurable goals, including rationale for revisions.	B.6.a	Section 3.0 and Appendix A
Service Area Expansions Description of any service area expansions anticipated to occur during the next permit term and a finding as to whether or not the expansion is expected to result in a substantial increase in area, intensity, or pollutant loads.	B.6.e	Section 4.0
Total Annual Pollutant Loading Updated estimate of total stormwater pollutant loads for applicable TMDL pollutants and other identified pollutants.	B.6.c	Section 4.0
Wasteload Allocations (WLAs) and Benchmarks • List of WLAs met • New benchmarks	B.6.h D.3.d	Section 5.0 and Appendix B
Fiscal Evaluation Current permit term expenditures summary and projected program allocations for next permit cycle.	B.6.f	Section 6.0
Monitoring Program Objectives Matrix Including an updated Monitoring Plan	B.6.d	Section 7.0 and Appendix C
MS4 Maps	B.6.g	Appendix D

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Section 2
Maximum Extent Practicable Evaluation

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

b. The information and analysis necessary to support the Department's independent assessment that the co-permittee's stormwater management program addressed the requirements of the existing permit. Co-permittees must also 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 – program elements are technically feasible considering local soils, geography, and other locale specific factors.
   iii. Program Resources – program elements are implemented considering availability to resources and the co-permittee's stormwater management program priorities.

This section of the permit renewal application provides information to support the Oregon Department of Environmental Quality's (DEQ's) assessment that the City of West Linn's (City) Stormwater Management Plan (SWMP) reduces pollutants in discharges from the municipal separate storm sewer system (MS4) to the maximum extent practicable (MEP).

To address this requirement, this MEP evaluation includes two parts:

Section 2.1 How the Existing Stormwater Management Program Addressed 2012 Permit Requirements

Section 2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

2.1 How the Existing Stormwater Management Program Addressed 2012 Permit Requirements

The City's stormwater management program is composed of activities outlined in its SWMP, environmental monitoring, and additional permit-defined regulatory programs and submittals. The following sections summarize how the SWMP (as a subset of the City's overall program) was adaptively managed during the permit term, and how the overall stormwater management program met the permit requirements.

2.1.1 Annual Adaptive Management Permit Requirements

The SWMP is assessed on an annual basis through an adaptive management process. SWMP modifications are made as necessary to achieve a reduction of pollutants in stormwater discharges to the MEP. This requirement is outlined in Schedule D.4 of the permit:

> *The co-permittee must follow an adaptive management approach to assess and modify, as necessary, any or all existing SWMP components and adopt new or revised SWMP components to achieve reductions in stormwater pollutants to the MEP…*

A description of the City's adaptive management approach was submitted to DEQ as required in Schedule D.4 by November 1, 2012. Historically, the City has implemented adaptive management principles to annually refine implementation methods and data collection activities in conjunction with its effective SWMP and best management practices (BMPs). More significant modifications to SWMP activities occur every 5 years, in conjunction with the permit renewal application and updated permit requirements.

As the City prepares its NPDES MS4 annual report, SWMP implementation is reviewed through BMP-specific measurable goals and tracking measures. The City collects data and feedback from staff responsible for implementing and reporting on each BMP to gauge whether implementation was deemed effective or whether there are suggested improvements to be made. Suggested adjustments to BMP implementation include consideration of resource availability, budget/funding, and overall need.

Each annual report submitted to DEQ includes a section to summarize implementation of the adaptive management process and any resulting proposed SWMP changes. During this permit term, and given the maturity of the stormwater program, no refinements were made to 2012 SWMP at a level requiring a formal modification of the SWMP.

2.1.2 Stormwater Program Compliance with Permit Requirements

Per Schedule A.2 of the permit:

> *Compliance with this permit and implementation of a stormwater management program, including the Department-approved Stormwater Management Plan, establishes this MEP requirement…*

The City met all of its 2012 permit requirements, as shown in Table 2-1 below. In addition, the City supplied information in each annual report related to tracking measures and meeting SWMP measurable goals. The City's existing, overall program met the MEP requirement.

Table 2-1. 2012 Permit Requirements

Requirement	Permit section	Due date	Status of Meeting Permit Requirements
Illicit Discharge Detection and Elimination			
• Document an enforcement response plan for responding to illicit discharges	A.4.a.ii	11/1/2012	• Enforcement response is part of the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure,* which was submitted to DEQ by 11/1/2012.
• Document pollutant parameter action levels and report them to DEQ in an enforcement response plan	A.4.a.iii	11/1/2012	• Pollutant parameter action levels were documented in the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure.*
• Annual dry weather field screening activities must include identified priority locations, which are identified on a map	A.4.a.iv and xi	11/1/2012	• Dry weather field screening locations are mapped and referenced in the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure.*
Industrial and Commercial Facilities Implement an updated strategy to reduce pollutants to the MS4 from industrial and commercial facilities identified as sources that contribute significant pollutant loads to the MS4	A.4.b.iii	7/1/2013	A strategy was completed and implementation was initiated.
Construction Site Runoff Control The construction site runoff control program must apply to activities that result in a land disturbance of 1,000 square feet or greater	A.4.c.i	11/1/2014	The City of West Linn development standards require submission of an erosion control permit application and an erosion and sediment control plan for all sites with 1,000 ft^2 of disturbance or greater, and recommends the use of the Clackamas County Erosion Prevention Planning and Design Manual.
Education and Outreach Conduct or participate in an effectiveness evaluation to measure the success of public education activities	A.4.d.vi	7/1/2015	The City participated in a regional public education effectiveness evaluation and submitted it to DEQ by 7/1/2015.
Public Involvement and Participation Provide opportunities for public comments on the 2012 monitoring plan, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development	A.4.e	9/1/2012 (monitoring plan)	The monitoring plan was provided for public review and comment and submitted to DEQ by 9/1/2012. Annual reports, proposed SWMP revisions, and pollutant load reduction benchmarks have also been provided to the public for review and comment.

Table 2-1. 2012 Permit Requirements			
Requirement	**Permit section**	**Due date**	**Status of Meeting Permit Requirements**
Post-construction Site Runoff			
• Implement a post-construction site runoff program that meets designated permit conditions	A.4.f	11/1/2014	• The City opted to continue to meet this requirement through implementation of the *Portland Stormwater Management Manual.*
• Identify, minimize, or eliminate barriers in ordinances, code, and development standards that inhibit LID/green infrastructure	A.4.f.ii	11/1/2014	• Through implementation of the *Portland Stormwater Management* Manual, the City prioritizes the use of LID. Barriers to LID were identified and eliminated with the adoption of this manual.
• Develop or reference an enforceable post-construction stormwater management manual or equivalent document	A.4.f.iii	11/1/2014	• See above bullets.
Pollution Prevention for Municipal Operations Inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that treat, store, or transport municipal waste	A.4.g.iii	7/1/2013	The City submitted a document titled *Stormwater Pollution Prevention Strategies for Municipal Facilities* to DEQ on 7/1/2013. Initiated implementation of the strategies in 2013.
Stormwater Management Facilities O&M Activities Inventory and map stormwater management facilities and controls and implement a program to verify that stormwater management facilities and controls are inspected, operated, and maintained	A.4.h.i	7/1/2013	The City submitted a document to DEQ on 7/1/2013 *titled City of West Linn Water Quality Facility Management Program.* Initiated implementation of the program in 2013.
Hydromodification Assessment Conduct assessment and submit report	A.5	7/1/2015	Submitted the *Hydromodification Assessment* report to DEQ on 7/1/2015.
Stormwater Retrofit Strategy Development			
• Identify 1 stormwater quality improvement project	A.6.c	7/1/2014	• A retrofit project was identified by 7/1/2014.
• Initiate, construct, or implement the project	A.6.c	Permit expiration	• Provided a new outfall structure for the detention facility on Salamo Creek. The new structure is anticipated to enhance sedimentation in the facility.
• Develop a retrofit strategy and submit plan to DEQ	A.6.b	7/1/2015	• Submitted the *Stormwater Retrofit Plan* to DEQ on 7/1/2015.
Monitoring and Reporting Requirements			
• Submit draft plan to DEQ for review	B.2	9/1/2012	• The *updated Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* was submitted to DEQ on 9/1/2012.
• Implement the approved plan	B.2	10/1/2012	• Implementation of the updated *Comprehensive Clackamas County NPDES MS4 Monitoring Plan* was initiated on 10/1/2012.
Annual Reporting Submit annual reports each year from the time frame 7/1 of the previous year through 6/30 of the same year	B.5	11/1 (annually)	All annual reports for the permit term were submitted to DEQ by 11/1 each year.

Table 2-1. 2012 Permit Requirements			
Requirement	**Permit section**	**Due date**	**Status of Meeting Permit Requirements**
Permit Renewal Application Package Submit permit renewal application package	B.6	9/2/2016 (180 days before permit expiration)	The City will submit the package by 2/28/2017 (at permit expiration) in accordance with NPDES MS4 permit, Schedule F, Section A.4.
303(d) Listed Pollutants Submit evaluation report in the 4th annual report	B.5.k D.2	11/1/2015 (4th annual report)	The City submitted as separate document along with the FY 2014–15 annual report.
Total Maximum Daily Loads • Submit a wasteload allocation attainment assessment	B.5.k D.3.b	11/1/2015 (4th annual report)	• Submitted February 1, 2016 in accordance with a 10/14/15 letter to DEQ.
• Submit a TMDL pollutant load reduction evaluation	B.5.k D.3.c	11/1/2015 (4th annual report)	• Submitted February 1, 2016 in accordance with a 10/14/15 letter to DEQ.
• Submit TMDL benchmarks	D.3.d	9/2/2016 (180 days before permit expiration)	• Provided in Section 5 of this permit renewal application (see above bullet regarding the deadline for the permit renewal package deadline).
Adaptive Management Submit an adaptive management approach	D.4	11/1/2012	Submitted to DEQ on 11/1/2012.
SWMP Revisions Revise to include new permit requirements	D.5 and D.8	5/1/2012	Revised the SWMP accordingly and submitted it to DEQ on 5/1/2012.

2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

The City's adaptive management process requires the City to conduct a comprehensive assessment of the stormwater management program at the end of the permit term, with the results used to identify proposed program modifications to be submitted as part of this permit renewal package.

This section provides background information related to the City's long-term and ongoing compliance with the MEP standard and provides results of the comprehensive assessment of the current program resulting in proposed SWMP modifications. Proposed SWMP modifications are detailed in Section 3 of this permit renewal application and reflected in the proposed SWMP, included as Appendix A.

2.2.1 Maximum Extent Practicable Background

MS4 permittees initially developed and established SWMPs that met the MEP requirement as part of the original 1993 permit applications. Those SWMPs have become the foundation for each permittee's program—a foundation that has been continuously evaluated and improved through adaptive management since the first permit was issued in 1995. As a result, the BMPs described in the permittee's current and proposed SWMP are the result of the cumulative effect of implementing, continuously evaluating, and making corresponding changes (i.e., adaptive management) to a variety of technically and economically feasible BMPs, which ensures that the most appropriate controls are implemented in the most effective manner based on site-specific conditions.

Up until submittal of this permit renewal application, the City adhered to the following process to ensure that its SWMP met the MEP standard. A more detailed summary can be found in the City's 2008 NPDES MS4 permit renewal application:

- **Original development of the SWMP submitted with the permit application (1993):** All Phase I NPDES MS4 permit applicants were encouraged by the U.S. Environmental Protection Agency (EPA) to design programs tailored for local problems, priorities, resources, and objectives. Part 1 of the application required the compilation of information related to the stormwater system within the permit area, including outfall investigation results, maps, and monitoring data. Part 2 of the application required the development of an SWMP.

  Clackamas County and co-permittees employed a coordinated, comprehensive, and structured approach to develop its original SWMPs. Committees were formed to coordinate technical-, public-, and policy-related issues. The process included monthly meetings open to all co-permittees to discuss general issues, and a series of meetings with each co-permittee to discuss issues specific to each jurisdiction. Co-permittee coordination meetings were used to discuss permit application and implementation requirements, scheduling, sharing of information on SWMP program elements, and sharing of issues and concerns. Individual meetings were used to identify specific issues, concerns, and water quality problems identified for each agency, and to develop BMPs and an individual SWMP that each co-permittee could implement. The individual actions considered for inclusion in the SWMPs were referred to as BMPs. General categories of BMPs were discussed during the monthly co-permittee meetings, and agency- or City-specific BMP selection occurred during the individual co-permittee meetings.

The specific steps in the process to select BMPs for the SWMPs included the following:

- Step 1: Identify local stormwater quality problems
- Step 2: Define objectives of the SWMPs
- Step 3: Identify BMPs to address objectives and permit requirements
- Step 4: Tailor implementation of BMPs to each co-permittee

Issuance of the first NPDES MS4 permit by DEQ, which included implementation of the SWMPs, was considered acceptance that the SWMPs met the MEP standard. The first 5-year permit term was 1995 to 2000.

- **Overall SWMP review conducted for the *Interim Evaluation Report* (2006):** DEQ issued the second-term Clackamas County NPDES MS4 permit in March 2004. The 2004 permit required a SWMP evaluation to be submitted to DEQ as part of the *Interim Evaluation Report* due in 2006. As a result of this requirement, the City of West Linn developed a process to evaluate its stormwater program. The process included an internal audit of the effectiveness of SWMP elements (based on best professional judgment regarding the state of the practice), financial allocations, and public acceptance. A table was prepared to summarize SWMP changes and the rationale for those changes. Drafts of the resulting updated SWMP were made available to the public and interested stakeholders. The updated SWMP was advertised to the public, made available on the City's website, and left open to public comment for 30 days. Copies of the SWMP were also available upon request, and comments that were received were addressed. Based on the results of the program analysis, a number of changes and updates were proposed and implemented for the new SWMP. Most revisions were general and applied to most or all BMPs; however, a few specific modifications were made as well.
- **Overall SWMP review conducted for the permit renewal application (2008):** As part of the adaptive management process, the City prepared a revised SWMP for its permit renewal application in 2008. The revised SWMP was intended to synthesize the implementation and findings from the permit cycle, and reflect an evaluation of the adequacy of the SWMP in reducing pollutants to the MEP based on three evaluation criteria as required by DEQ: (1) program effectiveness, (2) local applicability, and (3) program resources. The City reviewed the SWMP in conjunction with federal regulations and guidelines under the technical documents *MS4 Program Evaluation Guidance*, and *Protocol for Conducting Environmental Compliance Audits under the Stormwater Program* (EPA 2005). Some changes related to adaptive management were made and submitted to DEQ at that time. The updated SWMP was approved by DEQ in September 2012 in conjunction with issuance of this (third-term) permit.
- **Annual reports (ongoing since 1995):** To ensure that the SWMPs continued to meet the MEP standard, the effectiveness of the SWMPs was revisited annually. Each year, Clackamas County and co-permittees including the City of West Linn are required to submit an annual compliance report for NPDES MS4 permits. Each year, each jurisdiction examines work performed during the previous year, monitoring results, and information shared during ongoing co-permittee meetings and adjusts its programs accordingly. The City has used this adaptive management process since receiving its first permit in 1995 to meet the MEP standard.

2.2.2 Maximum Extent Practicable Evaluation Factors and Criteria

The purpose of this section is to address the permit requirement in Schedule B.6.b to describe how the proposed management practices, control techniques, and other provisions implemented as part of the stormwater program were evaluated using a 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-permittee's stormwater management program priorities.*

As described above, the SWMP was initially developed in the early 1990s and has continuously evolved through an adaptive management process.

As part of this 2017 MEP evaluation and demonstration, City staff defined objective criteria related to the three MEP evaluation factors listed above. In general, the City's program assessment—as described in Section 2.2.3—was conducted and modified (i.e., adaptively managed) with the goal of meeting/addressing the following criteria (listed by evaluation factor):

- Program effectiveness:
  - The program includes a range of BMPs that encompass pollution prevention, source control, and treatment approaches
  - The program includes BMPs that are technically feasible, effective, and implementable
- 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
- Program resources:
  - The program is included in the current budget allocations
  - The program considers implementation costs and practicability within the overall context of permittee priorities and resources

2.2.3 Program Assessment and Results for the Permit Renewal

Using the MEP factors and criteria described in Section 2.2.2 above, the City conducted a review of its stormwater program to identify proposed changes to the SWMP. As described in the City's adaptive management approach, the 5-year permit cycle adaptive management process includes a review of annual assessments, permit term trends, and evaluations/reports produced during the permit term. Results are summarized below:

1) **Review of annual assessments:** A summary of the annual adaptive management approach and results from the annual adaptive management process is provided in Section 2.1.1 above. Given the fairly recent development of an updated SWMP (2012) and given the maturity of the program, no refinements to the SWMP were identified as a result of annual assessments.

2) **Review of monitoring information (i.e., trends results):** In 2015, a summary of water quality trends was submitted to DEQ based on the results of environmental monitoring conducted under this permit. The City has been collecting instream water quality monitoring data since 2002 from three creek sites (some parameters have only been collected since 2007). The trends analysis is provided as an appendix to the *TMDL Pollutant Load Evaluation and TMDL Benchmarks* report, which is provided as Appendix B to this permit renewal application.

   Based on the results from this trends analysis, the majority (79%) of pollutants that were analyzed revealed either no trends or improving trends (at a significance level of 10 percent). Approximately 21 percent of the trends analyses showed declining trends, and of those, 67 percent were for zinc. The remaining declining trends occurred during dry weather. The result with respect to zinc was similar when combining the trends analyses from all co-permittees. The majority of negative trends that were detected were for zinc. This prompted discussion among co-permittees during meetings to update the monitoring plan. No changes were made to the monitoring plan or SWMP as a result; however, it is anticipated that further discussions will continue through co-permittee and Association of Clean Water Agencies (ACWA) meetings regarding the identification of likely sources and causes for this trend.

3) **Evaluations and reports:** As stated in the City's adaptive management process, specific deliverables required under the current permit were reviewed and considered with respect to stormwater program updates. The permit deliverables that were reviewed and submitted in 2015 included the following:

   - A hydromodification assessment (Schedule A.5),
   - A stormwater retrofit strategy (Schedule A.6),
   - A 303(d) list evaluation (Schedule D.2),
   - A total maximum daily load (TMDL) wasteload allocation attainment assessment (Schedule D.3.),
   - A TMDL pollutant load reduction evaluation and establishment of benchmarks (Schedule D.3.),
   - A public education program effectiveness evaluation (Schedule A.4.d).

   As a result of the preparation of these permit-required deliverables, those that resulted in a change to the City's overall stormwater program were the retrofit strategy and the hydromodification assessment.

   A primary outcome from the City's retrofit strategy was the goal to complete a City-wide stormwater master plan to include the identification of potential stormwater quality retrofit projects. The City is currently initiating the master planning effort, and its updated stormwater master plan is scheduled for completion in FY 2018. A capital project implementation schedule will be developed as part of the master plan to include water quality retrofits.

   Observations resulting from the hydromodification assessment revealed that most of the natural channel conditions appeared to be resistant to increased stream energy from urbanization and impervious surfaces. However, some problems were noted in areas where discharges to streams were concentrated (at outfalls and culvert crossings). The assessment included a list of potential instream capital project recommendations to address some of these issues. The results of the hydromodification assessment will be reviewed and incorporated into the master plan.

While the City's stormwater program will be focused on CIP planning to address water quality/hydromodification and retrofits over the next few years, specific SWMP modifications were not made as a result of the deliverables required by the permit as listed above.

4) **End of permit term SWMP review process:** For this permit renewal application, the City implemented an inter-department process to review the 2012 SWMP in conjunction with results of the findings from evaluations and reports completed over the permit term. The resulting summary of SWMP modifications is provided in Section 3 of this application.

5) **Public comment:** After a 30-day public comment period (from January 24, 2017, to February 23, 2017), no comments were received on the proposed SWMP revisions.

Some modifications to the City's SWMP are proposed as a result of the permit renewal program assessment. Proposed SWMP modifications are summarized in Section 3 of this permit renewal application. The updated and reformatted SWMP—reflecting the proposed SWMP modifications—is provided in Appendix A to this permit renewal application.

Section 3
Summary of Proposed SWMP Modifications

<u>Permit Requirements</u>

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

a. Proposed program modifications including the modification, addition, or removal of BMPs incorporated into the SWMP, and associated measurable goals.

As part of the permit renewal process, the City of West Linn (City) reviewed the current (2012) Stormwater Management Plan (SWMP) with respect to the need for updates and prepared an updated 2017 SWMP. The 2017 SWMP does not include substantive changes. The majority of changes are related to removing tasks that had a scheduled end date and have been completed. A summary of proposed changes to the 2012 SWMP is as follows:

Editorial Changes

The 2012 SWMP included the relevant permit language prior to each Best Management Practice (BMP). This language was removed as it is considered repetitive. The permit language is already summarized in the introductory section to each SWMP element. In addition, it is anticipated that the permit language will change with the issuance of the next permit, making the permit language outdated and in need of replacement.

BMP - Implement the Illicit Discharge Elimination (IDDE) Program. This BMP required the development of IDDE standard operating procedures (SOP) by November 2012. Development of the SOP was completed. Therefore, this BMP language has been changed to reflect ongoing implementation of the SOP, as opposed to SOP development.

BMP - Conduct Annual Dry Weather Field Screening: The dry weather field screening procedures are outlined in the City's IDDE SOP. This BMP was modified to reference the updated procedures in the IDDE SOP. In addition, the measurable goal to develop pollutant parameter action levels was removed as that was completed as part of the IDDE SOP development.

BMP - Conduct Priority Commercial Facility Inspections: This BMP required the development of a commercial/industrial facility inspection program by July 2013. The City completed the development of this program. As a result, this BMP was updated to reflect implementation rather than development of the program. During the last permit term, the City found efficiencies in inspecting commercial facilities for general housekeeping practices at the same time as conducting private stormwater facility maintenance inspections. This BMP was modified to reflect the strategy of combining inspections, and the measurable goal was changed from inspecting priority industrial facilities once over the permit term to placing more of an emphasis on priority commercial inspections on a yearly basis.

BMP - Participate in a Public Education Effectiveness Evaluation: This BMP was removed as it was completed as required by the permit.

BMP - Ensure Staff Training in Spill Response: This BMP was removed as it specified OSHA HazWopper training for City staff. The City only responds to non-hazardous spills and relies on Tualatin Valley Fire and Rescue for hazardous spill response expertise. Therefore, this training for City staff was not considered necessary and is not provided on a regular or routine basis.

BMP - Provide for Public Participation with Submittals: Public involvement is required by the permit for the updated 2017 SWMP and benchmarks that are prepared for the permit renewal package that is due to DEQ March 1, 2017. This BMP specified that a 30-day public review would be provided for these documents. The 30-day review period is not specified by the permit and has not historically resulted in substantial edits or changes to documents provided for public review. Therefore, this timeframe is proposed for removal from the BMP. The City will continue to provide the documents for public review for a shorter, unspecified time period, likely 1 to 2 weeks.

BMP - Review and Update Applicable Development Code and Development Standards Related to Stormwater Control: This BMP was removed. The permit required stormwater development standards to be updated by November 2014, in order to meet new conditions in the permit. This requirement/review was completed, and the City opted to continue to meet its post-construction stormwater requirements through implementation of the City of Portland Stormwater Management Manual.

BMP - Implement Community Development Code and Public Works Design Standards for Stormwater Treatment: The name of this BMP was changed to correctly reference the City's stormwater design standards. The new BMP title is "Implement Public Works Design and Construction Standards for Stormwater Treatment". The City references the City of Portland Stormwater Management Manual for their post construction stormwater requirements. The Community Development Code has been revised so that it no longer references these standards. This clarification has been provided to the BMP description.

BMP - Maintain Public Streets: This BMP described the use of contractors for street sweeping efforts. This language was removed as the City now conducts its own street sweeping without the use of contractors.

BMP - Implement a Program to Reduce the Impact of Runoff from Municipal Facilities: This BMP required the development of a strategy for reducing the impact of runoff from municipal facilities by July 2013. That strategy was developed by the City and is summarized in a document titled *Stormwater Pollution Prevention Strategy for Municipal Facilities*. The BMP has therefore been changed to reflect ongoing implementation of the strategy.

BMP - Conduct Master Planning for Stormwater Quality Improvement: This BMP was previously related to tracking CIP implementation and ensuring that flood control CIPs considered water quality retrofit options. The City is currently working on an update to its 2006 Stormwater Master Plan, and therefore, this BMP was updated to reflect the planned efforts for developing an updated master plan and addressing water quality through CIPs.

BMP - Private Water Quality Facility Maintenance Program: The permit required the development of a private water quality facility inspection program by July 2013. This program has been developed and is described in the City's document titled *City of West Linn Water Quality Facility Management Program*. Therefore, this BMP was updated to reflect implementation rather than development of the program. In addition, a tracking measure was added to track the number of facilities private inspected per year.

Section 4
Service Area Expansions and Total Annual Pollutant Load Estimate

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

c. An updated estimate of total annual stormwater pollutant loads for applicable TMDL pollutants or applicable surrogate parameters, and the following pollutant parameters: BOD_5, COD, nitrate, total phosphorus, dissolved phosphorus, cadmium, 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 methods.

e. A description of any service area expansions that are anticipated to occur during the following permit term and a finding as to whether or not the expansion is expected to result in a substantial increase in area, intensity or pollutant loads.

As part of the City of West Linn's (City's) renewal application for the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, the City is required to provide a description of service area expansions and an updated estimate of total annual stormwater pollutant loads for applicable total maximum daily load (TMDL) pollutants.

Based on the methodology and assumptions detailed in the City's previous permit renewal application (2008), the updated estimate of total annual stormwater pollutant loads needs to account for projected annexations through the end of the permit term. Therefore, evaluations to address both c. and e. above have been provided together in this report.

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

Section 4.1 Description of Service Area Expansions

Section 4.2 Updated Estimate of Total Annual Pollutant Loads

Section 4.3 Qualitative Evaluation of Impacts

4.1 Description of Service Area Expansions

This section outlines the process and results of the evaluation of the expansion of the City's NPDES MS4 service area expected over the next permit term.

4.1.1 Definition of the City's NPDES MS4 Permit Area

The City's NPDES MS4 permit area or "service area" is defined as the area included within its city limits for which the City has responsibility for implementing a stormwater management program. Historically, this area has excluded open water bodies and waterways and areas operated by another NPDES MS4-permitted entity.

The Oregon Department of Transportation (ODOT) has its own NPDES MS4 permit covering rights-of-way (ROW) associated with state highways and freeways. Therefore, the City's service area excludes ODOT ROW.

As of July 2016, the West Linn NPDES MS4 permit area was calculated to be 4,566 acres.

4.1.2 Identification of Projected Service Area Expansions

In West Linn, annexations are typically applicant-driven. The City and City Council do not typically initiate annexation of property outside of the city limits into the city. It should be noted that the current annexation conducted by the City is under review due to passage of House Bill 1573 and may be subject to change.

The process for annexation begins with a mandatory pre-application conference between the applicant and city planner to discuss eligibility and potential time frame for annexation. After the application for annexation is submitted, the city planner reviews the application for completeness within 30 days. Then, a quasi-judicial review is conducted based on the approval criteria in the Community Development Code (Chapter 81), City Municipal Code (Chapter 2.9), and *West Linn Comprehensive Plan.*

The city planner presents findings from the quasi-judicial review and recommended decisions to City Council in a public hearing within the next 120 days. As part of the public hearing process, notices to neighboring properties are provided and published in the newspaper. As a legislative action by City Council, City Council may vote in favor of the annexation and establish a zone designation. This may be followed by a city wide vote to ultimately determine whether the annexation can occur. A City Council vote that does not support the annexation would terminate the application, and the application would not be subject to a city wide vote.

To identify areas projected to be annexed into West Linn's city limits over the next permit term (through 2022), city planning staff reviewed current applicant-initiated annexation applications and pending large development activities that may result in the annexation of adjacent property during construction of infrastructure. Given the time frame and potential need for a public vote, annexation applications may require up to 1 year from submittal until they are approved.

A total of 12 parcels have been identified for potential future annexation, totaling approximately 11.8 acres, and bringing the City's total anticipated NPDES MS4 permit service area to 4,577 acres. Three parcels totaling 6.9 acres have applications submitted and are currently awaiting land use decisions and a public hearing. The remaining nine parcels have not yet submitted applications, but city planning staff indicated that the likelihood of annexation in the next 5 years is high.

The future annexation areas are currently single tax lots, located within pockets of unincorporated areas surrounded by the city. No proposed annexations are located along the outer city boundary. The areas are exclusively zoned as single-family residential (SFR) with either an R-7 or R-10 zoning designation. Approximately 3 acres of the future annexation area are currently developed to their current zoning designation and have a house or dwelling on the site. The remaining 9 acres have the potential to subdivide and be developed in accordance with the City Council-approved zoning designation.

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

4.2 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 pollutant loads.

The City submitted its original estimate of total annual pollutant loads in Part 2 of its 1993 NPDES MS4 permit application. The City provided its most recent updated estimate of total annual pollutant loads with its NPDES MS4 permit renewal application in 2008. The total modeled MS4 permit area in 2008 was 4,538 acres, which included area within the current (2008) city limits and projected annexations through 2014. A spreadsheet loads model, using the U.S. Environmental Protection Agency (EPA) simple method equation, was developed and used for the 2008 analysis.

Modeling methods and assumptions used for this estimate of total annual pollutant loads are detailed below and are generally consistent with the approach used in 2008.

4.2.1 Modeling Methods and Assumptions

Total annual pollutant loads were calculated for the City's current NPDES MS4 service area and annexations projected to occur through the end of the permit term (2022). The total modeled MS4 permit area is 4,577 acres, consistent with the City's anticipated NPDES MS4 service area expansions outlined in Section 4.1.

Total annual pollutant loads are required to be calculated for TMDL pollutants or applicable pollutant surrogates and additional parameters as listed in Schedule B.6.c. For the City, the Willamette Basin TMDL (Lower and Middle Willamette subbasins) includes waste load allocations (WLAs) for bacteria (*E. coli*). The Tualatin Basin TMDL includes WLAs for bacteria (*E. coli*), total phosphorus (as a surrogate for chlorophyll a and pH), and settleable volatile solids (as a surrogate for dissolved oxygen [DO]). As described in the City's 2015 pollutant load reduction evaluation (PLRE), given the lack of data for settleable volatile solids (SVS), the Tualatin Subbasin TMDL references total suspended solids (TSS) as a common parameter to evaluate instead of SVS.

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 contains baseline land use event mean concentrations (EMCs), which were developed in 2008 based on regionally collected data as part of a coordinated effort between the Oregon Association of Clean Water Agencies (ACWA) and Oregon Phase I jurisdictions. Land use EMCs are calculated as a range reflecting the upper and lower 95 percent confidence limit and reflect general (commercial [COM], residential, industrial [IND], parks and open space [POS]) land use categories. Table 4-1 below summarizes the land use EMCs used in the model.

The spreadsheet loads model and land use EMCs per Table 4-1 were also used to conduct the 2015 PLRE and calculate the TMDL benchmarks (see Section 5 and Appendix B of the permit renewal application).

Table 4-1. 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	72	64	82	103
	IND	48	117	184	284
	POS	10	16	31	50
	Residential[b]	65	44	66	99
E. coli, CFU/100 mL (geomean)	COM	52	573	1,247	2,409
	IND	58	154	438	1,004
	POS	9	57	87	124
	Residential[b]	65	970	1,656	2,651
BOD_5, mg/L	COM	22	8.5	11.9	16.6
	IND	23	26.1	39.6	56.1
	POS	3	2.4	3.3	4.2
	Residential[b]	28	5.9	8.1	10.8
COD, mg/L	COM	26	51.8	65.1	81.5
	IND	25	76.8	102.6	134.1
	POS	9	11.1	19.6	27.6
	Residential[b]	36	37.4	50.9	66.0
Nitrate, mg/L	COM	46	0.27	0.38	0.53
	IND	22	0.18	0.24	0.31
	POS	263	1.36	1.51	1.66
	Residential[b]	32	0.60	0.91	1.33
Total phosphorus, mg/L	COM	26	0.280	0.380	0.500
	IND	25	0.400	0.510	0.640
	POS	8	0.095	0.120	0.150
	Residential[b]	36	0.230	0.340	0.480
Dissolved phosphorus, mg/L	COM	46	0.09	0.11	0.14
	IND	21	0.10	0.17	0.27
	POS	261	0.04	0.04	0.04
	Residential[b]	30	0.08	0.11	0.15
Cadmium, total, µg/L	COM	53	0.75	1.11	1.56
	IND	23	2.27	3.47	5.00
	POS	131	0.10	0.11	0.13
	Residential[b]	45	0.41	0.53	0.66
Copper, total, µg/L	COM	26	20.8	28.6	38.2
	IND	26	33.8	45.5	58
	POS	10	2.0	2.5	3.0

Table 4-1. Land Use EMC Values used in the Total Annual Pollutant Load Estimate					
Parameter	Land use	Count[a]	Bootstrapped values		
			95% LCL	Mean	95% UCL
	Residential[b]	33	10.5	13.4	17.1
Lead, total, µg/L	COM	25	37.8	54.0	72.7
	IND	22	32.7	48.3	67.0
	POS	9	0.6	0.8	1.1
	Residential[b]	28	11.0	17.7	27.6
Zinc, total, µg/L	COM	28	130.0	170.0	217.0
	IND	24	283.0	674.0	1,353.0
	POS	9	6.3	7.8	9.5
	Residential[b]	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. Land use EMCs for residential are used to simulate SFR and MFR land use.

Full-buildout conditions (i.e., no remaining vacant lands) were simulated in the spreadsheet loads model, consistent with the 2008 assumptions. As the City does not maintain a current condition land use coverage map, the modeled land use categories are based instead on City zoning. Zoning categories were reviewed and consolidated into those categories for which land use concentration information (per Table 4-1) exists. The City maintained consistent land use categories with the 2008 assumptions, which were also used for the 2015 PLRE calculations.

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 2015 PLRE, the runoff coefficients are calculated from estimated impervious percentages for each land use category. Impervious percentages by land use are based on values defined in the *West Linn Stormwater Master Plan* (West Linn 2006). These values are consistent with the 2008 assumptions as well. Table 4-2 summarizes the modeled area by land use and associated impervious percentages used for this estimation of total annual pollutant loads.

Table 4-2. Modeled Area by Land Use and Impervious Percentage		
City zoning classification	Model area (ac)	Modeled impervious percentage (%)
SFR	3,447.3	21
MFR	179.0	35
COM	177.2	85
IND	181.7	85
POS	592.2	0
Total permit area[a]	4,577.4	

a. Includes anticipated annexations through the permit term.

The annual pollutant load estimates are based on an average annual rainfall volume of 47.5 inches, consistent with the rainfall volume assumed in the 2008 NPDES MS4 permit renewal.

4.2.2 Updated Estimate of Total Annual Pollutant Loads

Total annual pollutant loads, reflective of full-buildout conditions and the anticipated City permit area through the end of the permit term, are summarized in Table 4-3 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 4-3. Updated Annual Estimate of Pollutant Loads for the City of West Linn

Pollutant load parameter	LCL (lb or counts)	Mean (lb or counts)	UCL (lb or counts)
TSS	641,175	956,371	1,419,045
E. coli (counts)	4.26×10^{13}	7.56×10^{13}	1.26×10^{14}
BOD_5	100,872	144,216	197,992
COD	508,145	682,542	883,100
Nitrate	6,196	9,151	13,123
Total phosphorus	2,975	4,228	5,797
Dissolved phosphorus	970	1,357	1,887
Cadmium, total	8	11	15
Copper, total	169	221	285
Lead, total	195	298	436
Zinc, total	1,253	2,103	3,402

4.3 Qualitative Evaluation

This section provides a qualitative evaluation of the potential increases to area, intensity, and pollutant loads due to the proposed service area expansions discussed in Section 4.1. This discussion is required per Schedule B.6.e of the City's NPDES MS4 permit.

Outcomes from this evaluation are intended to support the Oregon Department of Environmental Quality's (DEQ) 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) 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 expects to have only minor expansion of its service area during the next (2017–22) permit term and concludes that the expansion will not result in substantial increases in permitted area, runoff intensity, or pollutant loads. Analysis provided in Sections 4.1 and 4.2 support these findings, as discussed in the subsections below.

4.3.1 Service Area Expansion

The City anticipates approximately 12 acres of service area expansion over the next 5-year permit term. This service area expansion represents less than 0.3 percent of the City's NPDES MS4 permit area anticipated in the year 2022, which is not a substantial increase.

All proposed service area expansions will be zoned as single-family residential (SFR), either an R-7 or R-10 designation. In West Linn, the service area expansions or annexations are typically applicant-initiated annexations and limited to enclave parcels to connect to City utility services. As described in Section 2.2, approximately 3 acres of area anticipated for annexation are already developed to their maximum density. These owners would seek annexation because of adjacent development activities impacting adjacent utilities and service connections. Because they are already developed, an increase in impervious area and associated pollutant load would not be expected. The remaining 9 acres anticipated for annexation are expected to be subdivided to support single-family housing at the R-7 or R-10 density. As outlined in Table 4-2, the anticipated, developed impervious percentage for SFR is 21 percent. Vacant lands in and around the city that are identified for annexation are estimated at 3 percent impervious (Brown and Caldwell 2015). Therefore, with annexation, the imperviousness (or intensity per the NPDES MS4 permit language) of these areas is anticipated to increase slightly, but the magnitude would vary depending on the nature of the current site usage.

At the present time, there is no proposed adjustment to the urban growth boundary that would further promote annexation of area surrounding the city. Widespread or large tract annexation of agricultural property is not commonplace and not anticipated over the next permit term.

