NPDES MS4 Permit Renewal Application Package

February 28, 2017

Cover: Aerial View of Oswego, Oregon, 1956.
Photo courtesy of the Lake Oswego Library.

City of Lake Oswego, Oregon

National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit

2017 Permit Renewal Application Package

Prepared for the

Oregon Department of Environmental Quality

February 28, 2017

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City of Lake Oswego

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

February 28, 2017

I, the undersigned, hereby submit this National Pollutant Discharge Elimination System (NPDES) Municipal Storm Water System 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 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 known violations.

For:
~~Name~~: Scott D. Lazenby
Title: City Manager
City of Lake Oswego

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

μg	microgram(s)
ac	acre(s)
ACWA	Association of Clean Water Agencies
BOD5	5-day biochemical oxygen demand
CFU	colony-forming unit(s)
City	City of Lake Oswego
COD	chemical oxygen demand
COM	commercial
DEQ	Department of Environmental Quality
DO	dissolved oxygen
EMC	event mean concentration
EPA	U.S. Environmental Protection Agency
IND	industrial
L	liter(s)
lb	pound(s)
LCL	lower confidence level
LUCS	Land Use Compatibility Statement
MFR	multi-family residential
mg/L	milligram(s) per liter
mL	milliliter(s)
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
PLRE	pollutant load reduction evaluation
POS	parks and open space
ROW	right-of-way
SFR	single-family residential
SVS	settleable volatile solids
SWMP	stormwater management plan
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence level
WLA	waste load allocation

Section 1
Introduction and Overview

1.1 Permit Overview

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 a NPDES municipal separate storm sewer system (MS4) permit (permit). Clackamas County was one of the jurisdictions required to obtain a NPDES MS4 permit, and the City of Lake Oswego is one of the 13 co-permittees on the Clackamas County permit.

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 (SWMPs), which included the requirement to develop specific categories 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 of Lake Oswego received their NPDES stormwater permit from DEQ in 1995.

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

Third-party groups made a request for DEQ to reconsider the permit. 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 of Lake Oswego submitted their 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 the City of Lake Oswego’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.

1.2 Description of Permit Area and Coordination with Co-Permittees

1.2.1 Description of City of Lake Oswego Permit Area

Lake Oswego is located in Clackamas County, approximately 7 miles south of the City of Portland. The city occupies a total of 11.4 square miles and has approximately 37,300 residents (Lake Oswego website). The City of Lake Oswego is bounded by the City of Portland to the north, the Willamette River to the east, on the west by Washington County, and on the south by the City of West Linn, unincorporated Clackamas County, and the Tualatin River. The City surrounds Oswego Lake, a 405-acre recreational lake.

The City is primarily comprised of residential land use, with limited amounts of commercial and industrial land throughout the City. There are numerous areas of public use, including several parks and open space areas. There are no identified agricultural or forest lands within the City limits. The City has a diverse topography, with elevations ranging from 10 feet along the Willamette River to over 970 feet on Mount Sylvania. There are several streams and waterbodies that convey stormwater runoff to Oswego Lake, the Tualatin River, and/or the Willamette River.

1.2.2 Summary of Clackamas County Co-permittees

The City of Lake Oswego is a co-permittee on the Clackamas County NPDES MS4 permit, along with the cities of West Linn, Oregon City, Milwaukie, Gladstone, Wilsonville, Happy Valley, Johnson City, Rivergrove, Clackamas County Department of Transportation and Development, as well as three utility districts: Oak Lodge Water Services District, Clackamas County Service District #1 (CCSD#1), and the Surface Water Management Agency of Clackamas County (SWMACC).

1.2.3 Summary of City Coordination with Co-Permittees

Per the NPDES MS4 permit itself, the co-permittees are responsible for meeting the same permit requirements as other 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, Clackamas County co-permittees have coordinated efforts (intergovernmental agreements, comprehensive programs) when possible to meet the permit objectives. Specifically, the City of Lake Oswego and other co-permittees have coordinated to ensure consistency with regards to erosion control standards and public education. The City of Lake Oswego plans to continue this coordinated effort throughout the new permit period.

1.3 Organization of Document

Table 1-1 below 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 and Overview	-	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 Appendices A and B
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 C
Fiscal Evaluation Current permit term expenditures summary and projected program allocations for next permit cycle.	B.6.f	Section 6.0
Monitoring Program Objectives and Modifications Including an updated Monitoring Plan	B.6.d	Section 7.0 and Appendix D
MS4 Maps	B.6.g	Appendix E

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Section 2
Maximum Extent Practicable Evaluation

The Federal Clean Water Act and the City's existing MS4 permit require the City to reduce pollutant discharges from the MS4 system "to the maximum extent practicable" (MEP). This is defined by the requirements in the permit, to the extent that they are prescriptive and fully descriptive, and by the City's *Stormwater Management Plan* (SWMP; 2012) and *Sampling and Analysis Plan for Surface Water Monitoring* (Monitoring Plan, 2014).

With each permit renewal, the City is expected to undertake an "evaluation of the adequacy of the proposed SWMP modifications in reducing pollutants in discharges from the MS4 to the MEP" (Schedule B.6 of the City's MS4 permit). This evaluation is based upon both an assessment of the City's actions during the current permit cycle, and a determination by the City that the proposed changes to the SWMP and other activities represents MEP for the City going forward into the next permit cycle. According to Schedule B.6.b of the current permit, this evaluation must allow:

> *[t]he 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-permittees stormwater management program priorities.*

This section describes, first, successes and shortcomings of the City's activities relative to the current MS4 permit requirements, and second, analysis of what MEP means for the City moving forward into the next permit cycle.

2.1 How the Existing Stormwater Management Program Addressed 2012 Permit Requirements

This section describes the City's activities under the existing permit requirements, with an overview of the annual adaptive management process and a detailed summary of the City's actions with respect to specific permit requirements.

Schedule A.2 of the permit describes the relationship between MEP and the activities of the permittee:

> *Each co-permittee must reduce the discharge of pollutants from the MS4 to the maximum extent practicable (MEP). Compliance with this permit and implementation of a stormwater management program, including the Department-approved Stormwater Management Plan (SWMP), establishes this MEP requirement*

Table 2-1 below summarizes the City's actions with respect to the requirements of the existing 2012 permit.

2.1.1 Annual Adaptive Management

The City's adaptive management strategy, submitted to DEQ on November 1, 2012, contains two parts: an annual adaptive management review, and an adaptive management review associated with permit renewal and development of a new SWMP. Lake Oswego's surface water utility is managed in an integrated manner across the MS4, TMDL, UIC, and FEMA regulatory environments. As such, the City's adaptive management of the MS4 program must necessarily integrate these other regulatory programs along with staff capacity and capability.

Equally important to a city of just over 35,000 residents, surface water management activities co-exist and compete for staff time and funding with the operational requirements of providing City services and programs, responding to community issues and concerns, and maintaining City infrastructure. Priorities for the City staff are set by the City Council. Since 2012, the City Council has had as a goal to reduce City staff. For staff of the Public Works and Engineering departments, the Council has been focused on improving the City's transportation infrastructure. City staff updated the Transportation System Plan during the permit cycle. The Council also approved the long-overdue construction of a new Public Works Operations Center; this is occurring on the same parcel that the existing Center occupies, using an approach of sequential demolition and re-construction that can be disruptive of ongoing operations. At the beginning of the permit cycle, the City was finishing a major wastewater interceptor line that followed the length of, and is suspended in Oswego Lake. Many of those staff members immediately transitioned to the construction of a new potable water treatment plant, headworks, and an intertie to the City's partner, the City of Tigard. Planning staff updated the Comprehensive Plan for the first time in over 20 years and were requested by the City Council to revise and scale down the City's Sensitive Lands requirements that implement Metro Titles 3 and 13; the Sensitive Lands program is a major aspect of the City's implementation of temperature TMDLs in City streams.

While these activities and changes are normal for a city the size of Lake Oswego, with a limited staff, the ability to annually undertake a thoughtful and strategic analysis of stormwater management activities and develop alternatives that are more efficient while remaining as robust as current requirements has been challenging. Staff turnover in mid-2013 resulted in a 5-month gap where only limited activities for which Engineering Department Staff were responsible – specifically ambient monitoring, contracted macroinvertebrate monitoring, and development review – continued on as needed. The City's stormwater staff has been working to catch up since that time. For this reason, the annual adaptive management process has focused more on improving the implementation of permit requirements and the SWMP and Monitoring Plan finalized in 2012 than in developing alternatives to the requirements of these plans.

2.1.2 Results of the Existing MEP Program Evaluation

Close inspection of Table 2-1 reveals that the City has attempted to meet the permit requirements, and has met most of them. However, deadlines for the following items slipped as a result of staff turnover or the need to focus on two elements of the surface water program that required more in-depth analysis, public involvement, and staff efforts:

- Revision of the Sensitive Lands program and associated development of an integrated TMDL Implementation Plan applicable to requirements of both the Tualatin and Lower Willamette TMDLs; and
- A complete overhaul of the City's stormwater development code, resulting in a new code chapter (LOC 38.25), and a manual to guide selection and design of stormwater and drainage facilities and approaches.

Table 2-1. Status of City Actions On 2012 NPDES MS4 Permit Requirements			
Permit requirement	**Permit section**	**Due date**	**Status**
Illicit Discharge Detection and Elimination			
• Document an enforcement response plan for responding to illicit discharges.	A.4.a.ii	November 1, 2012	• The City's Illicit Discharge Detection and Elimination scheme and pollutant parameter action levels were submitted to DEQ with the MS/TMDL Annual Report November 1, 2012.
• Document pollution parameter action levels; report them to the Department in the enforcement response plan or equivalent document.	A.4.a.iii	November 1, 2012	• The City identified priority outfalls for DEQ with the MS4/TMDL Annual Report November 1, 2012. This document also described the City's enforcement strategy.
• Identify priority outfalls on a map; perform annual dry weather field screenings using the action levels.	A.4.a.iii	November 1, 2012; annually thereafter	• Dry weather field screening began with the 2014-2015 permit year (September 2014) and has continued annually.
Industrial and Commercial Facilities			
• Implement an updated strategy to reduce from industrial and commercial facilities where site-specific information has identified a discharge as a source that contributes a significant pollutant load to the MS4. Strategy to 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. Begin inspection of facilities identified.	A.4.b.iii	July 1, 2013; annually thereafter	• The City developed a risk-based strategy for evaluating pollutant risks from industrial and commercial facilities by July 1, 2014. The City annually reviews the business license database to identify new candidate facilities and has performed aerial photographic evaluations of new facilities to evaluate outdoor activities that could potentially contribute stormwater pollutants. • The City has promoted the EcoBiz program for automotive and landscaping facilities, • The City has conducted one facility inspection in 2015-2016 permit year but has not yet begun systematic on-the-ground outreach to, or inspections of, industrial and commercial facilities.
Construction Site Runoff			
• Continue to implement a program to reduce pollutants in stormwater runoff to the MS4 from construction activities that includes inspections.	A.4.c	Ongoing	• The City continues to implement the erosion control program as described in Lake Oswego Code (LOC) Chapter 52. The City improved permit applications during the 2015-2016 permit year and strengthened code language regarding applicant responsibilities for inspectors effective March 17, 2016.
• By ordinance, ensure that the program applies to sites with greater than or equal to 1,000 square feet of soil disturbance.	A.4.c.i	November 1, 2014	• The City's Erosion Control Code has a threshold of applicability of 500 square feet of disturbance, or within 50 feet of a waterbody.

Table 2-1. Status of City Actions On 2012 NPDES MS4 Permit Requirements			
Permit requirement	**Permit section**	**Due date**	**Status**
Education and Outreach			
• Continue to implement a documented public education and outreach strategy that promotes pollutant source control and a reduction of pollutants in stormwater discharges.	A.4.d.i	Ongoing	• The City supports a broad education and outreach strategy that includes internal training; external outreach and messaging though staff interactions with the public during inspections or at City events (e.g., Farmers Markets); messages around water quality and pollution prevention best practices through the City's newsletter, website, social media and support of the KOIN-TV/Facebook "Water Do Your Part" campaign; actively participates in the Tualatin Basin Public Awareness Committee, the Regional Coalition for Clean Rivers and Streams, and outreach efforts by the Oregon Association of Clean Water Agencies (ACWA) .
• Conduct or participate in an effectiveness evaluation to measure the success of public education activities during the term of this permit.	A.4.d.vi	July 1, 2105	• The City participated in the ACWA public effectiveness meta-analysis and submitted to DEQ on July 1, 2015 a Public Education Effectiveness Evaluation Summary.
Public Involvement and Participation			
• 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.	A.4.e	Ongoing	• The City posts the current monitoring plan, annual MS4/TMDL reports, and other submittals to DEQ on the City's website. The City has used the Open City Hall application to solicit comments on this permit renewal package. Major changes to the City's stormwater development code were presented in study sessions and hearings by both the Planning Commission and City Council during the 2015-2016 permit year.
		February 20, 2017	• The City solicited comments via Open City Hall on the permit renewal package, including the Monitoring Plan, the Stormwater Management Plan, the TMDL Benchmark analysis, and a draft of this renewal package, as outlined in the City's 2012 *Stormwater Management Plan*. Five comments were received, none of which resulted in alteration of the draft materials. The comments, and the City's responses, are provided in Appendix B.
Post-Construction Site Runoff			
• Implement a post-construction site runoff treatment and reduction program that meets designated permit thresholds for applicability, treatment, and runoff control.	A.4.f.i	November 1, 2014	• In compliance with the 2012 permit, the City placed greater emphasis during development review on meeting the permit-specific treatment and runoff hydrology requirements for most development and redevelopment projects. Prior to 2016, the City's stormwater management requirements were applied based on development type (commercial, subdivisions, or small partitions) rather than impervious area.

Table 2-1. Status of City Actions On 2012 NPDES MS4 Permit Requirements			
Permit requirement	**Permit section**	**Due date**	**Status**
• Identify, minimize, or eliminate barriers in ordinances, code, and development standards that inhibit use of low impact development/green infrastructure.	A.4.f.ii	November 1, 2014	• The City began requesting that development projects implement low impact development/ green infrastructure stormwater treatment approaches according to requirements in the 2012 permit. The City adopted specific code language in LOC 38.25 implementing the permit requirements on February 16, 2016, with an effective date of March 17, 2016.
• Develop or reference an enforceable post-construction stormwater management manual or equivalent document.	A.4.f.iii	November 1, 2014	• The adopted stormwater code allowed for adoption of a Lake Oswego Stormwater Management Manual, effective March 17, 2016.
Pollution Prevention for Municipal Operations			
• Inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that are used to treat, store or dispose municipal waste that are not otherwise permitted by DEQ.	A.4.g.iii	July 1, 2013	• The City conducted an inventory of its Operations Center in June 2014. Insights from that exercise and subsequent evaluation using EcoBiz, Public Works facility certification criteria have been incorporated into design of the new facility that will be under construction beginning in the 2016-2017 fiscal year.
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 for effective pollutant removal, infiltration and flow control.	A.4.h.i	July 1, 2013	• The City began tracking public and large private stormwater facilities c. 2009, and began tracking smaller facilities including those associated with small partitions and single-lot residential construction in mid-2014. Facilities associated with single lot construction between January 15, 2012 and July 1, 2014 are not yet fully tracked. The City is tracking all stormwater facilities in the enterprise GIS system and, until recently, in the City's InFor asset management system. The City is in the process of changing asset management software.
• Implement a strategy that guides the long-term maintenance and management of all co-permittee-owned and identified privately-owned stormwater structural facilities.	A.4.h.ii	July 1, 2013	• The City has been tracking maintenance of public facilities in the City's asset management database. The City developed a risk-based inspection priority ranking for private facilities in June, 2014. The 2016 stormwater code revisions (LOC 38.25) require submission of O&M plans for all private stormwater facilities that are to be recorded on the parcel deed. As of July 1, 2016, the City is inspecting the final installation of stormwater management facilities on a parcel-wide basis.
Hydromodification Assessment			
• Prepare and submit a report	A.5	July 1 2015	• The City submitted the Hydromodification Assessment to DEQ on August 31, 2015

Table 2-1. Status of City Actions On 2012 NPDES MS4 Permit Requirements			
Permit requirement	**Permit section**	**Due date**	**Status**
Stormwater Retrofit Strategy Development			
• Develop a retrofit strategy to be incorporated into the Capital Improvement Plan and submit a report.	A.6.b	July 1, 2015	• The City submitted the Retrofit Strategy to DEQ on July 1, 2015
• Identify a retrofit project and begin implementation	A.6.c	July 1, 2014 for identification; March 1, 2017 for implementation	• The City identified the Kerr Road replacement as the designated retrofit project, using a mix of stormwater planters and swales to modify runoff rates, infiltrate stormwater where possible, and reduce loading of bacteria, phosphorus, and peak flow to Springbrook Creek. The project was completed in March 2015.
Monitoring and Reporting Requirements			
• Develop a monitoring plan and program consistent with new permit requirements.	B.2	September 1, 2012 submittal to DEQ;	• A monitoring plan was submitted to DEQ on August 30, 2012 and conditionally approved by DEQ on October 10, 2012. A revised plan was submitted to DEQ on January 29, 2014.
• Implement the monitoring plan.	B.1.b	October 1, 2012 and ongoing implementation	• The City began implementing the monitoring plan April 1, 2012. The City completed ambient instream monitoring, macroinvertebrate monitoring, mercury monitoring, and pesticide monitoring as required. The City was unable to implement the flow-weighted wet weather monitoring as described in the monitoring plan, and subsequently (December 2015) requested and obtained permission from DEQ to use the same time-weighted monitoring used by the Clackamas co-permittee cooperative monitoring group.
Annual Reporting			
• Prepare annual reports for each fiscal year detailing activities performed by the City under the MS4 permit requirements.	B.5	November 1, following the end of the fiscal year	• The City has prepared and submitted annual reports for each of the permit years. The 2011-2012 was submitted as a partial report on November 1, 2012; it was revised and submitted with the 2012-2013 annual report on February 20, 2014. The 2014-2015 Annual Report was submitted on March 3, 2016. All other reports were submitted on or before the November 1 due date.
Permit Renewal			
• Prepare and submit a permit renewal application package.	B.6	February 28, 2017	• The renewal package was initially due September 2, 2016, but with permission from DEQ can be submitted up until the expiration date of the current permit, March 1, 2017 according to Schedule F.4. of the permit. The City requested this extension on July 19, 2016.

Table 2-1. Status of City Actions On 2012 NPDES MS4 Permit Requirements			
Permit requirement	**Permit section**	**Due date**	**Status**
303(d) Listed Pollutants			
• Determine the applicable pollutants, determine whether existing BMPs are effective at removing these pollutants and, if not, what changes are needed to BMPs, and submit this analysis to DEQ.	D.2	November 1, 2015	• The City's 303(d) list evaluation was submitted to DEQ on November 1, 2015.
TMDLs			
• A Wasteload Allocation (WLA) Attainment Assessment that identifies "information related to the type and extent of BMPs necessary to achieve pollutant load reductions associated with an established TMDL WLA and the financial costs and other resources that may be associated with the implementation, operation and maintenance of BMPs " must be prepared and submitted to DEQ	D.3.b	November 1, 2015	• A Wasteload Allocation Attainment Assessment was submitted to DEQ on March 31, 2016.
• A TMDL Pollutant Load Reduction Evaluation using "a pollutant load reduction empirical model, water quality status and trend analysis, and other appropriate qualitative or quantitative evaluation approaches identified by the co-permittee" must be prepared and submitted to DEQ.	D.3.c	November 1, 2015	• A Pollutant Load Reduction Evaluation was submitted to DEQ on March 31, 2016.
• TMDL Pollutant Reduction Benchmarks "must be developed for each applicable TMDL parameter where existing BMP implementation is not achieving the WLA" and submitted to DEQ	D.3.d	February 28, 2017 (originally September 2, 2016; see above)	• TMDL benchmarks are presented in Section 5 of this permit renewal package.
Adaptive Management Approach			
• Submit a description of the process for conducting an adaptive management approach during the permit term.	D.4	November 1, 2012	• The City's adaptive management strategy was included as Appendix C of the 2011-2012 Annual Report, submitted in November 1, 2012.
SWMP Measureable Goals and Tracking Measures			
• Develop measurable goals and tracking measures in a revised SWMP and submit to DEQ	D.8.g-D.8.l	May 1, 2012	• The City revised the 2010 SWMP included in the permit renewal package to add or revise measurable goals and tracking measures consistent with new permit requirements, and submitted the SWMP to DEQ May 1, 2012.

In addition to these above efforts, major areas of challenge for staff included: wet weather sampling, and inspections for both the industrial and commercial facilities and private stormwater facilities. Staff did elect, based on the adaptive management framework, to move to time-weighted rather than flow-weighted composite wet weather sampling and received approval from DEQ in December 2015 to do so. A revised approach to inspections is described in the 2017 SWMP (Section 3 of this submittal).

2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

In evaluating what MEP means for the next permit term, the City looked more deeply at the requirements in Schedule B.6.b of the current permit. Specifically, the City evaluated MEP against the following:

- Effectiveness – "program elements effectively address stormwater pollutants" if:
  - The program contains a range of BMPs that encompass pollution prevention, source control, and treatment approaches;
  - The program contains BMPs that are technically feasible, effective, and implementable;
  - Program elements target pollutant discharges from development (new or redevelopment).
- Local Applicability – "program elements are technically feasible considering local soils, geography, and other locale specific factors" if:
  - The program is consistent with local ordinances and legal authority; and
  - Design standards reflect location conditions specific to soils, rainfall, infiltration, and stream conditions, along with development patterns.
- Program Resources – "program elements are implemented considering availability to resources and the co-permittees stormwater management program priorities" if:
  - The program considers cost effectiveness in determining optimal stormwater management approaches;
  - The program considers implementation cost and practicability within the overall context of City priorities and resources; and
  - The program has dedicated staff for implementation.

Key considerations for the City in determining what would be practicable include:

1. Typically poor infiltration conditions due to a mix of fine grained (tight) soils, steep and potentially unstable slopes, high groundwater, or compaction due to prior development activity;
2. Development is primarily infill, with very little new development relative to full or partial redevelopment; this means that development is typically restricted in space and has multiple site constraints associated with adjacent infrastructure;
3. There are almost no industrial lands or activities, with only two permitted facilities within the City (one each 1200-A ad 1200-Z permits);
4. Many of the commercial activities are offices or retail spaces;
5. The City Council desires to reduce the overall City workforce, resulting in little or no overlap in staff responsibilities and no efficient way to cover staffing gaps due to turnover or staff absences due to illness or disability.