4.3.2 Pollutant Load Discharge

With expansion of the service area, the pollutant load permitted under the City's NPDES MS4 permit would increase. However, the incremental increase in pollutant load generation would be mitigated by various programmatic and structural stormwater best management practices implemented by the City. As such, some pollutant load is likely already being generated by these properties. With annexation, the pollutant load will now be included under the City's NPDES MS4 service area boundary and subject to additional controls that would not otherwise be implemented.

Since 1995, the City has adaptively managed its stormwater program as detailed in both the City's *Stormwater Management Plan* (SWMP) and in the City's process outlined in the maximum extent practicable evaluation, included as Section 2 of this permit renewal application. The SWMP includes a variety of source control measures targeting typical stormwater pollutants of concern. Newly annexed properties will be subject to control measures outlined in the SWMP.

The City adopted stormwater design standards in 2010 for water quality, which refer to the latest edition of the *City of Portland Stormwater Management Manual* (currently the latest edition is 2016) for stormwater facility design guidance. Structural stormwater controls are required to mitigate pollutant discharges from new or redeveloping areas impacting 500 square feet or more of impervious surface. Proposed development of newly annexed parcels will be subject to the installation of these stormwater controls to offset the increase in impervious surface and associated pollutant discharge. Typical structural stormwater controls include planter boxes, rain gardens, and swales, which are types of low-impact development practices that, in addition to direct treatment of stormwater runoff, also infiltrate stormwater runoff and limit pollutant load discharges through volume reduction.

As part of the City's 2015 PLRE, a water quality trends analysis was conducted to determine 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 previously conducted in 2008. The most recent water quality trends indicate that instream water quality for TMDL parameters (total phosphorus, bacteria, and TSS) in the city is generally the same or improving during precipitation events, even in consideration of service area expansions that have historically occurred and associated development and redevelopment activities. For most sites and parameters evaluated, results indicated either no trend observed or trends toward decreasing pollutant concentrations, indicating improved water quality. Zinc (total and dissolved) was the only parameter shown to have trends towards increasing pollutant concentration during precipitation events.

4.3.3 Conclusion

At present time, annexation into the City’s service area is limited to single residential parcels, some of which have already been developed, at the discretion of the developer and/or the public. There is no proposed adjustment to the urban growth boundary that would further promote annexation of area surrounding the city.

Given the extensive efforts in implementing an effective stormwater program including source control and structural stormwater controls, the City’s 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.

4.3.4 References

Brown and Caldwell, 2015. *Pollutant Load Reduction Evaluation*, prepared for the City of West Linn, December.

West Linn. 2006. *West Linn Stormwater Master Plan*.

Section 5
Benchmarks

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

h. If applicable, the established TMDL pollutant load reduction benchmarks, as required in **Schedule D.3.d**.

In accordance with the City of West Linn's 2012 National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer (MS4) permit, Schedule D.3.d, the City must develop total maximum daily load (TMDL) pollutant load reduction benchmarks. TMDL benchmarks are calculated as the difference between the modeled pollutant loads associated with a no-BMP scenario and the loads associated with a future with-BMP scenario. Benchmarks must be developed for each TMDL parameter where existing best management practice (BMP) implementation is not estimated to achieve the wasteload allocation (WLA). The TMDL benchmarks must be submitted to the Oregon Department of Environmental Quality (DEQ) with the City's NPDES MS4 permit renewal application, due February 28, 2017.

West Linn is subject to TMDLs in four watersheds: Tualatin River, Lower Willamette, Middle Willamette tributaries, and Middle Willamette direct, as shown in Table 5-1.

The results from the Pollutant Load Reduction Evaluation (PLRE) that was conducted in 2015 (see Appendix B) show that structural BMP implementation in West Linn is estimated to result in the achievement of WLAs for bacteria in the Tualatin River TMDL watershed. Thus, new benchmarks for this parameter, in this watershed are not required.

The City is estimated to be meeting previously established pollutant load reduction benchmarks in the Lower Willamette, the Middle Willamette (direct and tributary) and the Tualatin River TMDL watersheds. However, significant additional pollutant reduction would be needed to achieve WLAs for bacteria in the Lower Willamette and Middle Willamette (direct and tributary) TMDL watersheds, and for total phosphorus and total suspended solids (TSS) in the Tualatin River TMDL watershed. Therefore, updated benchmarks for these watersheds are required for the next permit term.

Table 5-1. West Linn Applicable WLAs			
TMDL waterbody	**Parameter**	**WLA**	**Anticipated to meet WLAs (based on the PLRE 2015)**
Tualatin River	Bacteria *(E. coli)*	5,000 counts/100 mL (winter storm event concentration) 12,000 counts/100 mL (summer storm event concentration)	Yes
	Total phosphorus	0.14 mg/L (summer seasonal concentration)	No
	DO (TSS as a surrogate)	20% reduction (summer seasonal)	No
Lower Willamette	Bacteria *(E. coli)*	78% reduction (annual)	No
Middle Willamette (via tributaries)	Bacteria (*E. coli*)	88% reduction (summer seasonal) 75% reduction (fall, winter, spring seasonal)	No
Middle Willamette (direct)	Bacteria *(E. coli)*	75% reduction (annual)	No

This section outlines the City's plans for implementation of additional BMPs that will result in further reduction of TMDL pollutants over the next permit term and presents the associated TMDL benchmarks. Detailed information with regards to modeling methods, assumptions, and results are provided in the City's *TMDL Pollutant Load Reduction Evaluation and Benchmark* Report (January 2017), which is included as Appendix B to this NPDES MS4 permit renewal application.

5.1 BMP Identification

Benchmarks are developed by identifying additional stormwater BMPs that are likely to be installed before the end of the next permit term. City Public Works staff identified planned future stormwater facility installations associated with public works projects. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities. These facilities collectively reflect the City's projection for stormwater facility installations through 2022. One future capital project and more than 10 recent, in progress private facility installations were included in this analysis. City staff efforts included identification of the location, type(s), and anticipated drainage area(s) for these projects. Table 5-2 lists the projected stormwater facility installations by TMDL watershed, facility type, and drainage area.

Additional public and private stormwater facility installations beyond those listed in Table 5-2 are likely but have not been projected. This conservative assumption is due to the variable schedules of private development activities.

Table 5-2 TMDL Benchmark Status and Projected Future Stormwater Facility Installations

TMDL watershed	Model time frame	Parameter	2017 TMDL benchmark development	
			Projected BMP installations	Estimated future BMP drainage area addition (ac)[a]
Lower Willamette	Annual	Bacteria	• Pollution control manholes • Filtration raingardens • Swale • Dry detention pond	6.7
Middle Willamette direct	Annual	Bacteria	• No future BMPs identified.	---
Middle Willamette tributary	Summer season	Bacteria	• Filtration raingarden	1.4
	Fall, Winter, Spring season	Bacteria		
Tualatin River	Summer event	Bacteria	• Filtration raingarden • Dry detention pond • Swale	3.4
	Winter event	Bacteria		
	Summer season	Total phosphorus		
	Summer season	TSS		

a. The future BMP drainage area includes potential areas to be treated by future BMPs and area currently being treated by a structural BMP, but expected to receive treatment by a more effective BMP (through retrofit of existing systems or installation of new BMPs to serve the same drainage area).

5.2 TMDL Benchmark Results and Discussion

The spreadsheet loads model used for the PLRE in 2015 was used to simulate predicted future BMP implementation and calculate future pollutant load reduction estimates (i.e., TMDL benchmarks). As mentioned above, TMDL benchmarks are calculated as the difference between the modeled loads associated with the no-BMP scenario and the (future) with-BMP scenario. This load reduction is presented as a range to reflect the wide variability in stormwater pollutant concentration data. Table 5-3 provides TMDL benchmarks as a load reduction and as either a percentage load reduction or concentration, for direct comparison with the WLAs. Calculation of the TMDL benchmarks as a percentage load reduction allows for direct comparison with the WLAs established for bacteria and calculation as a concentration allows for direct comparison with the WLAs established for total phosphorus.

Table 5-3. TMDL Benchmarks for Bacteria and TSS (2017–22)					
TMDL watershed	**Time frame**	**Pollutant (units)**	**WLA (% reduction)[a]**	**TMDL benchmarks (load reduction)[b], range**	**TMDL benchmarks (% load reduction)[b], range**
Lower Willamette	Annual	Bacteria (counts)	78%	4.28×10^{11} to 1.61×10^{12}	2.3% to 3.1%
Middle Willamette direct	Annual	Bacteria (counts)	75%	1.68×10^{10} to 7.14×10^{10}	0.7% to 1.0%[c]
Middle Willamette tributary	Summer season	Bacteria (counts)	88%	2.64×10^{11} to 1.34×10^{12}	12.5% to 20.7%
	Fall, Winter, Spring season	Bacteria (counts)	75%	1.57×10^{12} to 7.99×10^{12}	12.5% to 20.7%
Tualatin River	Summer season	TSS (pounds)	20%	935 to 3385	10.6% to 17.1%
TMDL watershed	**Time frame**	**Pollutant (units)**	**WLA (concentration, mg/L)[a]**	**TMDL benchmarks (load reduction)[b], range**	**TMDL benchmarks (concentration)[b], range**
Tualatin River	Summer season	Total phosphorus (pounds)	0.14	2.00 to 3.64	0.15 to 0.21

a. The Willamette Basin TMDL expresses the bacteria WLA as a percent load reduction, and the Tualatin Subbasin TMDL expresses the TSS WLA as a percent load reduction. The Tualatin Subbasin TMDL expresses the total phosphorus WLA as a concentration.

b. 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.

c. There were no anticipated BMP installations for the Middle Willamette direct TMDL watershed due to limited property availability for retrofits. Therefore, the TMDL benchmarks reflect the 2015 pollutant load reductions.

The City's benchmarks reflect the installation of one public project and multiple private development projects, covering approximately 11.6 acres of drainage area. Approximately 7.9 acres of the new treatment area is currently untreated, and the remainder of the area is currently treated by a less effective BMP. As such, the change in load reduction due to the additional facilities is minimal.

The City prepared a WLA attainment assessment for DEQ in February 2016, which indicated that achieving the WLA would require construction and maintenance costs that far exceed the City's definition of MEP. Progress toward the WLA, and not achievement of the WLA, is West Linn's goal in setting benchmarks. Such progress is reflected in Tables 5-2 and 5-3.

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 estimates do not reflect non-structural BMP implementation in accordance with the City's current SWMP. Forecasted structural BMP implementation and coverage associated with the development of benchmarks is also conservative. The City anticipates additional private structural BMPs (not accounted for in the benchmarks) to be installed during redevelopment activities, which will further reduce pollutant load discharges.

The City is also anticipating an update to its 2006 Stormwater Master Plan to refine the stormwater capital improvement project (CIP) list. Through the update to the Master Plan, additional CIPs targeted at water quality improvement will be developed and incorporated into the capital improvement plan. New CIPs for water quality improvement projects have not yet been identified and are therefore not reflected in the benchmarks.

Section 6
Fiscal Evaluation of Stormwater Expenditures

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

f. A fiscal evaluation summarizing program expenditures for the current permit cycle and projected program allocations for the next permit cycle.

This section of the permit renewal application provides the fiscal evaluation including a summary of stormwater-related expenses incurred from fiscal year (FY) 2013 through FY 2016 and projections of expenditures through FY 2022. This section is organized as follows:

- Section 6.1: Funding Summary for the Current Permit Cycle
- Section 6.2: Projected Program Expenditures for Next Permit Cycle

6.1 Funding Summary for the Current Permit Cycle

The City spent approximately $4.21 million on stormwater management services and facilities during the first 4 years of the current permit term (FY 2013 through FY 2016) as shown in Table 6-1. The stormwater revenue requirements for FY 2017 are anticipated to total approximately $1.4 million.

The City relied on stormwater utility user fees to pay for an average of approximately of 91 percent of the total annual utility requirements during FY 2013 through 2016. Utility user fees are expected to finance approximately 92 percent of total stormwater utility requirements in FY 2017.

Table 6-1. Actual/Adopted Expenditures

Expenditure type	Current permit term, 2012-2017				
	Actual				Budget
FY	2013	2014	2015	2016	2017
Personal services	$281,484	$ 259,271	$270,267	$467,261	$459,376
Material and services	146,060	117,389	143,119	148,559	253,084
Capital outlay	104,362	314,028	214,229	410,761	300,000
Transfers out	325,000	321,000	338,000	352,000	382,000
Total stormwater	**$856,906**	**$1,011,688**	**$965,615**	**$1,378,581**	**$1,394,460**

6.2 Projected Program Allocations for Next Permit Cycle

Table 6-2 shows the City's forecasted stormwater revenue requirements of approximately $8.1 million during FY 2018 through FY 2022.

Table 6-2. Forecasted Expenditures

Expenditure type	Next permit term, 2018-2022				
	Forecast				
FY	**2018**	**2019**	**2020**	**2021**	**2022**
Personal services	$490,000	$512,050	$535,092	$559,171	$584,334
Material and services	270,000	283,500	297,675	312,559	328,187
Capital outlay	350,000	350,000	350,000	350,000	350,000
Transfers out	400,000	418,000	430,540	443,456	456,760
Total stormwater	**$1,510,000**	**$1,563,550**	**$1,613,307**	**$1,665,186**	**$1,719,281**

Section 7
Monitoring Objectives Matrix

<u>Permit Requirements</u>

Schedule B.6: MS4 Permit Renewal Application Package

…The application package must include an evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP. The application package must contain:

d. A proposed monitoring program objective matrix and proposed monitoring plan including the information required in Schedule B.2.d for each proposed monitoring project/ task.

This section of the permit renewal provides a summary of the City's stormwater monitoring program and an updated monitoring objectives matrix.

The City's monitoring plan and information required in Schedule B.2.d. of the NPDES MS4 permit is provided in the *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* (CCCSMP), dated January 2017 (scheduled for implementation July 1, 2017). The CCCSMP is provided as Appendix C in this permit renewal application. The CCCSMP was updated as a joint effort. In addition to West Linn, other participants included: Oak Lodge Water Services District (OLWSD), Clackamas County Service District #1, the Surface Water Management Agency of Clackamas County, and the cities of Gladstone, Milwaukie, Oregon City, Happy Valley and Wilsonville, Oregon.

Per Schedule B.2.e of the NPDES MS4 permit, the co-permittees were allowed to modify their monitoring plans on the condition that a 30-day notice was provided to the Oregon Department of Environmental Quality (DEQ) for review and approval. Participating co-permittees submitted a modified CCCSMP to DEQ on December 16, 2016 and did not receive comments back from DEQ within the 30-day window. Therefore, participating co-permittees intend to implement the 2017 CCCSMP beginning July 1, 2017. Adaptive management changes that were made to the monitoring plan are summarized in Section 3 of the CCCSMP.

The monitoring objectives matrix is provided in Table 7-1, below. This matrix summarizes the stormwater-related monitoring activities described in the 2017 CCCSMP including instream water quality, instream biological, instream physical condition, stormwater quality, and BMP effectiveness monitoring. The matrix provides a summary of how each of the listed monitoring activities is used to address the monitoring objectives that are specified in Schedule B.1.a of the NPDES MS4 permit.

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Table 7-1. Monitoring Objectives Matrix for 2017 Permit Renewal

Stormwater-related monitoring activity/program	Stormwater-related monitoring activity/program description	DEQ MS4 Monitoring Objectives - Schedule B.1.a.					
		i. Evaluate the sources of the 2004/ 2006 303(d) listed pollutants as applicable.	ii. Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities.	iii. Characterize MS4 runoff discharges based on land use, seasonality, geography or other catchment characteristics.	iv. Evaluate long-term trends in receiving waters associated with MS4 stormwater discharges.	v. Assess the chemical, biological, and physical effects of MS4 discharges on receiving waters.	vi. Assess progress towards meeting TMDL pollutant load reduction benchmarks.
Environmental Monitoring Activities							
In-Stream Water Quality	• Instream samples will be collected from 25 locations. • Sampling frequencies vary from 3 to 9 times per year depending on the sampling location. • A total of 147 data points will be collected per year. • Depending on the jurisdiction and sampling location, samples will be collected as: 1) ambient scheduled grabs and timed composite grabs if it is raining on the scheduled sampling day, or 2) targeted dry weather grabs and targeted storm event time composites. • Samples will be analyzed for both field and lab parameters (see Table 9 of the CCCSMP).	N/A	There are some paired instream sampling locations that will be used to evaluate and compare upstream and downstream water quality. Results will assist in evaluating effectiveness of the co-permittees overall SWMPs in terms of implementing BMPs.	N/A	Trends will be assessed for each location, based on available data. Trends may be assessed for both dry weather and wet weather data.	Chemical effects of MS4 discharges may be assessed by comparing dry weather and wet weather instream water quality sampling results.	N/A
In-Stream Biological	• Biological samples will be collected from 21 instream locations. • The sampling frequency will be once per permit term. • Samples will be evaluated for the type and number of macroinvertebrates present. Water quality and physical condition monitoring is also conducted at the same locations to help inform results.	N/A	N/A	N/A	N/A	Biological effects may be assessed based on macroinvertebrate sampling results with respect to MS4 discharge locations.	N/A
In-Stream Physical Conditions	• During biological sampling activities, physical conditions are assessed using the modified Rapid Assessment Technique. Physical attributes include stream width/ depth, riparian vegetation, tree canopy, and bank erodibility.	N/A	N/A	N/A	N/A	Physical effects (erodibility) may be assessed through geomorphic monitoring with respect to MS4 discharge locations.	N/A
Stormwater Quality	• Stormwater samples will be collected from 11 locations representing 5 land uses. • Samples will be collected during 3 storm events per year. • A total of 33 data sets will be collected per year (3 events from each of 11 sites). • Samples will be collected as timed composites. • Samples will be analyzed for both field and lab parameters (see Table 9 of the CCCSMP).	The 303(d) parameters bacteria and organics (via TSS as a surrogate) are monitored. Results may provide an indication of the predominant sources of these parameters in terms of general land uses.	As BMP implementation progresses, results of stormwater monitoring over time may help to indicate whether BMPs are effective for the range of parameters.	Stormwater sampling results may be used to characterize runoff quality for the respective contributing land use categories.	N/A	Chemical effects of MS4 discharges on receiving waters may be assessed by comparing MS4 runoff concentrations with instream concentrations.	Land use event mean concentrations (EMCs) are used to model pollutant loads for developing pollutant load reduction benchmarks. EMCs that are used in the model are evaluated periodically to determine whether updates are needed.
BMP Monitoring (Effectiveness)	• Stormwater samples will be collected from a regional water quality facility during 1 storm event per year. Samples will be evaluated for both field and lab parameters (see Table 9 of the CCCSMP).	N/A	Sampling results may be used to understand the effectiveness of this regional water quality/ detention facility.	N/A	N/A	N/A	Sampling results maybe used to refine/update BMP effluent concentrations included in the pollutant loads model used to develop benchmarks.
Program Monitoring Activities							
BMP Monitoring (Programmatic)	• Measurable goals and tracking measures are evaluated annually for BMPs listed in the co-permittee's stormwater management plans (SWMPs).	Tracking measures associated with commercial/industrial inspections, illicit discharge investigations, dry weather field screening, and private water quality facility inspections may indicate potential sources of 303(d) pollutants.	Measurable goals and tracking measures are assessed annually to assist in evaluating the effectiveness of SWMP BMPs.	N/A	N/A	N/A	Tracking measures for pollution prevention and operations and maintenance activities will require tracking of water quality facility installations and retrofits. Information will be used to help develop benchmarks.

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Appendices

Appendix A: Proposed Stormwater Management Plan

CITY OF WEST LINN'S STORMWATER MANAGEMENT PLAN (2017)

SWMP Overview

This 2017 version of the City of West Linn's Stormwater Management Plan ("SWMP") reflects updates to the City's effective (2012) SWMP and was developed based on a review and evaluation of the City's stormwater management program implemented during the 2012 – 2017 NPDES MS4 permit term. This proposed SWMP was prepared for the City's NPDES MS4 permit renewal application, due March 1, 2017.

NPDES MS4 permit language associated with the next reissuance of the permit has not yet been drafted by the Department of Environmental Quality (DEQ). As such, this (2017) SWMP continues to address and include the permit language from the City's current NPDES MS4 permit (issued March 16, 2012). Future updates are anticipated to address any new requirements associated with the next reissuance of the NPDES MS4 permit.

City of West Linn SWMP (2017)

The SWMP is organized into the eight major stormwater program elements listed below. The eight major elements correspond to those outlined in the NPDES MS4 permit (i.e., Schedule A (4)(a-h).

Element #1: Illicit Discharge Detection and Elimination
Element #2: Industrial and Commercial Facilities
Element #3: Construction Site Runoff Control
Element #4: Education and Outreach
Element #5: Public Involvement and Participation
Element #6: Post-Construction Site Runoff
Element #7: Pollution Prevention for Municipal Operations
Element #8: Stormwater Management Facilities Operations and Maintenance

SWMP Element #1
Illicit Discharge Detection and Elimination

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.a for the City's MS4 NPDES Permit. **See Table 1** for the City of West Linn's BMP fact sheets that address the permit requirements that are listed below.

SWMP Element #1: Illicit Discharge Detection and Elimination Summary			
	Applicable BMPs		
Schedule A.4.a Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Implement the Illicit Discharges Elimination Program**	**Conduct Annual Dry Weather Field Screening**	**Implement the Spill Response Program**
i. Prohibit, through ordinance or other regulatory mechanism, illicit discharges into the co-permittee's MS4.	✓		
ii. Describe enforcement response procedures by November 1, 2012.	✓		
iii. Develop or identify pollutant parameter action levels that will be used as part of the field screening to identify the source of an illicit discharge or other type of discharge…. by November 1, 2012.		✓	
iv. Conduct annual dry-weather inspection activities during the term of the permit. By November 1, 2012, the dry-weather field screening activities must include annual field screening of identified priority locations documented by the co-permittee.		✓	
v. Identify response procedures to investigate portions of the MS4 that, based on the results of general observations, field screening, laboratory analysis or other relevant information, indicates the likely presence of an illicit discharge.		✓	
vi. Maintain a system for documenting illicit discharge complaints or referrals, and suspected illicit discharge investigation activities.	✓		

SWMP Element #1: Illicit Discharge Detection and Elimination Summary			
	Applicable BMPs		
Schedule A.4.a Permit Requirement (permit requirements to be updated with subsequent permit issuance)	Implement the Illicit Discharges Elimination Program	Conduct Annual Dry Weather Field Screening	Implement the Spill Response Program
vii. Take appropriate action to eliminate the illicit discharges from the MS4 within 5 working days of detection…. If elimination will take more than 15 days…the co-permittee must develop and implement an action plan in an expeditious manner. The action plan must be completed within 20 working days of determining the source of an illicit discharge. The action plan, response procedures, response plan or similar document must include a timeframe for elimination as soon as practicable.	✓		
viii. Describe and implement procedures to prevent, contain, respond to and mitigate spills that may discharge into the MS4….			✓
ix. In the case of a known illicit discharge that originates within the co-permittee's MS4 regulated area and that discharges directly to a storm sewer system or property under the jurisdiction of another municipality, the co-permittee must notify the affected municipality as soon as practicable, and at least within one working day of becoming aware of the discharge.	✓		
x. In the case of a known illicit discharge that is identified within the co-permittee's permitted area, but is determined to originate from a contributing storm sewer system or property under the jurisdiction of another municipality, the City must notify the contributing municipality or municipality with jurisdiction as soon as practicable, and at least within one working day of identifying the illicit discharge.	✓		
xi. Maintain maps identifying known co-permittee-owned MS4 outfalls discharging to waters of the State. The dry-weather screening locations must be specifically identified on maps by November 1, 2012.		✓	
xii. Unless the following non-stormwater discharges are identified in a particular case as a significant source of pollutants to waters of the State by the co-permittee or the Department, they are not considered illicit discharges and they are authorized by this permit: (see Schedule A.4.a.xii for list of discharges). If a non-stormwater discharge is identified as a significant source of pollutants, the co-permittees must develop and require implementation of appropriate BMPs to reduce the discharge of pollutants associated with the source.	✓		

TABLE 1 – Illicit Discharge Detection and Elimination BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Implement the Illicit Discharges Elimination Program	**Responsible Department:** City of West Linn Operations – Environmental Services Division **Permit Year:** Ongoing **BMP Description:** The City of West Linn prohibits illicit discharges to their MS4 system in conjunction with their (City of West Linn Municipal Code, Chapter 4). The City has the authority to conduct appropriate response procedures and enforce against responsible parties per City of West Linn Municipal Code (Section 4.075). If an illicit discharge is discovered, the City conducts appropriate action to remove the illicit discharge in accordance with the City's Illicit Discharge Detection and Elimination Standard Operating Procedures (IDDE SOP) manual that was initially developed November 1, 2012 to comply with NPDES MS4 permit requirements. Currently, illicit discharges suspected and/ or identified by City staff (either independently or in conjunction with public reporting) are recorded in a tracking database. Procedures for recording such discharges and appropriate follow up activities are outlined in the IDDE SOP. **Measurable Goals:** • Implement the City's IDDE program as outlined in the IDDE SOP manual. • For identified illicit discharges, conduct appropriate actions to remove the discharge in conjunction with time frames outlined in the City's MS4 NPDES Permit. • Track and record all identified illicit discharges and how such discharges were removed.	(1) Track the number, location, resolution and enforcement activities related to any illicit discharge investigation conducted.
Conduct Annual Dry Weather Field Screening	**Responsible Department** Public Works Operations-Environmental Services Division (ESD) **Permit Year:** Ongoing **BMP Description:** The City of West Linn conducts illicit discharge inspections, monitoring, and investigations annually during dry-weather conditions (between July and September) at all priority outfall locations. Priority outfall locations have been identified based on contributing land use and development activities within the watershed and are summarized in the City's IDDE SOP.	(1) Track the number and location of high priority outfalls inspected during dry weather illicit discharge inspection activities. (2) Summarize inspection results and indicate outfalls requiring sampling and/or investigations.

TABLE 1 – Illicit Discharge Detection and Elimination BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Conduct Annual Dry Weather Field Screening (continued)	Dry weather field screening involves the inspection of select outfalls during dry weather conditions to determine if discharge is occurring. If discharge is occurring, the next steps are to identify the source of the discharge, determine whether the discharge is allowable, and eliminate the discharge if it is unallowable or anticipated to add pollutants to the MS4. If flows are present during dry weather, source identification and discharge characterization generally involves the following stepwise process as needed: 1. Visual observations and characterization (odor, color, turbidity, floatables). 2. Field analysis (on-site analysis for pH and conductivity). 3. Field tracking, or upstream system investigation to try and identify the pollutant source. 4. Laboratory analysis (sample collection for off-site analysis). As described in the previous BMP: Implement the Illicit Discharges Program, these activities and procedures are documented in an IDDE SOP. The Public Works Director is notified of all positive identifications of illicit connections and the Environmental Services Department will take all necessary steps to eliminate them. If necessary, in accordance with the annual dry-weather inspection activities, the City updates their GIS files and IDDE SOP related to existing outfall locations and priority outfall locations. **Measurable Goals:** • Conduct dry weather, illicit discharge inspections annually at all priority outfall locations. • If necessary, update existing mapping and the IDDE SOP related to outfalls and priority outfall locations in accordance with field observations.	(3) Indicate the outcome and resolution of any investigation activities conducted.

TABLE 1 – Illicit Discharge Detection and Elimination BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Implement the Spill Response Program	**Responsible Department:** City of West Linn through a contract with Tualatin Valley Fire and Rescue (TVF&R) **Permit Year:** Ongoing **BMP Description:** The City of West Linn Environmental Services initially responds to all calls reporting a spill within the City limits and then calls TVF&R. If the spill is minor, Environmental Services will address it; if it is not minor, TVF&R will resolve it. Procedures for spill response are outlined in the Fire Departments "Emergency Operations Plan" and coordination efforts by the Fire Department are as follows: 1. Contact the State Hazardous Materials Response Team. (TVF&R) 2. Contact the State and National Emergency Response System if the condition requires. 3. Contact the police department for traffic controls. 4. Contact the Public Works Department for storm system information and containment. Public Works staff will install catch basin covers and absorbent pads. The following procedures are followed for minor spills handled by the City: 1. Public Works Department is notified. 2. West Linn GIS is used to determine storm drain locations. 3. Spill is contained (i.e. install catch-basin covers and absorbent pads). 4. Spill containment materials are disposed of in an approved manner. **Measurable Goals:** • Respond to minor spills. • Call TVF&R to respond to other spills.	(1) Indicate the number of spills reported to the City of West Linn Environmental Services. (2) Track the number of spills responded to by the City of West Linn Environmental Services and TVFR. (3) Indicate sources, causes, and types of discharges resulting from identified spill activities.

SWMP Element #2
Industrial and Commercial Facilities

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.b. **See Table 2** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #2: Industrial and Commercial Facilities			
		Applicable BMP	
	Schedule A.4.b Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Screen Existing and New Industrial Facilities**	**Conduct Priority Facility Inspections**
i.	*Screen existing and new industrial facilities to assess whether they have the potential to be subject to an industrial stormwater NPDES permit or have the potential to contribute a significant pollutant load to the MS4.*	✓	
ii.	*Within 30 days after the facility is identified, notify the industrial facility and the Department that an industrial facility is potentially subject to an industrial stormwater NPDES permit.*	✓	
iii.	*Implement an updated strategy to reduce pollutants in stormwater discharges to the MS4 from industrial and commercial facilities…The strategy must include a description of the rationale for identifying commercial and industrial facilities as a significant contributor, and establish the priorities and procedures for inspection of and implementation of stormwater control measures. The strategy must be implemented by July 1, 2013, and applied within one calendar year from the date a new source contributing a significant pollutant load to the MS4 has been identified.*		✓

TABLE 2 – Industrial and Commercial Facility BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Screen Existing and New Industrial Facilities	**Responsible Department:** City of West Linn Operations – Environmental Services Division (ESD) **Permit Year:** Ongoing **BMP Description:** The City of West Linn currently has one industrial facility within its jurisdiction and this facility has obtained a 1200-Z permit for its stormwater discharges. Once during the permit term, the City of West Linn will review their existing business license inventory and new industrial development applications to determine whether any existing or new facilities would be subject to an industrial stormwater NPDES permit. This determination will occur based on a review of the facility(ies) proposed activities and the applicable SIC codes related to the 1200-series NPDES permit. If a facility is identified that would be subject to an industrial stormwater NPDES permit, the facility and DEQ will be notified within 30 days. During the review of the existing business license inventory and new industrial development applications, the City will also consider whether any facilities (industrial or commercial) have been identified that have the potential to contribute significant pollutant load to the MS4 and include such facility in their priority facility inventory. **Measurable Goal:** • Notify DEQ of any existing or new industrial facilities within the City of West Linn jurisdiction that may potentially be subject to an industrial stormwater NPDES permit.	(1) Track the number of existing or new facilities subject to a stormwater industrial NPDES permit during the permit term.
Conduct Commercial Facility Inspections	**Responsible Department:** City of West Linn Operations – Environmental Services Division **Permit Year:** Ongoing **BMP Description:** In conjunction with the BMP to conduct private water quality facility maintenance, the City will often take the opportunity to inspect housekeeping practices on commercial sites. Housekeeping practices and activities that are reviewed are discussed in the City's Industrial/Commercial Facility Inspection Program document and include vehicle operations, outdoor storage of materials, waste management, etc. **Measurable Goal:** • Place emphasis on priority commercial inspections on a yearly basis.	(1) Track the number and outcome of commercial facility inspections.

SWMP Element #3
Construction Site Runoff Control

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.c. **See Table 3** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #3: Construction Site Runoff Control			
	Applicable BMPs		
Schedule A.4.c Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Implement the Erosion Control Manual**	**Provide Educational Information to Construction Site Operators**	**Conduct Erosion Control Inspections and Enforcement**
i. *Include ordinances or other enforceable regulatory mechanism that requires erosion and sediment controls to be designed, implemented, and maintained to prevent adverse impacts to water quality and minimize the transport of contaminants to waters of the State. By November 1, 2014, the construction site runoff control program ordinances or other enforceable regulatory mechanisms must apply to construction activities that result in land disturbance of 1,000 square feet or greater.*	✓	✓	
ii. *Require construction site operators to develop site plans, and to implement and to maintain effective erosion and sediment control best management practices.*	✓	✓	
iii. *Require construction site operators to prevent or control non-stormwater waste that may cause adverse impacts to water quality, such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste.*	✓	✓	
iv. *Describe site plan review procedures to ensure stormwater BMPs are appropriate and address the construction activities being proposed. At a minimum, construction site erosion and sediment control plans for sites disturbing one acre or greater must be consistent with the substantive requirements of the State of Oregon's 1200-C permit site erosion prevention and sediment control plans.*	✓	✓	

SWMP Element #3: Construction Site Runoff Control			
	Applicable BMPs		
Schedule A.4.c Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Implement the Erosion Control Manual**	**Provide Educational Information to Construction Site Operators**	**Conduct Erosion Control Inspections and Enforcement**
v. Co-permittees must perform on-site inspections in accordance with documented procedures and criteria to ensure the approved erosion and sediment control plan is properly implemented…. Inspections must be documented, including photographs and monitoring results as appropriate.			✓
vi. Describe in an enforcement response plan or similar document the enforcement response procedures the co-permittee will implement. The enforcement response procedures must use all means necessary to ensure construction activities are in compliance with the ordinances or other regulatory mechanisms.			✓

TABLE 3 – Construction Site Runoff Control BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Implement the Erosion Control Manual	**Responsible Department:** City of West Linn Public Works –Engineering Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn development standards require submission of an erosion control permit application and an erosion and sediment control plan for all sites with 1,000 ft^2 of disturbance or greater, consistent with requirements provided in the Municipal and Community Development Codes. For sites disturbing five acres or greater, a 1200-C permit is also required, as issued by DEQ and consistent with the requirements of DEQ's 1200-C Guidance Manual. The City requests copies of all 1200-C permits issued from DEQ as well. The City recommends the use of the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual* (revised 2009) in preparing the erosion control plans and implementing the erosion control BMPs. This guidance document recommends various non-structural and structural techniques for erosion control and includes measures related to good housekeeping and non-stormwater related waste. During the plan review process, new and redevelopment will be assessed for compliance with the erosion control standards and provisions outlined in the guidance document. Plans not in compliance will not be approved and will be required to implement appropriate erosion control techniques prior to approval. **Measurable Goals:** • Require submission of erosion control plans for development greater than 1000 ft^2. • Require a copy of all 1200-C permit applications for development greater than five acres. • Assess new and redevelopment applications for erosion control compliance during plan review. Require erosion and sediment control plans not in compliance to be amended prior to approval in conjunction with provisions outlined in the Clackamas County Erosion Prevention and Sediment Control Manual (2009).	(1) Report any updates or modifications to the Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual (2009). (2) Record the number of erosion control permit (City issued and DEQ issued) applications received. (3) Track the number of erosion and sediment control plan reviews completed.

TABLE 3 – Construction Site Runoff Control BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Provide Educational Information to Construction Site Operators	**Responsible Department:** City of West Linn Engineering Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn makes the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual* available to engineers, contractors, and the general public. Educational brochures are attached to building and grading permits. The City of West Linn publicizes (via brochures, flyers, and pamphlets on the City Hall bulletin board) a variety of educational opportunities pertaining to erosion prevention geared for construction site operators and the general public. Such opportunities include classes at the Urban Watershed Institute, classes at Portland Community College, and participation in regional erosion control awards. **Measurable Goal:** • Provide educational information to construction site operators and the general public via brochures, flyers, pamphlets, and attachments to building and grading permit applications.	(1) Verify that this BMP was conducted.

TABLE 3 – Construction Site Runoff Control BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Conduct Erosion Control Inspections and Enforcement	**Responsible Department:** City of West Linn Engineering Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn development standards require erosion control to be in place prior to issuance of a construction and/or building permit. All sites greater than 1,000 ft^2 of disturbance are required to have an erosion and sediment control plan on record and are inspected during construction activities. Residential developments are inspected for erosion control three times, at a minimum. Large development and commercial developments are also inspected a minimum of 3 times for erosion control and more frequently as part of construction inspections. Additional inspections are conducted if permit violations occur. Erosion control inspections are conducted in accordance the City's erosion and sediment control inspection form. Erosion and sediment control enforcement procedures are outlined on the City's website as part of a three step progression. For sites with an initial erosion control violation, a written notice of inspection findings and required corrections is issued. 24 hours is typically given to correct the initial problem. If not resolved, a notice of non-compliance will be issued with required corrections. Should the required corrections not be addressed, a stop work order will be issued and other penalties such as fines and suspension/ withdrawal of development approvals may be imposed. Engineering or building inspections will also not be conducted while an erosion control violation exists. Before the final engineering or building inspection, all disturbed area must be permanently stabilized or revegetated. **Measurable Goals:** • Conduct a minimum of three site inspections on all sites with an erosion control plan for appropriate erosion control. • As necessary, enforce appropriate erosion and sediment control in conjunction with the three-step progression as outlined on the City's website. • Require all disturbed areas to be permanently stabilized or revegetated prior to final engineering or building inspection.	(1) Track the number of erosion control inspections conducted each year. (2) Report the number of notices of non-compliance and stop work orders issued, and describe the measures used to resolve the issue.

SWMP Element #4
Education and Outreach

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.d. **See Table 4** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #4: Education and Outreach					
		Applicable BMPs			
	Schedule A.4.d Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Provide Public Education and Outreach Materials Regarding Stormwater Management**	**Implement a Pet Waste Program**	**Ensure Staff Training for Pest Management**	**Promote Staff Education Related to Environmentally Friendly Solutions**
i.	*Continue to implement a documented public education and outreach strategy that promotes pollutant source control and a reduction of pollutants in stormwater discharges….The public education and outreach strategy may incorporate cooperative efforts with other MS4 regulated permittees or efforts by other groups or organizations provided a mechanism is developed and implemented to track the public education and outreach efforts within the MS4 regulated area and the results of such efforts are reported annually.*	✓	✓		
ii.	*Provide educational materials to the community or conduct equivalent outreach activities describing the impacts of stormwater discharges on water bodies and the steps or actions the public can take to reduce pollutants in stormwater runoff.*	✓	✓		
iii.	*Provide public education on the proper use and disposal of pesticides, herbicides, fertilizers and other household chemicals.*	✓	✓		
iv.	*Provide public education on the proper operation and maintenance of privately-owned or operated stormwater quality management facilities.*	See Element #8: Structural Stormwater Facility Operations and Maintenance BMP: Private Water Quality Facility Maintenance Program			

SWMP Element #4: Education and Outreach				
	Applicable BMPs			
Schedule A.4.d Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Provide Public Education and Outreach Materials Regarding Stormwater Management**	**Implement a Pet Waste Program**	**Ensure Staff Training for Pest Management**	**Promote Staff Education Related to Environmentally Friendly Solutions**
v. *Provide notice to construction site operators concerning where education and training to meet erosion and sediment control requirements can be obtained.*	See Element #3: Construction Site Runoff Control BMP: Provide Educational Information to Construction Site Operators			
vi. *Conduct or participate in an effectiveness evaluation to measure the success of public education activities during the term of this permit. The effectiveness evaluation must focus on assessing changes in targeted behaviors. The results of the effectiveness evaluation must be used in the adaptive management of the education and outreach program, and reported to the Department no later than July 1, 2015.* Note: This requirement has been fulfilled.		✓		
vii. *Include training for co-permittee employees involved in MS4-related activities, as appropriate. The training should include stormwater pollution prevention and reduction from municipal operations, including, but not limited to, parks and open space maintenance, fleet and building maintenance, new municipal facility construction and related land disturbances, design and construction of street and storm drain systems, discharges from non-emergency firefighting-related training activities, and stormwater system maintenance.*	Firefighting training activities are not conducted within the City of West Linn.			
			✓	✓
viii. *Promote, publicize and facilitate public reporting of illicit discharges through the use of newspapers, newsletters, utility bills, door hangers, radio public service announcements, videos, televised council meetings, brochures, signs, posters or other effective methods.*	✓	✓		

TABLE 4 – Education and Outreach BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Provide Public Education and Outreach Materials regarding Stormwater Management	**Responsible Department:** City of West Linn Engineering Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn continues to employ a public education strategy aimed at reducing the discharge of pollutants associated with a variety of activities including but not limited to: 1. The application of pesticides, herbicides and fertilizers by citizens. 2. Illicit discharges and dumping of waste materials into the storm drainage system. 3. Disposal of waste oil and toxic materials. Such educational materials are distributed throughout the City via newsletter publications, brochures, bill inserts, the City web page, and radio advertisements. Newsletter articles typically include information on recycling locations, local disposal programs, and other coordinated efforts with METRO. Other educational topics include: naturescaping and alternative pesticide/fertilizer use. Additionally, the City of West Linn coordinates with other local jurisdictions and organizations (i.e., ACWA, Regional Coalition for Clean Rivers and Streams) and makes monetary contributions to the Tualatin Basin Public Awareness Committee (TB PAC) to promote public awareness of water quality issues related to the above-mentioned practices. To aid in public education related to proper disposal of waste materials, the City of West Linn also works with individuals and groups who volunteer to conduct catch basin stenciling. The Public Works Environmental Services Division (ESD) provides direction and materials to volunteers for catch basin stenciling efforts. **Measurable Goals:** • Utilize newsletters, brochures, bill inserts, City web page, and radio advertisements to promote public awareness of stormwater quality issues and to provide information to encourage public reporting of illicit discharges. • Continue to make annual monetary contributions to TB PAC.	(1) Track the number, types, and topics of public educational materials dispersed to the public annually. (2) Indicate any large-scale public educational campaigns initiated during a given year. (3) Track coordinated public outreach activities with local co-permittees. (4) Record the number of catch basins stenciled in a given year. (5) Track amount donated to TB PAC each year.

TABLE 4 – Education and Outreach BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Implement a Pet Waste Program	**Responsible Department:** City of West Linn Parks and Operations Departments **Permit Year:** Ongoing **BMP Description:** During maintenance activities on public property (i.e., parks), staff look for evidence of domestic animal waste. If problems are identified, signs are installed to educate citizens about the effects of animal waste on stormwater. Staff will also leave educational door hangers in the immediate area to make citizens aware of the problem, and they provide baggies and disposal areas for cleanup of domestic animal waste. **Measurable Goals:** • If pet waste is observed as a problem upon routine maintenance activities at public property, install educational signs and distribute educational door hangers at homes in the immediate vicinity of the identified problem areas. • Continue to provide pet waste baggies and disposal areas in City parks for disposal of domestic animal waste.	(1) Report on activities conducted annually.
Ensure Staff Training for Pest Management	**Responsible Department:** City of West Linn Parks Department and Operations Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn informally follows the *Portland Integrated Pest Management (IPM) Plan*. In accordance with the program, crews from Public Works and the Parks Department are trained once every two years on proper pesticide and fertilizer application rates and techniques in conjunction with guidelines outlined in the IPM Plan. **Measurable Goals:** • Provide training to Public Works and Parks department crews once every two years on proper pesticide and fertilizer application rates and techniques in conjunction with guidelines outlined in the IPM Plan.	(1) Report on training conducted every year.

TABLE 4 – Education and Outreach BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Promote Staff Education Related to Environmentally Friendly Solutions	**Responsible Department:** City of West Linn Public Works Department Engineering & Operations. **Permit Year:** Ongoing **BMP Description:** A variety of training is provided to City staff associated with stormwater management in the City. Such training is conducted annually or every other year, depending on the number of employees with which to train. City of West Linn Operations and Engineering Staff also attend a variety of educational presentations and conferences throughout the year geared towards water resources and stormwater management. Such conference attendance includes ACWA, AIWA, and NW Stream Restoration. Staff also attends meetings and tours organized by ASCE-EWRG and Clackamas Community College Water Environment School. The City maintains a budget to allow for employee attendance at stormwater-related conferences. City staff participates in the Tualatin Basin Public Awareness Committee, Clackamas County Water Education Team (CCWET) and other professional meetings, seminars and conferences. The City of West Linn continues to coordinate with other local, Phase 1 NPDES MS4 jurisdictions including other Clackamas County co-permittees regarding regional water quality efforts. Areas for coordination include MS4 issues, education, public outreach and monitoring. **Measurable Goals:** • Conduct municipal training for employees associated with stormwater management in the City. • Continue to participate in, and attend environmental and water quality related professional meetings and conferences. • Continue to maintain a budget for employee attendance of conferences. • Continue to coordinate with other local Phase 1 jurisdictions regarding regional water quality efforts.	(1) Track the number of employees receiving training in stormwater management annually. (2) Track Operations and Engineering staff participation in professional organizations and attendance at relevant conferences.

SWMP Element #5
Public Involvement and Participation

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.e. **See Table 5** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #5: Public Involvement and Participation	
Schedule A.4.e Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Applicable BMPs** **Provide for Public Participation with Submittals**
e. Co-permittees must implement a public participation approach that provides opportunities for the public to effectively participate in the development, implementation and modification of the co-permittee's stormwater management program. The approach must include provisions for receiving and considering public comments on the monitoring plan due to the Department September 1, 2012, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development.	✓

TABLE 5 – Public Involvement and Participation BMP

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
Provide for Public Participation with Submittals	**Responsible Department:** City of West Linn Engineering Department **Permit Year:** Ongoing **BMP Description:** Schedule A.4.e of the City's MS4 NPDES permit requires the City to provide opportunity for public participation in the development, implementation, and modification of the City's stormwater management program. This includes the updated monitoring plan which was due to DEQ September 1, 2012, annual reports, SWMP revisions, and pollutant load reduction benchmark development. The monitoring plan and annual reports will be provided to the public for review and comment on the City's website, prior to submission to DEQ. SWMP revisions and pollutant load reduction benchmarks are required for submittal to DEQ with the permit renewal application. Prior to submittal of these items, the City will provide the public with an opportunity to comment on the revisions to the SWMP and proposed pollutant load reduction benchmarks. Comments on the documents will be collected and considered and response to comments will be publically provided. **Measurable Goals:** • Provide for public participation with the SWMP and pollutant load reduction benchmarks prior to the permit renewal application deadline. • Provide a public comment period for the updated stormwater monitoring plan and annual reports prior to submittal to DEQ.	

SWMP Element #6
Post-Construction Site Runoff

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.f. **See Table 6** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #6: Post-Construction Site Runoff	
	Applicable BMPs
Schedule A.4.f Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Implement Community Development Code and Public Works Design and Construction Standards for Stormwater Treatment**
i. *By November 1, 2014, the post-construction stormwater pollutant and runoff control program applicable to new development and redevelopment projects that create or replace impervious surfaces must meet the conditions described in this subsection. The minimum project threshold applicable to each co-permittee post-construction stormwater pollutant and runoff control program is identified in Table A-1. The post-construction stormwater site runoff permit conditions are as follows: 1) Incorporate site-specific management practices that target natural surface or predevelopment hydrologic functions as much as practicable…; 2) Reduce site specific post-development stormwater runoff volume, duration, and rates of discharges to the municipal separate storm sewer system (MS4)…; 3) Prioritize and include implementation of Low-Impact Development (LID), Green Infrastructure (GI) or equivalent design and construction approaches; and, 4) Capture and treat 80% of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity.*	✓

SWMP Element #6: Post-Construction Site Runoff	
Schedule A.4.f Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Applicable BMPs** **Implement Community Development Code and Public Works Design and Construction Standards for Stormwater Treatment**
ii. The co-permittee must identify, and where practicable, minimize or eliminate ordinance, code and development standard barriers within their legal authority that inhibit design and implementation techniques intended to minimize impervious surfaces and reduce stormwater runoff (e.g., Low Impact Development, Green Infrastructure). Such modifications to ordinance, code and development standards are only required to the extent they are permitted under federal and state laws. The co-permittee must review ordinance, code and development standards for modification, minimization or elimination, and appropriately modify ordinance, code or development standard barriers by November 1, 2014. If an ordinance, code or development standard barrier is identified at any time subsequent to November 1, 2014, the applicable ordinance, code or development standard must be modified within three years.	✓
iii. To reduce pollutants and mitigate the volume, duration, time of concentration and rate of stormwater runoff, the co-permittee must develop or reference an enforceable post-construction stormwater quality management manual or equivalent document by November 1, 2014 that, at a minimum, includes the following: 1) A minimum threshold for triggering the requirement for post-construction stormwater management control and the rationale for the threshold; 2) A defined design storm or an acceptable continuous simulation method to address the capture and treatment of 80% of the annual average runoff volume; 3) Applicable LID, GI or similar stormwater runoff reduction approaches, including the practical use of these approaches; 4) Conditions where the implementation of LID, GI or equivalent approaches may be impracticable; 5) BMPs…; and 6) Pollutant removal efficiency performance goals that maximize the reduction in discharge of pollutants.	✓
iv. The co-permittees must review, approve and verify proper implementation of post-construction site plans for new development and redevelopment projects applicable to this section.	✓

SWMP Element #6: Post-Construction Site Runoff		
		Applicable BMPs
	Schedule A.4.f Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Implement Community Development Code and Public Works Design and Construction Standards for Stormwater Treatment**
v.	*Where a new development or redevelopment project site is characterized by factors limiting use of on-site stormwater management methods to achieve the post-construction site runoff performance standards…the Post-Construction Stormwater Management program must require equivalent pollutant reduction measures, such as off-site stormwater quality management. Off-site stormwater quality management may include off-site mitigation…, a stormwater quality structural facility mitigation bank or a payment-in-lieu program.*	✓
vi.	*A description of the inspection and enforcement response procedures the co-permittee will follow when addressing project compliance issues with the enforceable post-construction stormwater management performance standards.*	✓

TABLE 6 – Post-Construction Site Runoff BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Implement Public Works Design and Construction Standards for Stormwater Treatment	**Responsible Department:** City of West Linn Development Services **Permit Year:** Ongoing **BMP Description:** The City of West Linn reviews development submittals for conformance with their Public Works Design and Construction Standards with regards to stormwater treatment and control (Chapter 2). The City references use of the current City of Portland Stormwater Management Manual, which requires treatment for projects that develop, or for redevelopment of more than 500 ft^2 of new impervious surface. In an effort to promote low-impact development, the City currently has City-specific standard details for rain gardens. Section 2.0051 of the City's Public Works Design and Construction Standards outline development factors that limit use of an on-site stormwater treatment facility and outline the equivalent measures that a developer would have to implement if on-site treatment cannot be provided. The City's Community Development Code (CDC) also designates several overlay zones that protect stream channels by requiring vegetated buffers. The Willamette and Tualatin River Protection Area (CDC Chapter 28) sets habitat conservation areas adjacent to the major rivers, with associated building restrictions and setback requirements. The majority of the city's tributary streams are also covered by Water Resource Area Protection requirements (CDC Chapter 32). The City requires a vegetated buffer to be maintained adjacent to stream channels in these areas. **Measurable Goal:** • Continue to require stormwater treatment in conjunction with provisions outlined in the City of Portland's Stormwater Management Manual.	(1) Track the number of development applications reviewed for compliance with the current stormwater requirements for treatment. (2) Track any modifications to the list of currently approved structural stormwater treatment facilities. (3) Track private BMPs that are implemented and their associated drainage areas.

SWMP Element #7
Pollution Prevention for Municipal Operations

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.g. **See Table 7** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #7: Pollution Prevention for Municipal Operations						
	Applicable BMPs					
Schedule A.4.g Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Conduct Street Area Repair**	**Maintain Public Streets**	**Implement an Integrated Pest Management Program**	**Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities**	**Control Infiltration and Cross Connections to the Stormwater Conveyance System**	**Conduct Master Planning for Stormwater Quality Improvements**
i. Operate and maintain public streets, roads and highways in a manner designed to minimize the discharge of stormwater pollutants to the MS4, including pollutants discharged as a result of deicing activities;	✓	✓				
ii. Implement a management program to control and minimize the use and application of pesticides, herbicides and fertilizers on co-permittee-owned properties;			✓			
iii. By July 1, 2013, inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that treat, store or transport municipal waste, such as yard waste or other municipal waste not already covered under a 1200 series NPDES permit, a DEQ solid waste permit, or other permit designed to reduce the discharge of pollutants;				✓		
iv. Limit infiltration of seepage from the municipal sanitary sewer system to the MS4;					✓	

SWMP Element #7: Pollution Prevention for Municipal Operations						
	Applicable BMPs					
Schedule A.4.g Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Conduct Street Area Repair**	**Maintain Public Streets**	**Implement an Integrated Pest Management Program**	**Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities**	**Control Infiltration and Cross Connections to the Stormwater Conveyance System**	**Conduct Master Planning for Stormwater Quality Improvements**
v. *Implement a strategy to control the release of materials related to fire-fighting training activities;*	The City of West Linn does not have a BMP to address this requirement, as the City contracts with Tualatin Valley Fire and Rescue Department who implements firefighting activities for a number of local jurisdictions in Clackamas, Multnomah, and Washington counties.					
vi. *Assess co-permittee flood control projects to identify potential impacts on the water quality of receiving water bodies and determine the feasibility of retrofitting structural flood control devices for additional stormwater pollutant removal. The results of this assessment must be incorporated and considered along with the results of the Stormwater Retrofit Assessment required by this permit.*						✓

TABLE 7 – Pollution Prevention for Municipal Operations BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Conduct Street Area Repair	**Responsible Department:** City of West Linn Public Works Department, Street Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn conducts road maintenance and repair activities continuously to prevent erosion and stormwater pollutant generation. Repair work is generally scheduled during the dry season when possible, to minimize pollutant discharge into the stormwater conveyance system. Applicable erosion and sediment control practices and provisions are implemented in conjunction with repair activities that meet the threshold requirement. **Measurable Goal:** • Ensure all road maintenance and repair activities implement appropriate erosion and sediment control to address potential water quality impacts.	
Maintain Public Streets	**Responsible Department:** City of West Linn Operations Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn Operations Department conducts street sweeping activities throughout the City. Each street in the City is swept approximately 3 - 6 times per year. Regenerative air sweeping techniques are employed to minimize wash water from entering the stormwater conveyance system. Leaf and yard debris pick up occurs weekly within the City limits. Additionally, the City maintains a drop off location for yard debris not collected during the weekly pick-up activities. A Deicing agent (Magnesium Chloride) is occasionally used during icy weather conditions at select locations within the City (bridges, steep slopes). **Measurable Goal:** • Sweep each street between 3 and 6 times per year.	(1) Track the number of sweeps conducted annually. (2) Track the volume of debris removed during sweeping activities. (3) Track the amount (volume) of deicing agent used annually.

TABLE 7 – Pollution Prevention for Municipal Operations BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Implement an Integrated Pest Management Program	**Responsible Department:** City of West Linn Operations Department, Parks Department **Permit Year:** Ongoing **BMP Description:** As an informal guide, the City of West Linn refers to the *Portland Integrated Pest Management (IPM) Program*, which defines appropriate pesticide and fertilizer application procedures and protocols along roadways, within City parks, and around water quality facilities. Staff adheres to such guidelines during maintenance activities. Per the IPM program, the following activities are typically implemented: • Application of chemicals is eliminated where possible; • Regular removal of invasive plant species is conducted; • Native plants are used for revegetation projects; and • Only spot spraying is conducted for blackberry removal. In addition, any work conducted within public right-of-ways requires certified, licensed chemical applicators. Education measures and staff training related to pest management and control are outlined under Element #4: Public Education and Outreach. **Measurable Goals:** • Use the *Portland Integrated Pest Management (IPM) Program* as a guide for appropriate pesticide and fertilizer application procedures along roadways, within City Parks, and around water quality facilities. • Conduct work within public right-of-way only with certified, licensed applicators.	(1) Track any updates or modifications to the referenced IPM procedures and protocols. (2) Track the amount of money spent on pest management chemicals each year.
Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	**Responsible Department:** City of West Linn Operations Department **Permit Year:** Ongoing **BMP Description:** In 2013, the City developed a stormwater pollution prevention strategy (SWPPS) for the Public Works compound. The SWPPS includes both source control measures and treatment measures. The City will implement the SWPPS on an ongoing basis. **Measurable Goal:** • Implement the SWPPS for the Public Works compound.	(1) Track status of SWPPS implementation and any updates made to the SWPPS.

TABLE 7 – Pollution Prevention for Municipal Operations BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Control Infiltration and Cross Connections to the Stormwater Conveyance System	**Responsible Department:** City of West Linn Operations Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn implements an inflow and infiltration (I&I) abatement program for the sanitary sewer system. Sanitary lines are inspected and tested via smoke-testing, T.V. techniques, and flow metering for any cracking or breakage that would possibly result in infiltration from the sanitary to the storm system. Repairs are made as necessary based on the results of the inspections. The City's Development Services Department reviews new and redevelopment plans for possible cross-connections. The City also implements an illicit discharge detection and elimination program that works to identify and remove any cross-connections during dry-weather field screening activities. **Measurable Goals:** • Annually investigate for cracking and breakage, and repair as necessary based on the results of the inspection, a minimum of 5,000 linear feet of sanitary lines. • Review new and redevelopment plan submittals for possible cross-connections. • Inspect for potential cross-connections during dry weather field screening activities.	(1) Indicate whether any sanitary sewer cross-connections were identified during sanitary line testing, during the plan review process, or during dry-weather field screening activities on an annual basis. (2) Describe any follow-up activities required for identified cross-connections.
Conduct Master Planning for Stormwater Quality Improvement	**Responsible Department:** City of West Linn Engineering Department **Permit Year:** Initiated in 2017 **BMP Description:** The City of West Linn last updated their Stormwater Master Plan in 2006. The City intends to initiate an update of their stormwater master plan in 2017. The updated plan will include an evaluation of current conditions and provide future direction for the City's surface water system. The master planning efforts will include the development of capital improvement projects and priorities. Capital improvement project development will include the consideration of: water quality retrofits, identified hydromodification issues, and addressing water quality issues as a part of flood control projects. **Measurable Goal:** • Ensure water quality is considered and addressed during the development of an updated stormwater CIP list.	(1) Track development of the updated Stormwater Master Plan. (2) Track the number of CIP projects implemented each year and discuss the added benefit (water quality, habitat restoration, etc.) of each. (3) Map the location and drainage area of water quality CIPs as they are constructed.

SWMP Element #8
Stormwater Management Facilities Operations and Maintenance Activities

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement. In some cases, language for the listed permit requirements has been condensed. Applicable provisions are outlined under Schedule A.4.h. **See Table 8** for the City of West Linn's BMPs that address the requirements that are listed above.

SWMP Element #8: Stormwater Management Facilities Operations and Maintenance Activities				
Schedule A.4.h Permit Requirement (permit requirements to be updated with subsequent permit issuance)	**Applicable BMPs**			
	Conduct Stormwater Conveyance System Cleaning and Maintenance	**Conduct Catch basin Cleaning and Maintenance**	**Public Structural Control Facility Cleaning and Maintenance**	**Private Water quality Facility Maintenance Program**
i. By July 1, 2013, the co-permittee must inventory and map stormwater management facilities and controls, and implement a program to verify that stormwater management facilities and controls are inspected, operated and maintained for effective pollutant removal, infiltration and flow control. At a minimum, the program must include the following: 1) Legal authority to inspect and require effective operation and maintenance; 2) A strategy to inventory and map public and private stormwater management facilities as provided under Schedule A.4.h.ii.; and, 3) Public and private stormwater facility inspection and maintenance requirements for stormwater management that have been inventoried and mapped as provided under Schedule A.4.h.ii.	✓	✓	✓	✓
ii. As part of the Stormwater Management Facilities Inspection and Maintenance program, the co-permittee must implement a strategy that guides the long-term maintenance and management of all co-permittee-owned and identified privately-owned stormwater structural facilities. At a minimum, the strategy must describe the following: *1. Co-permittee-owned or operated stormwater quality management facilities inventory and mapping process; inspection and maintenance schedule; inspection, operation and maintenance criteria and priorities; description of inspector type and staff position or title; and, inspection and maintenance tracking mechanisms.* *2. Privately-owned or operated stormwater management facilities procedures for and types of stormwater facilities that will be inventoried and mapped…; inspection criteria, rationale, priorities, inspection frequency and procedures…; required training or qualifications to inspect private stormwater facilities; reporting requirements; and, inspection and maintenance tracking mechanism.*			✓	✓

TABLE 8 – Stormwater Management Facilities Operations and Maintenance Activities BMPs

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Conduct Stormwater Conveyance System Cleaning and Maintenance	**Responsible Department:** City of West Linn Operations Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn annually inspects their stormwater conveyance system including: manholes, sewer pipes, culverts, and ditches. System components requiring repair or replacement will be maintained promptly following inspection. **Measurable Goal:** • Perform cleaning and repair promptly based on inspection results.	(1) Track the length of conveyance system inspected. (2) Track the volume of debris removed during cleaning activities.
Conduct Catch Basin Cleaning and Maintenance	**Responsible Department:** City of West Linn Operations Department **Permit Year:** Ongoing **BMP Description:** The City of West Linn inspects all public catch basins at least once per year. Cleaning activities are conducted as needed based on inspection and primarily occur during the dry weather season. A database tracking system is updated during each maintenance cycle to allow the City to better track catch basins requiring more frequent maintenance. Catch basins requiring repair or replacement will be maintained promptly. **Measurable Goals:** • Inspect all public catch basins once per year, and clean as needed based on inspection results. • Repair or replace catch basins promptly based on inspection results. • Update tracking database during each maintenance cycle.	(1) Track the number of catch basins inspected. (2) Track the volume of debris removed during cleaning activities.

TABLE 8 – Stormwater Management Facilities Operations and Maintenance Activities BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Public Structural Control Facility Cleaning and Maintenance	**Responsible Department:** City of West Linn Operations Department, Environmental Services Division **Permit Year:** Ongoing **BMP Description:** The City of West Linn owns and operates approximately 200 public structural water quality facilities. Such public structural facilities currently include ponds, swales, detention tanks, rain gardens, and pollution control manholes. Following construction of such public structural control facilities, as-built information is provided to the City's GIS department where the facility location and associated drainage area is mapped. Public structural control facilities are currently inspected annually and cleaned and maintained when inspections show it is needed. **Measurable Goal:** • Inspect public structural water quality facilities annually and maintain based on inspection results.	(1) Track the number and frequency of structural facilities inspected and maintained. (2) Track the volume of debris removed during cleaning activities.
Private Water Quality Facility Maintenance Program	**BMP Owner:** City of West Linn Public Works – Engineering & Operations Departments. **Permit Year:** Ongoing **BMP Description:** There are currently a significant number (approximately 150) of private structural water quality facilities in West Linn. The City of West Linn has provisions in its Municipal Code, including enforcement language, that require private facility owners to submit maintenance agreements to the City to ensure ongoing maintenance of these private water quality facilities. Such private water quality facilities tracked by the City include rain gardens, swales, ponds pollution control manholes, filters, and detention tanks. The maintenance agreement requires the owner to provide an annual report summarizing inspection and maintenance activities regarding the water quality facility, including verification by a maintenance contractor that maintenance was conducted. As maintenance agreements are submitted to the City, the City maps the facility location and contributing drainage area. Whether the owner inspects their facility or not, the City has a goal of inspecting approximately 25% of the facilities per year. For these facilities, an inspection report is drafted and sent to the owners. In this report, any actions they need to implement to maintain the health and function of their facility are included.	(1) Track number of maintenance agreements submitted to the City each year. (2) Track number of annual maintenance reports received each year. (3) Track the number of facilities inspected by the City each year.

TABLE 8 – Stormwater Management Facilities Operations and Maintenance Activities BMPs (continued)

City of West Linn BMP Descriptions	BMP Implementation	Tracking Measures
Private Water Quality Facility Maintenance Program (continued)	The City is also working to collect annual reports of inspection and maintenance activities for existing water quality facilities that do not currently have maintenance agreements. The City mails letters annually to all private water quality facility owners, regardless of whether they have a maintenance agreement with the City, requesting annual inspection and maintenance reports for the facilities. Annual reports are maintained on file at the City. **Measurable Goals:** • Require new private water quality facilities to submit maintenance agreements to the City. • Require submittal of annual reports related to inspection and maintenance activities for private water quality facilities with existing maintenance agreements. • Continue to work to identify the responsible parties associated with private water quality facilities that do not have an existing maintenance agreement.	

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Appendix B: TMDL Pollutant Load Reduction Evaluation and Benchmarks

DRAFT

TMDL Pollutant Load Reduction Evaluation and TMDL Benchmarks

Prepared for

The City of West Linn, Oregon

December 2015 (Pollutant Load Reduction Evaluation)

Amended January 2017 (addition of TMDL Benchmarks)

This is a draft and is not intended to be a final representation
of the work done or recommendations made by Brown and Caldwell.
It should not be relied upon; consult the final report.

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ac	acre(s)
ACWA	(Oregon) Association of Clean Water Agencies
ASCE	American Society of Civil Engineers
BC	Brown and Caldwell
BMP	best management practice(s)
CFU	colony forming unit(s)
City	City of West Linn
DEQ	(Oregon) Department of Environmental Quality
DO	dissolved oxygen
EMC	event mean concentration
EPA	United States Environmental Protection Agency
GIS	geographic information system
LA	load allocation
lb	pound(s)
LCL	lower confidence limit
mL	milliliter(s)
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
PLRE	pollutant load reduction evaluation
SFR	single-family residential
SOD	sediment oxygen demand
SVS	settleable volatile solids
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence limit
UIC	underground injection control
WLA	wasteload allocation

Definitions

Load allocation	The amount of pollutant allocated to existing nonpoint sources and natural background in a total maximum daily load (TMDL). (EPA 2014, http://toxics.usgs.gov/definitions/tmdl.html)
Pollutant load reduction benchmark	A future pollutant load reduction estimate for a parameter or surrogate, where applicable, for which a wasteload 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 when compared to previous loads for a parameter or surrogate, where applicable, for which a WLA is established. The pollutant load reduction evaluation (PLRE) is used to measure progress toward achieving a WLA or previously established benchmark.
Wasteload allocation	The amount of pollutant load allocated to a specified point source (e.g., a permitted sewage treatment plant, industrial facility, or stormwater discharge) in a TMDL. (EPA 2014, http://toxics.usgs.gov/definitions/tmdl.html)

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Section 1

Introduction

This report presents the 2015 total maximum daily load (TMDL) pollutant load reduction evaluation (PLRE) and the 2017 TMDL pollutant load reduction benchmarks for the City of West Linn (City). As required by the City's National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Separate Storm Sewer System (MS4) permit, the PLRE includes:

- An evaluation of the estimated pollutant loading based on current land use from all MS4 permitted areas of the city
- An evaluation of the pollutant load reduction based on the City's current use of structural water quality controls or best management practices (BMPs)
- A comparison of the current pollutant load reduction to benchmarks established as part of the City's permit renewal application in 2008

The City is required to establish new pollutant load reduction benchmarks for TMDL parameters where the PLRE shows that wasteload allocations (WLAs) are not currently being achieved. The benchmark development includes:

- Identification of additional or modified BMPs anticipated over the next permit term
- An evaluation of the estimated pollutant loading and pollutant load reduction based on the City's current and anticipated future use of BMPs

West Linn is subject to TMDLs in four watersheds: Tualatin River, Lower Willamette, Middle Willamette tributaries, and Middle Willamette direct, as shown in Table 1-1.

The PLRE results presented in Section 4.9 show that structural BMP implementation in West Linn is estimated to result in the achievement of WLAs for bacteria in the Tualatin River TMDL watershed. Thus, new benchmarks are not required for bacteria in this watershed.

The City is reducing pollutant loads and estimated to be meeting previously established pollutant load reduction benchmarks in the Lower Willamette and Middle Willamette TMDL watersheds and the Tualatin River TMDL watershed. However, significant additional pollutant reduction will be needed to achieve WLAs for bacteria in the Lower Willamette and Middle Willamette TMDL watersheds and for total phosphorus and total suspended solids (TSS) in the Tualatin River TMDL watershed. Therefore, updated benchmarks for these watersheds are presented in Section 5 and Appendix B.

This report also includes an analysis of long-term trends in receiving water quality based on instream monitoring data.

1.1 Permit Requirements

The City is a co-permittee on the Clackamas County NPDES MS4 Permit 101348, issued on March 16, 2012 (DEQ 2012a). The requirements to evaluate TMDL pollutant load discharges are detailed in Schedule D.3 as follows:

a. *Applicability: The requirements of this section apply to the co-permittee's MS4 discharges to receiving waters with established TMDLs or to receiving waters with new or modified TMDLs approved 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 implementation of BMPs and an adaptive management process.*

The following two subsections provide more detail regarding the TMDL pollutant load evaluation requirements from the permit: the PLRE and benchmarks.

1.1.1 PLRE Requirements

Per Schedule D.3.c of the Clackamas County NPDES MS4 permit, the City must complete a PLRE by November 1, 2015. 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.*

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 trends 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.*

viii. *A narrative summarizing progress towards applicable TMDL WLAs and existing TMDL benchmarks, if applicable.*

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

The City submitted a letter to the Oregon Department of Environmental Quality (DEQ) on October 14, 2015, requesting an extension for the PLRE until February 1, 2016 (West Linn 2015), and DEQ granted the requested extension.

1.1.2 Benchmark Requirements

Per Schedule D.3.d of the Clackamas County NPDES MS4 permit, the City must develop pollutant load reduction benchmarks for the next permit term for each applicable TMDL parameter where existing BMP implementation is not shown to be achieving WLAs. Benchmarks must be submitted with the permit renewal application, which is due March 1, 2017. Per subsection D.3.d.ii, the benchmark submittal must include the following:

1. *An explanation of the relationship between the TMDL WLAs and the TMDL benchmark for each applicable TMDL parameter;*
2. *A description of how SWMP implementation contributes to the overall reduction of the TMDL pollutants during the next permit term;*
3. *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*
4. *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.*

1.2 TMDL Applicability

TMDLs are developed to project 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).

West Linn is located in the Willamette River watershed, adjacent to both the Willamette and Tualatin rivers. The relevant TMDLs are the Willamette Basin TMDL, approved on September 29, 2006, by the United States Environmental Protection Agency (EPA) and the Tualatin Subbasin TMDL, approved on August 7, 2001, by EPA and amended on August 28, 2012.

1.2.1 Willamette Basin TMDL Pollutant Summary

The Willamette Basin TMDL addresses elevated in-stream temperatures, bacteria (*E. coli*), and mercury for the Willamette River and tributaries. Additional pollutant parameters are included in the Willamette Basin TMDL for select tributaries.

In West Linn, the Willamette Basin TMDL includes water-body-specific allocations for urban stormwater sources of bacteria in the Lower Willamette River, unspecified tributary discharges to the Middle Willamette River, and direct discharges to the Middle Willamette River. Bacteria are considered to be a pollutant with direct ties to stormwater runoff; thus, bacteria are regulated under the NPDES MS4 permits as a point source pollutant. Therefore, the City is required to conduct a PLRE for bacteria for all three Willamette TMDL watersheds and, as necessary, develop benchmarks.

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

Mercury is identified as a pollutant with direct ties to stormwater runoff, but DEQ has not yet completed its analysis to establish source-specific WLAs for mercury. Therefore, pollutant load reduction estimates and benchmarks for mercury are not required in this evaluation.

1.2.2 Tualatin Subbasin TMDL Pollutant Summary

The Tualatin Subbasin TMDL addresses elevated in-stream temperatures, bacteria *(E. coli),* chlorophyll *a* and pH (total phosphorus as a surrogate measure), and dissolved oxygen (DO) (ammonia and settleable volatile solids [SVS] as a surrogate measure) for the Tualatin River and tributaries.

As described in the previous section, bacteria are regulated under the NPDES MS4 permits as a point source pollutant. Therefore, the City is required to conduct a PLRE for bacteria in the Tualatin River TMDL watershed and, as necessary, develop benchmarks.

As described for the Willamette Basin TMDL, DEQ does not typically consider temperature to be a pollutant parameter associated with urban stormwater runoff. Therefore, WLAs have not been established for temperature, and temperature is not evaluated in this report.

DO, pH, and chlorophyll *a* are not independently considered to be pollutants, but rather an effect of elevated temperature, low flows, excessive algal growth, 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 have a direct tie to stormwater runoff when considering impacts of the discharge of pollutants such as nutrients (i.e., total phosphorus) and sediment. Total phosphorus and SVS are often used as surrogates for DO, chlorophyll a and pH. Given the lack of data for SVS, the Tualatin Subbasin TMDL references TSS as a common parameter to represent SVS. Therefore, the City is required to conduct a PLRE for total phosphorus and TSS in the Tualatin River TMDL watershed and, as necessary, develop associated benchmarks.

1.2.3 TMDL Wasteload Allocations

West Linn submitted a PLRE and pollutant load reduction benchmarks as part of its Phase I NPDES MS4 permit renewal submittal in September 2008 (West Linn 2008). It should be noted that the Tualatin Subbasin TMDL was amended in 2012 for total phosphorus and ammonia. However, this amendment did not affect the previously established WLAs for urban stormwater or change the results of the PLRE and benchmarks submitted in 2008.

The WLAs shown in Table 1-1 and the benchmarks established in 2008 are the two metrics used in this document to evaluate whether the City's current pollutant load reductions are meeting regulatory obligations.

Table 1-1. West Linn Applicable WLAs

TMDL waterbody	Parameter	WLA
Tualatin River	Bacteria *(E. coli)*	5,000 counts/100 mL (winter storm event concentration) 12,000 counts/100 mL (summer storm event concentration)
	Total phosphorus	0.14 mg/L (summer seasonal concentration)
	DO (TSS as a surrogate)	20% reduction (summer seasonal)
Lower Willamette	Bacteria *(E. coli)*	78% reduction (annual)
Middle Willamette (via tributaries)	Bacteria *(E. coli)*	88% reduction (summer seasonal) 75% reduction (fall, winter, spring seasonal)
Middle Willamette (direct)	Bacteria *(E. coli)*	75% reduction (annual)

In the Willamette Basin TMDL, the WLAs for bacteria[1] (*E. coli*) are calculated as a percent load reduction for each general land use type. The MS4 contribution is assumed to equate to the urban land use type and WLAs are defined for summer season, fall-winter-spring season, and annual loads as shown in Table 1-1. In the Tualatin Subbasin 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 in 24 hours and a winter storm event of 1.96 inches in 96 hours.

[1] There is some discrepancy in the way MS4 sources are addressed in various TMDL documents. The Willamette Basin TMDL uses the term "load allocation" to define pollutant load discharges from urban land uses, including the City's NPDES MS4 permit area. For the purposes of this evaluation, the load allocation referenced in the Willamette Basin TMDL is assumed to be a WLA because it is applied to the City's NPDES MS4 permit area.

In both the Willamette Basin TMDL and Tualatin Subbasin TMDL, the water quality criterion for bacteria, which is the monthly logarithmic mean concentration of 126 *E. coli* per 100 milliliters (mL), was used to establish the required bacteria WLAs.