The current (2012) permit included several required analyses (e.g., retrofit, hydromodification, and education effectiveness) that took significant effort and are not anticipated to be repeated in a subsequent permit. The City now has undertaken the required major code modification and manual development needed to bring development review and public facility practices up to the current level of practice. The City has developed the data and methods necessary to track riparian corridors. With the upcoming change in asset management software, the City should be able to better track private stormwater facilities and elements of the public stormwater management infrastructure.

Given these accomplishments in the current permit term, City staff can now pivot to focus on the remaining area of weakness, specifically building a robust scheme to facilitate inspections by private property owners with review by City staff. Therefore, other than to remove activities and reports that have been completed from the SWMP, City staff is proposing very few changes to the existing SWMP and other stormwater program elements. As noted above, the SWMP BMPs associated with inspections of both industrial and commercial facilities and private stormwater facilities have been re-written slightly to reduce the quantitative targets in the measurable goals and tracking measures. The City recognizes the importance of these inspection activities in reducing pollutant discharges from the MS4. However, given the substantial increase in the number of stormwater structural BMPs promoted by a combination of the City's new code favoring onsite management of stormwater and limited sites available for larger regional facilities, it is premature to settle on numerical tracking measures at this time. The City intends to build on the existing risk-based scheme for prioritizing inspection of private facilities that considers the risk of pollutant generation, the area treated, the age of the facility, and the type of facility. What the City is planning to develop next is the information system to: complete tracking of facilities associated with single-lot development, track prior (paper) O&M requirements from older facilities, elicit information from the landowners relative to their prior O&M activities, arrange inspections by City staff, and follow up with the inspections. Such a pivot, while maintaining ongoing activities such as development review, erosion control permitting, monitoring, and maintenance of public facilities, represents the City's meeting the MEP standard as outlined in the criteria above.

Section 3 describes changes to the proposed SWMP (Appendix A), while Section 7 describes changes to the monitoring plan (Appendix D).

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Section 3
Proposed Modifications to the Stormwater Management Plan

As part of the permit renewal process, the City of Lake Oswego reviewed their 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:

Global Changes: A summary of changes affecting the format and organization of the BMP fact sheets and overall clarity of the document is described below:

- The BMP fact sheets previously included additional commitments. A decision was made to remove additional commitments from the BMP fact sheet. It was determined that if these additional commitments are ongoing, they should be included with all of the other measurable goals and tracking measures for the BMP.
- The BMP fact sheets previously included a summary of the BMP adaptive management strategy. This was removed, given that the City has an overall document describing their adaptive management strategy for the SWMP. In addition, for the most part, the strategy was the same for all the BMPs so the information was considered repetitive.
- The BMP fact sheets previously included a summary of the relationship between the BMPs and the TMDL parameters. This row was updated to include mercury and other parameters as necessary.
- For some of the BMPs, editorial updates were made for the purposes of providing more clarity. If these updates did not substantively change the BMP, they are not specifically described by BMP in the detailed summary of changes below.

BMP ILL1 - Implement the Illicit Discharge Detection and Elimination (IDDE) Program: The 2012 NPDES MS4 permit required documentation of IDDE procedures (consistent with permit language) and an enforcement response plan by November 1, 2012. The City addressed the requirements. Therefore, language regarding development of IDDE procedures and enforcement response has been removed, and this BMP is now focused ongoing implementation of those procedures. The measurable goals and tracking measures for this BMP did not change.

BMP IND1 – Screen Existing and New Industrial Facilities: In terms of maintaining an inventory of industries and potential high pollutant source facilities, this BMP description was updated to include a review of the business license applications in addition to a review of the building permits.

BMP IND2 – Conduct Inspections of High Pollutant Source Facilities: The 2012 NPDES MS4 permit 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 description and measurable goals were updated to reflect ongoing implementation rather than development of the program.

BMP EC1 – Implement the Adopted Erosion and Sediment Control Planning and Design Manual and Associated City Ordinances Related to Erosion Control: The BMP description was updated to clarify that this BMP applies to control of construction waste and other non-stormwater pollutants in addition to erosion and sediment control. The BMP description was also updated to explain that City code requires that applicants designate certified erosion and sediment control staff with credentials similar to those required for DEQ's 1200-C permits. The measurable goals and tracking measures for this BMP did not change.

BMP EC2 – Conduct Erosion Control Inspections and Enforcement: The BMP description was updated to include the inspection schedule. Previously, the BMP description included description of three inspections: one initial inspection, one unscheduled inspection and one final inspection. This has been revised to reflect one inspection at the beginning of the project, one inspection during active construction prior to pouring footings or flatwork, and one inspection at the end of construction, consistent with final inspection of stormwater facilities.

Also the following text was added to the BMP description, consistent with BMP EC1: "The applicant's designated individual responsible for implementation of permit conditions is expected to have specific qualifications that are focused on those needed for certification such as the Washington Department of Ecology Certified Erosion and Sediment Control Lead, licensure as a professional engineer (operating within their erosion control expertise), or certification through the International Erosion Control Association as a Certified Professional in Erosion & Sediment Control". The measurable goals and tracking measures for this BMP did not change.

BMP PE1 – Provide Public Education and Outreach Materials Related to Stormwater Management: The 2012 NPDES MS4 permit required the City to conduct a public education effectiveness evaluation by July 1, 2015. That commitment was fulfilled and removed from the BMP description, the measurable goals and the tracking measures. Additional clarifications were made to this BMP regarding entities that the City coordinates with for public education and topics for public education.

BMP PE2 – Provide Educational Training Opportunities for Construction Site Operators: The BMP description was updated to remove text related to the City's participation in the Regional Erosion Prevention Awards Program, as that program has been discontinued. The measurable goals and tracking measures for this BMP did not change.

BMP PE4 – Provide Staff Training in Spill Response: The BMP measurable goal was updated to reflect that most spill training occurs as Fire Department (City first responders) and Public Works (support) staff join or change assignments into positions that put them into positions where they respond to spills. For other staff, the City includes spill response in annual multi-departmental stormwater training. The tracking measures for this BMP did not change.

Public Involvement: Public involvement is required by the 2012 NPDES MS4 permit for specific elements of the permit renewal package, which is due to DEQ March 1, 2017. The specific elements include the updated 2017 SWMP and the TMDL benchmarks. To address this requirement, the 2012 SWMP 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 30-day timeframe is proposed for removal from the BMP description. The City will continue provide the documents for public review for an unspecified time period, likely one to two weeks.

BMP DEV2 - Review and Update Applicable Code and Development Standards Related to Stormwater Control: This BMP has been removed. The 2012 NPDES MS4 permit required stormwater development standards to be updated by November 2014, in order to meet new conditions in the permit. The City completed this requirement. The City revised their stormwater code to be explicitly consistent with City's NPDES MS4 permit requirements related to maintaining predevelopment hydrologic function, implementing low-impact development and green infrastructure (GI) design approaches, promoting the minimization of impervious surfaces, and reducing stormwater runoff where applicable. The City also developed more comprehensive stormwater design guidelines, outlined in the current version of the *Lake Oswego Stormwater Management Manual* (first effective March 2016).

BMP OM2 – Deicing and Leaf Pick Up Activities: The measurable goals for leaf pick up and promotion of yard waste collection were changed from seasonally to annually. The only season with significant leaf drop is fall. During other seasons, the City sweeps the curbed streets and has city-wide yard waste pickup as part of the garbage franchise.

BMP OM3- Road Maintenance and repair activities: The BMP description was updated to describe City activities to upgrade catch basins to sumped catch basins as practical during roadway repair activities.

BMP PEST1 – Reduce Pollutants in Discharges Associated with the Application of Pesticides, Herbicides, and Fertilizers: The BMP description and measurable goal previously reflected a commitment to develop a process for inventorying pesticides and herbicides applied to City-owned or operated properties. The BMP description and measurable goal were changed to show that this process has been developed and pesticide use will be annually inventoried and reported in the City's annual report.

BMP PEST2 – Update the City of Lake Oswego Integrated Pest Management Practices: The BMP description and measurable goal previously reflected a commitment to update the City's Integrated Pest Management Practices. This BMP description and measureable goal were revised to reflect regular reviews of the IPM to ensure the current state of practice.

BMP OM4 – Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities: The BMP description and measurable goal previously reflected a commitment to inventory municipal facilities and implement a program to reduce impacts associated with the runoff from these facilities. The City of Lake Oswego conducted this inventory and subsequent recommendations have been incorporated into the design of the City's new Operations Center, where the City manages street sweeping debris. The City's new Operations facility is currently under construction. The BMP description and measurable goal were updated to reflect ongoing implementation of pollution reduction strategies.

BMP OM7 – Tracking, Inspection, and Maintenance of Water Quality Treatment Facilities: The 2012 NPDES MS4 permit required the development of a private water quality facility inspection program by July 2013. The City formalized a general tracking and inspection approach in 2014. In conjunction with 2016 modifications to the stormwater design standards, the City is working to finalize their current inspection and maintenance routines/schedules, inspection and maintenance criteria, and inspection and maintenance tracking mechanisms using an asset management approach. This BMP description, measurable goals, and tracking measures have been revised to reflect ongoing refinement to the inspection and maintenance program as needed. In addition, a new tracking measure was included to differentiate tracking measures between the approaches used for multi-family residential/commercial facility inspection, and individual residential parcel facility inspection.

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Section 4
Service Area Expansions and Total Annual Pollutant Load Updates

4.1 Introduction

As part of the City of Lake Oswego'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 and an additional list of selected parameters. Schedule B.6 of the permit outlines the following elements to be included in the permit renewal application:

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 load.*

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 report is organized as follows:

- Section 4.2 Description of Projected Service Area Expansions
- Section 4.3 Updated Estimate of Total Annual Pollutant Loads
- Section 4.4 Qualitative Evaluation of Impacts

4.2 Description of Projected Service Area Expansions

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

4.2.1 Definition of the City's NPDES MS4 Permit Area

The City's NPDES MS4 permit covers "all existing and new discharges of stormwater from the MS4 within the services boundaries of incorporated cities" (DEQ 2012a). As such, the modeled area for the estimate of annual loads in Section 3 has been defined to include all areas within city limits and the urban services boundary as of December 2016, including some unincorporated areas that exist between the urban services boundary and city limits that is currently managed as part of the City's MS4 service area.

Areas within the city limits or urban services boundary that are the responsibility of another Phase I NPDES MS4 permittee, specifically the Oregon Department of Transportation (ODOT) and the Surface Water Management Agency of Clackamas County (SWMACC), were omitted from the modeled area. ODOT has a separate NPDES MS4 permit for discharges from area within the ODOT right-of-way (ROW). For Lake Oswego, these areas include the Interstate 5 corridor and the Oregon Highway 43 corridor. SWMACC also has a separate NPDES MS4 permit, and a loads estimate will be developed and submitted for SWMACC and the City of Rivergrove in conjunction with their permit renewal submittal.

In addition, the open-water areas of the Tualatin River, Willamette River, and Oswego Lake were excluded from the modeled areas. These exclusions are all consistent with modeling assumptions from the previous annual loads estimate (2008) with the exception of the exclusion of the SWMACC area, which is an update/refinement in model area assumptions.

As of December 2016, taking these exclusions into account, the Lake Oswego MS4 service area within the urban services boundary was calculated to be a total 7,331.3 acres.

4.2.2 Identification of Projected Service Area Expansions

While future annexations are expected in Lake Oswego, specific locations for these annexations cannot be predicted with certainty at this time. However, some general areas have been identified where annexations are most likely to occur. These include groups of tax lots located between the city limits and south and western portions of the urban services boundary (USB) (i.e., mainly areas currently in SWMACC). Many of the houses in these areas were built prior to the 1970's and do not have sanitary sewer connections. By the end of the next permit term, the septic systems for these houses will be 50 plus years old and likely to fail. Annexations in these areas are typically driven by a need to obtain sewer services.

In order to attempt to quantify areas projected for annexation into Lake Oswego's over the next permit term (through 2022), city staff reviewed recent trends in annexations. Figure 4-1 shows the number of acres of annexations that have occurred since 2000. For the purposes of updating model loading estimates, rather than predicting specific locations where annexations will occur, the City projects an average of 20 acres of annexations per year, or 100 acres over the next permit term. This projection is based on recent trends as shown in Figure 4-1. For the purposes of loads modeling it was assumed that these annexations will be residential land use.

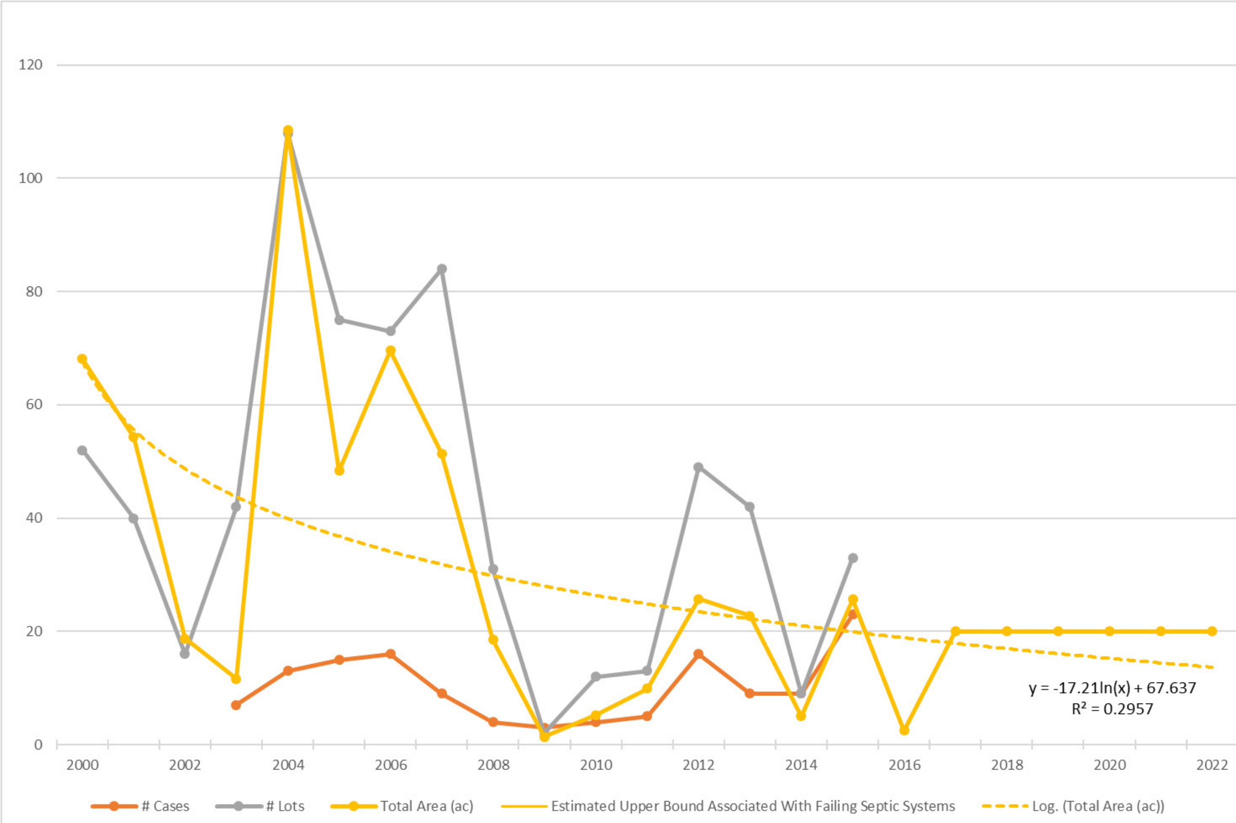

Figure 4-1. Lake Oswego annexations (2000 – present)

4.3 Updated Estimate of Total Annual Pollutant Loads

This section outlines the modeling methods, assumptions, and results associated with developing an updated estimate of total annual 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 7,986.8 acres. This did not account for any future annexations as annexations through the next five year permit term were not anticipated at that time. The City's current NPDES MS4 service area estimated for this 2017 permit renewal is 7,331.3. For the 2008 modeling effort, SWMACC was included which accounts for 564.9 acres of the difference. The remaining difference of approximately 90 acres is due to annexations and GIS refinements. 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.

4.3.1 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 for this assessment was 7,431.3 acres, consistent with the City's current MS4 service area of 7,331.3 plus the projected NPDES MS4 service area expansion of 100 acres as outlined in Section 4.2.2.

Total annual pollutant loads are required to be calculated for TMDL pollutants or applicable pollutant surrogates and additional parameters as listed in Schedule B.6.c. For the City, the Willamette Basin

TMDL (Lower Willamette subbasin) 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 were calculated as a range reflecting the upper and lower 95 percent confidence limit and reflect general (commercial [COM], residential [RES], industrial [IND], and parks and open space [POS]) land use categories. Table 4-1 below summarizes the land use EMCs used in the model.

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[c]	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[c]	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[c]	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[c]	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[c]	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[c]	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

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
Dissolved phosphorus, mg/L	COM[c]	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[c]	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[c]	26	20.8	28.6	38.2
	IND	26	33.8	45.5	58
	POS	10	2.0	2.5	3.0
	Residential[b]	33	10.5	13.4	17.1
Lead, total, µg/L	COM[c]	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[c]	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 were used to simulate loads for both single family and multi-family land uses.

c. Land use EMCs for commercial were used to simulate loads for agricultural and institutional land uses.

The same 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 C of this 2017 permit renewal application).

Full-buildout conditions (i.e., no remaining vacant lands) were simulated in the spreadsheet loads model, consistent with the 2008 assumptions. The modeled land use categories were based 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 most recent PLRE and benchmark analysis.

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 PLRE and benchmark analysis, the runoff coefficients were calculated from estimated impervious percentages for each land use category. The impervious percentages for each land use category were directly calculated based on the 2015 impervious coverage in the City's GIS. These values were updated from the 2008 assumptions. Table 4-2 below 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[a]	4,829.2[b]	36.1
MFR[a]	353.5	54.4
COM	554.2	60.2
IND	161.3	55.8
POS	1101.6	7.2
Agriculture[c]	177.8	7.2
Institutional[d]	253.8	31.5
Total permit area[e]	**7431.3**	

a. Runoff concentrations (EMCs) from the residential land use were applied to both the single family and multi-family residential land uses.

b. Includes 100 acres of projected annexations through 2022.

c. Runoff concentrations (EMCs) from the commercial land use were applied to the agricultural land use.

d. Runoff concentrations (EMCs) from the commercial land use were applied to the institutional land use.

e. Includes annexations through the permit term.

The annual pollutant load estimates were based on an average annual rainfall volume of 40 inches, consistent with the rainfall volume assumed in the 2008 NPDES MS4 permit renewal.

4.3.2 Updated Estimate of Total Annual Pollutant Loads

Total annual pollutant loads, reflective of full-buildout conditions and anticipated annexations to the City permit area through the end of the permit term, are summarized in Table 4-3 below for the applicable parameters. This updated estimate is presented in terms of a pollutant load range due to the inherent variability in stormwater runoff quality. Pollutant loads are shown in pounds (lbs) 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 Lake Oswego			
Pollutant load parameter	**LCL (lbs or counts)**	**Mean (lbs or counts)**	**UCL (lbs or counts)**
TSS	1,046,210	1,533,247	2,238,626
E. coli (counts)	8.18×10^{13}	1.45×10^{14}	2.39×10^{14}
BOD_5	147,828	206,508	280,128
COD	861,049	1,156,022	1,491,703
Nitrate	12,286	17,936	25,530
Total phosphorus	5,134	7,389	10,225
Dissolved phosphorus	1,738	2,350	3,182
Cadmium, total	11	15	20
Copper, total	272	356	459
Lead, total	338	516	757
Zinc, total	1,929	2,797	3,948

4.4 Qualitative Evaluation

This section provides a qualitative evaluation of the potential increases to area, intensity, and pollutant loads due to the projected service area expansions discussed in Section 4.2. 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 (2017–2022) 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 4.4.2 and 4.4.3 support these findings and is further discussed in the subsections below.

4.4.1 Service Area Expansion

The City anticipates approximately 20 acres of service area expansion per year over the next 5-year permit term for a total of 100 acres. This service area expansion represents less than 2 percent of the City's NPDES MS4 permit area anticipated in the year 2022.

It is anticipated that a majority of the annexations will be zoned as single-family residential (SFR). In Lake Oswego, the service area expansions or annexations are typically applicant-initiated annexations and limited to enclave parcels in order to connect to City sewers. A large number of these unincorporated and unsewered areas already have structures and existing impervious surfaces. Therefore, with annexation, the imperviousness (or intensity per the NPDES MS4 permit language) of these areas is anticipated to increase somewhat, but the magnitude would vary depending on the nature of the current site usage. These areas are not representative of the conversion from open space/forested land to urban land use. In addition, these areas are already accounted for under SWMACC's permit coverage. Therefore, annexation to the City will just reflect a shifting of areas from one jurisdiction to another.

At the present time, there is no proposed adjustment to the urban services 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.

4.4.2 Pollutant Loads Discharge

With expansion of the service area, the pollutant load permitted under the City's NPDES MS4 permit would likely increase somewhat. 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 may not otherwise be implemented under SWMACC's stormwater program. In addition, providing sewer services to these areas may actually reduce the discharge of bacteria that would be associated with any failing septic systems.

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 (e.g., street sweeping, catch basin cleaning, etc.) targeting typical stormwater pollutants of concern. Newly annexed properties will be subject to control measures outlined in the SWMP.

The City adopted updated stormwater design standards in 2016 for water quality. Structural stormwater controls are required to mitigate pollutant discharges from new or redeveloping areas impacting 1,000 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 discharges. Typical structural stormwater controls include planters, 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.

4.4.3 Conclusion

At present time, annexation into the City area is limited to enclaves of residential parcels, most of which have already been developed to some extent. There is no proposed adjustment to the urban services 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 annexations. Annexations may actually result in improvements to water quality with respect to bacteria as areas currently served by septic systems will become sewered.

Section 5
Wasteload Allocations and Benchmarks

In accordance with the City of Lake Oswego's (City'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. Benchmarks must be developed for each TMDL parameter where existing best management practice (BMP) implementation is not estimated to be achieving 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 March 1, 2017.