In the Tualatin Subbasin TMDL, the WLAs for total phosphorus (as a surrogate for pH and chlorophyll a) are established as a median concentration in stormwater runoff for the summer season (May to October). The TMDL assigns WLAs for point source discharges (excluding wastewater treatment plants) according to the location of discharges along the Tualatin River. Point source WLAs for total phosphorus are based on maintaining an in-stream total phosphorus concentration below 0.15 milligram per liter (mg/L), which is considered natural background conditions.

In the Tualatin Subbasin TMDL, the WLA for TSS (as a surrogate for SVS) was calculated based on the necessary reduction in sediment oxygen demand (SOD) required to meet DO criteria along the main stem and tributaries of the Tualatin River[2]. SOD reduction for runoff sources (i.e., MS4 runoff) is addressed through the allocation of SVS and total phosphorus. Because the background SVS load is unknown, the WLA is presented as a percent reduction from current conditions and management efforts are expected to incorporate TSS (as opposed to SVS) as a target parameter.

[2] The Tualatin Subbasin TMDL, pp. 124, indicates that SOD is caused in great part by the discharges of SVS. Load reduction to improve the DO concentration is referred to as the reduction of SVS in the TMDL.

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Section 2

Process and Methodology

In accordance with Schedule D.3.c of the City's NPDES MS4 permit, jurisdictions are required to conduct a PLRE for all applicable TMDL parameters. The PLRE must reflect current (2015) development conditions. The PLRE must include estimates of current pollutant loading both with and without BMP implementation. Results of the PLRE must be compared to previously established pollutant load reduction benchmarks and applicable WLAs. The PLRE can be 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 course of the next permit term.

The PLRE was conducted for each TMDL watershed and pollutant parameter listed in Table 1-1. Benchmarks have been calculated for select pollutant parameters, based on results of the PLRE. The overall process and methodology in conducting the PLRE and establishing benchmarks is described below. Modeling assumptions and input data are described in Section 3.

2.1 PLRE and Benchmark Process

Figure 2-1 depicts the 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 with 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 method 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 2-1, three general categories of BMPs are considered in the process:

1. Structural BMP systems for which pollutant removal can be reported quantitatively and is 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 effectiveness information is limited or unavailable. These BMPs include downspout disconnection programs, street sweeping, and catch basin cleaning. These BMPs may be reflected in the modeling effort by simulating their specific coverage area with adjusted impervious areas, runoff coefficients, or land use EMCs.
3. Non-structural/source-control BMP applications where pollutant removals are not likely to be reported in objective, quantitative terms. These BMPs include programmatic BMPs such as 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. Implementation of non-structural or non-quantifiable BMPs (Category 3) has the potential to reduce pollutant loads further than is reflected in this evaluation.

2.2 Model Methodology

The PLRE and benchmark analysis was conducted using a spreadsheet loads model that is based on the EPA simple method for pollutant load calculations. The model was developed in 2008 for multiple Oregon Phase I NPDES MS4 jurisdictions, including the City, to calculate pollutant loads and to develop pollutant load reduction benchmarks. The same spreadsheet loads model was used for this effort with the following modifications:

- Updated impervious percentages were calculated for each land use category
- New BMP categories were added to account for the following BMP facility types not included in the previous loads models: porous pavement, lined planters/filtration rain gardens, and eco roofs
- BMP effluent concentration data were refined based on a collective effort among ACWA jurisdictions to update BMP effectiveness information with new literature information

Rainfall, land use, and BMP coverage information was entered into the spreadsheet loads model. Using established land use EMCs, annual, seasonal, and design storm-specific (when applicable) pollutant loads were calculated as pounds for phosphorus and TSS, and counts for *E. coli*. Pollutant loads were calculated for each TMDL watershed for each parameter shown in Table 1-1.

Pollutant load and pollutant load reduction calculations were based on land use pollutant load concentrations and BMP effluent concentrations established through a joint effort between Oregon Phase I NPDES permittees. The statewide coordination process was facilitated through the Oregon ACWA Stormwater Committee. Tables of pollutant concentrations by land use, referred to in this report as “EMCs,” were originally developed in 2005 for Phase I jurisdictions and updated in 2008. The land use EMC data were developed using published, statistically verified national data, and data obtained by local jurisdictions. In each revision, the data were *bootstrapped*, a statistical method to estimate upper and lower confidence intervals.

The BMP effluent concentration data were originally developed in 2005, and updated in 2008 and 2014 to reflect additional BMP categories and updated BMP monitoring results. BMP effluent concentrations were used to calculate pollutant removal due to the implementation of structural BMPs in each TMDL watershed for applicable pollutant parameters (shown in Table 1-1).

Most structural BMPs are not capable of treating all runoff that may enter a facility in any given year. Generally, BMPs are designed to treat a proportion of the total annual rainfall/runoff that occurs. The City’s NPDES MS4 permit requires water quality treatment for 80 percent of the average annual runoff volume. Thus, structural BMPs included in the model were assumed to capture and treat 80 percent of the average annual rainfall, and bypass 20 percent of the average annual runoff.

As an exception, in the Tualatin Subbasin TMDL, WLAs for bacteria were established based on summer and winter storm events. The identified summer and winter storm events are, on average, smaller than a storm event that would equate to treatment of 80 percent of the average annual runoff volume. As a result, BMP bypass was not accounted for in the pollutant load modeling for bacteria in the Tualatin River TMDL watershed.

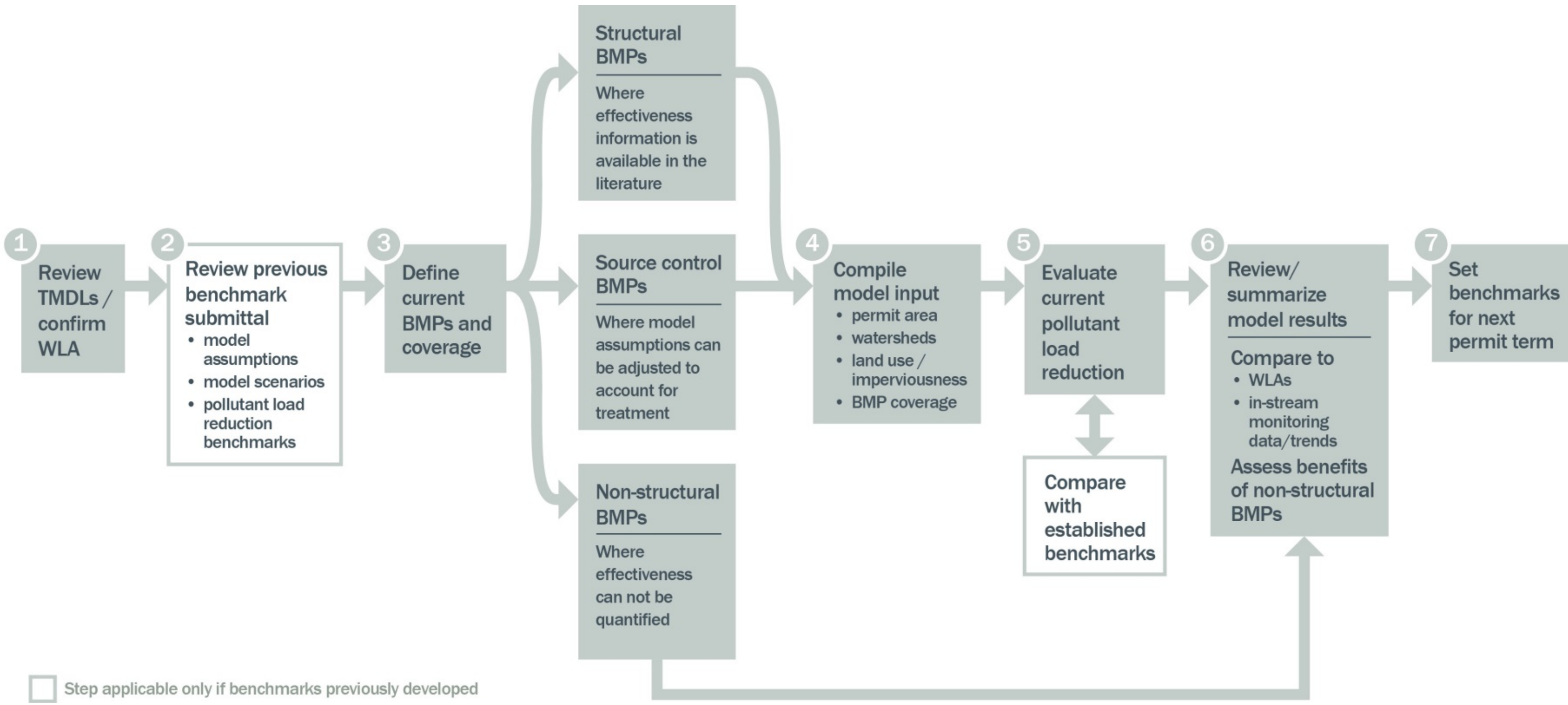

Figure 2-1. PLRE and benchmark development process

Quantitative data are not currently available to assess the effectiveness of source-control or non-structural BMPs for the City. Therefore, effectiveness of source-control and non-structural BMPs were not included in the model, but are qualitatively incorporated in the pollutant load evaluation based on best professional judgment and summarized in Section 4.6.

Model simulations were conducted for each PLRE scenario (current no-BMP and current with-BMP). Pollutant loads and pollutant load reductions were calculated for the upper confidence limit (UCL), mean (or geometric mean for bacteria), and lower confidence limit (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.

For TMDL parameters that require the development of benchmarks, an additional simulation (future with-BMP) was conducted. The future with-BMP scenario assumes all current (2015) BMPs are still in place and functioning, and it includes the addition of new BMPs anticipated to be constructed by the end of the next 5-year permit term (i.e., by 2022). Pollutant loads and pollutant load reductions were calculated using the current no-BMP and the future with-BMP scenarios consistent with the PLRE methodology.

2.3 Model Output

Based on the modeling results, the current no-BMP pollutant load range (LCL to UCL) was first documented for each TMDL pollutant for each watershed and each analysis period. This current no-BMP load is the starting point for PLRE calculations and comparison to WLAs and previously established TMDL benchmarks.

For West Linn, the WLAs were calculated as follows:

- The WLAs for bacteria in the Willamette River are defined as annual or seasonal percent reductions. The WLAs (as loads) were calculated as the percent load reduction from the current no-BMP, mean pollutant load.
- The WLAs for total phosphorus and bacteria in the Tualatin River are defined as concentrations. For both parameters, the pollutant concentrations listed in Table 1-1 were converted to pounds or counts based on the total seasonal or event runoff volume. This allows direct comparison between the WLA and the calculated pollutant loads.
- The WLA for TSS in the Tualatin River is based on a seasonal percent reduction. The WLA (as a load) was calculated as the percent load reduction from the current no-BMP, mean pollutant load.

PLRE calculations reflect the difference between the current no-BMP and current with-BMP pollutant loads. Because loads are presented as a range, the estimated pollutant load reduction is also identified as a range, reflecting the difference between the current no-BMP and current with-BMP pollutant loads for the UCL, and the difference between the current no-BMP and current with-BMP pollutant loads for the LCL.

2.3.1 Comparing Pollutant Loads to WLAs and Previous Benchmarks

For graphic representation, the current no-BMP loads and current with-BMP loads are shown as a range. The WLA is shown as a single value, based on the mean value calculations. The resulting PLRE graphs are included in Section 4 and indicate whether WLAs are being achieved. Additional discussion related to PLRE modeling results is also provided in Section 4.

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously established benchmarks (Schedule D.3.c.iv). The City previously developed TMDL benchmarks as part of the Phase I NPDES MS4 permit renewal submittal in September 2008. The 2008 benchmarks are presented in Section 4 as a pollutant load reduction range and are directly comparable with the PLRE results.

2.3.2 Calculating Benchmarks

Benchmarks are calculated as the difference between the current no-BMP and future with-BMP pollutant loads. As with the PLRE, the benchmarks are identified as a range, reflecting the difference between the current no-BMP and future with-BMP pollutant loads for the UCL, and the difference between the current no-BMP and future with-BMP pollutant loads for the LCL. Results and discussion related to development of TMDL benchmarks is included in Section 5.

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

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Section 3

Modeling Assumptions and Input Data

This section describes the assumptions and input data associated with developing the spreadsheet loads model for the PLRE and benchmark analysis. Model input data calculations were performed by Brown and Caldwell (BC), using updated geographic information system (GIS) data sets developed and maintained by the City.

Modeled area and land use coverage show only minor changes from the 2008 model. BMP coverage is significantly changed from 2008 assumptions due to changes in how the City is tracking stormwater management facilities and refining their mapping of BMP drainage areas.

The subsections below include information regarding modeled areas, land use and impervious area assumptions, BMP coverage, runoff concentrations, and BMP effluent data. As applicable, 2008 modeling assumptions are provided for comparison to show how modeled conditions have changed in the watershed.

A map showing model input data including current and anticipated future BMP coverage is included as Figure 3-1.

3.1 Model Area

The City's NPDES MS4 permit covers "all existing and new discharges of stormwater from the MS4 within the service boundaries of incorporated cities" (DEQ 2012a). As such, the modeled area for this PLRE and benchmark analysis has been defined to include all areas within city limits as of November 2015.

Areas within the city that are the responsibility of the Oregon Department of Transportation (ODOT) were omitted from the modeled area, as ODOT has a separate NPDES MS4 permit for discharges from these areas. For West Linn, this included the Interstate 205 corridor and the Oregon Highway 43 corridor. In addition, the open-water areas of the Willamette River and Tualatin River were excluded from the modeled areas. These exclusions are consistent with modeling assumptions from the previous analyses.

In addition, areas that are covered by a general 1200-Z NPDES permit for stormwater discharges from industrial sources were omitted from the modeled area. In West Linn, the West Linn Paper Company currently holds a 1200-Z permit and the associated area was omitted from the Middle Willamette tributary and Middle Willamette direct model areas.

As described in Section 1, individual WLAs are defined for four TMDL watersheds; therefore, each TMDL watershed was modeled separately and pollutant loads for the modeled areas were compared to the respective WLAs. The City's watershed basin GIS layer was used to define the subbasins across the city that have been assigned to the larger TMDL watersheds, as shown in Table 3-1.

Table 3-1. West Linn TMDL Watershed Summary		
TMDL watersheds	**Subbasins**	
Tualatin River	Dollar Creek Fritchie Creek Tualatin River	Upper Tualatin River Unnamed Johnson Creek
Lower Willamette	Arbor Creek Bolton Creek Fern Creek Gans Creek Heron Creek Hidden Springs Creek Maddax Creek	Robin Creek Robinwood Creek Trillium Creek Mary S. Young Creek Barlow Creek Lower Willamette direct Turkey Creek
Middle Willamette tributaries	Bernert Creek Cascade Pond Springs Creek McLean Creek	Salamo Creek Sunset Creek Tanner Creek
Middle Willamette direct	Middle Willamette direct	

Table 3-2 compares the 2015 total modeled area by TMDL watershed to the 2008 total modeled area for each TMDL watershed. Changes in the modeled areas between 2008 and 2015 are due to City annexations, adjustments in ODOT right-of-way mapping, and a greater understanding of drainage basin boundaries. It should be noted that the City's defined MS4 permit area and total modeled area includes areas that discharge through the MS4 system as well as areas that may discharge directly to receiving waters without first entering the MS4.

Table 3-2. Modeled Areas		
TMDL watersheds	**2015 PLRE, total modeled area (ac)[a]**	**2008 PLRE, total modeled area (ac)[a]**
Tualatin River	652.8	601.8
Lower Willamette	2,228.9	2,577.9
Middle Willamette tributaries	1,430.3	1,327.2[b]
Middle Willamette direct	247.6	

a. *The total modeled area reflects the NPDES MS4 permit area boundary minus ODOT right-of-way, 1200-Z permit areas, and water bodies.*

b. *The 2008 permit renewal documentation reported only the combined areas discharging both directly and through tributaries to the Willamette River.*

3.2 Land Use and Impervious Areas

Land use coverage for the PLRE and benchmark analysis was developed based on City zoning as of November 2015. The land use coverage also incorporated vacant-lands data from Metro, which is based on 2013 aerial photos. City staff reviewed the vacant-lands coverage in conjunction with the City's residential buildable-lands inventory in order to refine the vacant-lands coverage to exclude infill lots with existing development.

The zoning categories from the *City of West Linn Comprehensive Plan* (last amended June 2014) were grouped into the land use modeling categories as shown in Table 3-3.

The modeled impervious percentage for each modeled land use category was based on values defined in the *Final West Linn Stormwater Master Plan* (2006) and summarized in Table 3-3. Vacant lands were assumed to be 3 percent impervious, based on a visual review of the updated vacant-lands coverage in GIS and 2015 aerial photos. Vacant lands were previously modeled with zero percent impervious in 2008, which was determined not to be reflective of the typical condition of vacant lots in the City.

Table 3-3. Modeled Land Use Categories

Comprehensive Plan land use category	Modeled land use category	2015 modeled impervious percentage
No zone[a]	Single-family residential	21
Low-density residential	Single-family residential	
Medium-density residential	Single-family residential	
Medium-high density residential	Multi-family	35
Mixed use	Commercial	85
Commercial	Commercial	
Industrial	Industrial	85
Parks	Parks and open space	0
Open spaces	Parks and open space	
All vacant	Vacant[b]	3

a. *One parcel in the city is designated as "no zone." As such, that parcel has been assigned to the single-family residential land use category because it is surrounded by low-density residential zoning.*

b. *Vacant lands include areas of all land use categories that are not currently developed or are not developed to the density indicated in the comprehensive plan.*

The impervious percentages in the model were used to estimate runoff coefficients for each land use category by applying the following EPA equation:

Runoff coefficient = 0.05 + 0.009 (percent impervious)

Rainfall was multiplied by the runoff coefficient to obtain an estimated runoff volume. The appropriate pollutant concentration was then applied to that impervious area runoff to obtain a load estimate, based on the land use category as described in Section 3.4.

The breakdown of modeled area by land use for each TMDL watershed is outlined in Table 3-4 and shown in Figure 3-1.

Table 3-4. Summary of 2015 Model Input Parameters (Land Use)

TMDL water body	Total modeled area (ac)	Land use breakdown (ac)					
		Commercial	Industrial	Single-family residential	Multi-family residential	Vacant	Parks and open space
Tualatin River	652.7	2.9	0.0	518.5	40.3	25.2	65.8
Lower Willamette	2,228.8	33.4	0.0	1,697.4	45.1	57.3	395.7
Middle Willamette tributaries	1,430.3	127.1	45.8	1,020.4	93.1	45.6	98.3
Middle Willamette direct	247.6	13.0	129.8	71.6	0.0	0.9	32.3

3.3 BMP Coverage

A more robust GIS BMP inventory was available for this modeling effort as compared to what was available in 2008. The City maintains an inventory of public and private stormwater treatment facility installations, which is continually being updated as new facilities are constructed or identified.

The PLRE modeling effort included refinement of the drainage areas associated with each existing facility, resulting in more conservative estimates of BMP coverage (i.e., fewer acres [ac] contributing to an individual facility). Where BMP drainage areas overlapped, the area was assigned to the structural BMP that appeared to be the farthest downstream, and providing the better overall treatment (i.e., lower BMP effluent concentrations). This method does not give credit for additional load removal likely achieved with BMPs that perform in series.

Table 3-5 summarizes the structural BMP categories included in this modeling effort. The modeled BMP categories are based on categories with available BMP effluent concentrations, as described in Section 3.4. In some cases, the City GIS classification of BMPs differed from the modeled BMP categories. Table 3-6 and Figure 3-1 show the 2015 BMP coverage in each modeled TMDL watershed used to develop the PLRE. Potential BMP coverage used to develop benchmarks is also shown in Figure 3-1 and discussed in further detail in Section 5.

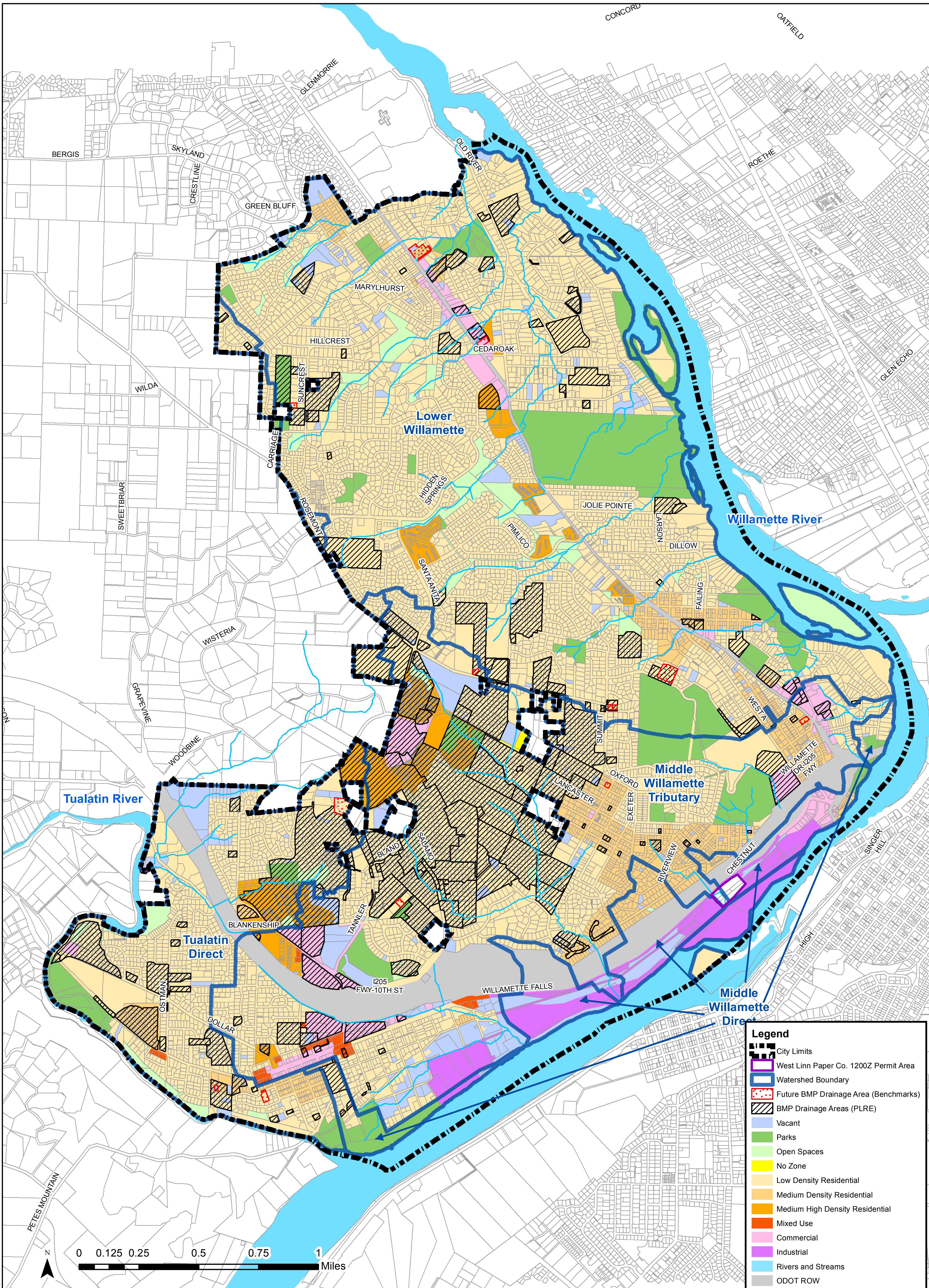
Table 3-5. Structural BMP Categories Used in West Linn's Pollutant Loads Model

2015 City BMP category	2015 modeled BMP category
Eco roof	Ecoroof
Filter	Media filter
PC manhole	Sedimentation manhole
Pond (dry)	Dry, detention pond
Pond (wet)	Wet, retention pond
Rain garden	Lined planter/rain garden with underdrain
Swale	Biofiltration swale/vegetated filter strip

Table 3-6. Summary of Model Input Parameters (2015 BMP Coverage)

TMDL water body	BMP coverage area (% model area)	BMP coverage (ac)						
		Media filter	Dry, detention ponds	Wet, retention ponds	Biofiltration swale/ vegetated filter strip	Sedimentation manhole	Lined planter/ rain garden with underdrain	Ecoroof
Tualatin River	25	0.0	23.5	14.1	108.3	14.4	5.4	0.0
Lower Willamette	8	8.3	4.7	9.9	69.8	58.9	21.5	0.0
Middle Willamette tributaries	37	18.1	78.0	273.4	113.4	35.0	12.1	0.0
Middle Willamette direct	3	0.0	0.0	0.0	5.8	0.0	0.4	0.0

The 2008 modeling effort included significant areas contributing to BMPs designated as wetland. However, improved mapping and tracking of BMPs has shown that those areas were generally natural open-space wetland areas. The wetlands were not constructed stormwater management facilities. As such, the wetland BMP category has not been included in this modeling effort. Detail regarding changes between the 2008 and 2015 BMP coverage assumptions and associated impacts to the PLRE results are documented in Section 4.5.



West Linn

CITY OF WEST LINN, OREGON

POLLUTANT LOAD REDUCTION EVALUATION

Brown AND Caldwell

Figure 3-1. TMDL Watersheds, Land Use, and BMP Coverage.

Data Source: City of West Linn GIS and Metro RLIS

Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Map Publication/Print Date: December, 10 2015

It is assumed that additional structural BMP facilities exist in West Linn that are not currently included in the City's structural BMP tracking system. While such facilities (likely associated with private property) may be providing additional pollutant load reduction, they are not currently inventoried and therefore are not accounted for in this modeling effort.

Non-structural BMPs were not directly included in the model simulations. Non-structural BMPs include street sweeping, illicit discharge investigations, public education, and other operational and/or programmatic actions. The model also did not account for private implementation of industrial source controls such as oil/water separators or spill control valves.

3.4 Runoff Concentrations and BMP Effluent Data

In 2014, Phase I jurisdictions worked together to review and refine land use EMC data, BMP categories, and BMP effluent concentrations. Land use concentration data, including the upper and lower confidence intervals, are provided in Table 3-7. These values are consistent with the City's 2008 data assumptions.

Table 3-7. Land Use-Based Pollutant Load Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Land use	Count[c]	Bootstrapped mean		
			95% LCL	Mean	95% UCL
TSS (mg/L)	Commercial	72	64	82	103
	Industrial	48	117	184	284
	Open space[a]	10	16	31	50
	Residential[b]	65	44	66	99
Parameter	Land use	Count[c]	Bootstrapped median		
			95% LCL	Mean	95% UCL
Total phosphorus (mg/L)	Commercial	26	Commercial	26	0.230
	Industrial	25	Industrial	25	0.360
	Open space[a]	9	Open space[a]	9	0.079
	Residential[b]	36	Residential[b]	36	0.160
Parameter	Land use	Count[c]	Bootstrapped geometric mean		
			95% LCL	Mean	95% UCL
E. coli, CFU/100 mL (geomean)	Commercial	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

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

a. *Land use EMCs for open space are also used to simulate pollutant loads from impervious areas of vacant land use.*

b. *Land use EMCs for residential are also used to simulate pollutant loads from impervious areas of multifamily residential.*

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

The land use EMCs listed in Table 3-7 do not include all of the modeled land use categories. Therefore, some land use categories were modeled using concentration data from a land use category that had a comparable pollutant load. This occurred for the vacant and multi-family land use categories as described in the table footnotes.

BMP categories and BMP effluent concentrations were updated in 2014 based on additional information contained in the American Society of Civil Engineers (ASCE) BMP database, and locally obtained data. New BMP categories included the addition of lined planters/filtration rain gardens, eco roofs, and porous pavement as options in the PLRE and benchmark models. The mean and median BMP effluent concentration values are provided in Table 3-8.

Table 3-8. BMP Effluent Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Unit	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	decimal %	0.00	0.00	0.23	0.05	0.29	0.00	0.00	0.50	1.00	1.00	0.30
		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:

Most values are consistent with the ACWA data set (2008) and consistent with 2008 data assumptions. Underlined values reflect an increase from 2008 values.

Shaded values are updated values per the 2014 ACWA Stormwater Committee reanalysis of BMP effectiveness.

*Values in **black background** are new values per the 2014 ACWA Stormwater Committee reanalysis of BMP effectiveness.*

Effluent concentrations shown as N/A are provided for BMP facilities that achieve 100% flow reduction, as no effluent is generated with which to analyze.

3.5 Rainfall Values

Modeled rainfall volumes are consistent with assumptions from the 2008 PLRE and benchmark development.

The Tualatin Subbasin TMDL includes 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). The 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 per 24 hours, and the winter seasonal storm event is 1.96 inches per 96 hours. The total phosphorus and TSS WLAs were identified as summer seasonal concentration and were evaluated based on a summer seasonal rainfall of 6.82 inches.

The Willamette Basin TMDL includes varying WLAs for bacteria. In the Lower Willamette, bacteria WLAs are identified as a single percent reduction and, for purposes of this evaluation, are evaluated on an annual basis with an annual rainfall of 47.5 inches.

In the Middle Willamette WLAs for bacteria vary depending on whether discharge is to a tributary or direct to the Willamette River. For tributary areas, the bacteria WLAs are identified as a seasonal percent reduction. The summer seasonal rainfall volume, reflecting rainfall between May 1 and October 31, is 6.82 inches. The fall-winter-spring seasonal rainfall volume, reflecting rainfall between November 1 and April 30, is 40.68 inches.

For direct-discharge areas in the Middle Willamette, the bacteria WLAs are identified as a single percent reduction, evaluated on an annual basis. An annual rainfall volume of 47.5 inches was used to evaluate pollutant loads for the Middle Willamette River direct watershed.

3.6 Model Input Files

City staff generated GIS shapefiles to populate the pollutant loads model with area-based information reflecting model area, model land use, and BMP coverage. BC performed necessary data processing calculations to establish base data for the models. The resulting map package (West_Linn_mappackage.mpk) provides a record for City files and future modeling efforts. It includes the following shapefiles to document BMP delineation and processing: BMPs_existing.shp; BMPs_future.shp; and BMPs_all_modified.shp.

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Section 4

Pollutant Load Reduction Evaluation Results

PLRE model results for each TMDL watershed, including comparison of model results to the benchmarks established in 2008, are described below. Model results include a numeric estimate of the current (2015) 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 WLAs (Schedules D.3.c.viii and D.3.c.ix).

PLRE model results include estimates of the incremental improvements associated with the implementation of structural BMPs. The model results are not reflective of full implementation of the City's stormwater program, which includes additional non-structural BMP activities. Therefore, model results are assumed to underestimate the pollutant removal achieved through the City's stormwater program.

4.1 Tualatin River

The Tualatin River watershed area includes approximately 650 acres at the west end of the city. The area is largely residential with some areas identified for future infill development. Many developments in the Tualatin River watershed area have been constructed with stormwater management facilities to provide flow detention and/or water quality treatment. Current structural BMP coverage is at 25 percent.

Results of the PLRE for each applicable pollutant are described in the following sections.

4.1.2 Tualatin River Bacteria

Figures 4-1 and 4-2 show that West Linn is currently estimated to be meeting the WLAs for bacteria in the Tualatin River TMDL watershed area. The bacteria WLAs are written as concentrations of 5,000 counts per 100 mL for a summer storm event, and 12,000 counts per 100 mL for a winter storm event. For the purposes of presenting graphical results, these concentrations have been converted to loads, based on the total runoff volume for each seasonal event. The current, with BMP pollutant load estimate equates to a concentration range between 853 and 2,207 counts per 100 mL, which is lower than both seasonal event WLAs.

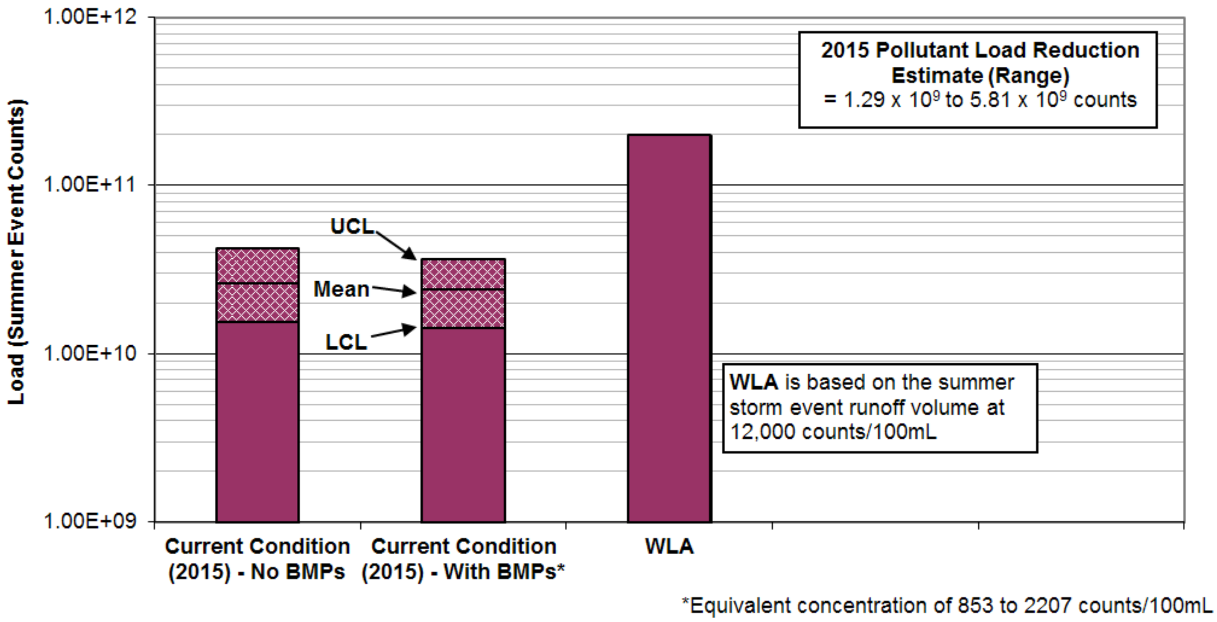

Figure 4-1. West Linn: *E. coli* PLRE results for Tualatin River TMDL watershed (summer event)

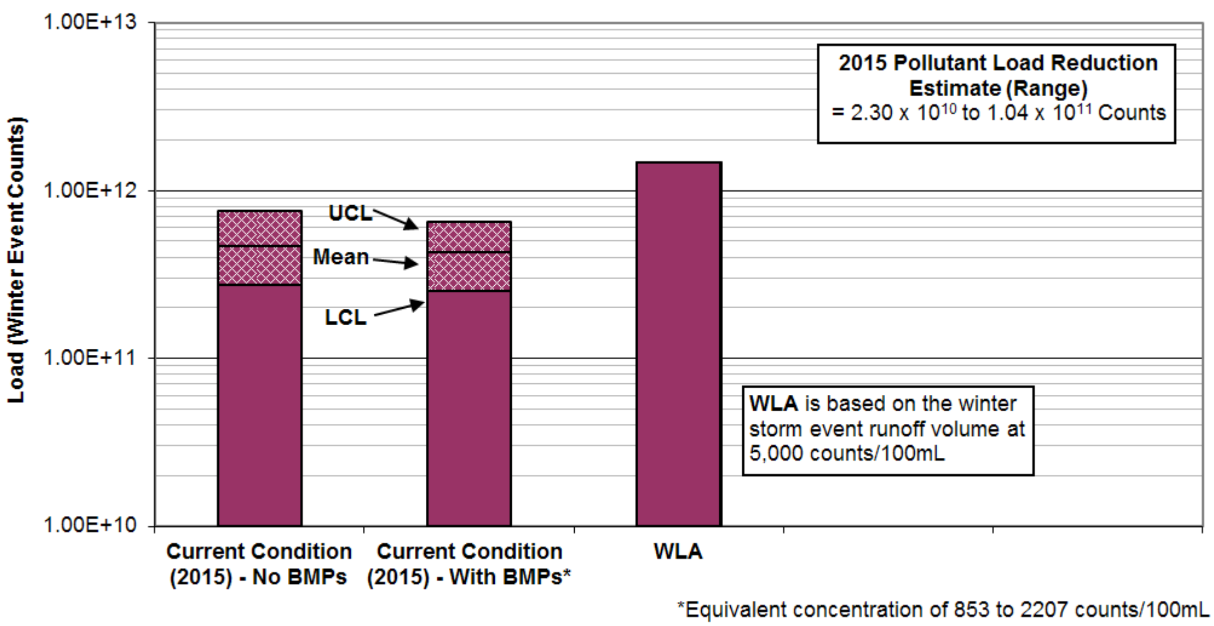

Figure 4-2. West Linn: *E. coli* PLRE results for Tualatin River TMDL watershed (winter event)

4.1.3 Tualatin River Total Phosphorus

Figure 4-3 shows that West Linn is not currently estimated to be meeting the WLAs for total phosphorus in the Tualatin River watershed area. The total phosphorus WLA is written as a concentration of 0.14 mg/L during the summer season (May 1 through October 31). For the purposes of presenting graphical results, the concentration has been converted to a seasonal load of 28.46 pounds, based on the total summer season runoff volume. The pollutant load estimates with current BMP coverage range from 30 to 42 pounds, which equates to a concentration range between 0.15 and 0.21 mg/L.

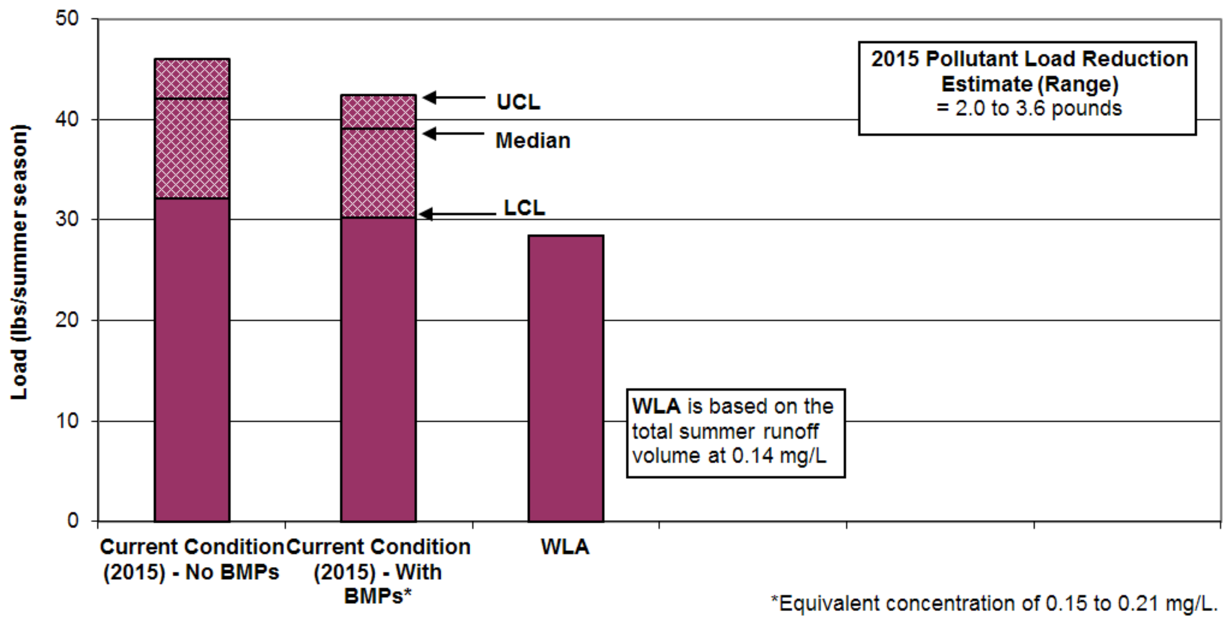

Figure 4-3. West Linn: Total phosphorus PLRE results for Tualatin River TMDL watershed (summer season)

Additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA for total phosphorus. Section 4.6 describes some of the non-structural BMPs that are implemented in this watershed, but not directly considered in the pollutant load reduction estimate. It is possible that the additional pollutant removal achieved through non-structural BMPs would result in meeting the WLA.

4.1.5 Tualatin River TSS

Figure 4-4 shows that West Linn is not currently estimated to be meeting the WLA for TSS in the Tualatin River watershed area. The PLRE shows a pollutant load reduction range of 10.5 to 16.8 percent compared with the WLA of 20 percent. The PLRE shows a mean load decrease of approximately 1,800 pounds for the summer season when comparing conditions with and without BMPs.

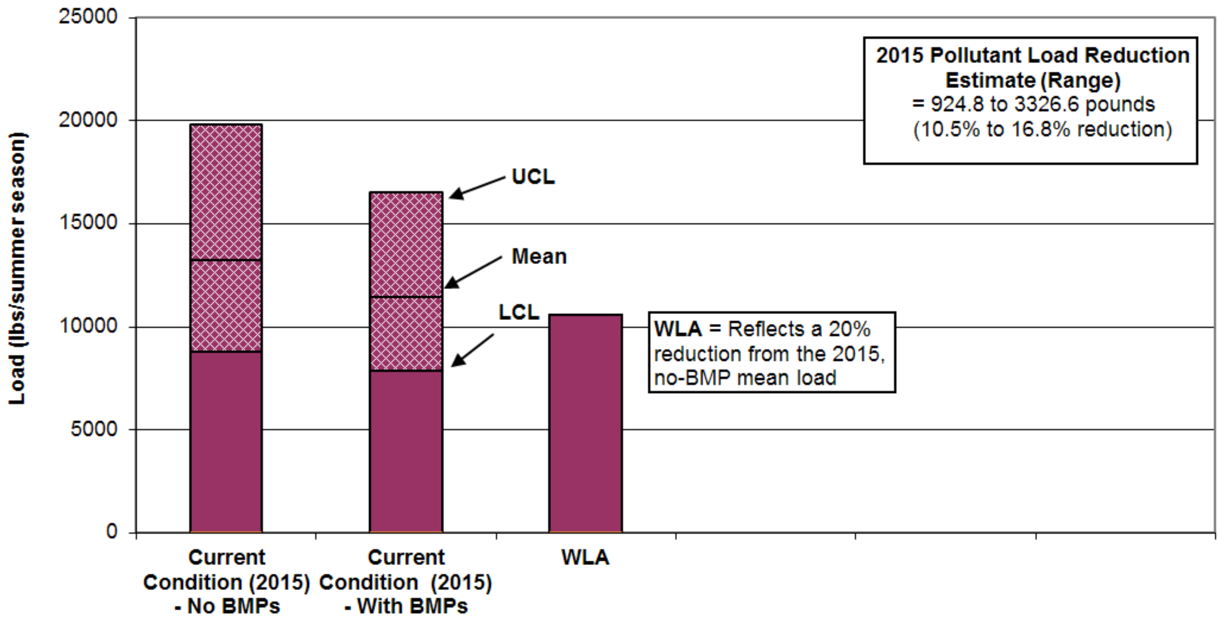

Figure 4-4. West Linn: TSS PLRE results for Tualatin River TMDL watershed (summer season)

Additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA for TSS. Section 4.6 describes some of the non-structural BMPs that are implemented in this watershed, but not directly considered in the pollutant load reduction estimate. It is possible that the additional pollutant removal achieved through non-structural BMPs would result in meeting the WLA.

4.2 Lower Willamette River

Figure 4-5 shows that West Linn is not currently estimated to be meeting the WLA for bacteria in the Lower Willamette watershed. The PLRE shows a mean pollutant load reduction of approximately 2.3

percent compared with the WLA of 78 percent. The PLRE shows a mean load decrease of approximately 7.58 x 10^{11} counts when comparing conditions with and without BMPs.

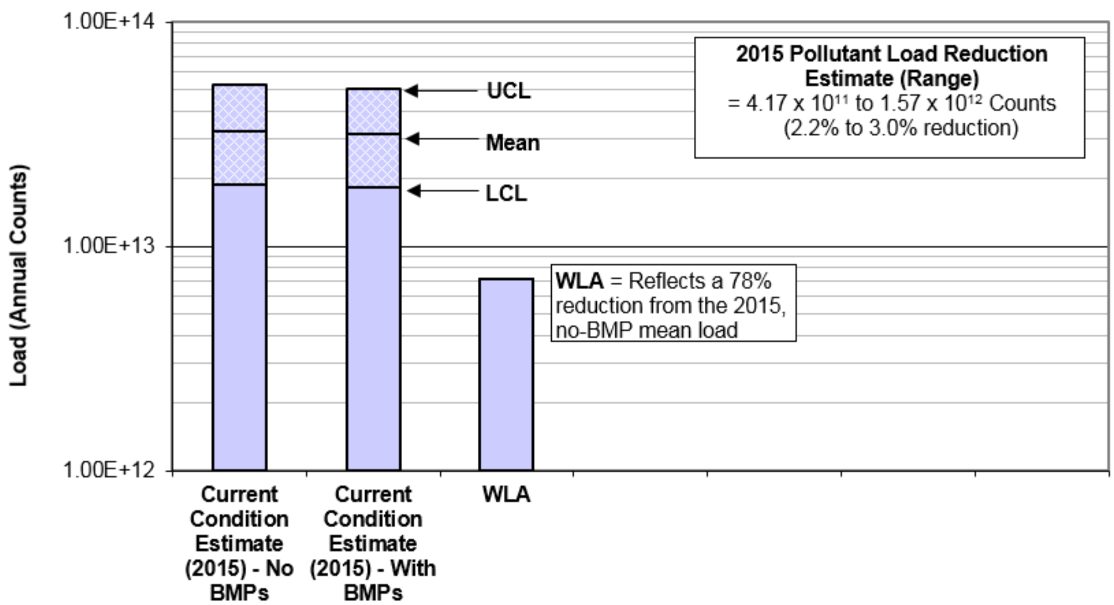

Figure 4-5. West Linn: *E. coli* PLRE results for Lower Willamette TMDL watershed

The Lower Willamette watershed covers the majority of West Linn's management area, including nearly 1,700 acres of residential development. In West Linn, the Lower Willamette watershed area is more than 75 percent residential with only small areas of commercial development along Oregon Highway 43. The development includes numerous residential neighborhoods constructed on the hills above the Willamette River. Because of topographic constraints and the age of development, most stormwater infrastructure was installed without the inclusion of stormwater management facilities to provide water quality treatment. Current structural BMP coverage is estimated at 8 percent.

Significant additional load reduction would be needed beyond the current (2015) structural BMP implementation to achieve the WLA. Although 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 achieved would result in meeting the WLA. The WLA is considered to be an ultimate discharge goal.

4.3 Middle Willamette Tributaries

Figures 4-6 and 4-7 show that West Linn is not currently estimated to be meeting the WLA for bacteria in the Middle Willamette tributaries area. The current PLRE shows a mean pollutant load reduction of 16 percent for the summer season, compared with the WLA of 88 percent, and a mean pollutant load reduction of 16 percent for the fall, winter, and spring seasons compared with the WLA of 75 percent.

The PLRE shows a mean load decrease of approximately 3.74 x 10^{12} for fall, winter, and spring and 6.28 x 10^{11} counts for summer, and when comparing conditions with and without BMPs.

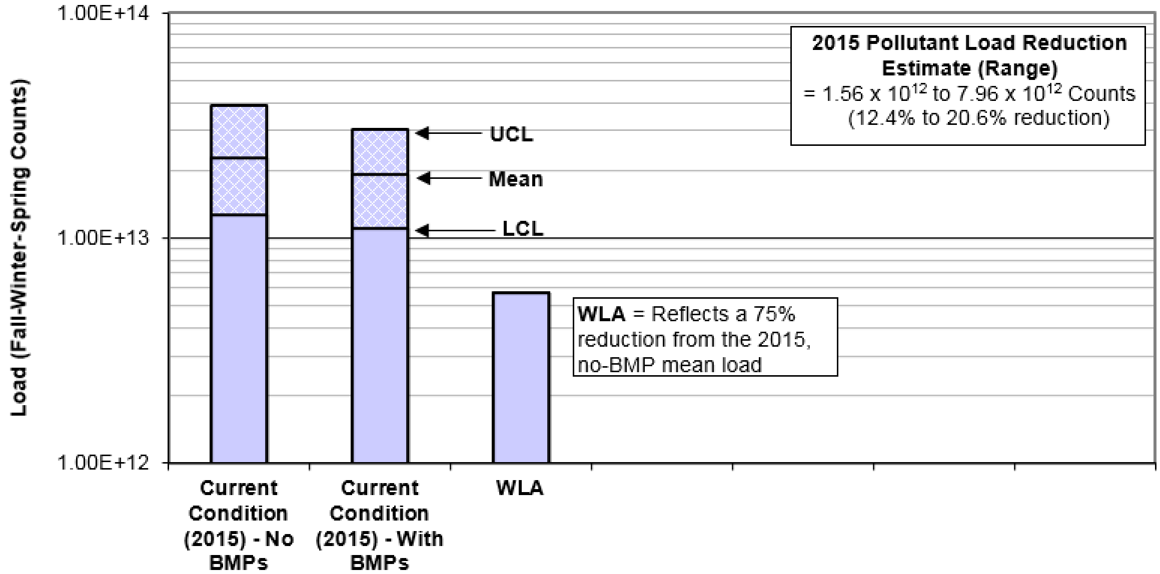

Figure 4-6. West Linn: *E. coli* PLRE results for Middle Willamette tributaries TMDL watershed (fall, winter, spring seasons)

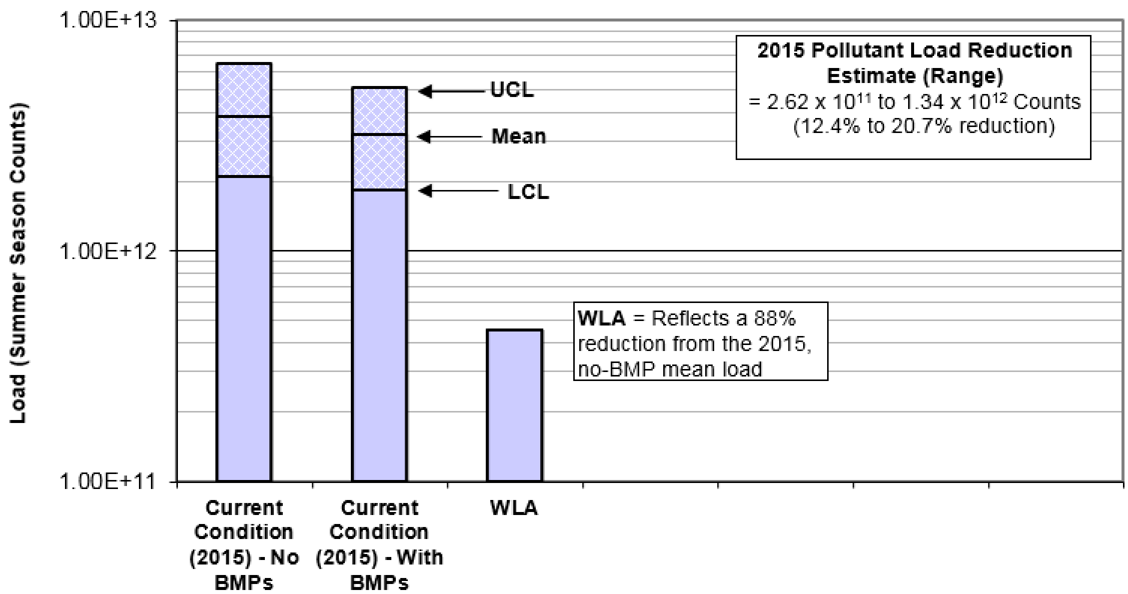

Figure 4-7. West Linn: *E. coli* PLRE results for Middle Willamette tributaries TMDL watershed (summer season)

The Middle Willamette tributaries area is over 70 percent residential. Many of the developments have been constructed with stormwater management facilities to provide flow detention and/or water quality treatment. Current (2015) structural BMP coverage in the Middle Willamette tributaries area is the highest of any basin in the city at 37 percent.

The structural BMPs implemented in this TMDL watershed (swales, wet ponds, and dry ponds) have varying effectiveness for bacteria removal. In general, wet ponds show better removal than dry ponds or swales. Although 37 percent of this TMDL drainage area is covered by structural BMPs, significant additional load reduction would be needed to achieve the WLA. Additional load reductions could be achieved through non-structural BMPs (which are not quantified in this PLRE), or through the wide-spread construction of additional structural BMPs as a result of redevelopment, or retrofit activities.

4.4 Middle Willamette Direct

Figure 4-8 shows that West Linn is not currently estimated to be meeting the WLA for bacteria in the Middle Willamette direct watershed. The PLRE shows a mean pollutant load reduction of 1 percent compared with the WLA of 75 percent. The PLRE shows a mean load decrease of approximately 2.87 x 10^{10} counts when comparing conditions with and without BMPs.

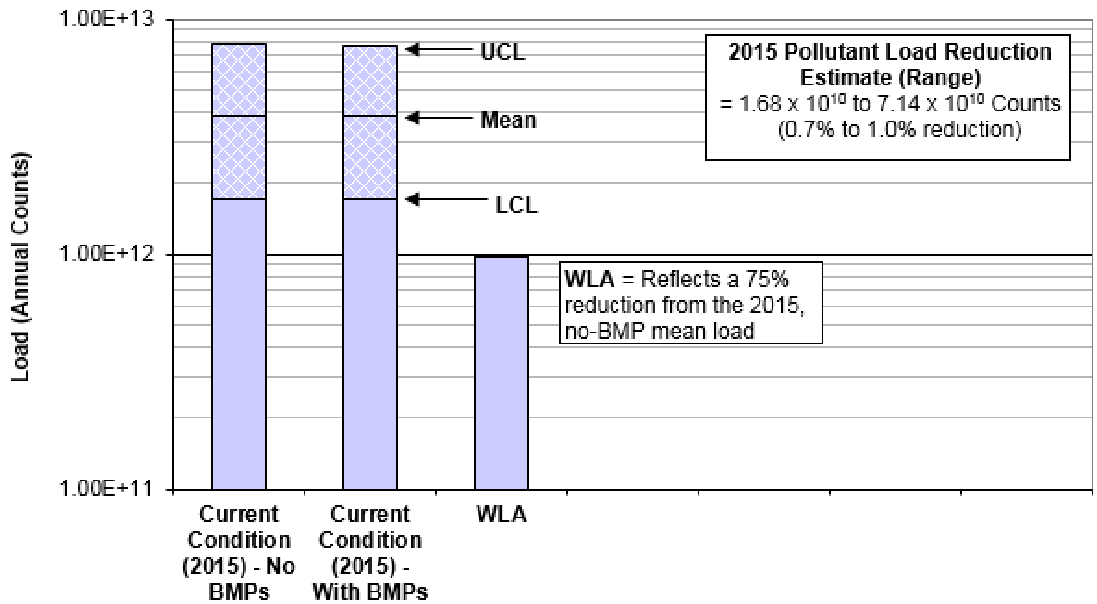

Figure 4-8. West Linn: *E. coli* PLRE results for Middle Willamette direct TMDL watershed

In West Linn, the Middle Willamette direct TMDL watershed area is the smallest basin in the city, with less than 250 acres of mixed land use. Over half the area is currently zoned for industrial land use. While the basin is fully built out, most development occurred without the installation of storm-water management facilities, so current structural BMP coverage stands at just 2.5 percent.

The basin does have some redevelopment potential that could result in increased BMP coverage. However, significant additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA. Although non-structural BMPs are implemented in this water-shed (and not directly considered in the pollutant load reduction estimate), it is unlikely that the ad-ditional pollutant removal achieved would result in meeting the WLA. The WLA is considered to be an ultimate discharge goal.

4.5 Benchmark Comparison

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously estab-lished pollutant load reduction benchmarks (Schedule D.3.c.iv). The City submitted PLRE and TMDL pollutant load reduction benchmarks as part of the Phase I NPDES MS4 permit renewal submittal in September 2008. The established pollutant load reduction benchmarks were based on projected de-velopment conditions and associated BMP implementation 5 years into the future, or approximately 2013.

Table 4-1 shows the difference in modeled areas and BMP coverage areas between the 2008 benchmark development and the 2015 modeling for the PLRE. Changes in model areas are largely a result of annexations, a greater understanding of drainage basin boundaries, and adjustments in ODOT right-of-way and 1200-Z permit coverage areas.

Table 4-1. Benchmark Assumptions Comparison

TMDL watershed	Assumption	2008 benchmark effort		2015 PLRE effort
		2008 (actual)	2013 (projected)	
Tualatin River	Model area (ac)	601.8	609.9	652.7
	BMP coverage (%)	58	59	25
Lower Willamette	Model area (ac)	2,577.9	2,581.8	2,228.9
	BMP coverage (%)	19	19	8
Middle Willamette tributaries	Model area (ac)	1,327.2	1,345.9	1,430.3
	BMP coverage (%)	64	64	37
Middle Willamette direct[a]	Model area (ac)	-	-	247.6
	BMP coverage (%)	-	-	3

a. For the 2008 benchmark effort, the Middle Willamette direct TMDL watershed was combined with the Middle Willamette tributaries TMDL watershed for reporting of land use and BMP coverage.

This 2015 PLRE included significant changes to the mapping of BMP coverage areas compared with the 2008 assumptions. In the 2008 modeling effort, many open-space areas with wetlands and open-water areas were categorized as “wetlands” for the purposes of establishing BMP coverage. While natural wetlands provide water quality benefits, they are not structural facilities constructed for the purpose of managing or treating stormwater. In accordance with the NPDES MS4 permit, the City now has systems in place to track public and private structural stormwater management facilities. For this 2015 PLRE, the City has taken a conservative approach of taking credit only for structural stormwater management BMPs that are currently tracked and inventoried by the City. The result is a significantly lower percentage of BMP coverage in all of the City’s TMDL watersheds, with BMP coverage less than 50 percent of the 2008 assumptions.

Numeric pollutant load reduction benchmarks were established in 2008 for all four applicable TMDL watersheds. The benchmarks were established based on land use and BMP coverage projected for year 2013, so changes in model area and BMP coverage have a direct impact on the City’s ability to show achievement of numeric benchmarks set in 2008 for TMDL parameters. Table 4-2 presents the results of the benchmark comparison.

Because of the statistical variability of the underlying data, the 2015 pollutant load reduction estimates and 2008 benchmarks are presented as ranges in loading. For purposes of this benchmark comparison effort, the following guidelines apply:

- Where the mean 2015 pollutant load reduction estimate falls within the 2008 benchmark range, the benchmarks are interpreted as likely to be met
- Where the UCL of the 2015 pollutant load reduction estimate falls within the 2008 benchmark range, the benchmarks are interpreted to possibly be met

As described previously, benchmarks are pollutant load reduction estimates for anticipated future conditions. Benchmarks are generally used as a tool and a goal for guiding adaptive management activities. Benchmarks are not considered numeric effluent limits.

Table 4-2. West Linn Pollutant Load Reduction Benchmark Comparison

TMDL watershed	Parameter (units)	2015 pollutant load reduction estimate[a]			2008 benchmarks based on projected 2013 conditions	Met benchmarks[b]
		LCL	Mean	UCL		
Tualatin River	Bacteria (counts) summer event	1.3×10^{9}	2.4×10^{9}	5.8×10^{9}	2.4×10^{9} to 1.2×10^{10}	Possibly met[c]
	Bacteria (counts) winter event	2.3×10^{10}	4.2×10^{10}	1.0×10^{11}	4.3×10^{10} to 2.1×10^{11}	Possibly met[c]
	Total Phosphorus (lb) summer	1.96	2.59	3.58	4.5 to 7.9	-
	TSS (lb) summer	925	1,837	3,327	1,684 to 6,116	Likely met
Lower Willamette	Bacteria (counts)	4.2×10^{11}	7.6×10^{11}	1.6×10^{12}	1.4×10^{12} to 6.9×10^{12}	Possibly met
Middle Willamette tributaries	Bacteria (counts) summer	2.6×10^{11}	6.3×10^{11}	1.3×10^{12}	3.6×10^{11} to 1.9×10^{12}	Likely met
	Bacteria (counts) fall/winter/spring	1.6×10^{12}	3.7×10^{12}	8.0×10^{12}	2.2×10^{12} to 1.1×10^{13}	Likely met
Middle Willamette direct	Bacteria (counts)	1.7×10^{10}	2.9×10^{10}	7.1×10^{10}	5.7×10^{10} to 2.7×10^{11}	Possibly met

a. *The UCL estimate is the difference between the current no-BMP and current with-BMP pollutant loads for the UCL; the mean estimate is the difference between the current no-BMP and current with-BMP pollutant loads for the mean; the LCL estimate is the difference between the current no-BMP and current with-BMP pollutant loads for the LCL.*

b. *This column is provided to comply with a permit requirement. However, refined tracking of stormwater management facilities and associated changes in BMP coverage have a significant impact on the ability to simulate pollutant reductions representative of the benchmarks.*

c. *The WLAs for bacteria in the Tualatin River TMDL watershed are already estimated to be achieved for both summer and winter events. The City's current NPDES MS4 permit does not require establishing benchmarks for watersheds that are meeting WLAs.*

4.6 Pollutant Load Reduction Evaluation Summary

The pollutant load reduction benchmarks comparison presented in Table 4-2 shows that benchmarks are estimated as likely to be met for TSS in the Tualatin River watershed and for bacteria in the Middle Willamette tributaries TMDL watershed.

The City's structural BMPs are estimated to possibly be achieving the interim pollutant load removal benchmarks established in 2008 for bacteria in the Tualatin River, Lower Willamette, and the Middle Willamette direct TMDL watersheds. It should be noted that the WLAs for bacteria in the Tualatin River TMDL watershed are already shown to be achieved based on current land use and BMP coverage assumptions. In the City's current NPDES MS4 permit, new TMDL benchmarks are not required for watersheds that are meeting WLAs.

The City's structural BMPs are not estimated to be achieving the interim pollutant load removal benchmarks established in 2008 for total phosphorus in the Tualatin River watershed. This may be due in part to significant adjustments in the mapping of BMP drainage areas. While the number of structural BMPs has increased across the city since 2008, the current model includes only structural BMPs that the City is actively tracking and that are included as part of the GIS BMP inventory. Natural wetland areas are no longer included in this modeling effort as structural facilities providing quantifiable pollutant removal. These changes in assumptions have reduced the estimated BMP coverage in all watersheds (see Table 4-1). In the Tualatin River TMDL watershed, the current BMP coverage is estimated to be less than half of what was modeled in 2008.

Regardless of mapping changes, significant additional load reduction will be needed beyond the current structural BMP implementation to achieve WLAs for bacteria in the Lower Willamette and Middle Willamette TMDL watersheds. Additional reductions are also needed to achieve the WLAs for total phosphorus and TSS in the Tualatin River TMDL watershed.

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 loads to show progress toward WLAs. In conducting a quantitative PLRE, the City chose a conservative approach to avoid overestimating the effectiveness of the programs. Over time, pollutant load reductions are expected to increase because of the following:

- Continued implementation of stormwater design standards for new development and re-development projects, resulting in construction of additional structural BMPs
- Stormwater retrofit efforts to install structural BMPs in untreated areas
- New technologies and scientific advances

In addition, the pollutant load reduction estimates, as detailed in the PLRE, are conservative. Greater reductions are likely currently achieved because of implementation of non-structural BMPs. The City conducts a variety of programmatic activities that are directly attributable to bacteria, total phosphorus, and TSS reduction. Such activities include erosion control, 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.

4.7 Water Quality Trends Analysis

In accordance with Schedule D.3.c.vii of the City's NPDES MS4 permit, the City prepared a water quality trends analysis as part of the PLRE. The City's overall monitoring program includes in-stream water quality monitoring, MS4 (stormwater) monitoring, biological monitoring, and physical condition monitoring. For the water quality trends analysis, in-stream monitoring data over the 5-year permit term were evaluated along with historical monitoring data to assess long-term trends in receiving water quality.

In-stream water quality trends were calculated for three sites in West Linn as identified in the *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* (Brown and Caldwell, 2014). The sites include locations on Trillium Creek and Tanner Creek in the Middle Willamette watershed and on unnamed Johnson Creek in the Tualatin River watershed. The following pollutant parameters were included in the water quality trends analysis:

- TSS
- *E. coli*
- Total phosphorus
- Total and dissolved copper
- Total and dissolved zinc

Each parameter was analyzed at each sampling site. The analyses were performed for either the "rain" or "no rain" conditions to help assess the potential influence of MS4 discharges on receiving water quality.

Temporal trends in water quality were evaluated using the Mann-Kendall test, a non-parametric method that is used for identifying monotonic (though not necessarily linear) trends. 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 4-3 summarizes results of the 2015 in-stream water quality trends evaluation for water bodies and parameters where observed trends are noted. Full documentation is included in Appendix A.

Table 4-3. Summary of Water Quality Trends Analysis

Monitoring location	Improving trends (decreasing concentrations)		Deteriorating trends (increasing concentrations)	
	No rain	Rain	No rain	Rain
Trillium Creek at Calaroga Road	Total phosphorus	TSS Total phosphorus	TSS Total zinc	Dissolved zinc
Tanner Creek at Imperial Drive	None	TSS Total phosphorus	TSS	None
Unnamed Johnson Creek at Johnson Road and Ryan Court	Total phosphorus	Total phosphorus	Total copper Total zinc Dissolved Zinc	Total zinc Dissolved Zinc

Note: Reporting for trends where p is less than 0.05.

Results from the trends analysis for 17 of the 42 data sets indicated statistically significant trends. Improving trends (decreasing concentrations) were observed for total phosphorus at all three of the in-stream sites and TSS at two out of three sites. Deteriorating trends (increasing concentrations) were observed for TSS and metals during no-rain conditions and only for zinc (total and dissolved) during rain events.

The majority of data sets evaluated (the remaining 25 out of 42 data sets) showed no statistically significant trends in the water quality sampling. This trends analysis reflects a period of time when West Linn grew in population by approximately 15 percent. Given that level of population growth and the potential impacts associated with the resulting development, seeing no trend in water quality is a positive result.

Correlating data from in-stream and outfall water quality sampling with stormwater management activities is a challenging task because of the myriad other influences in water quality. 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. The City will continue to conduct in-stream water quality sampling in compliance with the NPDES MS4 permit.

Section 5

Benchmarks

Based on results of the pollutant load reduction evaluation (Section 4), the City of West Linn is estimated to meet TMDL WLAs for bacteria in the Tualatin River watershed and new TMDL benchmarks are not required. However, WLAs are not being achieved for other TMDL parameters. The City is required to establish new pollutant load reduction benchmarks for bacteria in the Lower Willamette, Middle Willamette direct, and Middle Willamette tributary TMDL watersheds and for total phosphorus and TSS in the Tualatin River TMDL watershed.

Section 5.1 describes the assumptions related to benchmark development and the results of the model simulations. Section 5.2 presents the proposed benchmarks and Section 5.3 includes discussion of how SWMP implementation contributes to the overall reduction of TMDL pollutants.

5.1 Benchmark Development

Benchmarks are estimates of pollutant load reductions in the future. They reflect current BMP implementation and projected BMP implementation over the upcoming permit term.

5.1.1 PLRE Findings

In accordance with Schedule D.3.d.i of the City's NPDES MS4 permit, benchmarks must reflect pollutant load reductions necessary to achieve the benchmarks projected in 2008 for 2013 conditions (2008 benchmarks) and additional progress toward the TMDL WLA during the next permit term. As the City's current NPDES MS4 permit expires March 1, 2017, the next 5-year permit term is anticipated to be 2017 to 2022.

Benchmarks are required for bacteria in the Lower Willamette, Middle Willamette direct, and Middle Willamette tributary TMDL watersheds and for total phosphorus and TSS in the Tualatin River TMDL watershed. Table 5-1 summarizes the City's current status in meeting the 2008 benchmarks and the WLAs, as interpreted from Table 4-2.

<table>
<tr><th colspan="7">Table 5-1. TMDL Benchmark Status and Future Stormwater Facility Installations</th></tr>
<tr><th rowspan="2">TMDL watershed</th><th rowspan="2">Model time frame</th><th rowspan="2">Parameter</th><th colspan="2">2015 pollutant load reduction estimate results</th><th colspan="2">2017 TMDL benchmark development</th></tr>
<tr><th>Met TMDL WLA? (Y/N)</th><th>Met (2008) benchmark? (Y/N)</th><th>Future BMP installations</th><th>Future BMP drainage area addition (ac)[a]</th></tr>
<tr><td>Lower Willamette</td><td>Annual</td><td>Bacteria</td><td>N</td><td>Y</td><td>• Pollution Control Manholes
• Filtration raingardens
• Swale
• Dry detention pond</td><td>6.7</td></tr>
<tr><td>Middle Willamette direct</td><td>Annual</td><td>Bacteria</td><td>N</td><td>Y</td><td>No future BMPs identified.</td><td>---</td></tr>
<tr><td rowspan="2">Middle Willamette tributary</td><td>Summer Season</td><td>Bacteria</td><td>N</td><td>Y</td><td rowspan="2">• Filtration raingarden</td><td rowspan="2">1.4</td></tr>
<tr><td>Fall, Winter, Spring season</td><td>Bacteria</td><td>N</td><td>Y</td></tr>
<tr><td rowspan="4">Tualatin River</td><td>Summer event</td><td>Bacteria</td><td>Y</td><td>Y</td><td rowspan="4">• Filtration raingarden
• Dry detention pond
• Swale</td><td rowspan="4">3.4</td></tr>
<tr><td>Winter event</td><td>Bacteria</td><td>Y</td><td>Y</td></tr>
<tr><td>Summer season</td><td>Total phos-phorus</td><td>N</td><td>Unlikely[b]</td></tr>
<tr><td>Summer season</td><td>TSS</td><td>N</td><td>Y</td></tr>
</table>

a. *The future BMP drainage area includes potential areas to be treated by future BMPs and area currently being treated by a structural BMP, but expected to receive treatment by a more effective BMP (through retrofit of existing systems or installation of new BMPs to serve the same drainage area).*

b. *2008 benchmarks were not likely met due to the refinement of BMP drainage areas as part of the PLRE and reclassification of wetlands from a BMP category to open space land use.*

5.1.2 Anticipated BMPs

Benchmarks are developed by identifying additional stormwater BMPs that are likely to be installed before the end of the next permit term. City Public Works staff identified planned future stormwater facility installations associated with public works projects. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities since the PLRE was completed in November 2015. These facilities collectively reflect the City's projection for stormwater facility installations through 2022. One future capital project and more than 10 recent private facility installations were included in this analysis, as shown in Figure 3-1. City staff efforts included identification of the location, type(s), and anticipated drainage area(s) for these projects. Table 5-1 lists the anticipated stormwater facility installations by TMDL watershed, facility type, and drainage area.

Additional public and private facility installations beyond those shown in Figure 3.1 are likely but have not been projected. This conservative assumption is due to the variable schedule of private development activities and the unknown content and issuance date for the City's reissued NPDES MS4 permit.

5.2 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 3.

The benchmarks were 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.

Table 5-2 provides the new TMDL benchmarks for bacteria and TSS as both a load reduction and as a percentage load reduction. The WLAs, as a percentage load reduction (per the Willamette Basin TMDL and Tualatin Subbasin TMDL), are also shown in Table 5-2 for comparison.

Table 5-3 presents the new benchmarks for total phosphorus in the Tualatin River TMDL watershed as both a load reduction and as a concentration. The WLA as a concentration (per the Tualatin Subbasin TMDL) is also shown in Table 5-3.

Table 5-2. TMDL Benchmarks for Bacteria and TSS (2017–22)

TMDL watershed	Time frame	Pollutant (units)	WLA (% reduction)[a]	TMDL benchmarks (load reduction)[b], range	TMDL benchmarks (% load reduction)[b], range
Lower Willamette	Annual	Bacteria (counts)	78%	4.28×10^{11} to 1.61×10^{12}	2.3% to 3.1%
Middle Willamette direct	Annual	Bacteria (counts)	75%	1.68×10^{10} to 7.14×10^{10}	0.7% to 1.0%[c]
Middle Willamette tributary	Summer season	Bacteria (counts)	88%	2.64×10^{11} to 1.34×10^{12}	12.5% to 20.7%
	Fall, Winter, Spring season	Bacteria (counts)	75%	1.57×10^{12} to 7.99×10^{12}	12.5% to 20.7%
Tualatin River	Summer season	TSS (pounds)	20%	935 to 3385	10.6% to 17.1%

a. *The Willamette Basin TMDL expresses the bacteria WLA as a percent load reduction, and the Tualatin Subbasin TMDL expresses the TSS WLA as a percent load reduction.*

b. *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.*

c. *There were no anticipated BMP installations for the Middle Willamette direct TMDL watershed due to limited property availability for retrofits. Therefore, the TMDL benchmarks reflect the 2015 pollutant load reductions.*

Table 5-3. TMDL Benchmarks for Total Phosphorus (2017–22)

TMDL watershed	Time frame	Pollutant (units)	WLA (concentration, mg/L)[a]	TMDL benchmarks (load reduction)[b], range	TMDL benchmarks (concentration)[b], range
Tualatin River	Summer season	Total phosphorus (pounds)	0.14	2.00 to 3.64	0.15 to 0.21

a. *The Tualatin Subbasin TMDL expresses the total phosphorus WLA as a concentration.*

b. *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 concentration for direct comparison with the WLA.*

5.3 Discussion and Application of SWMP Implementation

As shown in Tables 5-2 and 5-3 and Appendix B, pollutant load reduction is anticipated through the implementation of current and additional future planned structural stormwater facilities or BMPs. However, as the future with-BMP pollutant loads and benchmarks indicate, the anticipated pollutant load reduction is far less than the load reduction needed to meet the TMDL WLAs.

The City's benchmarks reflect the installation of one public project and multiple private development projects, covering approximately 11.6 acres of drainage area. Approximately 7.9 acres of the new treatment area is currently untreated, and the remainder of the area is currently treated by a less effective BMP. As such, the change in load reduction due to the additional facilities is minimal.

The City prepared a WLA attainment assessment for DEQ in February 2016, which indicated that achieving the WLA would require construction and maintenance costs that far exceed the City's definition of MEP. Progress toward the WLA, and not achievement of the WLA, is West Linn's goal in setting benchmarks. Such progress is reflected in Tables 5-1, 5-2, and 5-3.

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 estimates do not reflect non-structural BMP implementation in accordance with the City's current SWMP. Discussion of non-structural BMP effectiveness is outlined in Section 4.9. In addition, the City anticipates opportunities to enhance its stormwater program with the renewed NPDES MS4 permit and updated SWMP. Programmatic efforts will continue to target TMDL parameters as pollutants of concern, particularly in the Middle Willamette direct watershed where no additional structural BMPs are anticipated. Enhanced programmatic efforts are proposed to target source identification and source tracking for bacteria.

Forecasted structural BMP implementation and coverage associated with development of benchmarks is also conservative. The City anticipates additional private structural BMPs (not accounted for in the benchmarks) to be installed during redevelopment activities, which will further reduce pollutant load discharges.

The City is also anticipating an update to its 2006 Stormwater Master Plan to refine the stormwater capital improvement project (CIP) list. Through the update to the Master Plan, additional CIPs targeted at water quality improvement will be developed and incorporated into the capital improvement plan. New CIPs for water quality improvement projects have not yet been identified and are therefore not reflected in the benchmarks.