The City is a designated management agency (DMA) in both the Willamette Basin and Tualatin Basin TMDLs due to urban stormwater discharges. The City's MS4 discharges runoff either directly or via tributaries to the Tualatin River and the Lower Willamette River. The applicable TMDL parameters are summarized in Table 5-1.

Table 5-1. Lake Oswego Applicable WLAs

TMDL document	TMDL water body	TMDL parameter	WLA	Anticipated to meet WLAs (based on the PLRE 2015)
Tualatin Subbasin TMDL	Lower Tualatin	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. Benchmarks are needed.
		DO (TSS as a surrogate)	20% reduction (summer seasonal)	Yes
	Fanno Creek	Bacteria (*E. coli*)	5,000 counts/100 mL (winter storm event concentration) 12,000 counts/100 mL (summer storm event concentration)	Yes
		Total phosphorus	0.13 mg/L (summer seasonal concentration)	No. Benchmarks are needed.
		DO (TSS as a surrogate)	50% reduction (summer seasonal)	No. Benchmarks are needed.
	Oswego Lake[a]	Total phosphorus	0.09 mg/L (summer seasonal concentration) 0.15 mg/L (fall/winter/spring seasonal concentration)	No. Benchmarks are needed.
Willamette Basin TMDL	Lower Willamette[b]	Bacteria (*E. coli*)	78% reduction (annual)	No. Benchmarks are needed.
	Springbrook Creek[c]	Bacteria (*E. coli*)	80% reduction (annual)	No. Benchmarks are needed.
	Tryon Creek	Bacteria (*E. coli*)	78% reduction (annual)	No. Benchmarks are needed.

a. For the Tualatin Subbasin TMDL, WLAs for total phosphorus are specified for the Oswego Lake subbasin (which includes both Oswego Lake Direct and Springbrook Creek subbasins).

b. For the Willamette Basin TMDL, WLAs for bacteria associated with the Oswego Lake subbasin area are specified under two other TMDL waterbodies. The Oswego Lake Direct subbasin is accounted for in the Lower Willamette subbasin and the Springbrook Creek subbasin is accounted for individually.

The City conducted a pollutant load reduction evaluation (PLRE) in 2015. Based on results of the PLRE, the City is estimated to be meeting TMDL WLAs for bacteria and TSS in the Lower Tualatin subbasin and for bacteria in the Fanno Creek subbasin. The City is required to establish TMDL pollutant load reduction benchmarks for the remaining parameters and TMDL waterbodies for the next permit term as shown in Table 5-1.

This summary document outlines the City's plans for implementation of additional BMPs that will result in further reduction of TMDL parameters 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 C to this NPDES MS4 permit renewal application.

5.1 BMP Identification

By definition, TMDL benchmarks are estimates of pollutant load reductions in the future. They reflect current BMP implementation and projected BMP implementation over the next permit term (i.e., through 2022).

City staff identified anticipated stormwater facility installations associated with upcoming public works and transportation related projects. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities since the PLRE analysis was completed in March 2016. In total, new public structural stormwater BMPs are anticipated to be installed as described in the City's 2015 Retrofit Strategy result in treatment of approximately 74.5 acres (ac). Table 5-2 lists the projected stormwater facility installations by TMDL watershed, facility type, and drainage areas.

Table 5-2. Projected Stormwater Facilities and Drainage Areas for 2022 Benchmarks		
TMDL subbasin	**Projected BMP categories[a]**	**Approximate projected new drainage area (acres)**
Fanno Creek	• Lined planter - filtration raingardens	7.8
	• Swales	2.6
Lower Willamette	• Lined planter - filtration raingardens	3.3
Oswego Lake direct	• Detention pond (dry)	1.3
	• Infiltration raingarden	5.0
	• Lined planter - filtration raingardens	9.9
	• Retention pond (wet)	1.6
	• Sedimentation manholes	0.9
	• Swale	0.5
	• UIC	0.5
Springbrook Creek	• Lined planter - filtration raingardens	25.7
	• Sedimentation manhole	0.6
	• UIC	0.6
Tryon	• Detention pond (dry)	0.7
	• Infiltration raingardens	10.0
	• Lined Planter - filtration raingardens	3.5
Total		**74.5**

a. The projected BMP categories and associated drainage areas in this table are subject to change. They are current best estimates of what is projected through 2022 for the purposes of developing benchmarks.

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).

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 data. Table 5-3 provides TMDL benchmarks as a load reduction and as a percentage load reduction. Calculation of the TMDL benchmarks as a percentage load reduction allows for direct comparison with the WLAs established for bacteria.

Table 5-3. TMDL Benchmarks for 2017–2022					
TMDL subbasin	**Model time frame**	**Pollutant(s)**	**WLA**	**TMDL benchmarks (load reduction)[a], range**	**TMDL benchmarks (in units matching the WLA)[d], range**
Lower Tualatin	Summer season	Total phosphorus	0.14 mg/L	NA	NA
Fanno Creek	Summer season	Total phosphorus	0.13 mg/L	10.1 – 23.0 lbs	0.16 mg/L to 0.21 mg/L
		TSS	50% reduction	4,612 – 13,245 lbs	16.2% - 22.9% reduction

Table 5-3. TMDL Benchmarks for 2017–2022					
TMDL subbasin	**Model time frame**	**Pollutant(s)**	**WLA**	**TMDL benchmarks (load reduction)[a], range**	**TMDL benchmarks (in units matching the WLA)[d], range**
Oswego Lake[b]	Summer season	Total phosphorus	0.09 mg/L	22.6 – 47.7 lbs	0.16 mg/L – 0.23 mg/L
	Fall/Winter/ Spring season	Total phosphorus	0.15 mg/L	110.0 – 232.0 lbs	0.16 mg/L – 0.23 mg/L
Lower Willamette[c]	Annual	Bacteria	78% reduction	$2.48x10^{12}$ - $1.16x10^{13}$ counts	7% - 11% reduction
Tryon Creek	Annual	Bacteria	78% reduction	$9.83x10^{11}$ – $3.99x10^{12}$ counts	9% - 13% reduction
Springbrook Creek	Annual	Bacteria	80% reduction	$7.59x10^{11}$ - $3.4x10^{12}$ counts	7% - 10% reduction

a. The TMDL benchmarks are a load reduction, calculated as the difference between the current no-BMP scenario load and the future with-BMP scenario load.

b. The Oswego Lake subbasin includes both the Oswego Lake Direct and Springbrook Creek subbasins for the purposes of developing the total phosphorus benchmark.

c. The Lower Willamette subbasin includes the Oswego Lake Direct subbasin for the purposes of developing the bacteria benchmark.

d. The benchmarks have also been calculated as a percent reduction or as a concentration for direct comparison with the WLA.

For this upcoming permit term, while the City anticipates more than 60 new facilities, no new BMPs are projected for the Lower Tualatin subbasin. This subbasin represents only 4 percent of the City's MS4 area that is subject to TMDLs. In addition, it already has approximately 33 percent BMP coverage, which is relatively high for the City. As a result, over the next permit term, higher priority was placed on implementing BMPs in other subbasins where the BMP coverage is not as extensive. However, several planters and swales are projected to be installed in the Fanno Creek subbasin, which will reduce pollutants in runoff from approximately 10 acres that eventually drains to the Tualatin River and will collectively help reduce pollutants in the Tualatin River.

The TMDL benchmarks presented in Table 3 are conservative estimates of the pollutant load reduction anticipated during the upcoming MS4 permit term with the installation of anticipated public and private structural BMPs. The City's overall stormwater program also comprises non-structural BMPs and programmatic activities, so the TMDL benchmarks do not reflect the full range of pollutant load reduction anticipated through implementation of the stormwater program. Additional load reduction is expected through the following:

- Non-structural and source control BMPs (e.g., erosion control, illicit discharge detection and elimination, street sweeping, public education, pet waste management activities, operation and maintenance) per the City's Stormwater Management Plan.
- Infiltration that is likely occurring in unlined planter facilities given that they were modeled as lined planters as a conservative assumption to account for poor infiltration conditions across much of the City.
- Additional private structural BMPs that are required to occur with redevelopment projects.

The City prepared a WLA attainment assessment for DEQ in March 2016, which indicated that achievement of some of the WLAs would require construction and maintenance costs that far exceed the City's definition of "maximum extent practicable." Consequently, progress toward the WLA, and not achievement of the WLA, is the City's goal for the TMDL benchmarks.

Section 6
Fiscal Evaluation

The Federal Clean Water Act and the City's existing MS4 permit require the City to maintain adequate resources to provide the stormwater quality management outlined in the MS4 permit and the City's SWMP. This section documents the expenditures of City resources during the current permit term, and projects the availability of fiscal resources during the next permit term.

The City has a surface water utility that collects monthly fees from city residents, both residential and commercial/industrial. The utility also collect nominal system development charges associated with new development, funds which must be dedicated to system capacity improvements, rather than retrofits of the existing system. In addition to supporting activities under the MS4 permit, the surface water utility revenues provide resources for City activities dedicated to programs required by TMDL and UIC state regulations, federal floodplain regulations issued by the Federal Emergency Management Agency (FEMA), and drainage of public infrastructure including roadways and adjacent rights of way and City facilities. The surface water utility does not directly fund development review activities for private development projects or property improvements, but does fund general support for setting standards (e.g., the City's *Stormwater Management Manual*) and for stormwater, surface water, and floodplain training in support of development review.

6.1 Fiscal Evaluation

6.1.1 Expenditures for the Current Permit Cycle 2012-2017

Lake Oswego's surface water utility revenues are dominated by a monthly surface water fee levied on residents and businesses located within the City limits. Single family residences and duplexes are charged the flat monthly fee regardless of impervious area; they are billed as 1 Equivalent Service Unit (EU) of 3030 square feet of impervious surface. Rates for other entities are based on impervious area, with the monthly rate multiplied by the number of ESUs on the parcel. Table 6-1 below summarizes the surface water utility rates, revenues, and expenditures over the current permit cycle from March 2012 through December 2016.

Figure 6-1 below shows the relative contributions of each of the three primary program areas: regulatory, maintenance, and capital. The surface water utility capital funds are used for surface water capital replacement/repair projects, drainage and water quality components of transportation projects, and surface water quality retrofit projects. Planned water quality projects are described in the City's *Retrofit Strategy* (2015). Maintenance figures are based on surface water system maintenance activities performed by the City's Public Works Department staff including primarily street sweeping, catch basin cleaning, and maintenance of the City's public stormwater facilities. As noted above, the regulatory program area supports activities related to all regulations of surface water bodies, although project-specific requirements are allocated to the project (capital) budgets. Figure 6-2 below shows the relative level of effort, as measured by staff hours and expenses, for the regulatory sub-programs. Funding sources for expenses that are external to the surface water utility and to the Engineering and Public Works Departments are noted where independently tracked. Labor outside of the Engineering and Public Works Departments, from staff in the Planning, Parks, and Fire Departments that perform ancillary activities that support the surface water program are not included in this summary.

6.1.2 Expenditures for the Upcoming Permit Cycle

The City of Lake Oswego anticipates that spending on surface water activities will generally rise at a modest pace, in keeping with increases in revenue. Table 6-2 below summarizes the projected stormwater utility revenues for the upcoming permit cycle, beginning with FY17-18 and extending through FY21-22. Two scenarios are presented, based on City Council decisions regarding surface water utility rates. The current surface water utility rate increases, at 7 percent per year, will sunset after FY2017-2018 if no action is taken by the City Council; this would result in revenues projected to be approximately $17.1 million over the permit term. Should the Council elect to continue the rate of monthly fee increases, an additional $1.3 million would be raised over the same time period.

The activities funded by this utility will also continue to be in line with current activities, with a few minor exceptions: approximately 20 percent spent on maintenance, 35 percent spent on regulatory compliance and related required activities (e.g., monitoring, tracking and reporting, education and outreach), and 45 percent on capital projects across all surface water regulatory programs. However, year to year variations could occur as a result of specific regulatory program requirements. For instance:

- The City anticipates additional maintenance of UIC stormwater facilities will occur during the early years of the upcoming permit cycle as an aid to developing pre-treatment retrofit capital projects.
- During FY 2018-2019, the City will be doing the analyses needed to update the TMDL Implementation Plan.
- Capital spending will fluctuate from year to year to accommodate cash flow needs within the surface water utility and to accommodate unplanned maintenance and repair projects.

The City has not chosen to project expenditures other than those already accounted for in the City's *Capital Improvement Plan* (CIP; 2016). Projected expenditures in the most recent approved CIP are shown in Table 6-2. The 2017-2018 CIP, particularly for Transportation projects, will more fully incorporate design and construction costs required by the City's new stormwater development code (LOC 38.25), which became effective March 2016. While not reflected in the current surface water CIP, it is possible that more of the funding for incorporating required stormwater components of transportation projects may be supported directly by the City's street utility rather than only by the surface water utility.

Table 6-1. Surface Water Utility Fiscal Status, Current MS4 Permit 2012-2017								
Category	**2011-2012**	**2012-2013**	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017 (budgeted)**	**Total**	**Average annual**
Monthly surface water utility rate per equivalent service units	$ 9.60	$10.27	$10.99	$11.76	$12.58	$13.46	$15,156,011	$11.44
Surface water utility revenues	$2,099,517	$2,228,588	$2,393,780	$2,552,591	$2,854,535	$3,027,000		$2,526,002
Year over year revenue increase, %		6.15	7.41	6.63	11.83	6.04	N/A	7.61
Surface water utility expenditures	$1,054,498	$2,461,072	$2,407,223	$4,433,595	$4,822,287	$3,262,262	$18,440,937	$3,477,288
Capital expenditures	$104,150	$626,225	$432,310	$2,583,516	$3,245,718	$1,277,262	$8,269,181	$1,633,006
Maintenance expenditures	$514,829	$585,701	$548,379	$698,753	$523,420	$640,000	$3,511,082	$599,251
Regulatory expenditures	$435,519	$1,249,146	$1,426,534	$1,151,326	$1,053,149	$1,345,000	$6,660,674	$1,245,031

Table 6-2. Projected Surface Water Utility Fiscal Status, Upcoming MS4 Permit Term 2017-2022							
Category	**2017-2018**	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**	**Total**	**Average annual**
Monthly Surface Water Utility Rate per Equivalent Service Units – Current Commitment	$14.40	$14.83	$15.28	$15.74	$16.21	N/A	$15.29
Surface Water Utility Revenues– Current Rate Commitment	$3,206,000	$3,312,000	$3,422,000	$3,535,000	$3,652,000	$17,127,000	$3,425,000
Monthly Surface Water Utility Rate Per Equivalent Service Units– Extending Current 7% Annual Rate Increases	$14.40	$15.41	$16.49	$16.35	$17.49	N/A	$16.03
Surface Water Utility Revenues– Extending Current Rate Increases	$3,206,000	$3,430,420	$3,670,549	$3,927,488	$4,202,412	$18,436,869	$3,687,000
Projected Capital Expenditures Based On 2015-2016 Capital Improvement Plan Addendum (June 2016)	$1,182,000	$1,277,000	$1,228,000	$1,535,000	Not yet available	Not yet available	Not yet available

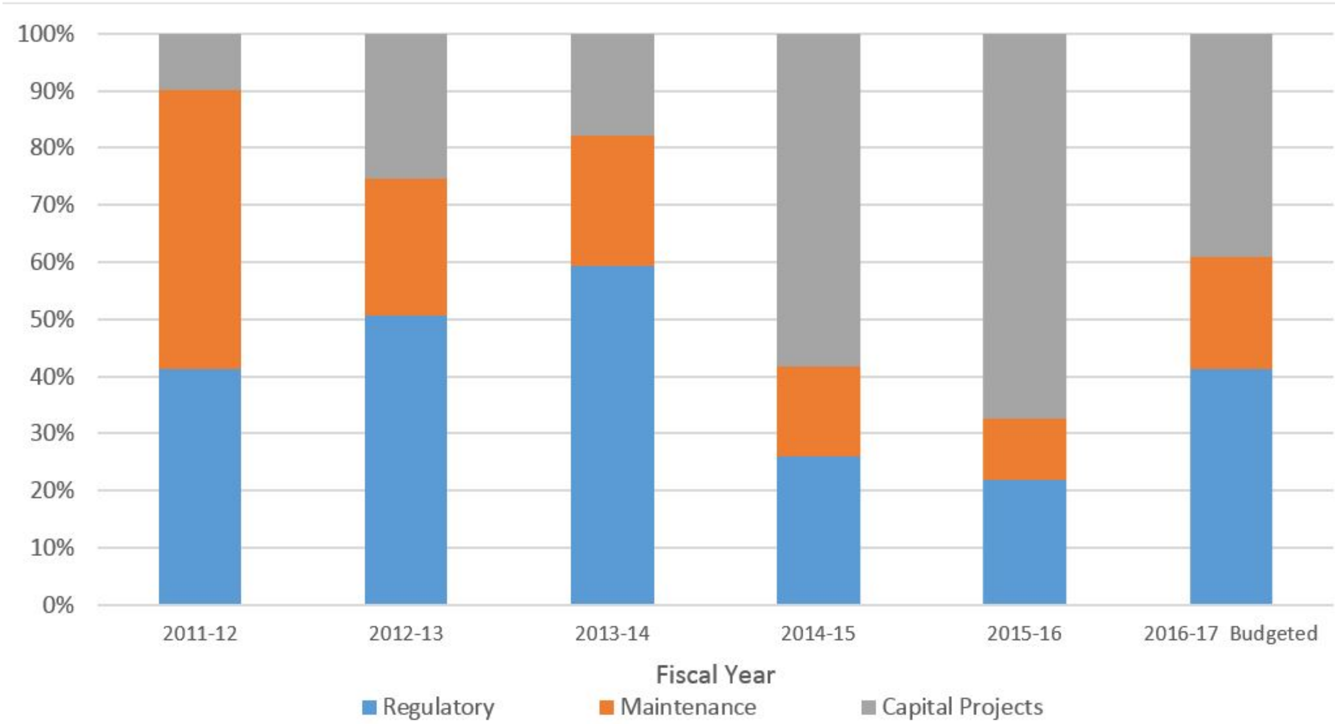

Figure 6-1. Relative stormwater expenditures over the current permit cycle 2012-2017

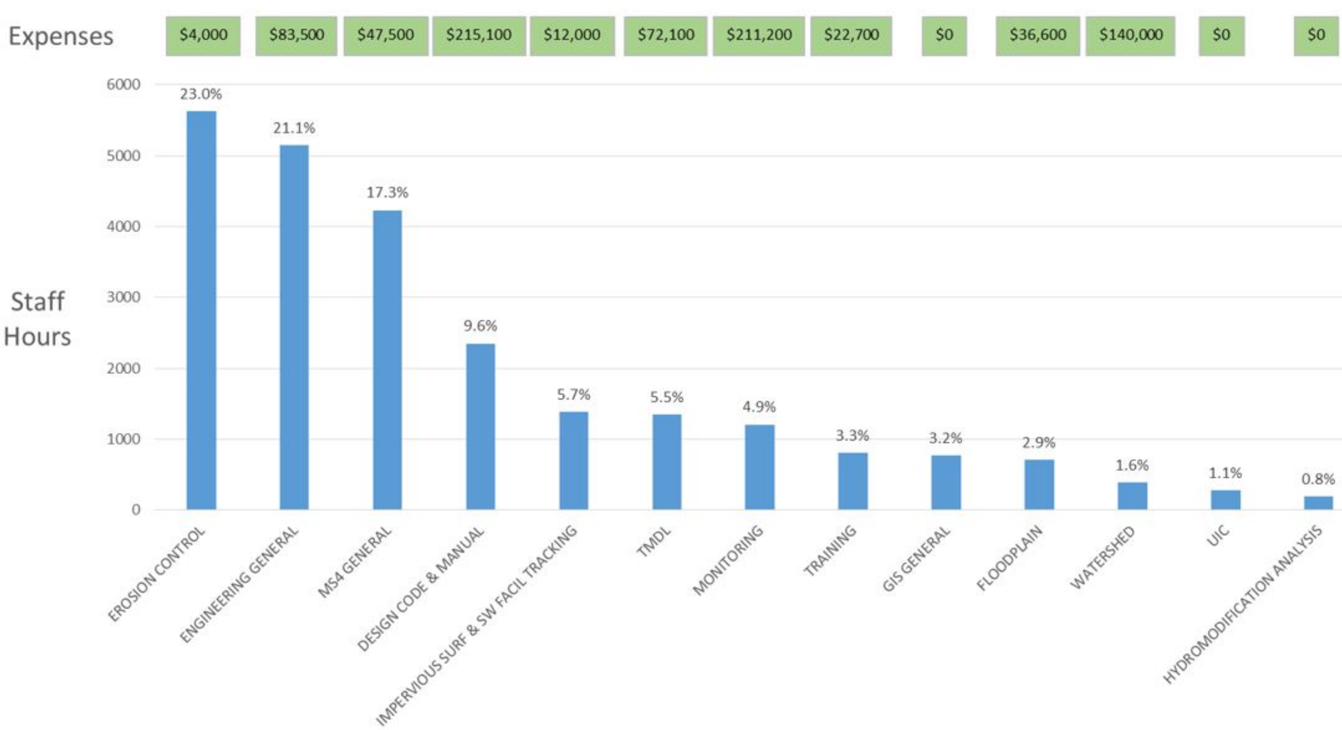

Figure 6-2. Regulatory compliance level of effort over the current permit cycle 2012-2017 by functional activity

Section 7
Monitoring Program Objectives and Modifications

The City of Lake Oswego monitors ambient surface water features and engineered elements of the City's MS4 to assess trends in water quality and overall stream health, and to evaluate the effectiveness of both structural and non-structural best management practices for improving water quality. With each permit renewal, the City is required to evaluate the monitoring program relative to monitoring objectives laid out in the City's MS4 permit (Schedule B.1). The City's monitoring program also considers requirements in the *TMDL Implementation Plan* (2015) and *UIC Stormwater Management Plan* (2016). City monitoring goals for the MS4 program are laid out in Table 7-1 below, the Monitoring Objective Matrix. Approaches and methods used in the MS4 monitoring program are provided in the *2017 Monitoring Plan* ver. 2.0, in Appendix D. This plan was submitted to DEQ for approval on January 26, 2017, with the intent to begin implementation by July 1, 2017.

Not detailed in the City's *2017 Monitoring Plan*, but important contributing actions to an effective stormwater management program, are program monitoring activities outlined in Table 7-1.