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Section 6

References

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

Brown and Caldwell. 2014. *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan*, September 1, 2012, updated June 30, 2013, and June 30, 2014.

Oregon Department of Environmental Quality (DEQ). 2006. *Willamette River Total Maximum Daily Load*, September.

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

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

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

West Linn. 2006. *Final West Linn Stormwater Master Plan*.

West Linn. 2008. *National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Discharge Permit Renewal*, September.

West Linn. 2014. *City of West Linn Comprehensive Plan* (amended June 2014).

West Linn. 2015. Timeline Extension Letter to the Oregon Department of Environmental Quality (DEQ). October 14th, 2015.

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

United States Environmental Protection Agency (EPA). 2014. http://toxics.usgs.gov/definitions/tmdl.html. Accessed November 17, 2014.

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Section 7

Limitations

This document was prepared solely for West Linn in accordance with professional standards at the time the services were performed and in accordance with the contract between the City and Brown and Caldwell dated October 16, 2015. This document is governed by the specific scope of work authorized by the City; 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 the City 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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Appendix A: Water Quality Trends Analysis

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Technical Memorandum

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Prepared for: City of West Linn

Project Title: Stormwater Management Support Services

Project No.: 146981.002

Technical Memorandum

Subject: Instream Water Quality Trends Analyses

Date: November 9, 2015

To: Beth Randolph and Mike Cardwell

From: Valerie Fuchs, Angela Wieland, and Krista Reininga, Brown and Caldwell

Prepared by: Valerie Fuchs, Ph.D., P.E., WA 52615

Limitations:

This document was prepared solely for the City of West Linn (City) in accordance with professional standards at the time the services were performed and in accordance with the contract between the District and Brown and Caldwell dated October 28, 2014. This document is governed by the specific scope of work authorized by the City; 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 the City and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Summary

The purpose of this technical memorandum (TM) is to summarize the review and analysis of instream water quality monitoring data for the City of West Linn (City). This data review and trends analysis was completed to comply with one of the City's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit requirements.

The City is a Phase 1 co-permittee on an NPDES MS4 permit along with several other local governments and service districts in Clackamas County, Oregon. As part of the NPDES MS4 permit requirements, the City must evaluate the overall effectiveness of its stormwater management program by conducting a pollutant load reduction evaluation (Schedule D.3 of the permit). This evaluation includes a requirement to conduct an instream water quality trends analysis including a summary of the relationship of identified trends to stormwater discharges.

The City has been collecting instream water quality monitoring data since 2002 from three creek sites. Brown and Caldwell (BC) was retained to review these instream environmental monitoring data and develop the trends analysis that is provided in this TM. This TM includes a summary of the review and processing of the data, a summary of the Mann-Kendall statistical analysis, and a summary of the results.

Data Review and Pre-Processing

BC reviewed the instream data collected within the City's watersheds in order to summarize and pre-process the data sets. Pre-processing of data was conducted to determine which data sets were sufficient to perform a statistically valid water quality trends analysis. Each record in the data to be analyzed represents a measurement recorded for one parameter at one site, and each data set represents all of the data collected for one parameter at one site during either a wet or dry day. The original criteria for determining which data sets would be used for the trends analysis were that only data sets with at least 5 years of data and 30 or more data points would be used, and that data sets for wet days and dry days would be analyzed separately (or wet season and dry season where daily rainfall records were not available). These criteria were recommended in a draft guidance document developed in 2007 by the Oregon Association of Clean Water Agencies (ACWA) Phase I stormwater committee. However, not all of the City's data sets included 30 or more observations; some of the data sets had 10 or more observations. Based on the review of the City's data, BC completed the analysis based on the following refined/updated ACWA criteria:

- Data were analyzed separately for wet days and dry days given that information regarding the occurrence of rainfall in association with data collection was readily available.
- The threshold for the trends analysis was reduced to data sets with 10 or more observations in order to allow for a trends analysis to be performed for copper and zinc and to be able to separate the data into wet-day and dry-day data sets when that resulted in fewer than 30 observations.
- Data sets were analyzed only when 50 percent or more of the data were reported as above the detection limit to provide more rigorous and statistically valid trends analyses.

The NPDES MS4 permit does not specify the parameters required for the trends analysis. The ACWA Committee draft guidance recommends that trends analyses be performed for total suspended solids (TSS), total phosphorus (TP) or other relevant nutrient, copper (total recoverable and soluble), zinc (total recoverable and soluble), and *E. coli* if adequate data are available to perform a rigorous Mann-Kendall trends analysis. BC performed the Mann-Kendall trends analysis on wet- and dry-day data sets for these seven parameters.

Based on the criteria described above for conducting the trends analyses, pre-processing of the data included a review of the following for each monitoring site and parameter:

- Total number of data points (where a single data point is one measurement recorded for one parameter at one site)
- Number of data points associated with 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 non-detects
- Summary of monitoring frequency
- Summary of the monitoring sites and parameters with adequate data for a trends analysis

For this analysis, BC assumed that the quality assurance/quality control (QA/QC) review of stormwater data was already completed by the City.

All three City sites had some data sets with 30 or more observations, but data sets for some parameters had less than 30 observations. In order to perform a trends analysis for these data sets, as mentioned above, BC elected to reduce the threshold for the trends analysis to data sets with 10 or more observations.

Table 1 shows a check mark (✓) for each data set that met the project criteria for conducting a Mann-Kendall trends analysis. As a result of the data review and pre-processing of instream water quality monitoring data, a total of 42 trends analyses were completed, including 21 trends analyses for dry weather (i.e., 3 sites x 7 parameters), and 21 trends analyses for wet weather (i.e., 3 sites x 7 parameters). Thirty-three of the 42 trends analyses had data sets with 10 to 29 observations.

Table 1. Summary of Monitoring Sites and Data Review Statistics

Trillium Creek (Trillium Creek: Calaroga)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2002–15	2002–15	2002–15	2007–15	2007–15	2007–15	2007–15
Number of observations	56	55	54	39	39	39	39
Wet-day detects	33	32	31	24	24	24	24
Wet-day non-detects	0	0	0	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	18	23	23	15	15	15	15
Dry-day non-detects	5	0	0	0	0	0	0
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Tanner Creek (Tanner Creek: Imperial)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2002–15	2002–15	2002–15	2007–15	2007–15	2007–15	2007–15
Number of observations	56	54	54	39	39	39	39
Wet-day detects	33	31	31	24	24	24	24
Wet-day non-detects	0	0	0	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	18	22	23	15	15	15	15
Dry-day non-detects	5	1	0	0	0	0	0
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓

Table 1. Summary of Monitoring Sites and Data Review Statistics							
Summerlinn Creek (Johnson Rd.: Ryan)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2002–15	2002–15	2002–15	2007–15	2007–15	2007–15	2007–15
Number of observations	57	56	55	39	39	39	39
Wet-day detects	33	33	32	24	24	24	24
Wet-day non-detects	1	0	0	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	19	23	22	15	15	15	15
Dry-day non-detects	4	0	1	0	0	0	0
Dry-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓

Mann-Kendall Trends Analysis

Temporal trends in water quality were evaluated using the Mann-Kendall test, a non-parametric method that is used for identifying monotonic (though not necessarily linear) trends. 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. 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 this analysis are:

Ho: slope = 0 (null) Ha: slope ≠ 0 (alternative)

The null hypothesis (Ho) of "no trend" was 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 not 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. When the null hypothesis is rejected, the conclusion is that the Kendall score (and the temporal trend) is not significantly different from zero.

Mann-Kendall tests for trends were conducted using the package "Kendall" in the programming language R. R is an open-source language and integrated suite of software applications for statistical computing, for which statistical packages are developed and scientifically peer-reviewed (available through the Comprehensive R Archive Network from the R Core Team [2013]). The Kendall package is the program developed to run the Mann-Kendall trends analysis (McLeod, 2011). Results of the Mann-Kendall trends analysis in R are produced in a table of values including two-sided p-value and Kendall Score. BC processed all data sets for each monitoring site using R, resulting in a table of Mann-Kendall trends analysis values for each of the parameters for the site.

To provide quality assurance on the automated processing of the site data, the Mann-Kendall test was also conducted in ProUCL for selected data sets. 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 data sets in ProUCL, ProUCL was used solely to spot-check selected results from the R package. The Kendall Score and p-value from the ProUCL Mann-Kendall trends analyses were compared with the Kendall Score and p-value from R. In all spot-checked cases, the results of the two software packages were in agreement, providing confidence in the results from all data sets processed through R.

Statistical Test Results

As described above, trends analyses were conducted on all wet-day and dry-day data sets that had at least 50 percent detected values and at least 10 observations. Of the 42 trends analyses completed, 9 were on data sets with 30 or more observations, and 33 were on data sets with 10 to 29 observations. Of the 42 trends analyses completed, 21 were conducted for wet-day data and 21 were conducted for dry-day data.

A legend for the results is shown in Table 2, and results of the trends analyses are summarized in Table 3. Based on the selected data criteria for performing the trends analysis, trends were evaluated for both the 5 and 10 significance levels (i.e., alpha of 0.05 and 0.10).

Table 2. Legend for Summary of Trends

No rain	< 0.1 inch of rainfall in the 24 hours prior to sampling
Rain	>= 0.1 inch of rainfall in the 24 hours prior to sampling
↑	Significant upward trend (p <= 0.05)
↓	Significant downward trend (p <= 0.05)
⇧	Somewhat significant upward trend (0.05 < p <= 0.1)
⇩	Somewhat significant downward trend (0.05 < p <= 0.1)
	Improvement in water quality indicator parameter
	Deterioration in water quality indicator parameter
	Not enough data for analysis
NA	Not enough uncensored values for analysis (<10)
	No trend was detected

Table 3. Summary of Trends

TMDL watershed	M Willamette										Tualatin				
Water body	Trillium Creek					Tanner Creek					Summerlinn Creek				
Site/Station ID	Trillium Creek - Calaroga					Tanner Creek - Imperial					Johnson Rd. - Ryan				
2015 instream monitoring site	At Caloroga Rd.					At Imperial Dr.					Johnson Rd. and Ryan Ct.				
		No rain		Rain			No rain		Rain			No rain		Rain	
WQ parameter	Date range	N	Trend	N	Trend	Date range	N	Trend	N	Trend	Date range	N	Trend	N	Trend
TSS	2002-2015	23	↑	33	↓	2002-2015	23	↑	33	↓	2002-2015	23		34	⇩
E. coli	2002-2015	23		32		2002-2015	23		31		2002-2015	23		33	
TP	2002-2015	23	↓	31	↓	2002-2015	23		31	↓	2002-2015	23	↓	32	↓
Total copper	2007-2015	15		24		2007-2015	15		24		2007-2015	15	↑	24	
Copper (diss.)	2007-2015	15		24		2007-2015	15		24		2007-2015	15		24	
Total zinc	2007-2015	15	↑	24		2007-2015	15		24		2007-2015	15	↑	24	↑
Zinc (diss.)	2007-2015	15		24	↑	2007-2015	15		24		2007-2015	15	↑	24	↑

Summary/Conclusions

A summary of results based on Table 3 is as follows:

- Given a significance level of 10 percent, fewer declining water quality trends (i.e., increasing pollutant concentrations) were observed during wet weather (three declining trends) than during dry weather (six declining trends).
- Given a significance level of 10 percent, more improving water quality trends (i.e., decreasing pollutant concentrations) occurred during wet weather (six improving trends) than during dry weather (two improving trends).
- The majority of all of the trends analyses (25 out of 42, or 59 percent) showed no trend given a significance level of 10 percent.
- The majority (i.e., 67 percent) of the declining water quality trends occurred for total and dissolved zinc (six of the nine declining trends).
- Two declining water quality trends occurred for TSS and one for total copper.
- The majority (i.e., 62 percent) of the improving water quality trends occurred for phosphorus (five of the eight improving trends).
- Three improving water quality trends occurred for TSS.
- Tanner Creek (Tanner Creek: Imperial) had the fewest data sets showing trends out of all the sites, with two improving water quality trends and one declining water quality trend.
- Summerlinn Creek had the most data sets showing trends out of all the sites with five of the eight trends analyses showing declining water quality trends.

These trends results should be evaluated in the context of where samples are collected and what watershed influences may be affecting water quality at each sampling site, while also considering the data available for the trends analysis such as the length of the measurement period and the number of data points in the data sets evaluated. In addition, these trends reflect a period when West Linn grew in population by approximately 15 percent. Given that growth, and the potential impacts associated with the resulting development, seeing no trend in water quality is a positive result.

It should be noted that 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 the myriad of other influences on water quality. 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 data set and the scatter of the data affect the results of the Mann-Kendall trends analysis. Data sets with more data may be more likely to exhibit a trend (if the data are not widely scattered) than data sets with fewer data points (McBride et al., 1993). In addition, a statistically significant result does not necessarily mean that the trend is significant in itself.

Other factors such as the magnitude and range of reported values compared to various 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 analysis are one piece of an overall evaluation of water quality.

References

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.

R Core Team. 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Accessed August 2015: < http://www.R-project.org/ >

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.

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Appendix B: Pollutant Load Summary

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Appendix B. City of West Linn Pollutant Load Summary, for use with the PLRE and TMDL Benchmarks																				
Waterbody	Season	WLA (% reduction or concentration)	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]			Future Conditions (counts or pounds)[e]			Future Conditions (% reduction or concentration)[e]		
			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)																				
Lower Willamette	annual	78%	5.22×10^{13}	3.23×10^{13}	1.87×10^{13}	5.06×10^{13}	3.16×10^{13}	1.83×10^{13}	5.06×10^{13}	3.15×10^{13}	1.83×10^{13}	1.57×10^{12}	7.58×10^{11}	4.17×10^{11}	1.61×10^{12}	7.78×10^{11}	4.28×10^{11}	3.09%	2.41%	2.28%
Middle Willamette Direct	annual	75%	7.79×10^{12}	3.87×10^{12}	1.72×10^{12}	7.72×10^{12}	3.84×10^{12}	1.70×10^{12}	Same as Current, with BMPs.			7.14×10^{10}	2.87×10^{10}	1.68×10^{10}	7.14×10^{10}	2.87×10^{10}	1.68×10^{10}	7.14×10^{10}	2.87×10^{10}	1.68×10^{10}
Middle Willamette Tributary	Summer season	88%	6.47×10^{12}	3.83×10^{12}	2.11×10^{12}	5.13×10^{12}	3.20×10^{12}	1.85×10^{12}	5.12×10^{12}	3.20×10^{12}	1.85×10^{12}	1.34×10^{12}	6.28×10^{11}	2.62×10^{11}	1.34×10^{12}	6.31×10^{11}	2.64×10^{11}	20.73%	16.49%	12.47%
	Fall, winter, spring season	75%	3.86×10^{13}	2.28×10^{13}	1.26×10^{13}	3.06×10^{13}	1.91×10^{13}	1.10×10^{13}	3.06×10^{13}	1.91×10^{13}	1.10×10^{13}	7.96×10^{12}	3.74×10^{12}	1.56×10^{12}	7.99×10^{12}	3.76×10^{12}	1.57×10^{12}	20.72%	16.48%	12.46%
Tualatin	Summer event	12,000 counts/ 100mL	4.23×10^{10}	2.63×10^{10}	1.54×10^{10}	3.65×10^{10}	2.40×10^{10}	1.41×10^{10}	N/A: WLA is estimated as being met. Benchmarks not required.			5.81×10^{9}	2.36×10^{9}	1.29×10^{9}	N/A			N/A		
	Winter event	5,000 counts/ 100mL	7.53×10^{11}	4.70×10^{11}	2.74×10^{11}	6.50×10^{11}	4.28×10^{11}	2.51×10^{11}	N/A: WLA is estimated as being met. Benchmarks not required.			1.04×10^{11}	4.20×10^{10}	2.30×10^{10}	N/A			N/A		
Total Phosphorus (pounds)																				
Tualatin	Summer event	0.14 mg/L	46.03	42.05	32.19	42.45	39.09	30.23	42.39	39.03	30.19	3.58	2.96	1.96	3.64	3.02	2.00	0.21 mg/L	0.19 mg/L	0.15 mg/L
TSS (pounds)																				
Tualatin	Summer event	20%	19,797	13,224	8,813	16,470	11,388	7,889	16,412	11,358	7,878	3,327	1,837	925	3,385	1,867	935	17.10%	14.11%	10.61%

a. The current (2015) no-BMP and with-BMP load estimates are presented in graphical form in Figures 4-1 to 4-8.

b. The future (2022) 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 4 in graphical and tabular form.

e. The future condition pollutant load reduction estimate is considered to be the TMDL Benchmark, as described in Section 5. The TMDL Benchmarks have been calculated as a load reduction and also 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).

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Appendix C: Updated Monitoring Plan

Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan

January 2017

Implementation start: July 1, 2017

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Comprehensive Clackamas County
NPDES MS4 Stormwater Monitoring Plan

Prepared for

Clackamas County
City of Gladstone, Oregon
City of Milwaukie, Oregon
City of Oregon City, Oregon
City of West Linn, Oregon
City of Wilsonville, Oregon
City of Happy Valley, Oregon
City of Rivergrove, Oregon
Clackamas County Service District #1
Surface Water Management Agency of Clackamas County
Oak Lodge Water Services District

January 2017

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List of Figures

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List of Tables

List of Abbreviations

°C	degree(s) Celsius
µg/L	microgram(s) per liter
2004 permit	2004 NPDES MS4 permit
2012 permit	2012 NPDES MS4 permit
ACWA	(Oregon) Association of Clean Water Agencies
BMP	best management practice
BOD	biochemical oxygen demand
$CaCO_3$	calcium carbonate
CCSD #1	Clackamas County Service District #1
CFR	Code of Federal Regulations
cm	centimeter(s)
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorophenyltrichloroethane
DEQ	(Oregon) Department of Environmental Quality
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
JFA	Joint Funding Agreement
mg/L	milligram(s) per liter
mL	milliliter(s)
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
OLWSD	Oak Lodge Water Services District
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Plan	Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan
QA/QC	quality assurance/quality control
RSAT	Rapid Assessment Technique
SM	Standard Methods
SOP	standard operating procedure
SWMACC	Surface Water Management Agency of Clackamas County
SWMP	stormwater management plan
TCE	trichloroethylene
TMDL	total maximum daily load
UIC	underground injection control
USGS	U.S. Geological Survey
WES	(Clackamas County) Water Environment Services

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Section 1 Introduction

As part of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit requirements, Clackamas County co-permittees are required to develop and implement a stormwater monitoring program. Stormwater monitoring requirements and objectives are outlined in Schedule B of the Clackamas County NPDES MS4 permit (101348), issued March 16, 2012 (2012 permit), and provide the basis for monitoring activities described in this 2017 Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan (Plan).

NPDES stormwater monitoring programs require two components. The first component is ***program monitoring***, which involves the tracking and assessment of programmatic activities, as described in the individual permittees' stormwater management plans (SWMPs). The second component is ***environmental monitoring,*** which includes the actual collection and analysis of samples. The purpose of this 2017 Plan is to address the environmental monitoring component of the requirements.

Clackamas co-permittees initiated implementation of environmental monitoring programs in July 2012 to address requirements of the 2012 permit. Specific monitoring obligations (e.g., data collection requirements, coordinated pesticide monitoring study, mercury monitoring) under the 2012 permit have been completed. This 2017 Plan documents updates to monitoring activities based on outcomes from completed monitoring and includes the following elements referenced in Schedule B.2 of the 2012 permit:

- Identification of how the monitoring objectives are addressed
- Discussion of how the monitoring program is related to adaptive management and a long-term monitoring program strategy
- Documentation and recordkeeping procedures
- Documentation of monitoring sites, parameters, and sample collection frequency and methods
- Identification of the analytical methods
- Protocols for quality assurance and quality control (QA/QC)
- Discussion of data management, review, validation, and verification

Following this introductory Section 1, this 2017 Plan is organized into the following sections:

- Section 2. Objectives- Summarizes objectives of the 2017 Plan, specifically related to the six objectives listed in Schedule B of the 2012 permit
- Section 3. Development and Implementation of the Plan- Provides background information related to the development of the 2017 Plan
- Section 4. Data Gathering Strategies- Outlines various data gathering and data collection strategies and describes how collected data will be used in the adaptive management of the individual stormwater programs and in the development of a long-term monitoring program strategy
- Section 5. Monitoring Activities- Describes environmental monitoring activities including monitoring frequency and locations
- Section 6. Sampling Parameters, Analytical Methods, and Quality Assurance and Control- Provides a summary of sampling parameters, sampling procedures, and analytical methods including applicable QA/QC
- Section 7. Monitoring Data Management and Plan Modifications- Summarizes data analyses, interpretation, and management activities

Section 2 Objectives

Schedule B.1 of the 2012 permit lists six specific monitoring objectives to be addressed with the stormwater monitoring program. The six objectives are listed below:

1. *Evaluate the source(s) of the 2004/2006 303(d) listed pollutants applicable to the co-permittees' permit area;*
2. *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
3. *Characterize stormwater based on land use type, seasonality, geography or other catchment characteristics;*
4. *Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges;*
5. *Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters; and,*
6. *Assess progress towards meeting total maximum daily load (TMDL) pollutant load reduction benchmarks.*

Each of the environmental monitoring activities listed in Section 5 below will be conducted in an attempt to answer specific questions to support the monitoring objectives listed above. These questions are listed for each monitoring activity. Descriptions of the monitoring activities also include a narrative describing how the monitoring objectives will be addressed.

Section 3 Development and Implementation of the Plan

Because of the wide range of variability in stormwater data, collecting and analyzing sufficient data to address environmental monitoring requirements and objectives requires significant resources in order to obtain statistically valid and robust data sets. The Oregon Department of Environmental Quality (DEQ) has acknowledged this issue and provided the following clause in the 2012 permit (Schedule B.4) to allow for a coordinated monitoring approach:

> *Environmental monitoring conducted to meet a permit condition in Table B-1 may be coordinated among co-permittees or conducted on behalf of a co-permittee by a third party. Each co-permittee is responsible for environmental monitoring in accordance with Schedule B requirements. The co-permittee may utilize data collected by another permittee, a third party, or in another co-permittee's jurisdiction to meet a permit condition in Table B-1 provided the co-permittee establishes an agreement prior to conducting coordinated environmental monitoring.*

The original Plan was developed in 2006 by nine Clackamas County co-permittees and was implemented beginning in July 2007. In 2016, coverage was expanded to include two additional co-permittees, Oak Lodge Water Services District (OLWSD), formerly Oak Lodge Sanitary District, and the City of Wilsonville. This 2017 Plan reflects this expansion of coverage.

Development of a coordinated monitoring program stemmed from the need to address the monitoring objectives listed in the 2004 NPDES MS4 permit (2004 permit). Previously, jurisdictions were collecting samples based solely on locations and frequencies outlined in the permit without additional consideration of the new monitoring objectives. Given the limited individual monitoring efforts, smaller jurisdictions with less significant environmental monitoring requirements did not have the resources to address the new monitoring objectives without substantial additional effort beyond the “maximum extent practicable” requirement.

The 2006 Plan was developed by reviewing and compiling each participating co-permittee’s existing monitoring efforts (through annual reports). Information compiled included monitoring locations, sample collection methods, sample collection frequencies, water bodies, TMDL/303(d) list status, and contributing land uses. Jurisdictions participated in a series of workshops to evaluate existing activities combined as a whole. Monitoring activities were then refined to (1) address the identified implementation gaps, (2) minimize duplication of monitoring efforts, and (3) ensure that data collected contained information that was sufficiently comprehensive to address the permit-required monitoring objectives. Key changes and features of the 2006 Plan included the following:

- Additional tracking and targeting of storm events during instream sample collection activities to better evaluate the impacts of stormwater runoff on receiving water quality
- Geographic distribution of instream monitoring locations to avoid “clustering of sites”
- Selection of instream monitoring locations based on “high-priority” tributaries, which were identified as those on the 303(d) list (water quality impaired), and/or those with significant development potential upstream
- Selection of stormwater monitoring locations to ensure representation of varying land use categories
- Changing instream and stormwater sample collection methods from grab sampling to use of a timed-composite sampling method in order to better represent changing runoff conditions throughout a storm event

Since 2006, the Plan has periodically been updated to reflect adjustments in monitoring locations, consistency with revisions to Table B-1 (per the 2012 permit), and inclusion of additional detail related to quality assurance procedures.

As mentioned above, for this 2017 Plan, two additional co-permittees (OLWSD and the City of Wilsonville) joined the coordinated monitoring program. Additionally, in June 2017, the co-permittees’ monitoring obligations under the 2012 permit will be met, prompting this update to the Plan.

This 2017 Plan, to be implemented beginning in July 2017, reflects completion of some select, one-time monitoring obligations under the 2012 permit and refinement of monitoring locations, parameters, and activities based on information collected over the last permit term. Key modifications include the following:

- Inclusion of OLWSD and City of Wilsonville instream, stormwater, and biologic monitoring activities
- Removal of mercury and pesticide monitoring activities, as those obligations have been met
- Removal of biochemical oxygen demand (BOD) and total volatile solids (for co-permittees outside of the Tualatin basin) from the analyte list, because of the limited usefulness of the collected data to date
- Adjustment of analytical methods and reporting limits based on consistency with Code of Federal Regulations (CFR) Title 40 and current laboratory capabilities
- Adjustment of monitoring locations to ensure geographic distribution of data and to continue to inform trends analyses
- Inclusion of routine instream sampling, in addition to targeted dry weather/wet weather instream sampling activities

- Removal of Clackamas County Service District #1's (CCSD #1's) geomorphic monitoring activities from the Plan, as physical conditions are evaluated during biologic (macroinvertebrate) monitoring activities
- Minor editorial updates to improve clarity and consistency with current practices

This 2017 Plan serves as an established agreement to conduct a coordinated monitoring effort. The current participating co-permittees include the cities of Gladstone, Milwaukie, Oregon City, Wilsonville, and West Linn; OLWSD; CCSD #1; and the Surface Water Management Agency of Clackamas County (SWMACC). Monitoring conducted by CCSD #1 and SWMACC is conducted on behalf of Clackamas County and the cities of Happy Valley and Rivergrove, and they are included as participants in this 2017 Plan as well.

Section 4 Data Gathering Strategies

As described in Section 3, development of the original (2006) Plan and subsequent iterations to the Plan have applied adaptive management principles in order to refine individual monitoring activities into a coordinated program and address monitoring objectives. This 2017 Plan reflects the results of these adaptive management efforts.

Three primary strategies are outlined in this 2017 Plan to obtain and review data and information necessary to address the six monitoring objectives of the 2012 permit. These strategies include the following:

1. *Collect water quality data and macroinvertebrate data to address the specified monitoring objectives:* Monitoring locations, frequencies, and parameters were reviewed by the co-permittees as providing beneficial information for the city/jurisdiction in order to address the current monitoring objectives. For some jurisdictions, this exercise resulted in a change (increase or decrease) in data points documented in Table B-1 of the 2012 permit. Selection of the monitoring locations, frequencies, and parameters reflects data that co-permittees have historically collected so that adequate data will be available to assess trends in the future.
2. Conduct literature reviews to track relevant technical information related to stormwater quality that is collected by others, yet representative of co-permittee activities: The scientific community, public agencies, and private organizations interested in stormwater management continue to conduct research related to stormwater characterization and treatment. This costly research is often beyond the means of any one co-permittee to conduct an equivalent type of study. Organizations such as the Oregon Association of Clean Water Agencies (ACWA), Bay Area Stormwater Management Association, Water Environment Research Foundation, state transportation departments, vendors of proprietary stormwater treatment systems, colleges and universities, and others continually conduct this type of research and examine complex stormwater-related issues. By participating in these groups and following current research, co-permittees can realize greater benefits from labor and capital investment than if they were to attempt such studies on their own. As such, the co-permittees plan to rely on information garnered by these organizations to address some of the more complex and costly objectives of the permit, especially with respect to understanding the effectiveness of BMPs.
3. Review and evaluate the monitoring results and other information (literature and stormwater management program tracking measures) collected by the co-permittees to support future decisions related to adaptive management and refinement of both the SWMP and environmental monitoring plan: The compilation of monitoring data during the annual reporting period and the permit renewal period will allow co-permittees to ensure that data are being collected as required and that the data are providing useful information to support adaptive management

goals. In conjunction with the monitoring objectives and adaptive management approach submitted to DEQ by the co-permittees in November 2012, the monitoring data can potentially provide rationale for co-permittees in making decisions related to the allocation of resources among stormwater management activities. Monitoring activities are then revised to better address needs. The intent of the stormwater monitoring program is to provide data to support conclusions related to implementation of the co-permittee's SWMPs (e.g., what are the trends) and NPDES MS4 permit requirements and to ensure that the data continue to provide value as questions are answered or new questions arise.

Section 5 Monitoring Activities

This section describes the coordinated environmental monitoring efforts for the participating Clackamas County co-permittees. This section is organized according to the following monitoring activities:

- Instream monitoring efforts (routine and targeted)
- Stormwater system monitoring efforts
- Biological monitoring efforts
- BMP effectiveness monitoring

The questions to be answered and objectives addressed by each monitoring activity are listed at the beginning of each subsection.

5.1 Instream Monitoring

Instream monitoring throughout the Clackamas MS4 permit area addresses objectives 2, 4 and 5 from Schedule B.1.a of the 2012 permit:

2. *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
4. *Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges; and*
5. *Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters.*

Instream monitoring activities will attempt to address the following questions:

- What is the ambient water quality status of the water body?
- What are the trends in water quality observed for the water body?
- How is stormwater runoff impacting receiving water quality?
- How does instream water quality change from an upstream location to a downstream location within an urbanized area?

The following sections describe the instream monitoring locations (Section 5.1.1), sample collection methods (Section 5.1.2), and additional instream sample collection efforts (Section 5.1.3).

5.1.1 Description of Instream Monitoring Locations

Instream monitoring efforts conducted by the participating Clackamas County co-permittees as part of this 2017 Plan include a total of 25 sampling locations representing 20 water bodies.

Instream monitoring site selection was conducted to prioritize locations with water quality impairment, meaning they have a TMDL in place or are 303(d)-listed for a specific parameter. Within the

Clackamas County area, the TMDL water bodies and effective and pending 303(d)-listed water bodies are listed in Table 1.

Table 1. Summary of Clackamas County TMDL and 303(d) Listed Streams

Monitored water body	Bacteria	Temperature	Dissolved oxygen (DO)	Ammonia	Phosphorus	pH/chlorophyll a	Mercury	PCBs	TCE	PAHs	DDE/DDT	Pesticides (dieldrin, eldrin aldehyde, endosulfan)	Arsenic	Thallium	Iron	Lead	Copper	Manganese	Zinc
TMDLs																			
Willamette River (and tributaries) (2006)	✓	✓					✓												
Johnson Creek (2006)	✓	✓					✓				✓	✓							
Tualatin River (1998/2001)	✓	✓	✓		✓	✓	✓												
2010 (effective) 303(d) list																			
Johnson Creek								✓		✓									
Willamette River (Lower or Middle)						✓		✓		✓	✓	✓			✓			✓	
Tualatin River/Fanno Creek			✓									✓			✓			✓	
2012 (proposed) 303(d) list (additional parameters)																			
Johnson Creek											✓	✓				✓			
Abernethy Creek			✓																
Kellogg Creek			✓																
Fanno Creek			✓						✓				✓	✓	✓	✓	✓		✓
Willamette River (lower or middle)			✓				✓									✓	✓		
Tualatin River				✓			✓									✓	✓		✓

DDE = dichlorodiphenyldichloroethylene

DDT = dichlorophenyltrichloroethane

PAH = polycyclic aromatic hydrocarbon

PCB = polychlorinated biphenyl

TCE = trichloroethylene

Instream monitoring site selection was also based on the length of record of historical data. Locations are primarily consistent with those included in the 2006 Plan and subsequent updates, to ensure a long enough period of record to inform future trends analyses. Finally, site selection was made to ensure geographic coverage of the participating co-permittees' MS4 permit areas.

Paired instream monitoring locations were selected when possible. Paired monitoring locations include one upstream location that represents more baseflow and/or rural conditions, generally located close to the co-permittee's MS4 permit area boundary, and one downstream location that represents urban MS4 stormwater runoff and baseflow conditions generated inside of the co-permittee's MS4 permit boundary. Paired monitoring was selected to help identify the effects of urban development on receiving water quality.

Figure 1 identifies the instream monitoring locations and includes the specific water body, responsible jurisdiction, and type of sampling method employed (see Section 5.1.2). Table 2 summarizes the total number of locations and the total number of data points (product of monitoring location and frequency) collected by participating co-permittees each year.

Table 2. Summary of the Clackamas County Co-permittee Instream Monitoring Efforts

Jurisdiction	Total number of monitoring locations	Data points/year
CCSD #1	8	72
SWMACC	1	9
Milwaukie	1	4
Oregon City	6	24
West Linn	3	15
Gladstone	1	3
OLWSD	3	12
Wilsonville	2	8
Total	25	147

5.1.2 Sample Collection Methods

Instream sample collection methods vary by jurisdiction and include either storm-targeted sample collection efforts or routine sample collection efforts. A description of both methods is provided below.

5.1.2.1 Targeted Sample Collection

The 2006 Plan's instream monitoring efforts were focused on collecting ambient water quality data during both dry weather and wet weather conditions. As instream water quality tends to vary during storm events, sample collection that is targeted during storm events and during dry weather conditions allows jurisdictions that conduct monitoring less frequently to assess water quality impacts associated with MS4 discharges. For this 2017 Plan, select jurisdictions (Milwaukie, West Linn, and OLWSD) opted to continue targeting storm events to meet their instream sampling requirements.

Grab samples will be collected instream during dry weather conditions. During storm events, multiple time-spaced grab samples will be collected throughout the storm event to provide a single time-composited sample. A composite sample collected during a storm event allows for capture of a larger portion of the storm hydrograph and better represents fluctuating pollutant concentrations. Rationale related to the use of a time-composite sampling approach was previously submitted to DEQ in 2012.

Instream sampling procedures applicable to this 2017 Plan are as follows:

1. Instream water quality samples will be collected during both dry and wet weather conditions, to support future trends analyses and evaluate differences in receiving water quality due to weather conditions and MS4 stormwater runoff. A select (varies by jurisdiction) number of samples will be collected during storm events (see Table 3).
2. Samples collected during a storm event will be collected as time-composited grab samples, which will require grab samples to be collected at a defined frequency and combined prior to analysis.
3. A minimum of 14 days shall be maintained between consecutive instream sampling events.

Table 3 outlines the storm-targeted instream monitoring locations, frequencies, and responsible jurisdiction. As shown in Table 3, a total of 31 individual samples are planned for collection via the storm-targeted instream sampling method per year, representing 7 water bodies. Approximately 17 of those samples are time-composited samples collected during storm events.

NOTE: The most resource-intensive element of water quality monitoring is sampling during storm events. Because of the difficulty in identifying suitable storms, the uncertainty associated with weather forecasts, and the need to mobilize in a timely manner to allow for characterizing the storm, storm-targeted sampling requires a significant time commitment. Staff conducting the sampling are typically assigned other responsibilities in addition to stormwater monitoring. To ensure that monitoring does not consume inordinate resources at the expense of activities that reduce pollution, the following limitations apply to the commitments made in this 2017 Plan related to storm event sample collection.

- Storms will not be sampled on major holidays including Thanksgiving Day, Christmas Eve, Christmas Day, New Year's Eve, New Year's Day, President's Day, Independence Day, Labor Day, Memorial Day, and Easter.
- Storm events shall be a minimum of 0.1 inch of rainfall and of a size for which, once a crew is mobilized, runoff is anticipated to occur for a minimum of 2 hours.
- For time-composite sample collection, the duration of time between the collection of individual grab samples will vary as necessary to meet the goal of obtaining at least three grab samples per storm event (these three grab samples will then be combined into one composited sample for analyses). In some cases, a storm may not last long enough to collect three individual grab samples. In these cases, the samples that are collected will be composited and analyzed; no minimum number of samples is specified.

Table 3. Targeted Instream Monitoring Site Summary

Monitored water body	Responsible party	Number of locations	Sampling frequency	Parameters monitored (field/lab)[a]	Storm events targeted
Minthorn Creek	Milwaukie	1	4/year	Field and lab	Y (2 of 4)
Summerlinn Creek	West Linn	1	5/year	Field and lab	Y (3 of 5)
Tanner Creek	West Linn	1	5/year	Field and lab	Y (3 of 5)
Trillium Creek	West Linn	1	5/year	Field and lab	Y (3 of 5)
River Forest Creek	OLWSD	1	4/year	Field and lab	Y (2 of 4)
Boardman Creek	OLWSD	1	4/year	Field and lab	Y (2 of 4)
Kellogg Creek	OLWSD	1	4/year	Field and lab	Y (2 of 4)

a. The term "field" indicates samples that are analyzed using meters in the field–typically for temperature, conductivity, DO, and pH.