7.1 Proposed Changes

The City is proposing only very limited changes to the existing monitoring program, restricted to three areas as described in the following subsections.

7.1.1 Ambient Instream Monitoring

The City proposes two changes to the ambient instream monitoring portion of the monitoring program.

1. First, the City proposes to drop the Rosewood instream monitoring site which has been sampled since 1997. This is one of two sites on the same small influent creek to Oswego Lake, bounding a regional stormwater facility on the upstream side. The City will continue to monitor the Bryant site, which is located on the same creek (known within the City as Boone's Ferry Creek) between the regional stormwater facility and Oswego Lake. This is proposed because the City feels that the question regarding the effectiveness of the regional stormwater facility has been answered, and resources would best be deployed elsewhere.
2. The City will add additional analytes to the instream monitoring at a frequency of 4 times per year through the 2018-2019 permit year to evaluate copper concentrations based on the recently approved biotic ligand model-based water quality standard. The additional analytes include anions, cations, and organic carbon species. This addition has been approved by DEQ, but the City proposes with this plan to add an "end date" to these additional analyses.

7.1.2 Wet Weather Stormwater Monitoring

The City will add an additional wet weather event to both wet weather field sites on Reese Rd at Lake Grove Avenue, and on Lost Dog Creek at South Shore Road east of Palisades Lake Terrace, using the time-weighted grab sampling approach approved for the Clackamas County group, as approved by DEQ in late 2015. The sampling on Reese Rd. will improve the understanding of the effectiveness of stormwater facilities to be incorporated into the City's anticipated 2018 re-construction of Boone's Ferry Rd.

7.1.3 Other Environmental Monitoring

The City is removing two completed monitoring elements contained in the City's current MS4 permit, for mercury in stormwater and for pesticide monitoring of stormwater, surface water, and streambed sediment. The City may elect to perform monitoring related to special studies outside of the permit.

Table 7-1. Monitoring Objective Matrix							
Stormwater-Related Monitoring Activity/Program	**Stormwater-Related Monitoring Activity/ Program Description**	**DEQ MS4 Monitoring Objectives**					
		Evaluate the sources of the 303(d) listed pollutants as applicable.	**Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities.**	**Characterize MS4 runoff discharges based on land use, seasonality, geography or other catchment characteristics.**	**Evaluate long-term trends in receiving waters associated with MS4 stormwater discharges.**	**Assess the chemical, biological, and physical effects of MS4 discharges on receiving waters.**	**Assess progress towards meeting TMDL pollutant load reduction benchmarks.**
Environmental Monitoring Activities							
Instream Water Quality (discrete)	• Six locations. Twelve monitoring events annually (~ 50% during the wet weather season October - April). • Single grab samples. Field and lab parameters monitored.	N/A	N/A	N/A	Trends assessed by comparing instream sampling results over time.	Chemical effects of MS4 discharges may be assessed by comparing dry season and wet season results.	N/A
In-Stream Biological	• Ten locations. One sample and field assessment per site approximately every three years (2017, 2020, 2023, etc.).	N/A	N/A	N/A	Trends assessed by comparing results of invertebrate monitoring over time.	Biological effects assessed by comparing results of invertebrate monitoring over time with respect to monitoring location (by MS4 outfall location).	N/A
Wet Weather Stormwater Quality	• Two locations - representative land use. Three monitoring events annually (during storms). • Time-composite sampling (with grabs for *E. coli*). Field and lab parameters monitored and flow monitored.	Bacteria and organics (via TSS as a surrogate) are monitored.	Reese Rd. sampling will be used to characterize the effectiveness of the Boones Ferry Rd. stormwater improvements to be constructed 2018-2019.	Will be used to characterize the runoff quality for the respective contributing land use categories and catchment areas.	N/A	Chemical effects assessed by comparing wet-weather results with instream concentrations.	Comparisons between monitoring data for various land use categories and land use EMC data used in the benchmark pollutant loads model will be made to evaluate whether updates to the EMCs are needed.
Program Monitoring Activities							
MS4 Program Monitoring	• Measurable goals and tracking measures for BMPs.	N/A	Program monitoring may help evaluate effectiveness of source controls/ non-structural BMPs.	N/A	N/A	N/A	N/A
Dry-weather Field Screening	• Inspect designated outfalls annually during the dry weather season.	Based on results of inspection and monitoring (if applicable), may identify potential illicit discharges that could be sources of 303(d) parameters.	N/A	N/A	N/A	N/A	N/A
Pollutant Load/ Water Quality Modeling	• Loads modeling per MS4 permit to evaluate overall pollutant load generation and watershed-scale BMP effectiveness.	N/A	Results indicate overall effectiveness of structural BMPs, estimate effectiveness of non-structural BMPs, and highlight locations of high pollutant load generation (for future retrofits).	Pollutant load modeling provides estimated MS4 runoff discharge characteristics (per land use based on land use EMC data used in modeling).	N/A	N/A	Pollutant load modeling allows for development of new benchmarks and assessment of progress towards meeting existing benchmarks.
Literature Review	• Review of Stormwater Quality and BMP effectiveness literature (structural/source control/non structural) is referenced in order to inform management decisions and design standards updates.	N/A	Provides additional BMP effectiveness information to allow BMP implementation prioritization.	N/A	N/A	N/A	Can apply BMP effectiveness data obtained from literature into pollutant load model for benchmarks where applicable.

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Appendix A:
Stormwater Management Plan

City of Lake Oswego Stormwater Management Plan (2017) NPDES MS4 Permit Renewal Submittal

February 2017

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Table of Contents

BMP Fact Sheets

Acronyms

ACWA	Association of Clean Water Agencies (Oregon and National Chapter)
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
AWRA	American Water Resources Association
BMP	Best Management Practice
CESCL	Certified Erosion & Sediment Control Lead
CIP	capital improvement project
DEQ	Department of Environmental Quality (Oregon)
EPA	Environmental Protection Agency
EPSCP	Erosion Prevention and Sediment Control Plan
GI	green infrastructure
IDDE	Illicit Discharge Detection and Elimination
LID	low-impact development
LOC	Lake Oswego Code
LOFD	Lake Oswego Fire Department
LOCOM	Lake Oswego Communications
MEP	Maximum Extent Practicable
METRO	Metropolitan Regional Government
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollution Discharge Elimination System
OAR	Oregon Administrative Rule
SARA	Superfund Amendments and Reauthorization Act of 1986
SOP	Standard Operating Procedure
SWMP	Stormwater Management Plan
TAPE	Technology Assessment Protocol (Washington Department of Ecology)
TBPAC	Tualatin Basin Public Awareness Committee
TMDL	Total Maximum Daily Load
TVFR	Tualatin Valley Fire and Rescue
WERF	Water Environment & Reuse Foundation
WEF	Water Environment Federation

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1.0 STORMWATER MANAGEMENT PLAN ORGANIZATION

This 2017 version of the City of Lake Oswego'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.

The SWMP is organized into the eight major stormwater program elements listed below. The eight major elements correspond to those required in the MS4 NPDES 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 Operation and Maintenance Activities

Each of the eight SWMP element sections begins with the applicable permit requirement(s) and contains a description of applicable Best Management Practices (BMPs). At the end of each section, a table (BMP fact sheet) specifies the measurable goals associated with the BMP(s) and tracking measures that the City will report on for the MS4 annual reports.

Each BMP has an assigned prefix, number, and name that help to identify the activity and associated responsible party. Table 1 provides a summary of the BMP number prefixes and associated BMP categories and indicates the corresponding relevant SWMP element.

Table 1. BMP Name and Category Designations

BMP Number Prefix	Associated BMP category	Associated SWMP Element
ILL	Illicit Discharge Detection and Elimination	1 and 7
IND	Industrial and Commercial Facilities	2
EC	Construction and Erosion Control	3
PE	Public Education and Outreach	3, 4, and 7
PI	Public Involvement and Participation	5
DEV	Planning and Development	6 and 7
OM	Operations and Maintenance	4, 7, and 8
PEST	Landscape Practices and Pest Management	7

2.0 ELEMENT #1 – ILLICIT DISCHARGE DETECTION AND ELIMINATION

The City of Lake Oswego prohibits illicit discharges to the storm sewer system by the provisions of Lake Oswego Code (LOC) Article 38.26. Specifically, LOC 38.26.920 prohibits connection of a sanitary sewer or wastewater pipe to the City's surface water drainage system. This code section also prohibits dumping of pollutants into the surface water drainage system. LOC 38.26.935 provides the code authority to enforce and issue penalties for Code violations, and LOC 34.04.106 provides the City with the legal authority to investigate potential illicit connections.

In an effort to proactively ensure that illicit discharges are not occurring, the City implements a program of inspections, dry weather field screening, and monitoring to eliminate any potential illicit discharges to the MS4 system.

The City also implements spill response measures through coordination with the City's Fire Department to ensure all spills are reported (if necessary) and promptly addressed and contained, to the maximum extent practicable (MEP). Spill prevention and illicit discharge prevention and reporting are conducted by the City through specific public education and outreach activities and campaigns, as described under SWMP Element #4 (Section 5.0).

2.1 BMP ILL1 – Implement the Illicit Discharge Detection and Elimination Program

NPDES permit requirements pertaining to BMP ILL1are summarized below. Applicable provisions are detailed under Schedule A.4.a of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement *– (i) Prohibit, through ordinance or other regulatory mechanism, illicit discharges into the co-permittee's MS4.*

NPDES Permit Requirement *– (ii) Include documentation in an enforcement response plan or similar document by November 1, 2012 describing the enforcement response procedures the co-permittee will implement when an illicit discharge investigation identifies a responsible party.*

NPDES Permit Requirement *– (iii) Develop or identify pollutant parameter action levels that will be used as part of the field screening…The pollutant parameter action levels and rationale for using the action levels must be documented in an enforcement response plan or similar document, and reported to the Department by November 1,2012.*

NPDES Permit Requirement *– (iv) Conduct annual dry-weather inspection activities during the term of the permit. By November 1, 2012, the dry-weather inspection activities must include annual field screening of identified priority locations documented by the co-permittee….. The dry-weather field screening activities must be documented and include: 1) General observation; 2) Field Screening; and 3) Laboratory Analysis.*

***NPDES Permit Requirement** – (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 presence of an illicit discharge. The response procedures must reflect the goal to eliminate the illicit discharge in an expeditious manner, as specified in subsection vii. below.*

***NPDES Permit Requirement** – (vi) Maintain a system for documenting illicit discharge complaints or referrals, and suspected illicit discharge investigation activities.*

***NPDES Permit Requirement** – (vii) Once the source of an illicit discharge is determined, the co-permittee must take appropriate action to eliminate the illicit discharges, including an initial evaluation of the feasibility to eliminate the discharge, within 5 working days. If the co-permittee determines that the elimination of the illicit discharge will take more than 15 working days due to technical, logistical or other reasonable issues, the co-permittee must develop and implement an action plan to eliminate the illicit discharge in an expeditious manner. The action plan must be completed within 20 working days of determining the source of an illicit discharge. In lieu of developing and implementing an individual action plan for common types of illicit discharges, the co-permittee may document and implement response procedures, a response plan or similar document. The action plan, response procedures, response plan or similar document must include a timeframe for elimination of the illicit discharge as soon as practicable.*

***NPDES Permit Requirement** – (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.*

***NPDES Permit Requirement** – (x) In the case of a known illicit discharge that is identified within the co-permittee's MS4 regulated area, but is determined to originate from a contributing storm sewer system or property under the jurisdiction of another municipality, the co-permittee 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.*

***NPDES Permit Requirement** – (xi) Maintain maps identifying known co-permittee-owned MS4 outfalls discharging to waters of the State. The dry-weather screening priority locations must be specifically identified on maps by November 1, 2012. If the co-permittee identifies the need to modify these maps, the maps must be updated in digital or hard-copy within six months of identification.*

***NPDES Permit Requirement** – (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 permittee or the Department, they are not considered illicit discharges and are authorized by this permit: (see Schedule A.4.a.xii for list of discharges). If any of these non-stormwater discharges under the co-permittees jurisdiction is identified as a significant source of pollutants, the permittee must develop and require implementation of appropriate BMPs to reduce the discharge of pollutants associated with the source.*

The City has the authority to prohibit illicit discharges in accordance with LOC 38.26.920 and 38.26.935.

The City conducts inspections to identify potential illicit discharges on an annual basis, typically during dry-weather conditions (between July and September) at all of the City's priority outfalls. Priority outfalls were identified based on the City's outfall reconnaissance survey conducted August 2009-August 2010. Priority outfalls were identified based on a process identified by the Center for Watershed Protection. Inspections and/or other follow-up measures are also conducted in accordance with citizen complaints as received via the Watershed Hotline, a City-operated call number available for citizens to report watershed concerns, illicit discharges and spills. This activity is further described under Element #4 (Section 5.0).

Dry weather inspections are conducted in conjunction with the Center for Watershed Protections Illicit Discharge Detection and Elimination (IDDE) manual *(Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessments, Center for Watershed Protection and Robert Pitt (2004))*. Dry weather flows are initially inspected for a variety of visual characteristics, and sources of flows are characterized as either permissible (listed in Schedule A.4.xii of the 2012 MS4 NPDES permit) or potentially non-permissible. If potentially non-permissible discharges are discovered, the City conducts sampling, analysis, and investigation to the MEP in conjunction with the following stepwise procedure:

1. Use a drainage map and other source identification data, to attempt to locate the potential sources upstream of the discharge location.
2. Investigate potential sources using one or more of the following techniques: onsite inspections, field screening for pH, conductivity, dissolved solids, turbidity, and dissolved oxygen, dye-testing, smoke testing, and/or TV inspection of lines.
3. Collect a water sample and analyze it for the suspected contaminant group. The City reviewed and revised its pollutant parameter action levels as required in the current (2012) permit based on the Center for Watershed Protection IDDE manual referenced above to ensure local applicability. Review of these action levels is part of the annual adaptive management process that the City undertakes.

Results of field screening activities are recorded and entered into a database. The City Engineer, the City Public Works Director or Appointee(s) will be notified of all positive identifications of illicit connections and the City will take all necessary steps to eliminate them in accordance with the time frame outlined in the City's 2012 MS4 NPDES permit. Illicit discharge complaints are tracked and indicate the resolutions to illicit discharge investigations. The City's enforcement plan was submitted to DEQ with the 2011-2012 Annual Report.

If necessary, in accordance with the annual dry-weather inspection activities, the City will update their GIS files related to existing locations and priority outfall designations.

2.2 BMP ILL2 – Implement the Spill Response Program

NPDES permit requirements pertaining to BMP ILL2 are summarized below. Applicable provisions are detailed under Schedule A.4.a of the City's 2012 MS4 NPDES Permit.

***NPDES Permit Requirement** – (viii) Describe and implement procedures to prevent, contain, respond to and mitigate spills that may discharge into the MS4. Spills, or other similar illicit discharges, that may endanger human health or the environment must be reported in accordance with all applicable federal and state laws, including proper notification to the Oregon Emergency Response System.*

The City implements spill prevention in accordance with public education BMPs described under Element #4 (Section 5.0).

Emergency response to chemical and hazardous material spills within the City is under the authority and administration of the Lake Oswego Fire Department, which tracks spills as part of their overall response tracking system. Most spills observed during the 2012-2017 permit cycle to date are related to vehicle accidents, with household accidents being a secondary source. All have been small volume (e.g., automobile gas tank). The City of Lake Oswego Fire Department contracts with the Tualatin Valley Fire and Rescue (TVFR) hazardous materials response unit to respond to hazardous materials spills beyond the small volume spills that can be managed by the Fire Department. City Public Works personnel serve in a support and advisory role under the Fire Department and are responsible for notification (as necessary) of 1) the Tyron Creek Treatment Plant, 2) the Lake Oswego Corporation, 3) Clean Water Services and 4) the City of Portland Bureau of Environmental Services. Public Works personnel take the lead for response and notification for sanitary sewer overflows.

The City operates the Watershed Hotline (503-675-3982), a call number for citizens to report watershed concerns, illicit discharges or spill activity. This hotline is advertised on the City's website and periodically in the City's monthly newsletter "Hello LO". During normal business hours, the City's Engineering staff answer this phone line and respond to non-emergency calls within one business day. Emergency calls taken during normal office hours are redirected to the City of Lake Oswego Fire Department. All calls reporting a spill are forwarded to LOCOM (503-635-0238 - Lake Oswego Non-Emergency Number) for Fire Department dispatch and all calls are initially responded to as a "Level 1 Emergency".

Fire Department personnel notify TVFR regarding hazardous materials if they determine the situation warrants. Notification of the Oregon DEQ will be conducted by the hazardous materials team or the Incident Commander. LOCOM shall also notify the Operations Division of Public Works (formerly Maintenance Division) "stand-by" personnel if the event occurs outside normal working hours.

Fire Department spill response is outlined in the City of Lake Oswego Hazardous Materials Annex (2008). General spill response procedures are as follows:

1. Spill reported to City of Lake Oswego (via email, phone, and personal contact).
2. City of Lake Oswego Fire Department called and alerted to "Level 1 Emergency".
3. City Water Quality Program Coordinator and City Stormwater Superintendent alerted to incident.
4. City Fire Department acts as point of contact for incident; maintenance and engineering services act in supportive role.

5. Nature of spill or illicit discharge is determined by Lake Oswego Fire Department or related emergency management division; containment and cleanup measures are identified.
6. If spill is determined hazardous, TVFR is notified and presence is requested onsite. Notification to the Oregon Emergency Response System is initiated and Clean-up options are identified.
7. If spill is determined to be non-hazardous, and a responsible party can be identified, the City will direct that entity to provide resources to mitigate the spill. If no responsible party can be identified or the responsible party does not have the resources to mitigate the spill, Public Works Operations and Engineering staff are responsible for either conducting the spill clean-up or contacting a qualified private vendor for cleanup activities. The City then bills the responsible party for such clean up activity, if a responsible party can be identified.
8. If hazardous, TVFR will coordinate spill response with DEQ.
9. All spills to natural waterways **OR** over 42 gallons on land are reported to DEQ by the City of Lake Oswego.

BMP Fact Sheet: Element #1 – Illicit Discharge Detection and Elimination BMPs (ILL)	
Introduction	The purpose of this BMP category is to improve water quality by implementing measures to prevent, contain, and remove illicit discharges to the City's MS4 system.

Measurable Goals and Tracking Measures	**BMP ILL1 – Implement the Illicit Discharge Detection and Elimination Program**
	• Measurable Goal: Conduct dry weather inspections at 100% of priority outfalls within the City annually.
	  ○ Tracking Measure: Number and percent of priority outfalls inspected annually.
	• Measurable Goal: Based on the results of the annual inspections and any citizen reports, conduct follow up investigations and take enforcement actions to address all non-permissible discharges.
	  ○ Tracking Measure: Describe results of all follow up investigations conducted.
	BMP ILL2 – Implement the Spill Response Program
	• Measurable Goal: Respond to all spills reported to the City using the general procedures outlined under BMP ILL2.
	  ○ Tracking Measure: Number of spills reported annually.
	  ○ Tracking Measure: Number of spills responded to by City Operations staff.
	  ○ Tracking Measure: Describe activities conducted as a result of each spill that City Operations staff responds to annually.

Related Documents	*Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessments,* Center for Watershed Protection and Robert Pitt (2004) *Hazardous Materials Annex (2008)* (City of Lake Oswego Fire Department)
Relationship to TMDLs	**Mercury.** Illicit discharge and spill response BMPs may result in the reduction of mercury load, as required under the goals in the Willamette River TMDL. **Phosphorus.** Illicit discharge and spill response BMPs may reduce the volume of organics discharged to the stormwater conveyance system and thus reduce phosphorus. **Bacteria.** Illicit discharges BMPs will potentially reduce the human and/or pet-related sources of bacteria as associated with non-permissible discharges and sanitary cross-connections. **Settleable Volatile Solids.** Illicit discharge and spill response BMPs may reduce the volume of organics discharged to the stormwater conveyance system and thus reduce the sediment oxygen demand.

3.0 ELEMENT #2 – INDUSTRIAL AND COMMERCIAL FACILITIES

The City does not contain any open or closed municipal landfills, hazardous waste treatment disposal and recovery facilities, or industrial facilities that are subject to Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). The City has a limited number of industrial facilities and potential high pollutant source (commercial and industrial) facilities. The City has developed an inventory of all industrial sources of stormwater discharge in the City. The City will continue to implement a program to conduct inspections of potential high pollutant source facilities.

3.1 BMP IND1 – Screen Existing and New Industrial Facilities

NPDES permit requirements pertaining to BMP IND1 are summarized below. Applicable provisions are detailed under Schedule A.4.b of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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.*

NPDES Permit Requirement – *(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.*

The City currently has an inventory of industrial facilities within the City limits, and no facilities on the list currently operate under a 1200-Z general industrial stormwater permit other than the Tryon Creek wastewater treatment plant, which discharges directly to the Willamette River. One facility currently operates under a 1200-A permit. At least once annually, the City will review and update (as necessary) this inventory with new industrial facilities and potential high pollutant source facilities by review of building permit and/or business license applications. Potential high pollutant source facilities will be determined based on past knowledge of water quality related issues at the site, results of past illicit discharge investigations, continuing inquiries and complaints made to the City, and facility age and the types of activities conducted onsite.

Additionally, the inventory of industrial facilities will be reviewed to determine whether any new facility has the potential to be subject to an industrial stormwater NPDES permit. If identified, such facility and DEQ shall be notified within 30 days.

3.2 BMP IND2 – Conduct Inspections of High Pollutant Source Facilities

NPDES permit requirements pertaining to BMP IND2 are summarized below. Applicable provisions are detailed under Schedule A.4.b of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(iii) Implement an updated strategy to reduce pollutants in stormwater discharges to the MS4 from industrial and commercial facilities where site-specific information has identified a discharge as a source that contributes a significant pollutant load to the MS4. 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. This 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.*

The City's inventory of high pollutant source facilities is described under BMP IND1. In 2014, the City also developed a documented strategy for high pollutant source facility inspections and follow-up. This strategy includes tiered inspections of identified facilities and connection to, or support of pollution prevention measures such as those provided by EcoBiz or the Clackamas County Office of Sustainability. Those facilities with the potential to release pollutants to the City's MS4 system based on initial inspections (e.g., windshield surveys or contact with facility operators) may be inspected on site once during the permit cycle. Such inspections may be conducted in conjunction with illicit discharge investigations or independently. Such independent inspections may also be conducted during pretreatment inspections, building inspections and/or private water quality facility inspections.