Number	Jurisdiction	Sampling Method	Site Description	Stream Name
1	CCSD #1	Routine	SE 120th Ave and Carpenter Dr (manhole)	Carli Creek
2	CCSD #1	Routine	Hwy 212/224	Sieben Creek
3	CCSD #1	Routine	Hwy 212/224	Rock Creek
4	CCSD #1	Routine	SE 84th Ave	Phillips Creek
5	CCSD #1	Routine	Hwy 224	Mt. Scott Creek
6	CCSD #1	Routine	SE Rusk Rd	Kellogg Creek
7	CCSD #1	Routine	SE Last Rd	Cow Creek
8	CCSD #1	Routine	Rowe Middle School (SE Lake Rd)	Kellogg Creek
9	Milwaukie	Storm-Targeted	Box Culvert at SE Lake Rd	Minthorn Creek
10	Oregon City	Routine	17082 Holly Ln (Holly Ln Bridge)	Abernethy Creek
11	Oregon City	Routine	316 17th St (at railroad trestle)	Abernethy Creek
12	Oregon City	Routine	Behind 415 S McLoughlin Blvd	Coffee Creek
13	Oregon City	Routine	Behind 13530 Redland Rd	Park Place Creek
14	Oregon City	Routine	North end of Singer Creek Park	Singer Creek
15	Oregon City	Routine	502 7th St (manhole 37138 on Center St)	Singer Creek
16	West Linn	Storm-Targeted	Imperial Dr	Tanner Creek
17	West Linn	Storm-Targeted	Caloroga Rd	Trillium Creek
18	West Linn	Storm-Targeted	Johnson Rd at Ryan Ct	Unnamed Creek
19	Gladstone	Routine	Outfall at Risley Rd	Rinearson Creek
20	SWMACC	Routine	SW Mossy Brae Rd	Pecan Creek
21	Wilsonville	Routine	Boeckman Rd at Boeckman Creek Crossing	Boeckman Creek (upstream)
22	Wilsonville	Routine	Memorial Park at Rose Ln Footbridge	Boeckman Creek (downstream)
23	Oak Lodge	Storm-Targeted	15000 SE Fairoaks Ave	River Forest Creek
24	Oak Lodge	Storm-Targeted	3131 SE Walta Vista Ct	Boardman Creek
25	Oak Lodge	Storm-Targeted	12686 SE 28th Ave	Kellogg Creek

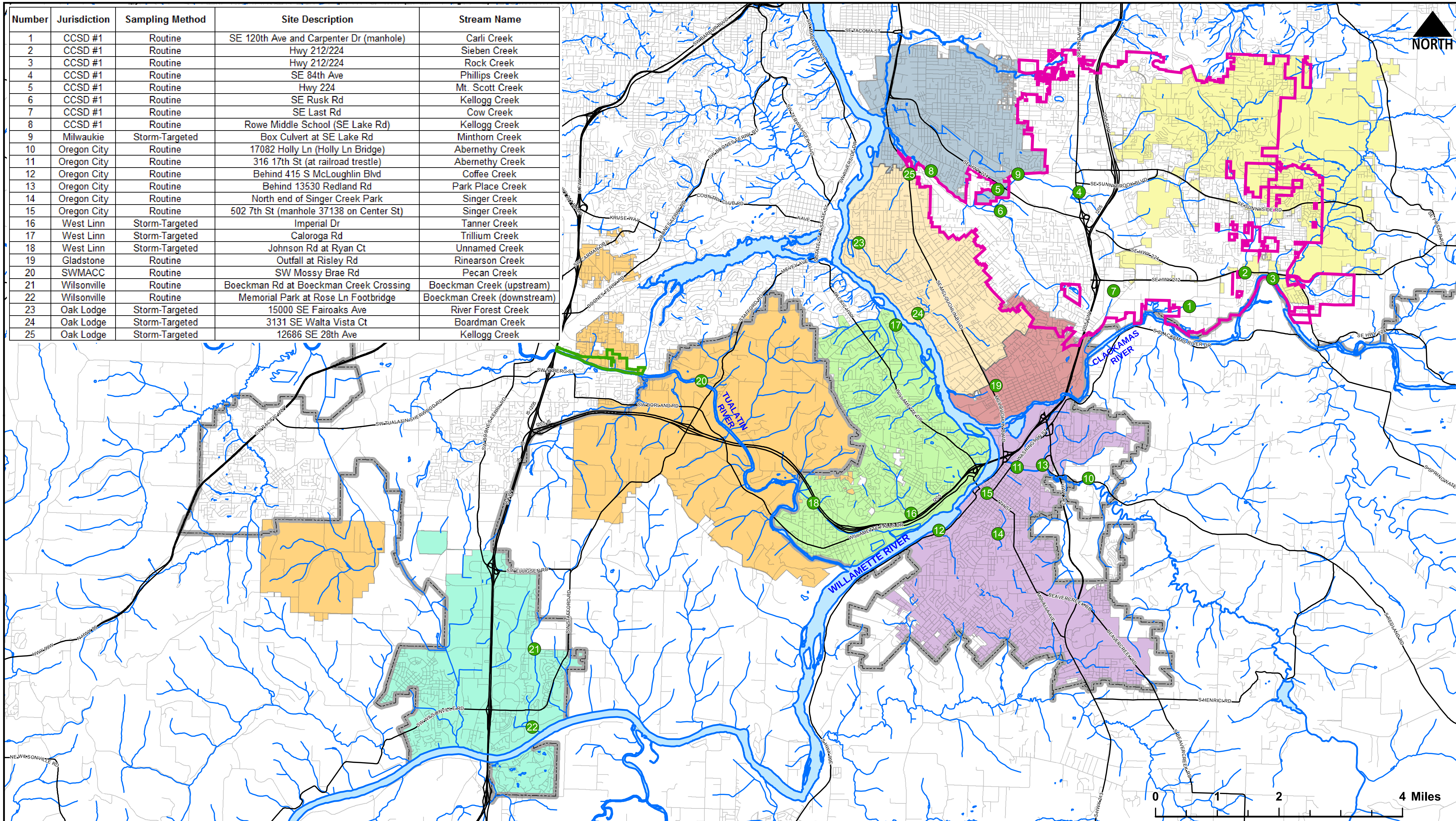

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FIGURE 1. INSTREAM MONITORING LOCATIONS

CCSD #1, SWMACC, Happy Valley, Rivergrove, Gladstone, Milwaukie, Oak Lodge, Oregon City, West Linn, and Wilsonville

5.1.2.2 Routine Sample Collection Methods

Routine instream monitoring efforts are focused on collecting ambient water quality data year round during both dry weather and wet weather seasons in accordance with a predetermined schedule.

For this 2017 Plan update, select jurisdictions (Wilsonville, Oregon City, Gladstone, SWMACC, and CCSD #1) opted to conduct routine instream monitoring instead of specifically targeting dry weather events and storm events to meet their instream sampling requirements. Routine sampling provides a more unbiased and comprehensive picture of ambient water quality conditions. Routine sampling requires prescheduling of sampling activities, reflective of consistent timing and frequency over the monitoring year. When prescheduled, samples will presumably be collected during both dry weather and wet weather conditions to allow for assessment of water quality impacts associated with MS4 discharges.

As with the storm-targeted instream sampling method, grab samples will be collected instream during dry weather conditions. During storm events, multiple time-spaced grab samples will be collected throughout the storm event to provide a single time-composited sample.

Instream sampling procedures applicable to this 2017 Plan are as follows:

1. Prior to the start of the monitoring year, the co-permittee shall establish an instream sampling schedule, based on frequencies shown in Table 4. Deviation from the predetermined schedule during the monitoring year is to be avoided to the extent possible.
2. Instream water quality samples will be scheduled and collected during both the dry and wet weather seasons. A minimum of 50 percent of the samples will be collected during the wet weather season (October 1 to April 30).
3. If it is raining on a prescheduled sampling day, samples shall be collected as time-composited grab samples, which will require grab samples to be collected at a defined frequency and then combined prior to analysis. Detail related to the time-composite sample collection procedures is provided in Section 5.1.2.1.
4. A minimum of 14 days shall be maintained between consecutive instream sampling events.

Table 4, below, outlines the routine instream monitoring locations, frequencies, and responsible jurisdiction. As shown in Table 4, a total of 116 individual samples are planned for collection via the routine instream sampling method per year, representing 18 locations across 14 water bodies.

Table 4. Routine Instream Monitoring Site Summary				
Monitored water body	Responsible party	Number of locations[a]	Sampling frequency	Parameters monitored (field/lab)[b]
Carli Creek	CCSD #1	1	9/year	Field and lab
Cow Creek	CCSD #1	1	9/year	Field and lab
Kellogg Creek	CCSD #1	2	9/year	Field and lab
Mt Scott Creek	CCSD #1	1	9/year	Field and lab
Phillips Creek	CCSD #1	1	9/year	Field and lab
Rock Creek	CCSD #1	1	9/year	Field and lab
Sieben Creek	CCSD #1	1	9/year	Field and lab
Abernethy Creek	Oregon City	2	4/year	Field and lab
Coffee Creek	Oregon City	1	4/year	Field and lab
Park Place Creek	Oregon City	1	4/year	Field and lab
Singer Creek	Oregon City	2	4/year	Field and lab
Pecan Creek	SWMACC	1	9/year	Field and lab
Rinearson Creek	Gladstone	1	3/year	Field and lab
Boeckman Creek	Wilsonville	2	4/year	Field and lab

a. Two locations on the same monitored water body reflects paired sampling sites.

b. The term "field" indicates samples that are analyzed using meters in the field–typically for temperature, conductivity, DO, and pH.

5.1.3 Additional Instream Monitoring Efforts

Since 1998, the City of Milwaukie and Clackamas County Water Environment Services (WES) have participated in a cooperative Johnson Creek watershed study with the U.S. Geological Survey (USGS) and other partners (Gresham, Portland, etc.). The project objectives included the following:

- Assess hydrologic hazards: Analysis of real-time flow and water surface elevations will allow for assessment of flooding conditions as a result of ongoing, significant changes in land use and groundwater discharges.
- Assess water quality: Analysis of stream temperature and turbidity data will provide insight into the effects of land use practices and pollutant sources.
- Assess the interaction between surface water and groundwater: The study provides data and analyses that relate directly to the inter-related nature of the surface and groundwater systems.

As part of this ongoing project, multiple technical reports and publications have been developed. Publications are available for public use and include topics such as: (1) pesticide contributions and transport, (2) overall system hydrology, and (3) suspended sediment loading and the relationship to turbidity levels.

In 2014, the City of Milwaukie and WES (on behalf of CCSD #1) agreed to extend participation in the study through September 2019. Joint Funding Agreements (JFAs) are prepared annually for each partner in order to provide funds to USGS (in part) to operate and monitor continuous flow gauges on Johnson Creek. This monitoring effort directly supports monitoring objective 4 and helps to assess ambient conditions in Johnson Creek. Because of the variable nature of the funding of this study and because future participation is unknown, this effort is referenced separately as an additional instream monitoring activity.

5.2 Stormwater System Monitoring Efforts

Stormwater monitoring throughout the Clackamas County MS4 permit area addresses objectives 1, 2, 3, 5, and 6 from Schedule B.1.a of the 2012 permit:

1. *Evaluate the source(s) of the 2004/2006 303(d) listed pollutants applicable to the co-permittees' permit area;*
2. *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
3. *Characterize stormwater based on land use type, seasonality, geography or other catchment characteristics;*
5. *Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters; and*
6. *Assess progress towards meeting TMDL pollutant load reduction benchmarks.*

Stormwater (outfall) monitoring activities will attempt to address the following questions:

- Are stormwater-related sources of 303(d) pollutants discharging to receiving waters?
- How do stormwater pollutant concentrations vary based on land use?
- How do stormwater pollutant concentrations vary based on BMP implementation upstream?
- Are pollutant loads from stormwater being reduced over time?

The following sections describe outfall monitoring locations (Section 5.2.1) and sample collection methods (Section 5.2.2).

5.2.1 Description of Stormwater Monitoring Locations

Stormwater monitoring efforts conducted by the participating Clackamas County co-permittees as part of this 2017 Plan represent a total of 11 sampling locations and five land use categories. As with the instream monitoring locations, stormwater outfall monitoring locations were originally selected as part of the 2006 Plan development and have been continually refined based on site accessibility and safety.

In 2006, stormwater monitoring locations were originally selected based on the distribution and consistency of the upstream land use type or category (i.e., residential, commercial, industrial, and mixed use). Classification of stormwater quality by land use allows for estimation and evaluation of the sources of specific pollutants. Additionally, the classification of stormwater quality based on land use can be used for pollutant load modeling efforts, and the identification and application of specific BMPs to address specific pollutant loading from a particular land use. Monitoring locations were also selected based on whether non-stormwater flow (e.g., baseflow from groundwater) was present. Samples collected during a storm event from locations with significant baseflow would not be entirely representative of MS4 discharges. Therefore, sites with baseflow were avoided.

Figure 2 identifies the selected stormwater monitoring locations and includes the associated receiving water, upstream contributing land use, and sampling frequency. Table 5, below, summarizes the total number of locations and total number of data points (product of monitoring location and frequency) collected by participating co-permittees each year.

Table 5. Summary of the Clackamas County Co-permittee Stormwater Monitoring Efforts

Upstream land use	Number of outfalls monitored	Total number of samples collected per year
Residential	4	12
Multifamily residential	1	3
Commercial	2	6
Mixed use	3	9
Industrial	1	3
Total	11	33

5.2.2 Sample Collection Methods

Stormwater monitoring efforts are focused on capturing storm-specific data from select outfall locations representing drainage from various land use categories. In conjunction with the monitoring objectives, collection of stormwater samples allows for the identification of pollutant sources, characterization of stormwater (based on land use), and indication of the effects that stormwater runoff may have on instream water quality when compared with instream water quality data.

Samples will be collected as time-composite grab samples. Given the number of stormwater monitoring sites and the geographic coverage of sites, a time-composite sampling method is preferred for participants in the Comprehensive Clackamas County Monitoring Program as opposed to flow composite sampling. Composited samples (either time- or flow-composited samples) collected during storm events allow for capture of a larger portion of the storm hydrograph. As fluctuations of pollutant concentrations vary throughout a storm event, use of composite sampling techniques will better represent those variations during storm events.

Stormwater sampling procedures are as follows:

1. Qualifying stormwater monitoring events must be associated with a storm event resulting in greater than 0.1 inch of rainfall.
2. As possible, qualifying stormwater monitoring events shall occur after a minimum 24-hour antecedent dry period.
3. Stormwater samples will be collected during three storm events per year per location.
4. For each sampling event, a minimum of three time-spaced grab samples will be collected throughout the storm event. As possible, based on the number and location of stormwater monitoring sites, sample collection will be initiated toward the beginning of the storm event and individual grab samples will be collected throughout the storm event, but no more frequently than one sample per 30 minutes.
5. The time-spaced grab samples collected will be combined into a single time-composited sample in accordance with the field collection methods outlined in Appendix A.

The discussion in Section 5.1.2.1 regarding limitations on the commitments for storm event sampling for instream monitoring efforts is also applicable to stormwater monitoring efforts.

For each monitored storm event, the contributing storm event rainfall depth will be estimated based on local rainfall gauge records. In lieu of storm event rainfall depth estimates, the flow rate in the pipe may be estimated. Flow rate may be estimated using the average depth of flow measurement taken in the pipe (or outfall) during sample collection activities, the pipe (or outfall) slope and diameter, and Manning's equation.

Number	Juristiction	Site Description	Receiving Water	Associated Land Use	Sampling Frequency
1	CCSD #1	Outfall #19 at SE Webster Rd	Kellogg Creek	Residential	3 / Year
2	CCSD #1	Outfall #12 at Pheasant Ct	Mt. Scott Creek	Mixed Use	3 / Year
3	CCSD #1	Sunnyside Village Apartments	Sieben Creek	Multi-family Residential	3 / Year
4	CCSD #1	SE Oregon Trail Dr. near SE Sieben Park Way	Unnamed tributary to Sieben Creek	Commercial	3 / Year
5	Milwaukie	Outfall #23003 at Roswell Street	Johnson Creek	Residential	3 / Year
6	Oregon City	Oregon City Shopping Center	Clackamas River	Commercial	3 / Year
7	Oregon City	Clackamette Cove at Agnes Ave	Clackamas River	Industrial	3 / Year
8	SWMACC	Rivergrove Boat Ramp at SW Dogwood Dr	Tualatin River	Residential	3 / Year
9	West Linn	Summit St & Horton Rd	Barlow Creek	Residential	3 / Year
10	Wilsonville	Library Detention Pond Inlet at Memorial Park	Tributary to Boeckman Creek	Mixed Use	3 / Year
11	Oak Lodge	SE Naef Rd (Stringfield Park)	Boardman Creek	Mixed Use	3 / Year

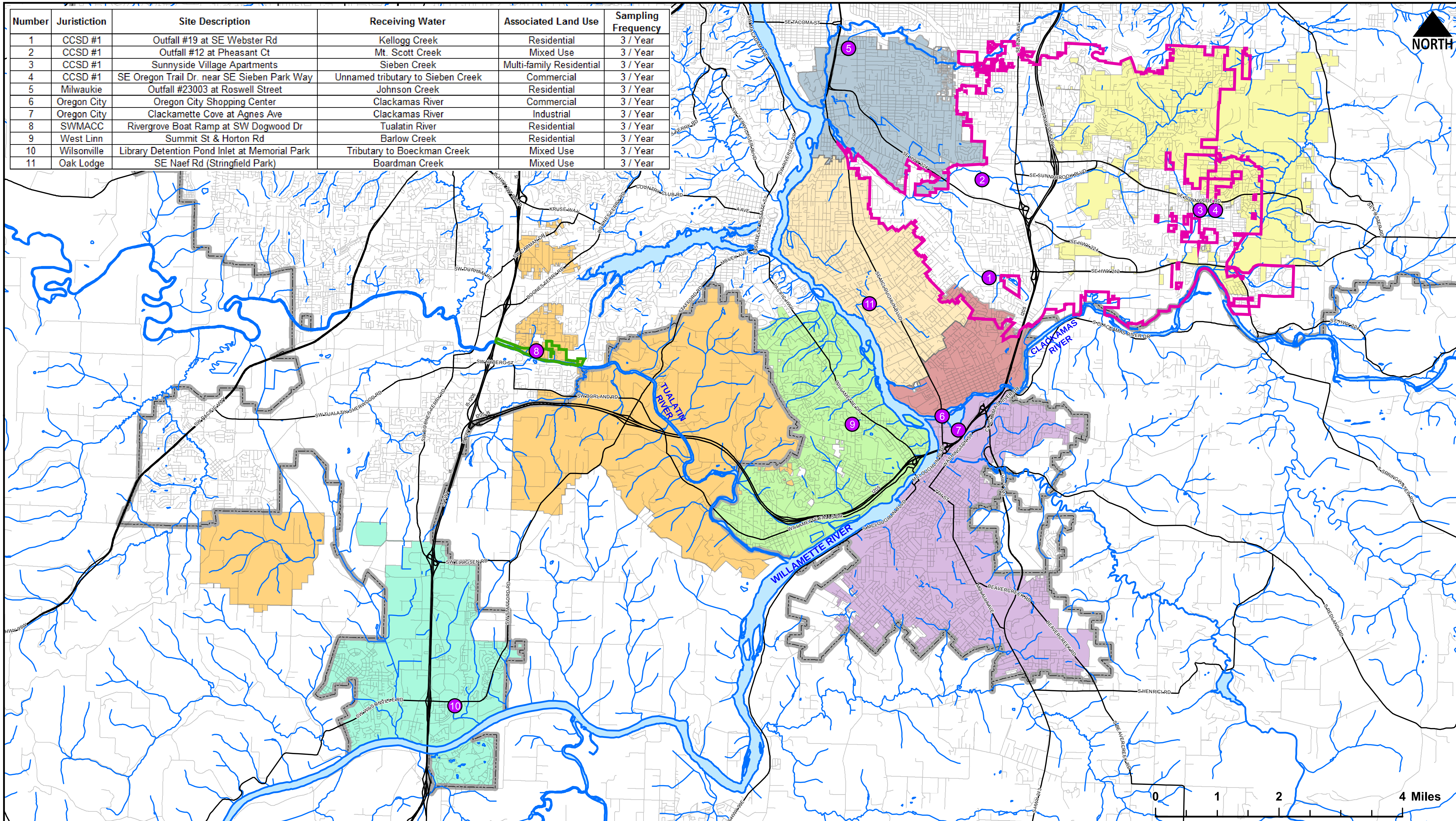

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FIGURE 2. OUTFALL MONITORING LOCATIONS

CCSD #1, SWMACC, Happy Valley, Rivergrove, Gladstone, Milwaukie, Oak Lodge, Oregon City, West Linn, and Wilsonville

Each stormwater monitoring location is listed in Table 6, along with a reference regarding the sampling frequency and parameters monitored.

Table 6. Stormwater System Monitoring Site Summary

Upstream land use	Outfall description	Receiving water	Responsible party	Sampling frequency	Parameters monitored (field/lab)
Residential	Outfall 19: SE Webster Road	Kellogg Creek	CCSD #1	3/year	Field and lab
Residential	Rivergrove Boat Ramp at SW Dog-wood Drive	Tualatin River	SWMACC	3/year	Field and lab
Residential	Outfall 23003 at Roswell Street	Johnson Creek	Milwaukie	3/year	Field and lab
Residential	Summit Street and Horton Road	Barlow Creek	West Linn	3/year	Field and lab
Multifamily residential	Sunnyside Village Apartments	Sieben Creek	CCSD #1	3/year	Field and lab
Mixed use (industrial, highway, commercial, residential)	Outfall 12: SE Pheasant Court	Mt. Scott Creek	CCSD #1	3/year	Field and lab
Mixed use (park, school, commercial, residential)	Inlet to Library Detention Pond at Memorial Park	Unnamed tributary to Boeckman Creek	Wilsonville	3/year	Field and lab
Mixed use (park, highway, commercial, residential)	SE Naef Road at Stringfield Park	Boardman Creek	OLWSD	3/year	Field and lab
Commercial	SE Oregon Trail Drive near SE Sieben Park Way	Unnamed tributary to Sieben Creek	CCSD #1	3/year	Field and lab
Commercial	Oregon City Shopping Center	Clackamas River	Oregon City	3/year	Field and lab
Industrial	Clackamette Cove at Agnes Avenue	Clackamas River	Oregon City	3/year	Field and lab

5.3 Biological Monitoring Efforts

Biological monitoring throughout the Clackamas County MS4 permit area addresses objective 5 from Schedule B.1.a of the 2012 permit:

5. *Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters.*

Biological monitoring activities will attempt to address the following questions:

- What are the biologic conditions of receiving waters?
- Based on past macroinvertebrate sampling activities, are there noticeable trends of improvement or impairment in receiving waters?

The following sections describe the macroinvertebrate monitoring site locations (Section 5.3.1), sample collection methods (Section 5.3.2), and connection to physical condition monitoring (Section 5.3.3).

5.3.1 Description of Biological Monitoring Locations

Biological monitoring efforts conducted by the participating Clackamas County co-permittees as part of this 2017 Plan include a total of 21 sampling locations representing 17 water bodies.

Biological monitoring sites reflect locations where biologic and water quality sampling has historically been conducted. In some cases, the locations are consistent with previous pesticide monitoring activities and/or ongoing instream water quality monitoring. Conclusions and recommendations from previous biological monitoring efforts related to site conditions and site adjustments were considered for this 2017 Plan.

For CCSD #1 and SWMACC, biological monitoring locations reflect the Clackamas County Water Environmental Services (WES) clustered monitoring approach and locations of detailed, in-stream physical condition assessments, not directly included in this 2017 Plan. WES's clustered monitoring approach is internal to CCSD #1 and SWMACC and is intended to allow for a more comprehensive assessment of watershed conditions at specific sites.

The biological monitoring locations are described in Table 7 and shown graphically in Figure 3.

Table 7. Biologic Monitoring Site Summary

Jurisdiction	Target monitoring date	Site description	Receiving water	Past biologic monitoring efforts?	Existing instream water quality monitoring location?
CCSD #1	2018	Rowe Middle School (SE Lake Road)	Kellogg Creek	Y (2009, 2011, 2015)	Y
CCSD #1	2018	Downstream of 11814 Jennifer Street	Carli Creek	Y (2007, 2009, 2011, 2015)	Y[a]
CCSD #1	2018	Highway 212/224, near SE 135th	Sieben Creek	Y (2007, 2009, 2011, 2015)	Y
CCSD #1	2018	SE Troge Road and SE Foster Road	Rock Creek	Y (2007, 2009, 2011, 2015)	N
CCSD #1	2018	SE Rusk Road	Kellogg Creek	Y (2007, 2009, 2011, 2015)	Y
CCSD #1	2018	Highway 224	Mt. Scott Creek	Y (2007, 2009, 2011, 2015)	Y[b]
CCSD #1	2018	Highway 212/224, near SE 142nd Avenue, upstream of confluence with Trillium Creek	Rock Creek	Y (2007, 2009, 2011, 2015)	Y
CCSD #1	2018	Downstream of SE Dean Drive	Cow Creek	Y (2007, 2009, 2011, 2015)	N
SWMACC	2018	SW Mossy Brae Road	Pecan Creek	Y (2007, 2009, 2011, 2015)	Y
Gladstone	2018	River Road (Brookside Village Apartments)	Rinearson Creek	N[c]	N
Milwaukie	2018	SE Lake Road	Minthorn Creek	Y (2013)	Y
Oregon City	2018	Singer Creek Park	Singer Creek	Y (2013)	Y
Oregon City	2018	Lower Coffee Creek	Coffee Creek	Y (2013)	Y
West Linn	2018	Imperial Drive	Tanner Creek	Y (2013)	Y
West Linn	2018	Caloroga Road	Trillium Creek	Y (2013)	Y
Wilsonville	2018	Memorial Park at Rose Lane footbridge	Boeckman Creek	Y (2013)	Y
Wilsonville	2018	Kolbe Lane Bridge	Boeckman Creek	Y (2004, 2013)	N
Wilsonville	2018	Boeckman Creek footbridge	Boeckman Creek	Y (2004, 2013)	N
OLWSD	2018	2350 SE Swain Avenue	River Forest Creek	Y (2013)	N
OLWSD	2018	SE Naef Road at Stringfield Park	Boardman Creek	Y (2013)	N
OLWSD	2018	4507 SE Boardman Avenue	Boardman Creek	Y (2013)	N

a. *The Carli Creek biologic monitoring location corresponds to the CCSD #1 instream monitoring location at SE 120th Avenue and Carpenter Drive. This biologic monitoring site description is consistent with the historical biologic monitoring reports.*

b. *The Mt. Scott Creek biologic monitoring location corresponds to the historical CCSD #1 instream and biologic monitoring location at North Clackamas Park. The past biologic monitoring efforts refer to the North Clackamas Park location. The instream and biologic monitoring site was relocated to Highway 224 for the 2013–14 monitoring year.*

c. *This site was relocated from the Risley Road instream monitoring location based on recommendations following Gladstone's 2013 biological monitoring effort.*

Number	Juristiction	Site Description	Stream Name
1	CCSD #1	Downstream of 11814 Jennifer St	Carli Creek
2	CCSD #1	Hwy 212/224	Sieben Creek
3	CCSD #1	SE Troge Rd and SE Foster Rd	Rock Creek
4	CCSD #1	SE Rusk Rd	Kellogg Creek
5	CCSD #1	Hwy 224	Mt. Scott Creek
6	CCSD #1	Hwy 212/224	Rock Creek
7	CCSD #1	Downstream of SE Dean Dr	Cow Creek
8	CCSD #1	Rowe Middle School (SE Lake Rd)	Kellogg Creek
9	SWMACC	SW Mossy Brae Rd	Pecan Creek
10	Milwaukie	Box Culvert at SE Lake Rd	Minthorn Creek
11	Oregon City	Singer Creek Park	Singer Creek
12	Oregon City	Lower Coffee Creek	Coffee Creek
13	Gladstone	19535 River Rd (Brookside Village Apartments)	Rinearson Creek
14	West Linn	Imperial Dr	Tanner Creek
15	West Linn	Caloroga Rd	Trillium Creek
16	Wilsonville	Memorial Park at Rose Ln Footbridge	Boeckman Creek
17	Wilsonville	Kolbe Ln Bridge	Boeckman Creek
18	Wilsonville	Boeckman Creek Footbridge	Boeckman Creek
19	Oak Lodge	2350 SE Swain Ave	River Forest Creek
20	Oak Lodge	SE Naef Rd (Stringfield Park)	Boardman Creek
21	Oak Lodge	4507 SE Boardman Ave	Boardman Creek

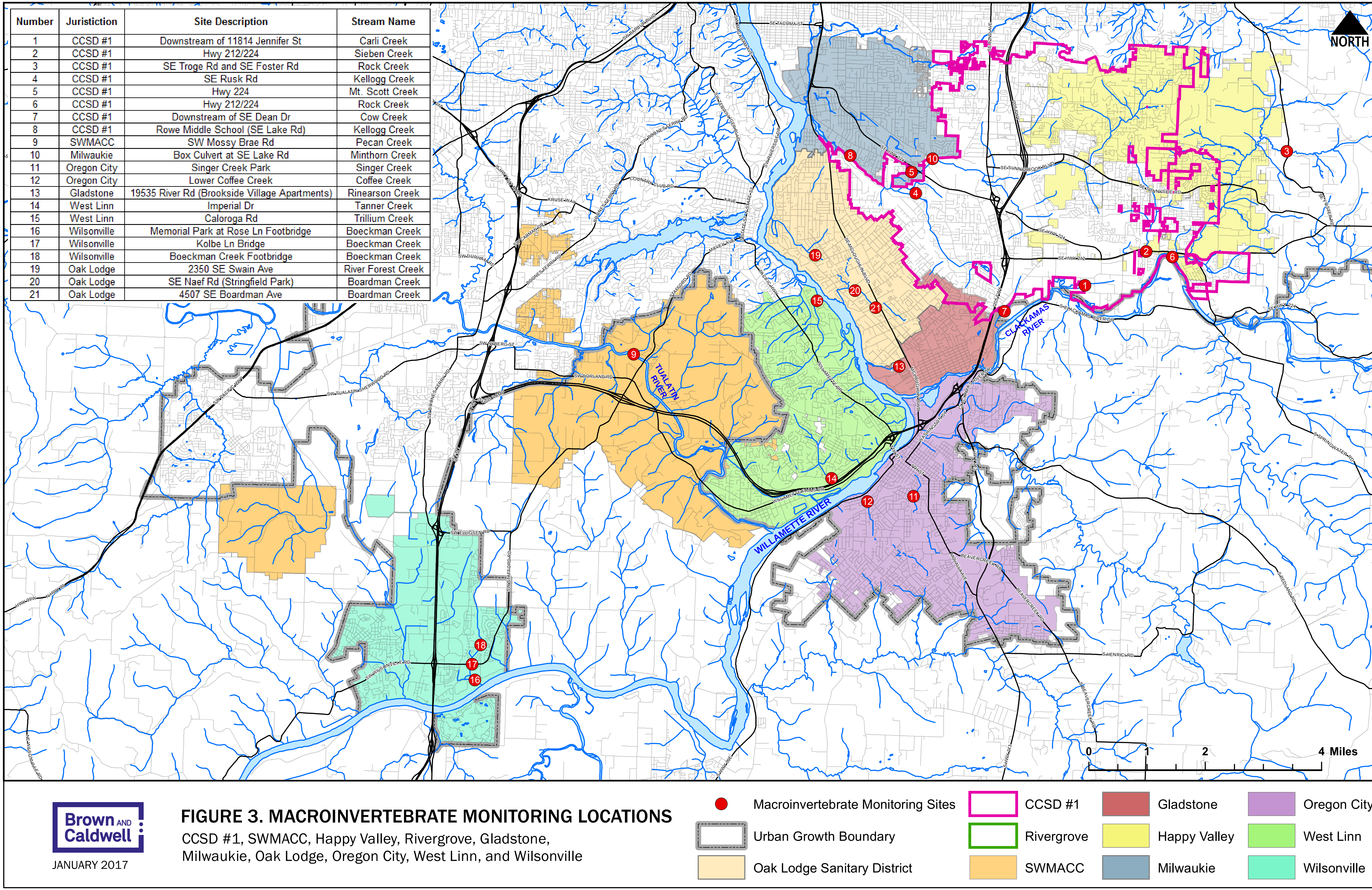

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FIGURE 3. MACROINVERTEBRATE MONITORING LOCATIONS

CCSD #1, SWMACC, Happy Valley, Rivergrove, Gladstone, Milwaukie, Oak Lodge, Oregon City, West Linn, and Wilsonville

5.3.2 Sample Collection Methods

Biological monitoring efforts will be conducted by each participating co-permittee a minimum of once over the next 5 years (i.e., July 2017 through July 2022). Efforts include macroinvertebrate sampling and associated physical habitat, riparian assessment, and water chemistry sampling that accompanies the sample collection. Historically, the co-permittees have used a contractor to conduct the sampling and prepare the documentation in a separate report.

Sampling efforts are typically targeted for summer or early fall, low-flow conditions.

Sample collection processes and methods summarized below are consistent with methods previously employed. Detailed documentation of methods can be referenced in the *Clackamas County NPDES MS4 2013 Coordinated Macroinvertebrate Assessment* (February 2014), prepared by Cole Ecological, Inc. on behalf of the cities of Gladstone, Lake Oswego, Milwaukie, Oregon City, West Linn, and Wilsonville. At the time of sampling, sampling methods may be slightly adjusted to conform to new technologies. Such changes will be documented in a final assessment report at the conclusion of the monitoring event.

Macroinvertebrate community sampling will be conducted using the *Benthic Macroinvertebrate Sampling Protocol for Wadeable Rivers and Streams* (DEQ 2003). Samples are sorted and identified to the level of taxonomic resolution recommended for Level 3 macroinvertebrate assessments. Level 3 protocols include duplicate composite sampling for quality assurance. Both glide and riffle samples are assessed using a multi-metric analysis and using a predictive model.

Water temperature, dissolved oxygen (DO), and specific conductivity will be measured at each site. Standard operating procedures (SOPs) and calibration procedures will be provided to participating co-permittees by the contractor prior to field sampling efforts.

5.3.3 Connection to Physical Condition Monitoring

With urbanization and increased development along the stream corridor, the timing and magnitude of discharge to stream channels often results in changes to the geomorphic character of the channel. This physical change to the stream channel can be observed through changes to stream channel width and depth and changes to the riparian vegetation.

During macroinvertebrate community sampling activities, habitat surveys and riparian assessments are conducted to inform the presence or lack of macroinvertebrates. Habitat surveys and riparian assessments are a type of physical condition monitoring that also help to locate areas of erosion, incision, and migration, and other changes to the stream corridor.

The physical conditions of the stream corridor are assessed using the modified Rapid Assessment Technique (RSAT), which includes data collection from channel habitat units (a sample reach equal to 20 times the wetted width or 75 meters, whichever is greater), channel cross sections, and the adjacent riparian zone. Habitat surveys are conducted to measure or visually estimate the number, length, gradient, and depth of pools and riffles instream; the percent of eroding or downcutting banks; woody debris characteristics; and substrate characteristics. Riparian assessment efforts include identification of riparian plant community type and percent vegetative cover present in the riparian area.

5.4 BMP Monitoring Efforts

Monitoring to analyze the effectiveness of BMPs is conducted to address monitoring objective 2 from Schedule B.1.a of the 2012 permit:

2. *Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities; and,*

6. *Assess progress towards meeting TMDL pollutant load reduction benchmarks.*

BMP monitoring activities will attempt to address the following questions:

- What are the relative pollutant removal capabilities of BMPs being used/implemented in the jurisdiction?
- Has implementation of programmatic BMPs provided information to validate whether stormwater quality improvement is being made, based on defined schedules, and frequencies in the SWMP?

BMP is a broad term that can be used to describe structural water quality facilities and source control/programmatic activities (as reported in the co-permittees' SWMPs). Both are implemented to achieve a net water quality benefit. The monitoring of a structural BMP facility (e.g., detention and retention ponds, swales, constructed wetlands, proprietary systems) would represent an environmental monitoring effort, while monitoring (tracking) of source control/ programmatic activities (erosion and sediment control, stormwater conveyance system cleaning and maintenance, industrial and business inspection programs, and public education and outreach) would represent a program monitoring effort.

This 2017 Plan focuses on environmental monitoring efforts. However, program monitoring is referenced because it also addresses objective 2 from Schedule B.1.a of the 2012 permit. Additionally, the evaluation of stormwater monitoring data, when combined with programmatic monitoring information, may help to quantify the water quality benefit of BMPs.

BMP monitoring also helps indirectly to address monitoring objective 6: *Assess progress towards meeting applicable pollutant load reduction benchmarks*. BMP effectiveness data are used in pollutant load modeling and the development of pollutant load reduction estimates in order to meet requirements for TMDL compliance. Evaluating BMP effectiveness allows for refinement of these effectiveness values used in the model and allows for the pollutant load modeling to reflect current conditions more accurately.

The following sections describe BMP monitoring efforts pertaining to environmental monitoring (Section 5.4.1) and program monitoring (Section 5.4.2).

5.4.1 BMP Monitoring (Environmental)

Limited environmental monitoring is currently being conducted by Clackamas County co-permittees associated with the performance of structural or source control BMPs. Structural BMP monitoring can be a very time- and cost-intensive activity, while the results apply only to the specific characteristics of the sampled BMP. Sampling of stormwater for purposes of evaluating source control activities often provides inconclusive results because of the variability of stormwater runoff, pollutant sources, and implementation efforts.

As stormwater management and stormwater treatment are continually changing and evolving fields, extensive literature regarding the monitoring of various treatment technologies and practices (structural and source control BMPs) is being generated by researchers, public entities, and private companies to meet both regulatory and non-regulatory needs. Clackamas co-permittees collect effectiveness information and cost information for various BMPs in conjunction with implementation of their stormwater programs. When made available from local, regional, and national sources, Clackamas County co-permittees obtain information that aids their individual stormwater management efforts and influences future decision making regarding appropriate levels of treatment technology to require for new development and redevelopment. Review and application of these findings provides a more cost-effective means of addressing monitoring objective 2.

A number of Clackamas County co-permittees are actively involved in ACWA, which provides an open forum for stormwater management discussions and provides additional educational opportunities for local officials regarding stormwater quality and treatment. Participation in ACWA will continue to support literature tracking efforts.

Finally, the City of Milwaukie will begin monitoring a large, structural BMP that serves as a regional water quality facility. Objectives of the monitoring include evaluation of the performance of the system (from a water quality perspective) and potential refinement of the BMP effluent concentrations used to evaluate pollutant load reduction of the facility in order to establish TMDL benchmarks. Table 8 summarizes the structural BMP to be evaluated, the proposed sampling frequency, and the parameters to be evaluated.

Table 8. Structural BMP Monitoring Site Summary

Responsible party	Structural BMP description	Receiving water	Sampling frequency	Parameters monitored (field/lab)
Milwaukie	Roswell detention facility	Johnson Creek	1/year	Field and lab

5.4.2 BMP Monitoring (Programmatic)

Clackamas County co-permittees currently conduct a variety of program monitoring efforts, generally related to implementation of their SWMPs. Qualitative information is currently collected in the form of tracking measures. These tracking measures provide valuable information to assist in the assessment of BMPs. Examples of BMP categories that are assessed for effectiveness through the use of tracking measures include the following:

- Illicit discharge detection and elimination (e.g., have the number of illicit discharge incidents decreased?)
- Public education (e.g., based on survey information, is there increased public awareness related to the jurisdiction’s stormwater program and overall stormwater management?)
- Maintenance of structural controls (e.g., based on inspection records, is maintenance being performed more regularly? Are facilities operating more consistently?)

Specific tracking measures for these BMP categories are described in each of the co-permittees’ SWMPs and are reported on with annual reports.

Quantitative effectiveness data for the programmatic elements outlined in the SWMP are currently not collected, but efforts to look at the effectiveness of these source control activities may occur as discussed above under Section 5.4.1.

Section 6 Sampling Parameters, Analytical Methods, and Quality Assurance and Quality Control

This section includes a summary of sampling parameters and analytical methods (Section 6.1) and a summary of QA/QC procedures (Section 6.2).

6.1 Sampling Parameters and Analytical Methods

The purpose of both instream and stormwater outfall monitoring efforts is to assess the degree to which ambient water quality is impacted by stormwater runoff. Therefore, consistent pollutant parameters are monitored for both instream and outfall (stormwater) sampling locations.

Pollutant parameters for this 2017 Plan are based on Table B-1 of the 2012 permit and are listed below in Table 9. A suggested analytical method is also identified in Table 9; however, use of an alternative, U.S. Environmental Protection Agency (EPA)-approved method listed in the most recent publication of 40 CFR 136 is permissible. The suggested analytical methods documented in Table 9 include both EPA and Standard Methods and (SM) are consistent with provisions of 40 CFR 136.

Table 9. Pollutant Parameters and Analytical Methods

Type (field or lab)	Analyte	Sample type (grab or time-spaced composite)	Unit	Suggested analytical method	Target MDL	Notes
Field	Specific conductivity	Grab	µmhos/cm	SM 2510 B	1	Method assumes use of probe
Field	pH	Grab	Standard units	SM 4500-H B	0.1	Method assumes use of probe
Field	Temperature	Grab	°C	SM 2550-B	0.1	Method assumes use of probe
Field	DO	Grab	mg/L	EPA 360.1	0.1	Method assumes use of probe
Lab	Copper, total	Composite	µg/L	EPA 200.8	0.1	
Lab	Copper, dissolved	Composite	µg/L	EPA 200.8	0.1	
Lab	DO[a]	Grab	mg/L	SM 4500-C	0.02	Conducted to verify field reading
Lab	*E. coli*	Grab	MPN/100 mL	SM 9223 B	1.0	
Lab	Total hardness	Composite	mg $CaCO_3$/L	SM 2340 C	5	
Lab	Lead, total	Composite	µg/L	EPA 200.8	0.01	
Lab	Lead, dissolved	Composite	µg/L	EPA 200.8	0.01	
Lab	Nitrogen: ammonia	Composite	mg/L	SM 4500 NH_3G	0.05	
Lab	Nitrogen: nitrate	Composite	mg/L	SM 4500-NO_3 F	0.04	
Lab	Phosphorus, total	Composite	mg/L	SM 4500-P A, B, & E	0.04	
Lab	Phosphorus, ortho-phosphate	Composite	mg/L	SM 4500-P FEPA 300.0 365.3	0.02	
Lab	Solids: total suspended	Composite	mg/L	SM 2540 D	1.0	
Lab	Solids: total dissolved	Composite	mg/L	SM 2540 C	5.6	
Lab	Solids: total volatile[b]	Composite	mg/L	SM 2540 B	5.0	
Lab	Zinc, total	Composite	µg/L	EPA 200.8	1	
Lab	Zinc, dissolved	Composite	µg/L	EPA 200.8	1	

a. *The Winkler Titration Method is employed to verify field DO readings in accordance with field sampling procedures outlined in Appendix A. Some jurisdictions may opt to analyze DO using only the Winkler Titration Method instead of collecting field samples.*

b. *Parameter is monitored by SWMACC and West Linn only.*

°C = degrees Celsius; µg/L = micrograms per liter; $CaCO_3$ = calcium carbonate; cm = centimeters; mg/L = milligrams per liter; mL = milliliters; MPN = most probable number.

Water quality monitoring conducted as part of the macroinvertebrate sampling will conform to documented SOPs and may deviate from the approved methods listed in 40 CFR 136.

6.2 Quality Assurance and Quality Control Procedures

For purposes of this 2017 Plan, QA/QC procedures for field analysis are initiated directly by the jurisdiction. QA/QC procedures for laboratories are developed by the individual laboratories and available on request.

Field QA/QC procedures are outlined in Appendix A and included in the SOPs for field sample collection (SOP A-1), chain of custody (SOP A-2), and sample handling and transportation (SOP A-3). General sampling procedures for parameters analyzed in the field are provided in SOP A-4. ACWA developed detailed QA/QC procedures for stormwater data collection and sample handling and custody as part of the ACWA UIC [Underground Injection Control] Monitoring Study. Provisions from this ACWA study have been incorporated into the field QA/QC procedures in Appendix A as appropriate.

Co-permittees will use laboratories that have comprehensive QA programs and are DEQ-accredited. The WES water quality laboratory, which currently conducts laboratory analysis for samples collected by some Clackamas County co-permittees operating under this 2017 Plan, operates under the WES *Water Quality Assurance Manual* (May 17, 2007). This manual outlines pertinent test methods, validation, and reporting limits; equipment calibration and maintenance procedures; sample handling and storage procedures; sample acceptance and results reporting procedures; and data qualification and validation procedures. This manual is available by request from the WES Water Quality Laboratory.

Contracted monitoring activities related to biologic monitoring employ field procedures and protocols unique to the monitoring effort. A description of study methods and QA/QC guidelines will be documented in the final assessment report provided to each jurisdiction at the conclusion of the monitoring event.

Section 7 Monitoring Data Management and Plan Modifications

This section includes a summary of data management procedures (Section 7.1) and procedures for modifying this 2017 Plan (Section 7.2).

7.1 Data Management

Participants in this 2017 Plan individually (or through an inter-governmental agreement) collect samples and are responsible for the quality control of their samples prior to delivery at the laboratory. Field sample collection procedures are outlined in Appendix A. Sample validation and verification is conducted at the laboratory and, following analysis, the monitoring results are provided to the responsible jurisdiction to validate and verify that the findings are consistent with their expectations. Questionable monitoring results will be flagged for further review and possible follow-up in the field. If data quality indicators (i.e., field blanks, field duplicates) suggest that contamination or corruption of the sample occurred, data may be discarded and sampling would be conducted again, and the cause of the failure would be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be assessed and improved; if the cause is found to be with the sample collection process, field techniques will be assessed, revised, and retrained as appropriate.

Individual jurisdictions are responsible for the compilation of instream and stormwater monitoring data in database or spreadsheet format. Monitoring data are compiled by monitoring location and monitoring event, and data include times, concentrations, and indication of whether a sample represents a grab- or time-composited sample. Statistics (i.e., mean, maximum, minimum) may be calculated on the data by an individual jurisdiction for its own use. A summary of monitoring results is provided to DEQ with submittal of the individual jurisdiction's NPDES MS4 annual reports. Compiled monitoring data may be provided to DEQ in digital format upon request.

Technical reports documenting results of the biologic monitoring effort shall be maintained by individual jurisdictions and results shall be summarized or attached to the associated NPDES MS4 annual report.

A water quality trends analysis will be conducted during the fifth year of this 2017 Plan implementation, based on the instream monitoring data collected to date. The benefit of a coordinated monitoring program is that resources can be distributed more widely to produce data that will provide comprehensive information for Clackamas County as a whole. As a result, data analyses will be conducted specific to each jurisdiction and water body, but assessment and interpretation can be conducted for watersheds as a whole. As part of the water quality trends analysis effort, previously collected monitoring data specific to the water body will be reviewed.

7.2 Plan Modifications

Modifications to monitoring locations and frequency as outlined in this 2017 Plan are permissible as long as the number of monitoring data points collected on an annual basis (the product of monitoring location and frequency) is not reduced. Additionally, if on an annual basis a participating co-permittee is not able to collect the required samples because of climatic conditions, sampling conditions, equipment malfunction, monitoring location inaccessibility, etc., such inability is not directly reflective of a need to modify the monitoring plan.

Currently, as required in the extended 2012 permit, if a modification to this 2017 Plan is requested or required, such need will be documented to DEQ in the form of a 30-day notice of proposed monitoring plan modification. Written approval must be received from DEQ before such modification can take place. If DEQ does not respond within 30 days, the proposed modification is deemed to be approved without written approval.

Appendix A: Field QA/QC Procedures

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Appendix A: Field Quality Assurance and Control Procedures for Sample Collection, Handling, and Custody

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SOP A-1: Field Sample Collection Procedures

Field crews are responsible for collecting samples, recording information, and transferring collected samples.

Prior to sample collection, field crews shall verify that adequate sample collection bottles and sample storage equipment are obtained. Sample collection bottles shall be of adequate size and appropriate material, per requirements of the applicable analytical method. Most sample collection bottles are pre-preserved by the laboratory for the appropriate analytical test. If necessary to meet preservation requirements, additional preserving agents will be added to samples by the laboratory upon receipt of the samples.

Upon arrival at the site, field crews shall establish a safety zone for sample collection if necessary (this may include the placement of traffic cones, etc.). Site conditions and other sampling notes shall be recorded in a monitoring log and/or on the Monitoring Field Data Sheet.

Procedures for conducting grab sampling and composite sampling are as follows.

Grab Sampling Procedures

Grab sample collection methods shall be employed for all dry weather instream monitoring activities and for wet weather instream and stormwater (outfall) monitoring activities for select parameters.

Bottle preparation

Obtain clean half-pint, pint, quart, or half-gallon sample bottles from the laboratory conducting the water quality analyses. Each monitoring site would require a minimum number of sample bottles such that separate sample bottles are obtained based on the analytical test methods to be employed by the laboratory. Bottles shall be pre-labeled by field crews or staff to include the site number and monitoring parameter. In some cases, the laboratory may pre-label sample bottles.

1. Based on the number of sampling sites, obtain additional sample bottles for the collection of grab sample duplicates and field blanks. Bottles for duplicate sampling and field blanks shall be obtained from the laboratory conducting the water quality analyses as required. Based on the number of analytical test methods to be employed, the appropriate number of bottles should be obtained for the collection of duplicate samples and field blanks at a site. Bottles for duplicate and field blank samples shall also be pre-labeled with the designated duplicate site number and monitoring parameter.
2. Procedures related to the collection of grab sample duplicates and field blanks are outlined under SOP A-1, QA/QC Sampling Procedures.

Grab sampling technique

Depending on the site characteristics, samples can be obtained by hand or with the aid of tools (i.e., a grab pole).

1. For sample collection from a (flowing) surface water body, the sample should be collected from the middle of the flow stream (if possible). Care must be taken to avoid collecting particulates that are suspended as a result of bumping the bottle on the

streambed. To sample with a hand-held bottle/container, stand downstream of the bottle while it is being filled.

2. If sampling at a surface water outfall, the sample should be collected, if possible, at the point where the flow leaves the pipe.
3. When no sample is collected because of lack of flow or any other circumstances beyond the sampler's control, the associated condition should be noted in the appropriate entry point on the Monitoring Field Data Sheet.
4. Once the bottle is filled to the proper level, replace the lid on the sample bottle and complete the Monitoring Field Data Sheet with appropriate information related to sample collection (i.e., time, sampling conditions, date, etc.).
5. As directed by the laboratory, filter or preserve samples as necessary in accordance with laboratory-issued standard operating procedures. As an example, the WES laboratory requires field filtration of ortho-phosphate at the time of sample collection.
6. Samples should be stored for transport to the laboratory in an "iced" cooler (i.e., using ice or an ice substitute that has been frozen).
7. If a grab sample duplicate is to be obtained at a particular sampling site, the duplicate samples will be obtained by completing the normal grab sampling procedures and documenting information on the Monitoring Field Data Sheet consistent with collection of an actual sample.
8. For samples that are collected for the analysis of bacteria, samples must be transported to the lab within 6 hours of sample collection.
9. Ensure that all elements of the Monitoring Field Data Sheet are complete prior to relinquishing the samples to the laboratory.

Composite Sampling Procedures

Composite sample collection methods shall be employed for wet weather instream and stormwater (outfall) monitoring activities for all laboratory parameters (with the exception of bacteria) as outlined in Table 9 of the Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan.

Bottle preparation

Obtain a minimum of one clean, half-gallon sample bottle from the laboratory or other clean sampling receptacle for collection of the individual samples and one carboy (i.e., large glass or plastic vessel) to combine the individual samples and mix the composited sample. The bottle(s) and the carboy shall be pre-labeled to include the site number.

Obtain additional, clean half-pint, pint, quart, or half-gallon sample bottles for transport of the composited sample to the laboratory. Each monitoring site would require a minimum number of sample bottles such that separate sample bottles are obtained based on the analytical test methods to be employed by the laboratory. Bottles shall be pre-labeled to include the site number and monitoring parameter.

1. Based on the number of sampling sites, obtain the same number of sample bottles as outlined above for the collection of a composite duplicate samples and field blank samples. Bottles for duplicate sampling and field blanks shall also be obtained from the laboratory conducting the water quality analyses as required.

2. Procedures related to the collection of composite duplicate samples and field blank samples are outlined under SOP A-1, QA/QC Sampling Procedures.

Composite sampling technique

Depending on site conditions, samples can be obtained by hand or with the aid of a tool (i.e., grab pole).

Grab sample collection methods, steps 1 through 4 as documented above, should be employed for each of the minimum three individual grab samples collected prior to pouring in the carboy. Composite samples are generally collected at timed intervals and/or on a sampling rotation. Following collection of the minimum three individual grab samples that will compose the composited sample, the following procedures should be followed:

1. Ensure equal portions from individual grab samples are poured into the pre-labeled carboy. This effort shall occur in a closed or covered environment.
2. Properly mix the composited sample and pour a sufficient quantity of water into each pre-labeled sample bottle that is to be relinquished to the lab for analysis.
3. Implement grab sample collection methods, steps 5 through 7.
4. Update the Monitoring Field Data Sheet to document completion of the composite sample collection efforts.

Please note if a composite sample duplicate is to be obtained at a particular sampling site, in order to test the accuracy of the sample collection procedures, the duplicate sample shall be obtained by completing the normal grab sampling procedures, compositing as indicated above, and transferring the composited sample into the pre-labeled sample collection bottles for the laboratory.

QA/QC Sampling Procedures

The use of field blanks and grab and composite sample duplicates will help to identify potential sources of error in the stormwater sampling process, specifically those associated with sample collection, transportation, and analytical procedures.

For grab and composite samples for all parameters, field blanks and grab or composite duplicates shall be collected at a minimum of 10 percent of the total number of monitoring locations for a single event and for samples collected by a single sampling crew. For example, if samples are to be collected at 10 sites or less for one monitoring event, then one field blank and one duplicate sample shall be obtained for that monitoring event. If individual grab samples are to be collected at 12 sites for one monitoring event, then two field blanks and two grab sample duplicates shall be obtained for that monitoring event. A minimum of one field blank and one duplicate shall be obtained for a single monitoring event.

Guidelines related to the collection of a field blank and duplicate sample are outlined below:

1. Procedures for collection of field blank samples should follow the appropriate grab or composite sampling procedures with the exception that the analyte bottle (in the case of grab sample collection) or half-gallon sample bottles (in the case of composite sample collection) are instead filled with deionized (DI) water as provided by the lab. The field blanks shall be transported to all sampling sites associated with a monitoring event in the storage containers with other sample bottles. This will assist with identifying any potential contamination that may occur with the sample collection and transportation of samples.
2. Procedures for collecting the duplicate sample should follow the appropriate grab or composite sample procedures. The duplicate sample bottles shall be pre-labeled with the designated duplicate site number and monitoring parameter. These duplicate samples will assist with identifying any potential contamination that may occur with sample collection or analytical procedures.

SOP A-2: Field Data Sheets and Chain-of-Custody Records

Monitoring Field Data Sheets are completed by field staff conducting the monitoring activities during sample collection activities. Monitoring Field Data Sheets are maintained with the samples during transport to the laboratory.

A chain-of-custody (COC) record is a legal document generated at the laboratory based on information contained in the Monitoring Field Data Sheet. The COC is prepared either prior to or during the delivery of the samples and identifies the person(s) responsible for the sample bottles during all elements of monitoring activity.

The Monitoring Field Data Sheet(s) shall be completed for each sampling location and event. The COC shall be maintained for each sampling event.

The procedures for filling out these forms are as follows.

Before and during Sample Collection

Before sample collection activities, field staff shall document the following general information on a Monitoring Field Data Sheet, unless otherwise documented on the COC:

- Source/location
- Site code or ID
- Person(s) sampling
- Type of sample (instream dry weather/season, instream wet weather/season, or stormwater outfall)
- Date of sample collection
- Time of sample collection
- Number of sample (if applicable): pertains to collection of multiple individual grab samples to compile as a time-composite sample
- Parameters desired for analysis

During sample collection, the Monitoring Field Data Sheet should remain with the sample bottles. During sampling, staff should add to the Monitoring Field Data Sheet for each individual grab sample to document the time and date that the sample was collected.

The Monitoring Field Data Sheets should remain with the samples for the duration of sampling.

After Sample Collection

If composite sampling methods are being used, the Monitoring Field Data Sheet should be updated to include the time and date at which the individual grab samples were composited. If a separate Monitoring Field Data Sheet is completed for the composite sample, any Monitoring Field Data Sheets associated with individual grab samples used to generate the composite sample should be maintained (e.g., stapled to the back) of the composite sample Monitoring Field Data Sheet.

At the Laboratory

The person responsible for completion of the Monitoring Field Data Sheets should be the one to relinquish this paperwork to laboratory personnel or other staff as necessary. At the time of transfer, information contained on the Monitoring Field Data Sheets shall be entered into the laboratory's tracking database (e.g., Clackamas County Water Environment Services Labworks program). In addition to information contained on the Monitoring Field Data Sheets, any special instructions and information related to the transfer of responsibility is also documented.

Using the laboratory's tracking system, the COC is recorded and internal tracking labels may be generated.

SOP A-3: Transporting, Packaging, and Shipping Samples from Field to Lab

Procedures for handling and transportation of samples to the applicable water quality laboratory are as follows:

1. Keep the Monitoring Field Data Sheet with the samples at all times.
2. Pack samples well within ice chest to prevent breakage or leakage.
3. As stated previously, samples should be packed in ice or an ice substitute with a goal to maintain a sample temperature of 4 degrees Celsius during transport. Acquire more ice or ice substitute as necessary.
4. Samples must be delivered to the water quality laboratory within 6 hours (standard for bacteria analysis) or in accordance with required holding times for other parameters.
5. Most samples will be collected in pre-preserved bottles. Some samples may require additional preservation agents to meet preservation requirements. If needed, additional preserving agents will be added to samples by the laboratory personnel upon receipt of the samples.

SOP A-4: Sampling Procedures for Parameters Analyzed in the Field

Sampling procedures for field parameters (i.e., dissolved oxygen [DO]/temperature, conductivity, and pH) are outlined below.

Field Dissolved Oxygen/Temperature Procedure

Meter preparation

1. Check the device for damage.
2. Check and replenish the field supply of deionized (DI) water.
3. Calibrate the device for DO (refer to current manufacturer's calibration instructions). Record calibration in a Calibration Log Book. As necessary, have experienced personnel calibrate the device prior to field sampling event.
4. Verify the device's temperature reading to a National Institute of Standards and Technology (NIST) thermometer. The temperature reading should be within ± 0.5 degree Celsius. Record the temperature verification in a Calibration Log Book.

Analysis timeline

1. All temperature and DO samples are obtained in the field.
2. Samples must be obtained in a fresh glass or plastic bottle or beaker.
3. Sample analysis is performed on site.

Technique

1. Immerse the device directly in the sample. The device is not to be moved around in the sample. Depending on the device used, measurement may occur in a pre-rinsed sample beaker or bottle or directly in the flow path.
2. Record the DO and temperature readings on the Monitoring Field Data Sheet.
3. Remove the device from the sample and rinse with DI water prior to storage or analysis of the next sample.

QA/QC

1. In order to verify DO concentrations obtained in the field, employ the Winkler Titration Method for one sample collected per event. A separate grab sample shall be collected and analyzed at the laboratory, and results shall be compared to the instrument analysis from the same location.
2. In accordance with the rationale outlined in SOP B-1, duplicate samples shall be collected.
3. Monitoring Field Data Sheets are completed during field sample collection and during grab sample collection (when conducting the Winkler test).

Field pH Procedure

Meter preparation

1. Set up the field pH meter(s).
2. Check the device for damage.
3. Check and replenish the buffer solution (4, 7, 10) and DI water.
4. Calibrate the device using at least two pH buffers (4 and 7) and document (refer to current manufacturer's calibration instructions). As necessary, be sure to remove the device's filling solution vent plug before making any pH measurements.

Analysis timeline

1. All pH samples are obtained in the field as grab samples.
2. Samples must be obtained in fresh glass or plastic bottles or beaker.
3. Sample analysis shall be performed on site within 15 minutes of grab time.

Technique

1. Remove device from the field storage solution. Do not remove from storage solution until water sample is ready for analysis.
2. Pre-rinse the sample bottle or beaker with sample water prior to obtaining the actual sample.
3. Collect a 200-milliliter (mL) sample (minimum).
4. Thoroughly rinse the device tip with DI water, pat dry with clean paper towel, and put the device into the sample.
5. Once the device is immersed in the sample, slowly rotate in a circular pattern until the reading stabilizes (30 seconds).
6. Record the pH (to nearest 0.1 unit).
7. Enter the pH data on the Monitoring Field Data Sheet.
8. Remove the device from the sample and rinse with DI water prior to storage or analysis of the next sample.

QA/QC

1. Monitoring Field Data Sheets are completed in the field as the samples are collected.
2. After the completion of each day's sampling, device calibration(s) must be verified and checked for accuracy. The verified pH readings shall be recorded in the pH Calibration Log Book. Devices should be cleaned with DI water and stored in the correct storage solution.
3. A low ionic strength pH probe and an automatic temperature compensation (ATC) probe should be used (e.g., pH probe Orion 815600 and ATC probe 917005).

Field Conductivity Procedure

Meter preparation

1. Set up the field conductivity meter.
2. Check the device for damage.
3. Calibrate the device according to current manufacturer's calibration instructions.
4. Check and replenish the field supply of DI water for rinsing the device following sampling.

Analysis timeline

1. All conductivity samples are obtained in the field as grab samples.
2. Samples must be obtained in fresh glass or plastic bottles or beaker.
3. Sample analysis is performed on site within 15 minutes of grab time.

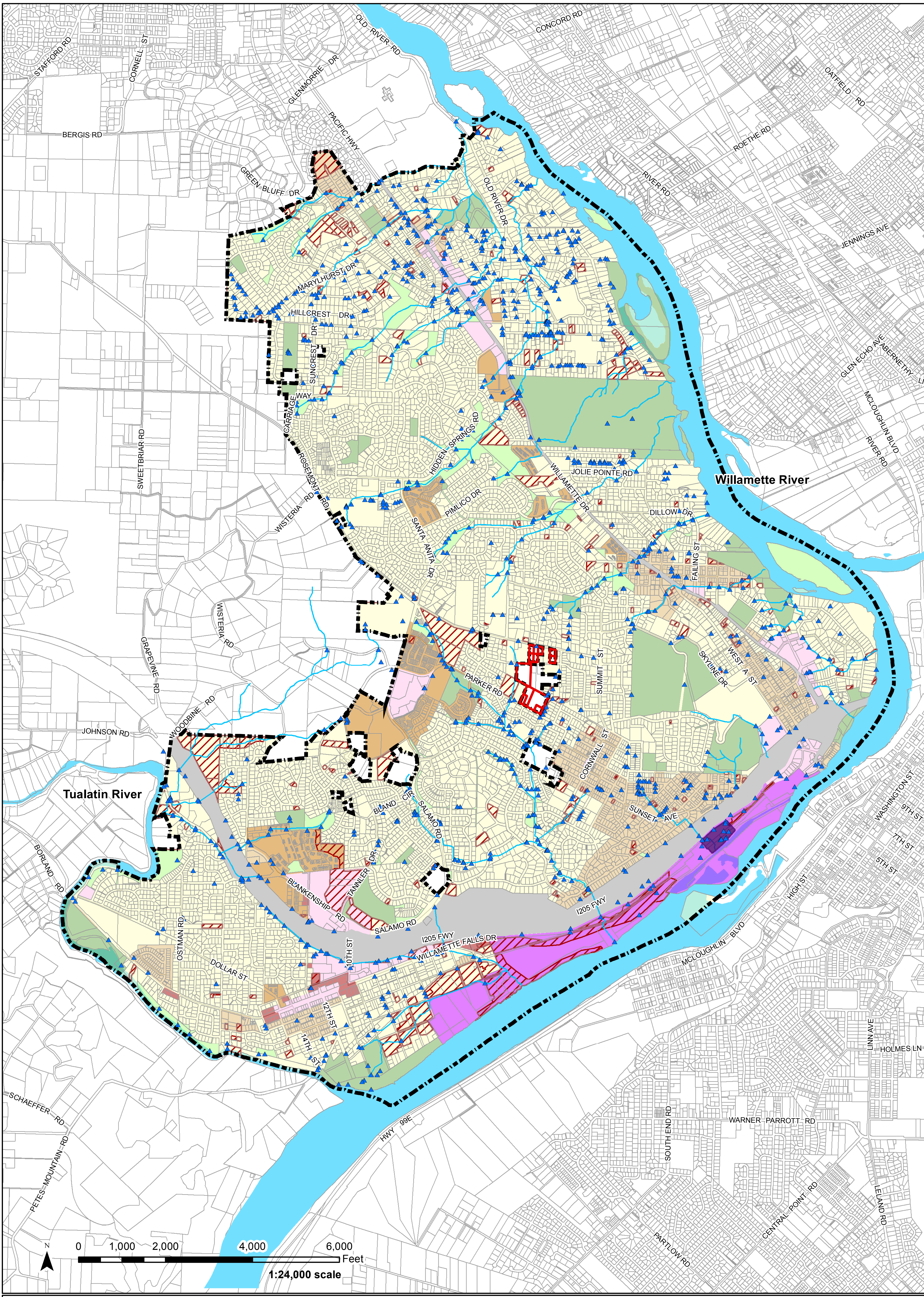
Technique

1. Pre-rinse the sample bottle with sample water prior to obtaining the actual sample.
2. Collect 200 mL sample (minimum).
3. Ensure that the meter is reading in conductivity mode, if necessary.
4. Rinse device with DI water and pat dry with clean paper towel.
5. Immerse the device in the sample and do not allow the device to touch the bottom of the container or any solid object.
6. Enter the conductivity data on the Monitoring Field Data Sheet.
7. Remove the device from the sample and rinse with DI water prior to storage or the next analysis.

QA/QC

1. Monitoring Field Data Sheets are completed in the field as the samples are collected.
2. After the completion of each day's sampling, device calibration(s) must be verified, checked for accuracy, and recorded.
3. Devices should then be cleaned with DI water and stored appropriately.

Appendix D: Maps



City of West Linn

Brown AND Caldwell

CITY OF WEST LINN, OREGON

MS4 Maps

Figure D-1: Service Area and Land Use

- Outfalls
- 1200Z Permit Area
- ODOT ROW (not included in MS4 service boundary)
- Future Service Area Expansions*
- City Limits/MS4 Service Boundary
- Streams

Zoning/Land Use

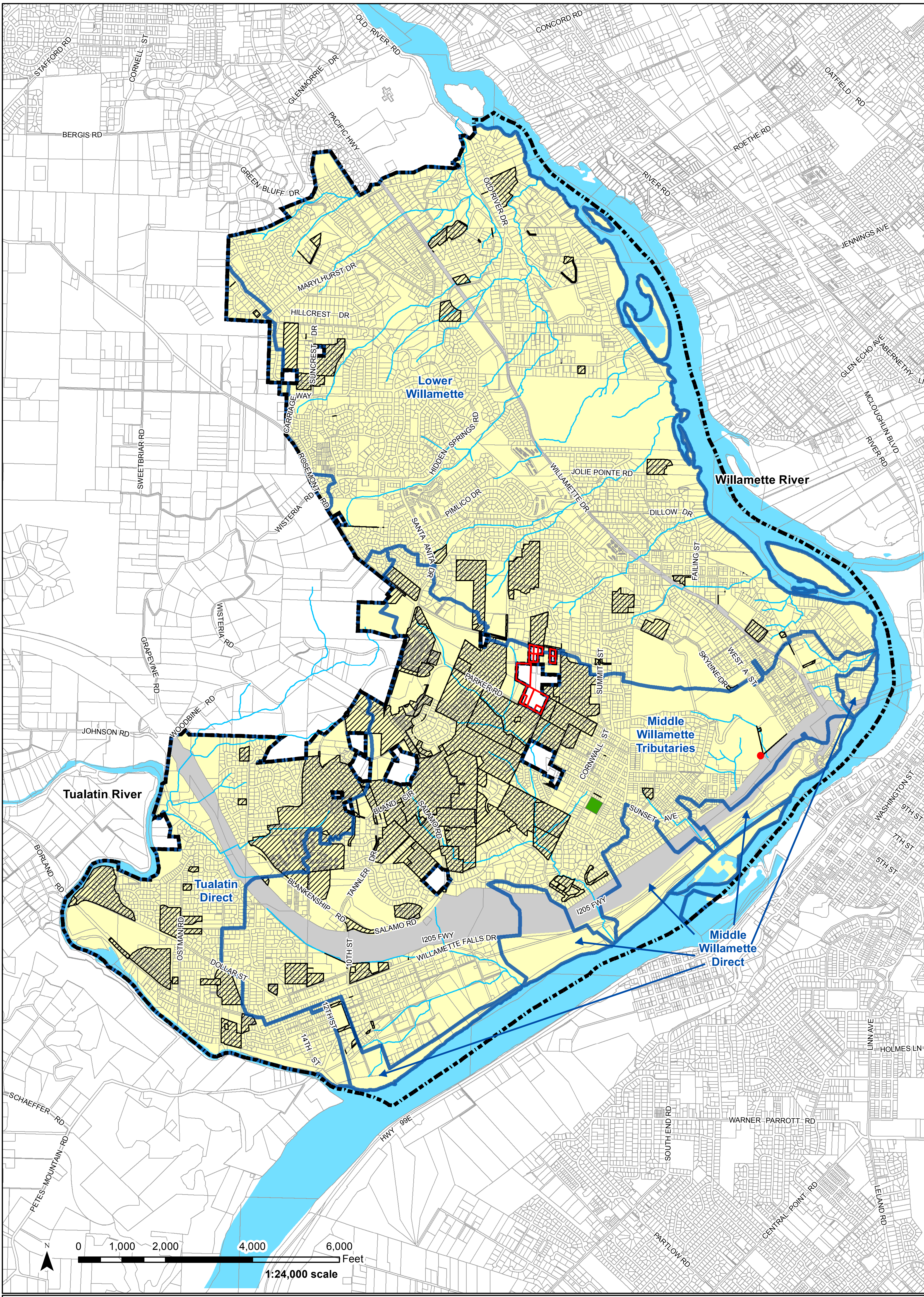
- Low Density Residential
- Medium Density Residential
- Medium High Density Residential
- Mixed Use
- Commercial
- Industrial
- Parks
- Open Spaces
- Vacant

Data Source: City of West Linn GIS and Metro RLIS

Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Map Publication/Print Date: December 2016 Produced by Brown and Caldwell

* Identified by West Linn Planning Department as potential properties likely to annex in the next permit term



West Linn

Brown AND Caldwell

CITY OF WEST LINN, OREGON

MS4 Maps

Figure D-2: Public Facilities

- Landfill (Closed)
- Municipal Maintenance Facility
- TMDL Watershed Boundary
- Public Stormwater Facility Drainage Area
- ODOT ROW (not included in MS4 service boundary)
- Future Service Area Expansions*
- City Limits/MS4 Service Boundary
- Streams

Data Source: City of West Linn GIS and Metro RLIS

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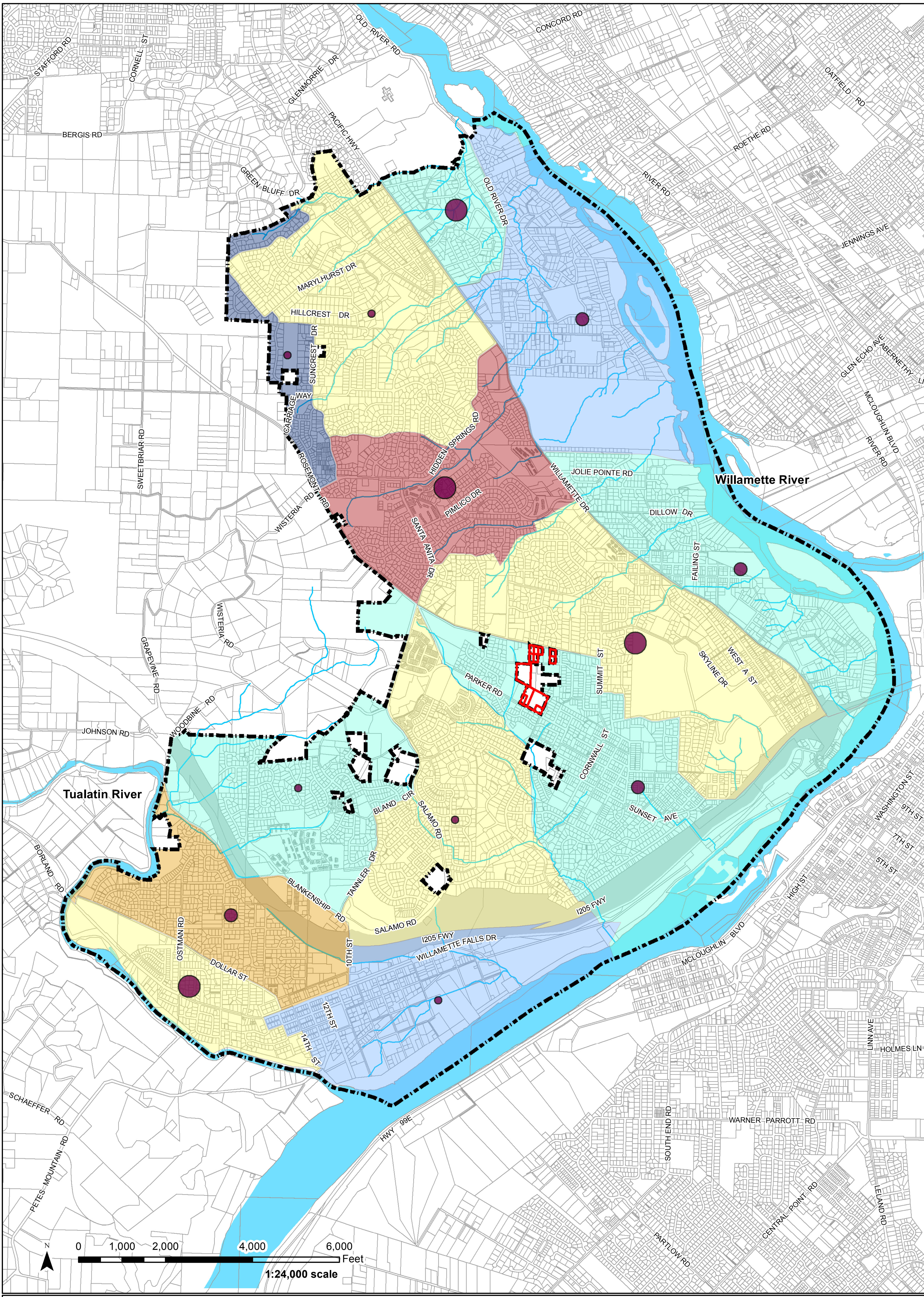

CITY OF WEST LINN, OREGON

MS4 Maps

Figure D-3: Population Density and Growth Projections

Future Service Area Expansions*

City Limits/MS4 Service Boundary

Streams

Population Density Per Square Mile (2010 Census)

0 - 1000, 1000 - 2000, 2000 - 3000, 3000 - 4000, 4000 - 5000, 5000 - 6000

Estimated 10-yr Population Growth by Population Block Group

No anticipated change

< 10%

> 10%

Data Source: City of West Linn GIS and Metro RLIS

Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

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