<table>
<tr><td colspan="2">BMP Fact Sheet:
Element #2 – Industrial and Commercial Facilities
(IND)</td></tr>
<tr><td>Introduction:</td><td>The purpose of this BMP category is to improve water quality by tracking and proactively inspecting industrial discharges and other potential high pollutant source facilities to the City’s MS4 system.</td></tr>
<tr><td>Measurable Goals and Tracking Measures:</td><td>BMP IND1 – Screen Existing and New Industrial Facilities
• Measurable Goal: Annually review and update the list of industrial dischargers and potential high pollutant source facilities to the City’s MS4 system.
    o Tracking Measure: Number of industrial dischargers and potential high pollutant source facilities identified annually.
• Measurable Goal: Notify the industrial facility and DEQ when industrial facilities are identified that are subject to an industrial stormwater NPDES permit during the annual update of the list of industrial dischargers and potential high pollutant source facilities. Notification shall occur within 30-days of identification.
    o Tracking Measure: Number of industrial facilities requiring permits identified annually.
BMP IND2 – Conduct Inspections of High Pollutant Source Facilities
• Measurable Goal: Implement the City’s strategy to Inspect the identified, potential high pollutant source facilities a minimum of once over the permit term.
    o Tracking Measure: Number of facility inspections conducted and the results of such inspections.</td></tr>
<tr><td>Relationship to TMDLs</td><td>Mercury. Industrial source-control related BMPs may result in the reduction of mercury load, as required under the goals in the Willamette River TMDL.
Phosphorus. Industrial source-control related BMPs may result in the reduction of nutrient related pollutants (including total phosphorus) discharged to the stormwater conveyance system.
Bacteria. Industrial source control BMPs targeting prevention and removal of any illicit discharges may result in the reduction of bacteria sources discharged to the stormwater conveyance system.
Settleable Volatile Solids. Industrial source-control related BMPs may result in the reduction of organics discharged to the stormwater conveyance system and thus reduce the sediment oxygen demand.</td></tr>
</table>

4.0 ELEMENT #3 – CONSTRUCTION SITE RUNOFF CONTROL

The City of Lake Oswego implements a number of BMPs associated with construction activities, and erosion and sediment control. Specific erosion and sediment control requirements are outlined in LOC Chapter 52. In summary, erosion and sediment control must be addressed and an erosion control plan submitted for development projects or other activities involving more than a 500 square foot soil disturbance or within 50 feet of streams, rivers, ponds, and Oswego Lake (with some limited exceptions). The plans must be submitted with the development construction plans or the building permit application or on their own. Exceptions to this threshold (e.g. certain types of residential landscape activities) are listed in LOC 52.02.040. Erosion and sediment plan requirements are tracked through the issuance of the City's Erosion and Sediment Control permits.

To maintain regional consistency, Lake Oswego has adopted BMPs and erosion control procedures in the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual* (2009), which is used by other local jurisdictions within Clackamas County. This manual provides comprehensive information, descriptions, and details of structural and non-structural erosion control measures and practices, as well as information to help assist contractors and developers in designing effective erosion control plans to effectively minimize disturbance. The manual also outlines housekeeping measures to prevent or control non-stormwater waste that may cause adverse impacts to water quality.

The City also references use of their *Design and Construction Standards for Sanitary Sewer and Surface Water Management* (2008). This technical specification references LOC Chapter 52 for erosion control associated with construction of sanitary and storm sewer pipe including the laying and jointing of pipe; the installation of pipe, manholes, catch basins, and other appurtenances; testing; and quality assurance and control.

BMPs related to education and training of construction site operators is addressed under Component #4 (Section 5.0).

4.1 BMP EC1 – Implement the Adopted Erosion and Sediment Control Planning and Design Manual and Associated City Ordinances Related to Erosion Control

NPDES permit requirements pertaining to BMP EC1 are summarized below. Applicable provisions are detailed under Schedule A.4.c of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement *– (i) Include ordinances or other enforceable regulatory mechanism that require erosion prevention 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 mechanism must apply to construction activities that result in a land disturbance of 1,000 square feet or greater.*

***NPDES Permit Requirement** – (ii) Require construction site operators to develop site plans, and to implement and to maintain effective erosion and sediment control best management practices.*

***NPDES Permit Requirement** – (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.*

***NPDES Permit Requirement** – (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.*

LOC Chapter 52 requires that erosion prevention and sediment control plans (EPSCP) be provided as part of the permit process. In addition, LOC Chapter 52 dictates that regardless of the approved EPSCP, additional measures and practices must be implemented as needed to effectively address erosion and sediment control and control of construction waste and other non-stormwater pollutants on the construction site. As a courtesy to the developer or applicant, if the development requires a DEQ issued 1200-C permit, the DEQ approved erosion and sediment plan may be submitted with some additional provisions to meet the City's erosion control requirements. EPSCP submission is tracked through the City-issued Erosion and Sediment Control permits.

Requirements of the EPSCP submittal are outlined in the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual*. In summary, the EPSCP must include information on site topography, area of disturbance, nearby waterways, and stormwater drainage facilities, and must show locations and protection of sensitive lands, wetlands, and significant tree groves, as development and site disturbing activity is restricted from these areas. The EPSCP must also list structural and non-structural BMPs to be applied on site, selected in accordance with site and weather conditions. The manual also outlines various runoff control practices, sediment control practices, and other pollution control BMPs including inspection and maintenance of BMPs that would need to be included in the EPSCP submittal.

Structural and non-structural BMP application varies depending on the construction activity. Issuance of the City's Erosion and Sediment Control permit requires proper installation and maintenance of both temporary and permanent erosion control measures. On all residential and smaller commercial sites, the BMPs must include perimeter protection, inlet protection, and construction entrances designed to minimize disturbance. Commercial scale developments must include all the residential elements, as well as staging and storage areas, concrete truck wash out areas, wheel washes where appropriate, and crew parking areas. All erosion and sediment control measures must be pre-approved, either through inclusion of the adopted *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual*, in approved city details and specifications, or through approval of City engineering staff. Wet-weather season (October 1 to May 31) requirements are issued to the construction site operator with each permit, regardless of the time of year. Finally, newly revised City code requires that applicants designate certified erosion and sediment control staff with credentials similar to those required for DEQ's 1200-C permits.

4.2 BMP EC2 – Conduct Erosion Control Inspections and Enforcement

NPDES permit requirements pertaining to BMP EC2 are summarized below. Applicable provisions are detailed under Schedule A.4.c of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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.*

NPDES Permit Requirement – *(vi) Describe in an enforcement response plan or similar document the enforcement response procedures the co-permittee will implement. The enforcement response procedures must ensure construction activities are in compliance with the ordinances or other regulatory mechanisms.*

All construction sites that file an EPSCP are inspected by City staff a minimum of three times during construction: one inspection at the beginning of the project, one inspection during active construction prior to pouring footings or flatwork, and one inspection at the end of construction, coincident with final inspection of stormwater facilities. All required structural BMPs must be properly installed and in good working order, as defined in the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual.* The applicant's designated individual responsible for implementation of permit conditions is expected to have specific qualifications that are focused on those needed for certification such as the Washington Department of Ecology Certified Erosion and Sediment Control Lead, licensure as a professional engineer (operating within their erosion control expertise), or certification through the International Erosion Control Association as a Certified Professional in Erosion & Sediment Control.

Additional erosion and sediment control inspections may be conducted on sites with steep grades, significant aquatic resources, highly erosive soils, citizen complaints, or a history of non-compliance or failed inspections. These inspections are generally conducted on a case-by case basis. Finally, any site that is under an active enforcement action is also inspected per the schedule identified in correction notices, to the MEP.

All active large-scale sites operating under NPDES 1200-C coverage, must be inspected by an Oregon Department of Environmental Quality-designated inspector provided by the applicant. Typically the inspection frequency is defined in the 1200-C application, and is required daily during periods of rainfall during active construction and at least weekly during non-rainfall periods. These sites are also inspected by City staff against the City's permit.

If any inspection identifies the need for additional erosion and sediment control measures, the additional BMPs must be installed within 24 hours.

As erosion and sediment control permits must be obtained per City code, which requires submittal of an EPSCP and the installation and maintenance of required erosion and sediment control measures, the Lake Oswego Code provides enforcement authority. Enforcement action is taken for those sites where efforts to gain voluntary compliance aren't effective. Typically, the first level of enforcement comes in the form of a verbal warning that is issued by the City Erosion Control Inspector. The inspector typically identifies the deficiencies in the BMPs, explains why additions or modifications to the BMPs are necessary, and outlines the required corrective action. The timeframe associated with the correction is typically between 24-48 hours, depending upon the conditions. If corrective actions are not implemented in the necessary timeframe, secondary enforcement may be issued which includes a municipal court citation and/or a Stop Work Order. The timeframe for correction depends upon the severity of the violation, weather factors, the level of activity on the site, and the potential for significant impact to water quality.

BMP Fact Sheet:
Element #3 – Construction Site Runoff Control BMPs (EC)

Introduction:	The purpose of this BMP category is to improve water quality by implementing control measures including inspections and enforcement to reduce or prevent soil erosion from occurring during development.

Measurable Goals and Tracking Measures:	**BMP EC1 – Implement the Adopted Erosion and Sediment Control Planning and Design Manual and Associated City Ordinances Related to Erosion Control**
	• Measurable Goal: Throughout the permit term implement erosion and sediment control requirements through issuance of city permits and tracking of DEQ permits.
	  ○ Tracking measure: Number of city-issued erosion and sediment control permits annually.
	• Measurable Goal: Provide wet-weather construction requirements with all City-issued Erosion and Sediment Control permits
	BMP EC2 – Conduct Erosion Control Inspections and Enforcement
	• Measurable Goal: Conduct an initial and a final inspection for all new residential and commercial construction sites requiring a City-issued Erosion and Sediment Control permit and submittal of an ESPCP.
	  ○ Tracking Measure: Number of initial and final inspections conducted annually.
	• Measurable Goal: Conduct a minimum of one unscheduled inspection during active construction at all sites requiring a City-issued Erosion and Sediment Control permit, and conduct additional inspections for sites that are potentially problematic (steep grade, proximity to sensitive features, sites where an enforcement action has already occurred).
	  ○ Tracking Measure: Number of unscheduled inspections conducted annually during active construction.
	  ○ Tracking Measure: Number of sites requiring more than the three (initial, unscheduled during active construction, and final) required erosion and sediment control inspections.
	• Measurable Goal: In conjunction with construction activities requiring a City-issued Erosion and Sediment Control permit, implement an escalating enforcement matrix which includes written warnings, Stop Work Orders, and Civil Citations.
	  ○ Tracking Measure: Number of enforcement actions including written warnings (Deficiency Notice or similar action), Stop Work Orders, and Civil Citations.

Related Documents	*Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual (2009)*. http://www.co.clackamas.or.us/wes/designmanual.htm The City of Lake Oswego *Design and Construction Standards for Sanitary Sewer and Surface Water Management.*
Relationship to TMDLs	**Mercury.** The City's erosion and sediment control program assists in reducing the sediment-related mercury load, as required under the goals in the Willamette River TMDL. **Phosphorus.** The City's erosion and sediment control program was established under the Tualatin Basin Rule, in order to meet the phosphorus wasteload allocations as established in the Tualatin River TMDL. **Bacteria.** Waste and site control components of the erosion and sediment control BMPs may result in the reduction of bacteria sources discharged to the stormwater conveyance system. **Settleable Volatile Solids.** Erosion and sediment control BMPs reduce the discharge of organic matter and sediment (total and suspended), which results in reduced sediment oxygen demand in receiving waters.

5.0 ELEMENT #4 – PUBLIC EDUCATION AND OUTREACH

Public education, outreach, and training activities are conducted as required by the City of Lake Oswego's MS4 NPDES permit.

Although not specifically outlined as a requirement in the permit, coordination with other jurisdictions and involvement in stormwater related professional groups is necessary for the training of City staff and to continue to ensure sound stormwater management related decisions and adaptive management. Coordination with other jurisdictions and involvement in stormwater related professional groups is implemented to the MEP. BMPs associated with intergovernmental coordination are provided in this Section as well.

5.1 BMP PE1 – Provide Public Education and Outreach Materials Regarding Stormwater Management

5.2 BMP PE2 – Provide Educational Training Opportunities for Construction Site Operators

NPDES permit requirements pertaining to BMP PE2 are summarized below. Applicable provisions are detailed under Schedule A.4.d of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(v) Provide notice to construction site operators concerning where education and training to meet erosion and sediment control requirements can be obtained.*

To assist engineers, contractors and developers, the City of Lake Oswego provides physical and online access to the adopted *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual*, which provides in-depth information on the causes and effects of erosion, information on the types and proper installation procedures for BMPs, as well as detailed information on designing an effective erosion control plan. The City also posts current CESCL course contacts on its website.

Landscape projects and small construction projects that don't trigger formal erosion control permits or submittal of an ESPCP are provided information on the City's storm water system and information about how sediment and pollutants adversely affect water quality. The *ACWA Construction Site Stormwater Guide* (2013) is also made available to this audience.

All permit holders are provided with specific information on the wet-weather season (October 1 through May 31) construction requirements.

5.3 BMP PE3 – Provide Staff Training for Pest Management

NPDES permit requirements pertaining to BMP PE3 are summarized below. Applicable provisions are detailed under Schedule A.4.d of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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 fire-fighting related training activities, and stormwater system maintenance.*

The City ensures that all City employees performing pesticide application are trained and licensed in accordance with the Oregon Department of Agriculture regulations.

As the City's Integrated Pest Management Practices are updated in conjunction with BMP PEST2, City staff will also be trained accordingly.

5.4 BMP PE4 – Provide Staff Training in Spill Response

NPDES permit requirements pertaining to BMP PE4. Applicable provisions are detailed under Schedule A.4.d of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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 fire-fighting related training activities, and stormwater system maintenance.*

The City provides individual job-related training for new or newly assigned LOFD and Public Works Operations employees that participate in spill response activities. General spill response is included as a topic in cross-departmental stormwater training.

5.5 BMP PE5 – Promote Staff Education and Participation with Local Organizations

NPDES permit requirements pertaining to BMP PE5 are summarized below. Applicable provisions are detailed under Schedule A.4.d of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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.*

A variety of training is provided to City staff associated with stormwater management including attending seminars, conferences and task specific training. Training and advisory committee opportunities are also made available to City staff through state, and local agencies and groups involved with a broad range of water quality issues including stormwater. Such training is conducted as needed, depending on the number of employees being trained and types of training required. Training opportunities are implemented to the MEP. The City also conducts regular team meetings -on average bi-monthly for staff with BMP implementation responsibilities, and an annual interdepartmental training with updates on the City's surface water management program. Meetings are be used to track progress on BMP implementation and to present training type materials related to stormwater quality and the MS4 NPDES permit requirements.

The City's Engineering, Planning, Building, Parks, and Public Works-Operations staff regularly attend conferences, meetings, webinars, and seminars. Over the permit term, staff have attended trainings hosted by AWRA, ACWA, APWA, Environmental and Water Resources Group of ASCE, Northwest Environmental Training Center, Washington Department of Ecology Low Impact Development training program, Pacific Northwest Clean Water Association, WERF/WEF, Center for Watershed Protection, Northwest Regional Floodplain Managers Association and Association of State Floodplain Managers, the Regional Coalition for Clean Rivers and Streams, and the TBPAC. Attendance of conferences, meetings, webinars, and seminars is encouraged and implemented to the MEP given financial and workload constraints. Additionally, the City continues to meet and coordinate with other Clackamas County co-permittees and MS4 permittees across the state regarding regional water quality efforts. Areas for coordination include MS4 issues, education, public outreach and monitoring. These opportunities for coordination help promote additional staff education.

BMP Fact Sheet: Element #4 – Public Education and Outreach (PE)	
Introduction:	The purpose of this BMP category is to improve water quality through public education, outreach, coordination, and training. BMPs under this category attempt to inform the public and influence behaviors in order to reduce pollutant discharge into the MS4.

Measurable Goals and Tracking Measures	**BMP PE1 – Provide Public Education and Outreach Materials Regarding Stormwater Management**
	• Measurable Goal: Provide educational materials two times per year related to impacts of fertilizers, herbicides, and pesticides on receiving water quality and on the use of alternative, environmentally friendly products the public may consider as an alternative.
	  ○ Tracking measure: Summarize the distribution and content of outreach material related to landscape management on an annual basis.
	• Measurable Goal: Provide educational materials related to watershed protection, proper disposal practices, and facilitation of public reporting of illicit discharges annually.
	  ○ Tracking measure: Summarize the distribution and content of outreach material related to proper disposal practices for oil, hazardous wastes, paints, and other items that may cause harm to surface waters on an annual basis.
	  ○ Tracking measure: Specify how the spill control/ watershed protection number was publicized annually.
	• Measurable Goal: Conduct catch basin marking through the use of volunteers during the permit term.
	  ○ Tracking measure: Number and percent of total catch basins marked annually.
	• Measurable Goal: Continue participation with the Regional Coalition of Clean Rivers and Streams.
	BMP PE2 – Provide Educational Training Opportunities for Construction Site Operators
	• Measurable Goal: Continue to provide access to the Erosion Prevention and Sediment Control Planning and Design Manual to engineers, contractors, and developers.
	BMP PE3 – Conduct Staff Training for Pest Management
	• Measurable Goal: During the permit term, require training and certification for City applicators in accordance with Oregon Department of Agriculture regulations. Require staff to maintain certification.
	  ○ Tracking Measure: Number of staff attending continuing education classes to maintain ODA applicators license.
	• Measurable Goal: In accordance with the City's Integrated Pest Management Practices (see BMP PEST2), annually train staff on relevant maintenance activities.
	BMP PE4 – Conduct Staff Training in Spill Response
	• Measurable Goal: Provide spill response training to appropriate city staff during onboarding of new employees and re-assignment of existing employees. Provide general staff updates on spill response procedures and best practices annually.
	  ○ Tracking Measure: Number of city staff that received spill-related training annually.

BMP Fact Sheet: **Element #4 – Public Education and Outreach (PE)**	

	BMP PE5 – Promote Staff Education and Participation
	• Measurable Goal: Conduct 2 to 4 meetings annually for employees associated with stormwater management in the City.
	  ○ Tracking Measure: Track the number of employees attending meetings regarding stormwater management annually.
	• Measurable Goal: Coordinate annually with other Clackamas County co-permittees regarding regional water quality efforts.
	  ○ Tracking Measures: Track the number of joint efforts related to stormwater management that the City is currently involved.
	• Measurable Goal: Throughout the permit term, participate, where practicable, in conferences and training opportunities available through state and local agencies and groups associated with water quality.

Related Documents	*Lake Oswego Clean Streams Plan* (2009) City's Healthy Watersheds Program website (Current URL: https://www.ci.oswego.or.us/publicworks/healthy-watersheds-program)
Relationship to TMDLs	**Mercury.** Public education elements related to sustainability/pollution prevention and riparian zone best practices may assist in reducing mercury loads, as required under the goals in the Willamette River TMDL. The City also benefits from pre-treatment programs implemented by the City of Portland and Clean Water Services. **Phosphorus.** Public education elements related to application and management of fertilizers and other phosphorus-containing materials is necessary to reduce phosphorus loads in water bodies. **Bacteria.** Pet-waste pickup messages and opportunities should result in the reduction of human-related bacteria sources discharged to the stormwater conveyance system. **Settleable Volatile Solids.** Public messages related to seasonal leaf disposal and yard waste pickup may reduce the load of settleable volatile solids to local water bodies.

6.0 ELEMENT #5 – PUBLIC INVOLVEMENT

Per Schedule A.4.e of the City's MS4 NPDES permit, the City of Lake Oswego requires the following:

NPDES Permit Requirement - *(e) Co-permittees must adopt 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 process 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.*

The City provides opportunity for public participation in the development, implementation, and modification of the policies, practices, procedures, and codes that comprise the City's SWMP and pollutant load reduction benchmark development.

SWMP revisions and pollutant load reduction benchmarks are required for submittal to DEQ at the permit renewal submittal. Prior to submittal of these items, the City will provide the public with the 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.

Annually, the City reports to DEQ on the status of implementation of their current SWMP. Such report is called the City's MS4 NPDES Annual Report. To aid in public participation and involvement, the City posts their annual report on the web for public access and review.

No measurable goals or tracking measures are outlined for this permit requirement.

7.0 ELEMENT #6 – POST-CONSTRUCTION SITE RUNOFF CONTROL

The City conducts plan review activities for new and redevelopment applications within its jurisdiction. Existing stormwater development standards focus on low impact development/ green infrastructure techniques that promote infiltration (onsite management) where possible and treatment and flow control, as appropriate, where full onsite management isn't possible. While the pre-2016 City Code was used to require that post-construction site runoff controls met the treatment requirements of the City's MS4 NPDES permit, this code was not explicitly linked to impervious area thresholds and did not provide comprehensive design guidance. The City revised the stormwater code to be explicitly consistent with City's MS4 NPDES permit requirements related to maintaining predevelopment hydrologic function, implementing low-impact development and green infrastructure (GI) design approaches, and promoting the minimization of impervious surfaces and reducing stormwater runoff where applicable. The City also developed more comprehensive design guidelines, outlined in the current version of the *Lake Oswego Stormwater Management Manual* (first effective March, 2016).

7.1 BMP DEV1 – Development Review

NPDES permit requirements pertaining to BMP DEV1 are summarized below. Applicable provisions are detailed under Schedule A.4.f of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(i) By the 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. The site-specific management practices should optimize on-site retention based on the site conditions; 2) Reduce site specific post-development stormwater runoff volume, duration and rates of discharges to the municipal separate storm sewer system (MS4)…; 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.*

NPDES Permit Requirement – *(ii) The co-permittee must identify, and where practicable, minimize or eliminate 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)…. 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.*

NPDES Permit Requirement – *(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) Best Management Practices; and 6) Pollutant removal efficiency performance goals that maximize the reduction in discharge of pollutants.*

NPDES Permit Requirement – *(iv) The co-permittee must review, approve and verify proper implementation of post-construction site plans for new development and redevelopment projects applicable to this section.*

NPDES Permit Requirement – *(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, such as…. the Post-Construction Stormwater Management program must require equivalent 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.*

NPDES Permit Requirement – *(vi) A description of the inspection and enforcement response procedures the co-permittee will follow when addressing project compliance issued with the enforceable post-construction stormwater management performance standards.*

The City of Lake Oswego Planning, Public Works, and Building divisions share review responsibilities for new and redevelopment applications. Specifically the Planning and Engineering Divisions review development proposals for consistency with any applicable regulatory *Comprehensive Plan policies*, and for consistency with applicable community development code requirements (i.e., zoning and development standards), including compliance with natural resource protection standards for wetlands, stream corridors, floodplains, etc., and with other City code provisions related to development. The Engineering Division specifically evaluates development proposals and conducts site plan reviews with regards to proposed stormwater conveyance, treatment, and disposal. Such development standards specific for stormwater conveyance, treatment, and disposal are specified in LOC Chapters 38.25 (Stormwater Utility Code). Design guidelines are presented in the Lake Oswego Stormwater Management Manual which can be updated as necessary by the City Engineer.

Through the development review process, the City currently requires onsite infiltration of stormwater where possible, and surface water quality control (treatment) for new or redeveloped impervious surface greater than or equal to 3,000 square feet ("large" projects), or for new development that results in a net increase greater than or equal to 1,000 square feet ("small" projects). Flow control via 2-, 5-, and 10-year hydrograph matching is required (with exceptions) on large projects.

The City has a *Lake Oswego Stormwater Management Manual* (2016) that provides design guidance and criteria for stormwater facilities. Typical approved stormwater treatment facilities include rain gardens, stormwater planters, bioswales, dry wells, retention ponds, vegetated filter strips, and pollutant control manholes. The City discourages but will allow proprietary stormwater treatment devices that have received Washington TAPE general use level designation approval.

The City will continue to update design guidance and improve process around post-construction stormwater management facilities, both in code and in the City's manual, with the goal of removing pollutants to the MEP.

BMP Fact Sheet: Element #6 – Post Construction Site Runoff Control (DEV)	
Introduction:	The purpose of this BMP category is to improve water quality by implementing appropriate post-construction design requirements.
Measurable Goals and Tracking Measures:	**BMP DEV1 – Development Review** • Measurable Goal: Continue to review all new development applications for compliance with existing stormwater quality standards. ○ Tracking Measure: Track the number of new development applications reviewed for stormwater quality compliance.
Related Documents	The City of Lake Oswego Comprehensive Plan (1984, as amended) (undergoing periodic review during the permit term). The City of Lake Oswego *Public Facilities Plan* (1990, updated 1997) *Lake Oswego Clean Streams Plan* (2009) *Lake Oswego Stormwater Management Manual* (2016 or most current version) *City of Lake Oswego Municipal Code (LOC)*
Relationship to TMDLs	**Mercury.** The City's stormwater treatment design standards are developed to remove sediment-associated mercury. **Phosphorus.** The City's existing stormwater treatment design standards are developed to remove phosphorus. **Bacteria.** Through implementation of proposed treatment standards promoting infiltration techniques, bacteria will be reduced. **Settleable Volatile Solids.** The City's existing stormwater treatment design standards address settleable volatile solids by reducing the particulate load to receiving water bodies.

8.0 ELEMENT #7 – POLLUTION PREVENTION FOR MUNICIPAL OPERATIONS

The City of Lake Oswego conducts a variety of activities focused on the prevention of typical stormwater pollutants (sediment, hydrocarbons, trash and debris, nutrients, metals) from entering the MS4 system. Such activities include the maintenance and repair of City streets; the maintenance of public parks and recreational areas with the intent of minimizing fertilizer and pesticide use; the maintenance of municipal facilities; control of potential cross-connections from the sanitary sewer system; and master planning for stormwater quality improvement.

It should be noted with respect to NPDES permit requirement A.4.g.v. (*implement a program to control the release of materials related to fire-fighting training activities)* that firefighting training activities do not occur within Lake Oswego. Therefore, a BMP was not developed to address this requirement.

8.1 BMP OM1 – Street Sweeping of Curbed Arterial and Residential Streets

NPDES permit requirements pertaining to BMP OM1 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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;*

The City conducts street sweeping activities throughout the City. Street sweeping is conducted on all major and minor curbed arterial streets and all curbed residential streets. Curbed arterial streets are swept at least 13 times per year, and all curbed residential streets in the City are swept at least 2 times per year. Both sweeping frequencies may be adjusted based on management findings and MEP.

A vacuum sweeper is used to minimize wash water from entering the stormwater conveyance system.

8.2 BMP OM2 – Deicing and Leaf Pick-up Activities

NPDES permit requirements pertaining to BMP OM2 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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;*

The City of Lake Oswego applies washed gravel to roadways when ice is present. Street sweepers sweep up the applied gravel after the ice has melted and as promptly as resources and weather allows.

The City's contracted waste hauler, Allied Waste, provides weekly yard debris collection for grass clippings, leaves, etc., year-round. The City's Operations staff also collects fallen leaves seasonally in City streets. The City Operations Program addresses leaf debris in City streets and is primarily implemented to prevent flooding issues associated with clogged inlets.

8.3 BMP OM3 – Road Maintenance and Repair Activities

NPDES permit requirements pertaining to BMP OM3 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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;*

The City conducts road maintenance and repair activities on an ongoing basis to prevent erosion and future pollution from occurring. Repair work is generally scheduled during the dry season when possible, to minimize polluted discharges from entering the stormwater conveyance system, to the MEP.

City-conducted road maintenance and repair activities that would trigger erosion control requirements (an erosion and sediment control plan and/or permit) require that the project is monitored for erosion control compliance by city staff.

As practical during extensive roadway repair activities, existing catch basins are upgraded to those with sumps, allowing some sediment to be removed as part of BMP OM6 (described below in Section 9.2) rather than flushed to receiving waters.

8.4 BMP PEST1 – Reduce Pollutants in Discharges Associated with the Application of Pesticides, Herbicides, and Fertilizers

NPDES permit requirements pertaining to BMP PEST1 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(ii) Implement a management program to control and minimize the use and application of pesticides, herbicides and fertilizers on co-permittee-owned properties;*

The City has adopted standard operating procedures (SOPs) for pest and landscape management activities, which utilize components of the City's Integrated Pest Management Practices. The City's Integrated Pest Management Practices define appropriate application procedures and protocols along roadways, within City parks, and around water quality facilities for staff to adhere to during maintenance activities. Per the SOPs, the following activities are typical:

- Application of chemicals is reduced and/ or 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.

The City has developed a process for inventorying pesticides and herbicides applied to City-owned or operated properties. Pesticide use will be annually inventoried and is reported in detail in the City's annual report.

Any work conducted within public right-of-ways, on City property, or for City-funded projects requires certified, licensed applicators.

Specific education measures and staff training are discussed under Section 5.0 – Element #4 - Public Education and Outreach.

8.5 8.4 BMP PEST2 – Update the City of Lake Oswego Integrated Pest Management Practices

NPDES permit requirements pertaining to BMP PEST2 are summarized below . Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(ii) Implement a management program to control and minimize the use and application of pesticides, herbicides and fertilizers on co-permittee-owned properties;*

The City has been using its Integrated Pest Management Practices for close to 30 years. In spite of this, the City has set a measureable goal of regularly reviewing the current Integrated Pest Management Plan to reflect the current state of practice for areas of improvement.

The City currently incorporates a variety of Integrated Pest Management Practices, for example:

- Operations staff has long concentrated on buying disease-resistant plants and plants that attract beneficial insects so they stay healthy without insecticides.
- Turf maintenance began with experimenting with low phosphorus fertilizer 25 years ago by working with manufacturers to mix a special Lake Oswego blend.
- Water management was improved by installing a computerized irrigation system 17 years ago. For many years wetting agents have been used as standard practice at the golf course and park turf areas to increase water absorption.
- Every year all the shrub beds are mulched with a compost/dark bark mix to help organically feed the soil, smother weeds and retain soil moisture. Medians are filled with plants, which reduces weed growth since healthy plants shade out and out-compete weeds. This technique also works for a lawn since healthy vigorous turf can out-compete weeds and thus no chemicals need to be used.
- The Operations and Parks staff are constantly experimenting with new disease-resistant plant varieties and drought tolerant plants in an effort to showcase how sustainable and beautiful water-wise gardening can be.

8.6 BMP OM4 – Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities

NPDES permit requirements pertaining to BMP OM4 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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 and are not already covered under a 1200 series NPDES, a DEQ solid waste permit, or other permit designed to reduce the discharge of pollutants;*

The City currently operates various maintenance facilities that have the potential to treat, store, or transport municipal waste. Such facilities include the Public Works Operations Building/Yard, Lake Oswego Municipal Golf Course, and Parks Maintenance Buildings.

The City inventoried the active facility managing municipal waste. Recommendations with respect to pollution prevention from this inventory, and subsequent assessment of the old facility from EcoBiz staff, have been incorporated into the design of the new Operations Center, where the City manages street sweeping debris. A new Operations facility is currently under construction.

8.7 BMP ILL3 – Control Infiltration and Cross Connections to the Stormwater Conveyance System

NPDES permit requirements pertaining to BMP ILL3 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(iv) Limit infiltration of seepage from the municipal sanitary sewer system to the MS4.*

The City implements an inflow and infiltration (I&I) abatement program for the sanitary sewer system. Sanitary lines are tested via smoke-testing, T.V. techniques, and flow metering for any cracking or breakage that would possibly result in infiltration or other release from the sanitary to the storm system.

The City's Engineering Division reviews new and redevelopment plans for possible cross-connections. The City's illicit discharge program also works to control and prevent any cross-connections during their outfall inspections and dry-weather field screening activities. Response procedures and timeframes outlined as part of the illicit discharge program (see BMP ILL1) would be applicable.

8.8 BMP DEV3 – Master Planning for Stormwater Quality Improvement

NPDES permit requirements pertaining to BMP DEV3 are summarized below. Applicable provisions are outlined under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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;*

The City operates under a number of planning and development-related documents with goals to reduce and/or eliminate pollutant discharges to surface water bodies. The City's *Comprehensive Plan* was acknowledged by the Land Conservation and Development Commission in 1984 and was updated in 2015 (as part of Periodic Review). Specific sections of the *Comprehensive Plan* address water quality and the state land use goals (Goal 5, Goal 6 and Goal 11). The City's *Public Facilities Plan* was originally adopted in 1990 as part of the Comprehensive Plan update and updated in 1997, and it provides an inventory and conditions analysis for the major elements of the City's infrastructure including stormwater management facilities.

The City finalized and adopted the *Lake Oswego Clean Streams Plan* in November 2009. The *Lake*

Oswego Clean Streams Plan serves as an update to the City's previous surface water management master plan (dated 1992). The *Lake Oswego Clean Streams Plan* serves as the basis for the stormwater management and facility infrastructure portion of the *Public Facilities Plan,* described above, and the City's ongoing, 5-year Capital Improvement Plan. The *Lake Oswego Clean Streams Plan* contains a number of recommended capital improvement projects (CIPs) for flow control and water quality that the City references for future utility and infrastructure improvements. Such CIPs include low impact development technologies where practicable, though many areas of the city contain soils that don't support effective infiltration.

Prioritization of CIPs (as outlined in the City's 5-year Capital Improvement Plan) is generally based on overall planning goals, cost, public safety, and environmental benefit. As funding is available, the City implements the CIPs and continues to update the CIP inventory. Future updates to the City's Capital Improvement Plan are expected to include provisions/projects that further the City's retrofit plan and address hydromodification impacts.

LOC 38.24.505 and .510 created the Surface Water Management Utility, which plans, designs, constructs, maintains, administers, and operates public surface water facilities including those projects identified within the City's prioritized CIP list. Utility user charges are also established by LOC 38.06.030, which fund portions of CIP implementation.

Within the City, there is limited opportunity for retrofit of existing flood control facilities because there are very limited facilities that solely address flood control. The City operates one major flood control facility (Foothills pump station) and works with the Lake Oswego Corporation (Lake Corp.), which operates the gates, weirs, and overflow facilities related to operation of Oswego Lake. Most public drainage facilities are constructed to support both flood control and water quality management. Water quality is always taken into account if the City is repairing, retrofitting or constructing new infrastructure, through compliance with current development standards and erosion and sediment control practices.

BMP Fact Sheet: **Element #7 – Pollution Prevention for Municipal Operations** **(OM, PEST, ILL)**	
Introduction:	The purpose of this BMP category is to improve water quality by implementing appropriate operations and maintenance and other pollution prevention practices.

Measurable Goals and Tracking Measures:	**BMP OM1 – Street Sweeping of Curbed Arterial and Residential Streets**
	• Measurable Goal: Annually sweep curbed arterial streets between 13 and 22 times.
	  ○ Tracking Measure: List all curbed arterial streets and dates swept.
	• Measurable Goal: Annually sweep all curbed residential streets between 2 and 6 times.
	  ○ Tracking Measure: List all curbed residential streets and dates swept.
	BMP OM2 – De-Icing and Leaf Pick-up Activities
	• Measurable Goal: Pick up all deicing materials as promptly as weather and resources allow.
	• Measurable Goal: Pick up leaf debris from City Streets a minimum of annually to prevent inlet clogging and localized flooding.
	  ○ Tracking Measure: Report volume of leaves collected from City Streets in annual report.
	• Measureable Goal: Promote yard waste collection services provided by City Waste Contractor a minimum of annually during permit term.
	  ○ Tracking Measure: Description of leaf debris information provided to public for leaf pick up and recycling.
	BMP OM3 – Road Maintenance and Repair Activities
	There are no measurable goals identified for this BMP.
	BMP PEST1 – Reduce Pollutants in Discharges Associated with the Application of Pesticides, Herbicides and Fertilizers.
	• Measurable Goal: Continually ensure that 100% of pesticide applicators operating within the public right-of-way are certified and licensed.
	• Measurable Goal: Annually inventory pesticide use on co-permittee-owned or operated property.
	  ○ Tracking Measure: Following development of a process for inventorying pesticides used in the City, annually report the quantity of pesticides applied to City property.
	  ○ Tracking Measure: In conjunction with the schedule identified under BMP PEST2 for IPM program updates, annually report any efforts and alternatives used to reduce the quantity of pesticides used by the City on City property.
	BMP PEST2 – Update the City of Lake Oswego Integrated Pest Management Practices.
	• Measurable Goal: Continue to implement and update the City of Lake Oswego City's Integrated Pest Management Practices to reflect generally accepted integrated pest management principals.
	BMP OM4 – Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities
	• Measureable Goal: Inventory new facilities subject to this requirement and implement and track strategies to reduce the impact of stormwater runoff from these new and existing facilities.
	  ○ Tracking Measure: Track the status of inventorying and implementing strategies at municipal facilities subject to this requirement.
	BMP ILL3 – Control Infiltration and Cross Connections to the Stormwater Conveyance System
	• Measurable Goal: Ensure that all identified cross connections are abated upon discovery.
	  ○ Tracking Measure: Number of cross connections discovered and abated annually.

BMP Fact Sheet: Element #7 – Pollution Prevention for Municipal Operations (OM, PEST, ILL)	
Related Documents	The City of Lake Oswego Comprehensive Plan (1984, as amended). The City of Lake Oswego *Public Facilities Plan* (1990, updated 1997) *Lake Oswego Clean Streams Plan* (2009) *Lake Oswego Stormwater Management Manual* (2016, as updated) *City of Lake Oswego Municipal Code (LOC)* Standard operating procedures (SOPs), dated August 25, 2005, issued by Park Maintenance: 1) Vegetation Removal, Mowing, and Alteration, 2) Animal Waste Control, and 3) Pesticide and Fertilizer Application.
Relationship to TMDLs	**Mercury.** The City's stormwater treatment design standards are developed to remove sediment-associated mercury. Roadway maintenance activities that remove solids before deposition in receiving water will also reduce this load. **Phosphorus.** The City's stormwater treatment design standards, utilized in the design and construction of CIPs, are intended to remove phosphorus. Roadway maintenance activities that remove solids before deposition in receiving water will also reduce this load. **Bacteria.** Through appropriate pollution prevention activities and appropriate pest management techniques, sources of bacterial contamination will be identified and corrected. **Settleable Volatile Solids.** Roadway maintenance activities will reduce the discharge of settleable volatile solids that accumulate in the system.

9.0 ELEMENT #8 –STORMWATER MANAGEMENT FACILITIES OPERATION AND MAINTENANCE ACTIVITIES

The City of Lake Oswego conducts a variety of activities focused on the prevention of typical stormwater pollutants (sediment, hydrocarbons, trash, debris, nutrients and metals) from entering the MS4 system. Such activities include the installation, tracking, and maintenance of stormwater conveyance system components and structural stormwater facilities.

9.1 BMP OM5 – Inspection and Maintenance of Publicly Owned Conveyance System Components

NPDES permit requirements pertaining to BMP OM5 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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 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 facilities that have been inventoried and mapped as provided under Schedule A.4.h.ii.*

NPDES Permit Requirement – *(ii) As part of the Stormwater Management Facilities Inspection and Maintenance program, 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 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.*

The City will inspect publicly owned conveyance system components during the permit term. Components of the public conveyance system include culverts, conveyance ditches, inlet structures, and catch basins without sumps. Problem areas are identified during the inspections, and maintenance and/or repair/replacement activities are addressed to the MEP.

Inspections of public conveyance system components (specifically drainage pipe) may occur in conjunction with citizen complaints and inquiries. During inspections, problem areas are identified and maintenance and/or repair activities are scheduled and promptly conducted, to the MEP.

A database tracking system is updated during each maintenance reporting period to allow the City to track maintenance activities and inventory their conveyance system.

9.2 BMP OM6 – Inspection and Maintenance of Publicly Owned Catch Basins with Sumps

NPDES permit requirements pertaining to BMP OM6 are summarized below. Applicable provisions are detailed under Schedule A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *(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 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 facilities that have been inventoried and mapped as provided under Schedule A.4.h.ii.*

NPDES Permit Requirement – *(ii) As part of the Stormwater Management Facilities Inspection and Maintenance program, 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 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.*

As of the date of this version of the SWMP, there are more than 1,800 sumped catch basin inlets that are publicly owned and operated by the City. The number of catch basins and publically owned sumped catch basins change annually, and are reflected with updated inventories. Sumped catch basins are classified by the City as those catch basins with a 12 inches deep or greater sump. The City inspects all of their publicly owned, sumped catch basins annually. Problem areas are identified during the annual inspection, and maintenance, repair, or replacement activities are scheduled thereafter.

Eighty percent of all sumped catch basins are typically cleaned at least once annually. Maintenance activities primarily occur during the dry weather season. In general, cleaning of publically owned sumped catch basins involves removing standing water and debris from the catch basin and sump. Debris levels in catch basins are qualitatively noted on data collection forms along with other observations and background information (site location, date cleaned, etc.).

As with the stormwater conveyance system maintenance (BMP OM5), inspections of public sumped catch basins also occur in conjunction with citizen complaints and inquiries, to the MEP. As a result of public complaint or inquiry, problem areas are identified and maintenance and/or repair activities are scheduled as necessary.

A database tracking system is updated during each maintenance cycle to allow the City to track maintenance efforts and inventory existing sumped catch basins.

9.3 BMP OM7 – Tracking, Inspection, and Maintenance of Water Quality Treatment Facilities

NPDES permit requirements pertaining to BMP OM7 are summarized below. Applicable provisions are detailed under Schedule A.4.d and A.4.g of the City's 2012 MS4 NPDES Permit.

NPDES Permit Requirement – *Schedule A.4.d.iv - Provide public education on the proper operation and maintenance of privately-owned or operated stormwater quality management facilities.*

NPDES Permit Requirement – *Schedule A.4.g.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 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 facilities that have been inventoried and mapped as provided under Schedule A.4.h.ii.*

NPDES Permit Requirement – *Schedule A.4.g.ii - As part of the Stormwater Management Facilities Inspection and Maintenance program, 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 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.*

The City owns and operates public, structural water quality facilities. Such structural facilities currently include dry detention ponds, wet retention ponds, lined planters, infiltration rain gardens, swales, and sedimentation manholes that provide for pollutant removal by controlling flow, promoting infiltration, providing for sedimentation, and filtering pollutants from stormwater.

Public stormwater facility maintenance records are currently tracked at the Public Works Operations Division. Public structural water quality facilities are inspected throughout the permit term and routine maintenance is conducted to the MEP. Typical routine maintenance activities include mowing, trimming, inlet/outlet maintenance, and removal of debris. Watering vegetation in water quality treatment facilities is conducted until new vegetation is established. Based on the results of the inspections, non-routine maintenance activities may be warranted. Non-routine maintenance activities include planting vegetation, reshaping/reconstructing, and silt and sediment removal. Proprietary system maintenance typically falls under non-routine maintenance activities. The City has formalized their current inspection and maintenance schedules, inspection and maintenance criteria, and inspection and maintenance tracking mechanisms using an asset management approach.

The City has begun to implement a program to track private, structural water quality facility maintenance. Private facilities typically are owned and operated by homeowner associations or similar private entities in Lake Oswego or by individual residences. As a result, some do not realize that they are legally responsible for the operation and maintenance of these privately owned facilities. The City has compiled an inventory of all known (existing) private facilities that serve multiple residential lots or commercial development. Beginning with the 2012 MS4 permit, the City began to require individual residential lots to manage stormwater onsite, resulting in many dispersed facilities. The City has only recently begun to track private water quality facilities installed on single lots. New facilities are tracked in conjunction with receipt of the facility's operations and maintenance agreement (a draft of which is required for submittal during development plan review). This maintenance agreement is finalized at the end of construction to match the "as built" conditions, at which time the agreement is recorded with the parcel deed and filed with the City. The City Code supports legal access to inspect newer facilities, but this was not uniformly granted for older facilities (e.g., from the 1980s and 1990s).

In accordance with the schedule outlined for public water quality facilities, the City is formalizing inspection and maintenance schedules, inspection and maintenance criteria, and inspection and maintenance tracking mechanisms for structural control facilities. The City has begun to conduct spot inspections of multi-lot residential and commercial private water quality facilities and is refining an approach to inspecting facilities on individual parcels. Information will also be made available to private facility owners to assist them in conducting independent inspections and maintenance of private structural control facilities.

BMP Fact Sheet: Element #8 – Structural Stormwater Facilities Operations and Maintenance (OM)	
Introduction:	The purpose of this BMP category is to improve water quality by implementing appropriate operations and maintenance practices for structural stormwater facilities.

Measurable Goals and Tracking Measures:	**BMP OM5** - **Inspection and Maintenance of Publicly Owned Conveyance System Components**
	• Measurable Goal: Inspect the publicly owned stormwater conveyance system components (pipes, culverts, ditches, and inlets) during the permit term.
	  ○ Tracking Measure: Number or length of conveyance system components inspected annually.
	• Measurable Goal: Based on the results of the inspections and citizen complaints, maintain/ repair the conveyance system components in need of service during the permit term.
	  ○ Tracking Measure: Describe all maintenance activities potentially impacting water quality that are conducted annually.
	BMP OM6 - **Inspection and Maintenance of Publicly Owned Catch Basins with Sumps**
	• Measurable Goal: Inspect all of the publicly owned, sumped catch basins in the City annually.
	  ○ Tracking Measure: Number and percent of sumped catch basins inspected annually.
	• Measurable Goal: Maintain a minimum of 90% of City owned sumped catch basins annually, based on regular maintenance schedules and results of inspections.
	  ○ Tracking Measure: Number and percent of sumped catch basins maintained annually.
	BMP OM7 – Tracking, Inspection and Maintenance of Water Quality Treatment Facilities
	• Measurable Goal: Refine a program to track and report on public and private water quality facility operations and maintenance activities including those on individual residential lots. Such program shall include mapping, inspection and maintenance schedules, inspection and maintenance criteria, and inspection and maintenance tracking mechanisms for structural control facilities.
	  ○ Tracking Measure: Track status of updates made to the program.
	• Measurable Goal: Annually inspect all of the publicly owned water quality treatment facilities.
	  ○ Tracking Measure: Number and percent of total public water quality treatment facilities inspected annually.
	• Measurable Goal: Annually conduct routine maintenance activities to ensure functionality of public water quality treatment facilities.
	  ○ Tracking Measure: Number of public water quality treatment facilities maintained annually and description of maintenance activity.
	• Measurable Goal: Maintain an inventory of private water quality facilities in conjunction with receipt of private facility operations and maintenance agreements throughout the permit term.
	• Measurable Goal: Annually inspect or spot-check submitted maintenance reports of a portion of the private water quality facilities for which an O&M agreement is on file with the City.
	  ○ Tracking Measure: Number and percent of total private commercial and multi-lot water quality treatment facilities inspected annually. Document the date of inspection.
	  ○ Tracking Measure: Report on development and implementation of a systematic inspection program for water quality facilities on individual residential parcels.

BMP Fact Sheet: **Element #8 – Structural Stormwater Facilities Operations and Maintenance (OM)**	
Related Documents	*Lake Oswego Stormwater Management Manual* (2016, as updated) *City of Lake Oswego Municipal Code (LOC)*
Relationship to TMDLs	**Mercury.** The City's stormwater treatment design standards are developed to remove sediment-associated mercury. Roadway maintenance activities that remove solids before deposition in receiving water will also reduce this load. Through maintenance and inspection, water quality facilities maintain their effectiveness. **Phosphorus.** The City's stormwater treatment design standards result in structural water quality facilities that are developed to remove phosphorus. Through maintenance and inspection, water quality facilities maintain their effectiveness. **Bacteria.** Through appropriate maintenance and inspection of the conveyance system and structural water quality facilities, human sources of bacterial contamination will be identified and corrected. **Settleable Volatile Solids.** Adequate maintenance of the structural water quality facilities will reduce the discharge of settleable volatile solids that accumulate in the system.

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Appendix B: Public Comments and Response to Comments

Appendix B: Public Comments and Response to Comments

What do you think of the proposed Stormwater Management Plan and TMDL Benchmarks for the City's municipal stormwater permit?[1]

Signature	Location	Date/Time	Statement	Response
Name not shown	inside Oak Creek	2/5/2017 9:09	I don't think The City of Lake Oswego is doing an adequate job of street sweeping and to add insult to injury, they dumped tons of nasty tar like "gravel" on the roads this winter and have not cleaned it up in a timely manner. During the Fall the leaves and debris were terrible and a sweeper only came through my the neighborhood once. The two sweepers are often in for repairs it seems or they don't have enough drivers. In other cities the sweepers run regular routes on a much more frequent schedule... also the neighbors are notified what day so they can move their cars ahead of time. The sweepers here are "hit-or-miss" and lots and lots of stuff is getting washed into the sewer system as a result.	The City currently sweeps curbed arterials approximately monthly, and all other curbed residential streets between 2 - 6 times a year (BMP OM1). The City also picks up de-icing and traction materials as promptly as possible (BMP OM2); this current winter (2016-2017) has proved a challenge to City crews due to repeated storms. (Sweeping uncurbed streets is not effective, because the sweeper is likely to remove materials forming the road shoulder without curbs as guides.) Finally, the City is working to change catch basins below storm drain inlets into models with sumps, whereby some of the traction materials and other pollutants can be trapped and removed by the City's vactor truck. While the City is not prepared to change the sweeping schedule based on this comment, the City will evaluate the relative effectiveness of sweeping rates for arterials vs. other residential streets, along with cleanup of traction materials. The City' Public Works/Streets home page (http://www.ci.oswego.or.us/publicworks/street-sweeping) includes this notice: "If your street needs sweeping, please call Public Works at 503-635-0280."
John Earle	inside Forest Highlands	1/23/2017 21:36	While my experiences may be anecdotal, there is some relevance to this discussion. I live next to Nettle Creek which feeds into Tyron Creek/Tyron Park. Over the last ten years there has been a noticeable increase in winter water flow. With the increase has come significant erosion of the banks, scouring of the stream bottom, and a resulting loss of vegetation. The flow of the creek was altered when Atwater road was constructed, channeling the stream through a culvert under the road. At peak flow during the first few months of the year the water exiting the culvert appears as if it is a "class 5" rapids. Ideally the creek would flow normally sans culvert. But that would require a traffic bridge and that's not going to happen anytime soon ... or ever! Underlying this increase in water and subsequent erosion is, I believe, the increased density of the surrounding neighborhood(s). With each new lot division two homes spring up where once there was one. The accompanying hardscape that comes with each new home results in that much more runoff. Water that was able to filter into open soils now flow into catch basins that fill up our streams ever quicker. While the proposed stormwater plan outlines what steps the city takes for its own properties and construction (i.e. reducing runoff, etc.), I would like to see the same requirements of all new construction - commercial and residential. The details would need to be decided by those more knowledgeable than me but there are simple things such as the use of permeable driveway materials, the incorporation of bioswales in landscapes, encouraging certain vegetation for absorption and filtration, etc. As a taxpayer I'm already paying for this existing problem. It would be nice to lift some of these charges and put them on the responsible parties - those at the front end of the process. These should be requirements of the builder. Naturally he'll pass these along to the purchaser of the finished property. That seems appropriate. Stormwater issues will increase under the current proposal. I do not believe the city leaders and staff are being as proactive as the situation calls.	In 2016, the City adopted major changes to the development code, requiring all new development with more than 1,000 square feet of new impervious area, and all with more than 3,000 square feet of new or redeveloped impervious area to address stormwater treatment and volume/ discharge rate (BMP DEV-1). Over the past several years, approximately 20 acres within a 10 square mile City is developed or redeveloped per year. The adopted *Lake Oswego Stormwater Management Manual* includes details on how to select, design, and implement the types of features noted in this comment. Lot density, and development approval, is governed by the City's planning code rather than stormwater code or program activities.

[1] The City received no comments via Open City Hall on the *Monitoring Plan* or the remainder of the *MS4 Permit Renewal Package*.

Appendix B: Public Comments and Response to Comments

What do you think of the proposed Stormwater Management Plan and TMDL Benchmarks for the City's municipal stormwater permit?[1]

Signature	Location	Date/Time	Statement	Response
			In exchange for all the new properties being added to our tax roll there needs to be a more inclusive plan and fair division of costs.	
Clay Werts	inside Bryant	1/22/2017 7:09	Leave it as is!!!! Its only a problem in the minds of government bureaucrats! Let it go, leave it alone.	No response necessary.
Name not shown	inside Forest Highlands	1/21/2017 21:24	The targets of all of this paper work are primarily phosphorus and E.coli bacteria. The phosphorus comes from agricultural and lawn fertilizers, while the E.coli comes from the gut of all sorts of farm animals, cattle, chickens, wild and domesticated ducks and geese, and almost all forms of mammalian wildlife (e.g. raccoons, opossums, deer, coyotes, skunks, etc.) as well as humans. The phosphorus can be eliminated by law or regulation, but what will be the allowed agricultural replacement? You cannot get rid of all wildlife. Some of these proposed benchmarks, I suspect, are therefore not attainable by any amount bureaucratic incrementalism. These proposals are TMI for most people, unless you are an [sic] hydrologist. The acronyms cause your eyes to glaze over if your are [sic] not in the hydrology, an environmental lobby, or the DEQ businesses. Putting this much flack into the air tells me that an entrenched bureaucracy and various environmentalists are in search more public funding through an increased surface water fee, in the City of Lake Oswego. I am opposed to any surface water fee increase.	The City encourages uses of soil testing before applying phosphorus-containing fertilizer, and use of slow-release fertilizers if needed (BMP PE1). Phosphorus also comes from soil erosion, which the City addresses in multiple ways: a) through an Erosion and Sediment Control program for construction-phase activities (BMPs EC1, EC2, and PE2; https://www.ci.oswego.or.us/publicworks/erosion-control-permit-and-information) b) through flow-control elements of the City's stormwater code (BMP DEV1; Lake Oswego Code Chapter 38.25) to reduce instream flow volumes and rates, and c) through support of riparian habitat enhancement activities on public and private lands (TMDL Implementation and BMP PE5). The commenter is correct that most bacteria is related to wildlife and pets. The City encourages proper pet-waste management behaviors among residents (BMP PE1) and addresses sanitary sewer cross-connections to storm sewers and sanitary sewer overflows promptly upon discovery (BMPs ILL1, ILL2, and ILL3).
Name not shown	inside Lakewood	1/21/2017 8:19	Hi city, Thanks for the work you do on behalf of all of us. I see a lot in the Stormwater Management Plan about measuring and recording, but very little about mitigation or compliance enforcement. I understand good intentions are a pre-requisite for action. I just want to make sure the city can do something if, for example, a point source of pollution is identified on private property.	The City's enforcement is related to protecting the public stormwater infrastructure, so doesn't come into effect until pollution is discharged to the storm infrastructure. The City has broadly defined that as pipes, ditches, and streams. The City's first goal is to correct the problem via a warning, and follow up with additional enforcement measures (stop work orders or fines) if the problem is not promptly or appropriately corrected or if there are repeated offenses. The City can and does enforce on Erosion Control permits (BMP EC2 in particular) and on non-permitted non-stormwater discharges to the storm drainage system (e.g., BMP ILL1). The City also is now inspecting new stormwater facilities on development projects and requiring design or construction flaws to be corrected before allowing occupancy (BMP DEV1; Lake Oswego Code Chapter 38.25).

Appendix C:
TMDL Pollutant Load Reduction Evaluation and Benchmarks

TMDL Pollutant Load Reduction Evaluation and Benchmarks

Prepared for

The City of Lake Oswego, Oregon

March 2016

Amended to include Benchmarks, January 2017

Brown AND Caldwell

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

ac	acre(s)
ACWA	(Oregon) Association of Clean Water Agencies
ASCE	American Society of Civil Engineers
BC	Brown and Caldwell
BMP	best management practice
CCSD #1	Clackamas County Service District #1
CFU	colony forming unit(s)
City	City of Lake Oswego
CI	Commercial Institutional
CR&D	Campus Research and Development *(zoning designation)*
DEQ	(Oregon) Department of Environmental Quality
DO	dissolved oxygen
EC	East End General Commercial *(zoning designation)*
EMC	event mean concentration
EPA	(United States) Environmental Protection Agency
GC	General Commercial *(zoning designation)*
GIS	geographic information system
HC	Highway Commercial *(zoning designation)*
I	Industrial *(zoning designation)*
IP	Industrial Park *(zoning designation)*
lb	pound(s)
LCL	lower confidence limit
mg/L	milligram(s) per liter
mL	milliliter(s)
MS4	municipal separate storm sewer system
N/A	not applicable
NC	Neighborhood Commercial *(zoning designation)*
NPDES	National Pollutant Discharge Elimination System
OC	Office Campus *(zoning designation)*
ODOT	Oregon Department of Transportation
P	Parks *(zoning designation)*
PF	Public Function *(zoning designation)*
PLRE	pollutant load reduction evaluation
PNA	Parks and Natural Area *(zoning designation)*
R	Residential *(zoning designation)*
ROW	right-of-way
SOD	sediment oxygen demand
SVS	settleable volatile solids
SWMACC	Surface Water Management Agency of Clackamas County
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence limit
UIC	underground injection control
WLA	wasteload allocation
WLG	West Lake Grove Zone *(zoning designation)*

Definitions

Load allocation	The amount of pollutant allocated to existing nonpoint sources and natural background in a total maximum daily load (TMDL) (EPA 2014)
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)

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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 Lake Oswego (City). The City is subject to TMDLs for two major waterbodies: the Willamette River and the Tualatin River. For the City, these TMDLs cover six TMDL subbasins: the Lower Tualatin, Fanno Creek, Oswego Lake, Springbrook Creek, Tryon Creek and Lower Willamette.

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 facilities or best management practices (BMPs)[1]
- A comparison of the current pollutant load reduction to benchmarks established as part of the City's permit renewal application in 2008

The PLRE results presented in Section 4 show that structural BMP implementation in Lake Oswego results in the achievement of wasteload allocations (WLAs) for bacteria in the Lower Tualatin River and Fanno Creek TMDL subbasins. The WLA for total suspended solids (TSS) is also achieved in the Lower Tualatin River TMDL subbasin.

The PLRE results also show that the City is estimated to be meeting some of the previously established pollutant load reduction benchmarks in the Lower Willamette (including Springbrook Creek), Lower Tualatin, and Oswego Lake TMDL subbasins. However, significant additional pollutant reduction will be needed to achieve the WLAs for bacteria in the Lower Willamette, Tryon Creek, and Springbrook Creek TMDL subbasins and for total phosphorus in the Lower Tualatin River, Fanno Creek, and Oswego Lake TMDL subbasins. Additional reductions could come from structural BMPs or non-structural BMPs such as source controls and programmatic activities.

As part of the City's NPDES MS4 permit renewal application, the City is required to establish new pollutant load reduction benchmarks for TMDL parameters where 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.

Updated benchmarks for the TMDL subbasins are presented in Section 5 and Appendix B.

This report also includes an analysis of long-term trends in receiving water quality based on in-stream monitoring data. The trends analysis is provided in Appendix A.

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

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 pollutant load reductions 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 was to complete a PLRE that was required to 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 the PLRE to DEQ on March 30, 2016.

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).

Lake Oswego is located in the Willamette River watershed, adjacent to both the Willamette and Tualatin rivers. Oswego Lake is a major water body within the Lake Oswego city limits. The relevant TMDLs are the Tualatin Subbasin TMDL, approved on August 7, 2001, by the United States Environmental Protection Agency (EPA) and amended on August 28, 2012, and the Willamette Basin TMDL, approved on September 29, 2006, by EPA. Oswego Lake was incorporated into the 2001 Tualatin Subbasin TMDL with unique load and WLAs, for reasons described below.

1.2.1 Tualatin Subbasin TMDL Pollutant Summary

The Tualatin Subbasin TMDL addresses elevated in-stream temperatures, bacteria *(E. coli),* chlorophyll a and pH (using 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, and for Oswego Lake. The Tualatin Subbasin TMDL includes water-body-specific allocations for the Fanno Creek TMDL subbasin and the larger Tualatin subbasin that includes direct discharges to the Tualatin River as well as discharge to smaller tributaries.

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. Therefore, no WLA is established for temperature in either the Tualatin River Subbasin or Willamette River TMDLs, and temperature is not included in this PLRE or benchmark evaluation.[2]

Bacteria are considered to be a pollutant with direct ties to stormwater runoff, so bacteria are regulated under the NPDES MS4 permits as a point source pollutant. Therefore, the City is required to conduct a PLRE, and establish benchmarks as needed, for bacteria for its MS4 permit area within the Fanno Creek TMDL subbasin and the Lower Tualatin TMDL subbasin.

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

[2] Evaluation of temperature load allocations for Lake Oswego can be found in the City's TMDL Implementation Plan (Lake Oswego 2015a), as modified (Lake Oswego 2016b)

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 and pH. Given the lack of data for SVS, the Tualatin Subbasin TMDL references TSS as a common parameter to evaluate instead of SVS. Therefore, the City is required to conduct a PLRE for total phosphorus and TSS for its MS4 permit area within the Fanno Creek TMDL subbasin and the Lower Tualatin TMDL subbasin and also establish benchmarks as needed.

1.2.2 Oswego Lake TMDL Pollutant Summary

Oswego Lake is a human-enhanced lake located in the city of Lake Oswego. It was historically constructed by raising the outlet of a shallow natural lake using a low-head dam. A navigation connection to the Tualatin River was used to divert flow from the river to maintain flow through the lake particularly in summer. Although Oswego Lake discharges to the Willamette River, it was included in the original 1988 phosphorus TMDL and 2001 Tualatin Subbasin TMDL documents to more efficiently address concerns related to phosphorus in this area and because of the importance of the Tualatin River to the water quality of the lake. Intake from the Tualatin River has decreased substantially since 2002 in part to maintain water quality in both the lake and the river. Individual load and WLAs for total phosphorus are documented in the amended 2012 Tualatin Subbasin TMDL for the Oswego Lake subbasin. The TMDLs for temperature, bacteria, and mercury associated with the Oswego Lake subbasin are included in the Willamette Basin TMDL.

For the purposes of this PLRE and benchmark analysis, Oswego Lake is documented independently from the Tualatin subbasin for total phosphorus. The MS4 area within the Oswego Lake subbasin is reflected as part of the Springbrook Creek or Lower Willamette TMDL subbasins for purposes of evaluating bacteria loads.

1.2.3 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 including Tryon Creek. Additional pollutant parameters are included in the Willamette Basin TMDL for select tributaries, none of which are within the City.

Relevant to the City of Lake Oswego, the Willamette Basin TMDL includes water-body-specific allocations for urban stormwater sources of bacteria in the Lower Willamette River subbasin[3] and the Springbrook Creek subbasin. Bacteria are considered to be a pollutant with direct ties to stormwater runoff; therefore, bacteria are regulated under the NPDES MS4 permits as a point source pollutant, and the City is required to conduct a PLRE, and establish benchmarks as necessary, for bacteria for its MS4 permit area within the Lower Willamette and Springbrook Creek TMDL subbasins.

As mentioned in Section 1.2.1, DEQ does not typically consider temperature to be a pollutant parameter associated with urban stormwater runoff. Temperature is regulated by DEQ and addressed by individual NPDES Wastewater Discharge permits such as the one held by the City of Portland for the Tryon Creek wastewater treatment plant and, as noted above, TMDL Implementation Plans (Lake Oswego 2015a), but not under the NPDES MS4 permit.

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[3] For this analysis, the City has elected to evaluate the Tryon Creek subbasin as a separate contributor within the Lower Willamette subbasin. The Tryon Creek subbasin does not have a water-body-specific allocation for any pollutant parameter within the Willamette Basin TMDL, so the same WLAs for the Lower Willamette subbasin apply to the Tryon Creek subbasin.

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, no pollutant load reduction estimates for mercury are required in this evaluation.

1.2.4 TMDL WLAs

Lake Oswego submitted a PLRE and TMDL pollutant load reduction benchmarks as part of its Phase I NPDES MS4 permit renewal submittal in September 2008 (Lake Oswego 2008). While the Tualatin Subbasin TMDL was amended in 2012 for total phosphorus and ammonia, 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 for comparison in this present evaluation.

Table 1-1. Lake Oswego Applicable WLAs

TMDL document	TMDL water body	Parameter	WLA
Tualatin Subbasin TMDL	Lower Tualatin	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)
	Fanno Creek	Bacteria (*E. coli*)	5,000 counts/100 mL (winter storm event concentration) 12,000 counts/100 mL (summer storm event concentration)
		Total phosphorus	0.13 mg/L (summer seasonal concentration)
		DO (TSS as a surrogate)	50% reduction (summer seasonal)
	Oswego Lake[a]	Total phosphorus	0.09 mg/L (summer seasonal concentration) 0.15 mg/L (fall/winter/spring seasonal concentration)
Willamette Basin TMDL	Lower Willamette[b]	Bacteria (*E. coli*)	78% reduction (annual)
	Springbrook Creek[c]	Bacteria (*E. coli*)	80% reduction (annual)

a. *For the Tualatin Subbasin TMDL, WLAs for total phosphorus are specified for the Oswego Lake subbasin (which includes both Oswego Lake Direct and Springbrook Creek subbasins). For the Willamette Basin TMDL, WLAs for bacteria are specified for the Oswego Lake subbasin in two places. Oswego Lake Direct is accounted for in the Lower Willamette subbasin and the Springbrook Creek subbasin is accounted for separately.*

b. *WLAs for the Lower Willamette apply to the Tryon Creek TMDL subbasin.*

In the Willamette Basin TMDL, the WLAs for bacteria[4] (*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 for stormwater are defined as an annual load reduction as shown in Table 1-1. In the Tualatin Subbasin TMDL, the WLAs for bacteria are presented as a concentration for 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 (see Tualatin Subbasin TMDL, Section 4.2.9).

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.

[4] 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 was assumed to be a WLA because it is applied to the City's NPDES MS4 permit area.

The WLAs for total phosphorus (as a surrogate for pH and chlorophyll a) in the Tualatin Subbasin TMDL were established as a median concentration of total phosphorus in stormwater runoff. For point source discharges (excluding wastewater treatment plants) to the Tualatin River and tributaries (i.e., the Lower Tualatin TMDL subbasin and Fanno Creek TMDL subbasin) the WLAs were assigned according to the location of discharges along the Tualatin River for the summer season (May to October). The WLAs vary by subbasin as shown in Table 1-1 and are based on maintaining an in-stream total phosphorus concentration below 0.15 milligram per liter (mg/L), which is considered natural background conditions. For the Oswego Lake subbasin, a separate WLA was established for the summer season (May to October) and winter season (November to April) and are consistent with natural background condition concentrations.

The WLAs for TSS (as a surrogate for SVS) in the Tualatin Subbasin TMDL were calculated based on the necessary reduction in sediment oxygen demand (SOD) required to meet the DO criteria along the main stem and tributaries of the Tualatin River[5]. 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 WLAs are presented as a percent reduction from current conditions and management efforts are expected to incorporate TSS (as opposed to SVS) as a target parameter. The WLAs were established for the summer season (May to October).

[5] The Tualatin Subbasin TMDL, p. 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.

Section 2

PLRE and Benchmark 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 2015 development conditions. The PLRE must also include estimates of current pollutant loading both with and without stormwater 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, and benchmarks were developed for each TMDL subbasin and pollutant parameter listed in Table 1-1. The overall process and the methodology used for conducting the PLRE and establishing new benchmarks are 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 of the PLRE 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 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 erosion control program activities, 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 event mean concentrations (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, protection of riparian buffers, 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 analyses were 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:

- A new land use category (institutional) was established to reflect public properties including schools
- 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 (ACWA 2014).

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 pollutant loads were calculated. Pollutant loads were calculated as pounds (lbs.) of phosphorus and TSS and counts of *E. coli*. Pollutant loads were calculated for each TMDL subbasin 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 (ACWA 2014).

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 subbasin 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 Fanno Creek or Lower Tualatin TMDL subbasins.

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 4.5.

Model simulations were conducted for each PLRE scenario (current no-BMP and current with-BMP). Pollutant loads and pollutant load removals 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 the development of new/updated benchmarks, an additional simulation (future with-BMP) was conducted. The future with-BMP scenario assumed all 2015 BMPs were 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) as indicated by the City's *Retrofit Strategy* (2015b). Pollutant loads and pollutant load reductions were calculated using the current no-BMP and the future with-BMP scenarios consistent with the PLRE modeling methods.

2.3 Model Output and Comparison to WLAs

Based on the modeling results, the current no-BMP pollutant load range (LCL to UCL) was first documented for each pollutant for each subbasin and analysis period. This current no-BMP load was the starting point for PLRE calculations, WLA comparisons, and benchmark development.

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

2.3.1 Comparing Pollutant Loads to WLAs and Previous Benchmarks

For Lake Oswego, the WLAs were calculated as follows:

- The WLAs for bacteria in the Willamette Basin TMDL were defined as an annual percent reduction. The WLAs (as loads) were calculated as the percent load reduction from the current no-BMP, mean pollutant load.
- The WLAs for total phosphorus and bacteria in the Tualatin Subbasin TMDL were defined as concentrations. For both parameters, the WLAs (as loads) were calculated based on the total seasonal or event runoff volume and the target pollutant concentration listed in Table 1-1.
- The WLAs for TSS in the Tualatin Subbasin TMDL were based on a seasonal percent reduction. The WLAs (as loads) were calculated as the percent load reduction from the current no-BMP, mean pollutant load[6].

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 graphs and discussion related to modeling results are included 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 of the MS4 permit). 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.

6 The 2008 TMDL pollutant loading benchmarks established for the city were calculated based on a summer storm event, rather than the summer season. This effort corrects the analysis to evaluate TSS for the summer season.

2.3.2 Calculating New Benchmarks

New benchmarks were 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, using the results from the LCL and UCL calculations. Results and discussion related to development of TMDL benchmarks are included in Section 5.

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

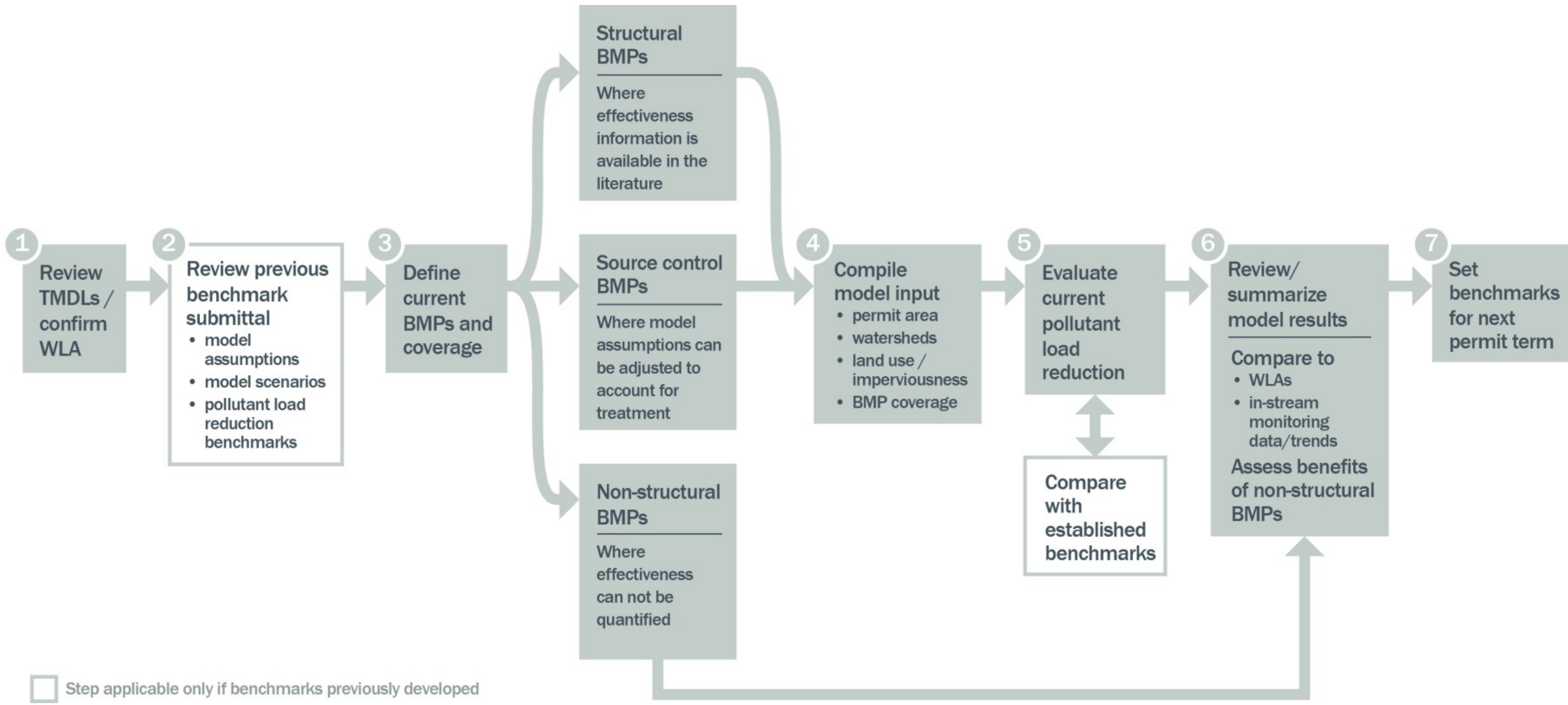

Figure 2-1. PLRE process and relationship to benchmark development efforts

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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 PLRE analysis and benchmark development. Model input data calculations were performed by Parametrix as a subcontractor to Brown and Caldwell (BC), using updated geographic information system (GIS) data sets developed and maintained by the City.

The total modeled area and land use show only minor changes from the 2008 model. BMP coverage has significantly changed from 2008 assumptions due to an increase in the number of facilities installed and refined mapping of 2008 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 subbasins.

A map showing model input data including current and projected 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 or urban services boundary as of September 2015, including small portions of unincorporated Clackamas County.

Areas within the city limits or urban services boundary that are the responsibility of another Phase I NPDES MS4 permittee, specifically the Oregon Department of Transportation (ODOT) and the Surface Water Management Agency of Clackamas County (SWMACC), were omitted from the modeled area. ODOT has a separate NPDES MS4 permit for discharges from area within the ODOT right-of-way (ROW). For Lake Oswego, these areas included the Interstate 5 corridor and the Oregon Highway 43 corridor. SWMACC also has a separate NPDES MS4 permit, and loads analyses have been conducted and submitted for SWMACC in conjunction with the PLRE and benchmark submittals for Clackamas County Service District #1 (CCSD #1) and the cities of Rivergrove and Happy Valley. It should be noted that a small portion of the modeled area is also served by Clean Water Services, but this area was not excluded from the modeled area, as Clean Water Services has not completed a PLRE or developed new benchmarks for this area.

In addition, the open-water areas of the Tualatin River, Willamette River, and Oswego Lake were excluded from the modeled areas. These exclusions are consistent with modeling assumptions from the previous analyses with the exception of the exclusion of the SWMACC area, which is a change in model area assumptions from 2008.

As described in Section 1, WLAs were defined for five TMDL subbasins; therefore, each TMDL subbasin was modeled separately and pollutant loads for the modeled areas were compared to the respective WLAs. In addition, the City elected to evaluate the Tryon Creek subbasin separately from the Lower Willamette subbasin, so a total of six TMDL subbasins were included in the modeling efforts.

The City's watershed GIS layer was used to define the modeled subbasins across the city that have been assigned to the larger TMDL subbasins, as shown in Table 3-1.

Table 3-1. Lake Oswego TMDL Subbasin Summary

TMDL subbasins	Modeled subbasins
Lower Tualatin River	Lower Tualatin
Fanno Creek	Fanno Creek
Oswego Lake	Springbrook Creek Oswego Lake Direct
Lower Willamette River	Oswego Lake Direct Lower Willamette
Springbrook Creek[a]	Springbrook Creek
Tryon Creek[b]	Tryon Creek

a. The Springbrook Creek TMDL subbasin is included in the Oswego Lake modeled subbasin to model total phosphorus loads and is modeled separately to evaluate bacteria loads.

b. The Tryon Creek TMDL subbasin was evaluated as part of the Lower Willamette River subbasin in 2008.

Table 3-2 compares the total modeled area by TMDL subbasin to the 2008 total modeled area for each TMDL subbasin. The changes in the modeled area between 2008 and 2015 are due to annexations (both into and out of the city limits), exclusion of the SWMACC service area, and refinement of watershed and subbasin 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 subbasins	2015 PLRE, total modeled area (ac)[a]	2008 PLRE, total modeled area (ac)
Lower Tualatin River	299.1	1,718.2[b]
Fanno Creek	1,113.7	
Oswego Lake	3,668.8	3,944.7
Lower Willamette River	3,508.7	5,049.7[c]
Tryon Creek	1,237.9	
Springbrook Creek	1,171.9	1,219.1

a. The total modeled area reflects the NPDES MS4 permit area boundary minus ODOT ROW, SWMACC service area, and water bodies.

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

c. The 2008 permit renewal documentation reported only the combined areas discharging directly and through tributaries to the Willamette River, with the exception of Springbrook Creek, which was accounted for separately.

3.2 Land Use and Impervious Areas

Land use coverage was developed based on City zoning as of September 2015. The land use coverage also incorporated vacant-lands data from Metro, which are based on 2013 aerial photos. City staff reviewed the vacant-lands coverage and refined the coverage based on more recent development activities and to exclude undevelopable open-space areas and infill lots with existing development. Agricultural areas were not based on designated zoning but individually identified by the City from the zoned Park and Natural Area zoning coverage.

The City's zoning categories were grouped into the land use modeling categories as shown in Table 3-3.

The modeled impervious percentages for each modeled land use category were directly calculated based on 2015 impervious coverage in the City's GIS and are summarized in Table 3-3. The updated impervious percentages reflect a general increase in the impervious percentages that were estimated and used in 2008.

Table 3-3. Modeled Land Use Categories

City zoning code	Zoning description	Modeled land use category	2015 modeled impervious percentage
R-5 and higher R-3 R-2	Residential	Single-family residential	36.1
R-3 R-2 R-0	Residential	Multi-family residential	54.4
OC	Office campus	Commercial	60.2
WLG	West Lake Grove Zone		
NC	Neighborhood commercial		
EC	East End general commercial		
GC	General commercial		
CR&D	Campus research and development		
HC	Highway commercial		
CI	Commercial institutional		
I	Industrial	Industrial	55.8
IP	Industrial park		
PF	Public function	Institutional	31.5
P	Parks	Parks and open space	7.2
PNA	Parks and natural area	Parks and open space	
N/A		Vacant[a]	2.0
		Agriculture	7.2

a. *Vacant lands were identified based on Metro vacant lands coverage and include area within all zoning coverage.*

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

$$\text{Runoff coefficient} = 0.05 + 0.009 \times (\text{percent impervious})$$

Rainfall was multiplied by the runoff coefficient to obtain an estimated runoff volume. The appropriate pollutant concentration is 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 subbasin is outlined in Table 3-4 and shown in Figure 3-1.

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

TMDL subbasin	Total modeled area (ac)	Land use breakdown (ac)							
		Agriculture	Commercial	Industrial	Single-family residential	Multi-family residential	Vacant	Parks and open space	Institutional
Lower Tualatin River	299.1	0.7	0.0	18.4	173.7	0.0	9.8	73.0	23.4
Fanno Creek	1,113.7	0.0	167.9	0.0	600.5	130.2	17.1	164.2	34.0
Oswego Lake[a]	3,668.8	150.3	179.6	120.9	2,373.3	134.2	119.9	460.3	130.3
Lower Willamette River[b]	3,508.7	150.3	207.4	121.0	2,369.0	100.3	176.8	283.6	100.3
Tryon Creek	1,237.9	26.7	44.9	18.5	699.6	19.6	96.6	280.9	51.1
Springbrook Creek	1,171.9	0.0	109.9	0.0	576.6	98.1	42.4	299.9	45.0

a. *Includes both the Oswego Lake Direct and Springbrook Creek subbasins.*

b. *Includes Oswego Lake Direct, but not Springbrook Creek or Tryon Creek subbasins.*

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 periodically updated as new facilities are constructed or identified. This modeling effort included the addition of public and private BMPs installed since 2008 and refinement of the drainage areas associated with BMPs accounted for in 2008. In some cases, refinement of the BMP drainage areas has resulted in a more conservative estimate of BMP coverage (i.e., fewer acres [ac] contributing to an individual facility). Where BMP drainage areas overlap, the area was assigned to the structural BMP that appears to be the farthest downstream, and provides 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. Section 4.4 provides a comparison of the BMP coverage areas between the 2008 model and the current model.

Table 3-5 summarizes the structural BMP categories included in the 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 or required review of as-builts to verify the appropriate modeled BMP category. For instance, flow through planters in the City database, while typically built with an open bottom, were modeled as lined (i.e., non-infiltrating) facilities due to the generally poor infiltration conditions across the City with clay-rich soils, steep slopes where infiltration is not encouraged due to slope stability concerns, and/or shallow groundwater. Table 3-6 and Figure 3-1 show the BMP coverage in each modeled TMDL subbasin used to develop the PLRE.

Anticipated future BMP coverage used to develop benchmarks is also shown in Figure 3-1 and discussed in further detail in Section 5.

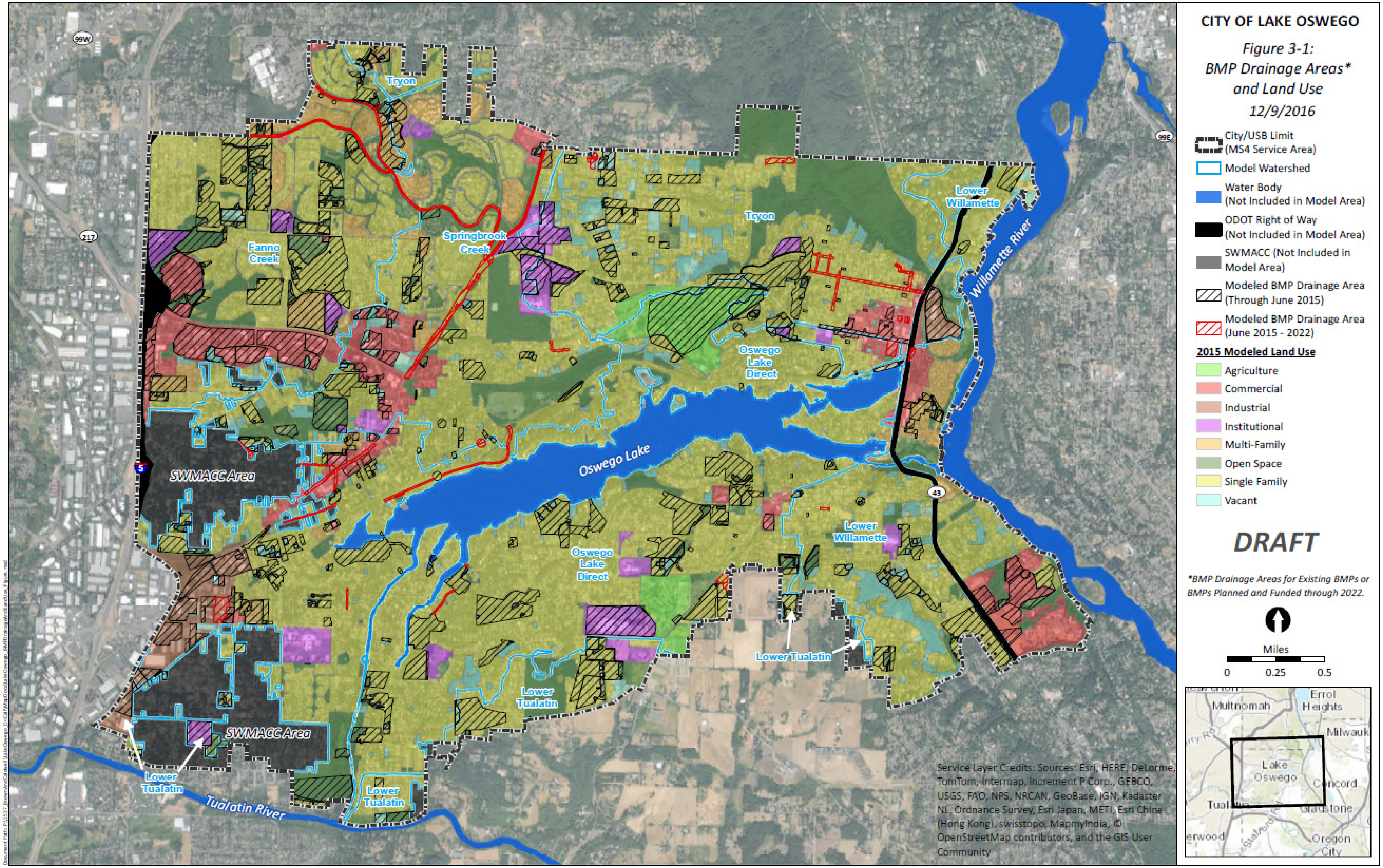
CITY OF LAKE OSWEGO
Figure 3-1:
BMP Drainage Areas*
and Land Use
12/9/2016
City/USB Limit (MS4 Service Area)
Model Watershed
Water Body (Not Included in Model Area)
ODOT Right of Way (Not Included in Model Area)
SWMACC (Not Included in Model Area)
Modeled BMP Drainage Area (Through June 2015)
Modeled BMP Drainage Area (June 2015 - 2022)
2015 Modeled Land Use
Agriculture
Commercial
Industrial
Institutional
Multi-Family
Open Space
Single Family
Vacant
DRAFT
*BMP Drainage Areas for Existing BMPs or BMPs Planned and Funded through 2022.
Miles
0
0.25
0.5
Multnomah
Errol Heights
Milwauk
Lake Oswego
Concord
Tualatin
Gladstone
Oregon City
Tryon
Fanno Creek
Springbrook Creek
Lower Willamette
Willamette River
Oswego Lake Direct
Oswego Lake
SWMACC Area
Lower Tualatin
Tualatin River
99W
217
99E
5
43
Service Layer Credits: Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Table 3-5. Structural BMP Categories Used in Lake Oswego's Pollutant Loads Model

City BMP category	2015 modeled BMP category
StormFilter®	Media filter
Detention pond	Dry, detention pond
Detention pond	Wet, detention pond
Swale Open channel	Biofiltration swale/vegetated filter strip
Sediment manhole	Sedimentation manhole
Hydrodynamic separator	Hydrodynamic separator
Infiltration trench Soakage trench Proprietary infiltration chambers	Infiltration rain garden/soakage trench
Stormwater planter Rain garden Swale	Lined planter/rain garden with underdrain
UIC	UIC

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

TMDL watershed	BMP coverage area (% model area)	BMP coverage (ac)								
		Media filter	Dry, detention ponds	Wet, retention ponds	Biofiltration swale/ vegetated filter strip	Sedimentation manhole	Hydrodynamic separator	Infiltration rain garden/ soakage trench	Lined planter/rain garden with underdrain	UIC
Lower Tualatin River	33	0.0	12.6	45.4	27.5	0.0	0.0	0.0	2.8	10.2
Fanno Creek	36	0.0	0.0	235.7	163.9	0.0	0.0	5.7	0.0	0.0
Oswego Lake[a]	18	0.0	0.1	314.6	272.5	0.7	1.3	12.2	20.9	32.6
Lower Willamette River[b]	19	0.0	0.1	312.0	273.7	0.7	1.3	11.5	26.9	27.9
Tryon Creek	15	4.9	0.0	61.7	57.4	0.0	0.0	8.9	26.5	24.8
Springbrook Creek	12	0.0	0.0	93.8	38.5	0.0	0.0	6.0	0.0	7.2

a. *Includes Oswego Lake Direct and Springbrook Creek subbasins.*

b. *Includes Oswego Lake Direct, but not Springbrook Creek or Tryon Creek subbasins.*

It is assumed that additional structural BMP facilities exist in Lake Oswego that are not currently included in the City's structural BMP tracking system. The City began requiring stormwater treatment for development exceeding 3,000 square feet of new, or redeveloped impervious surface upon receipt of the 2012 MS4 permit. However, while stormwater facilities have been tracked for partitions and small subdivisions, the program to track facilities for single-lot residential developments was not initiated until mid-2014. Therefore, a small number of private facilities approved for single-lot construction between mid-March 2012 and September 2014 are not yet included in the "with BMP" model scenarios. The impervious area treated by these omitted facilities is estimated by the City to account for less than 1% of the total impervious area in the City.

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 Modeling Effort

Parameter	Land use	Count[d]	Bootstrapped mean		
			95% LCL	Mean	95% UCL
TSS (mg/L)	Commercial[a]	72	64	82	103
	Industrial	48	117	184	284
	Open space[b]	10	16	31	50
	Residential[c]	65	44	66	99
Parameter	**Land use**	**Count[d]**	**Bootstrapped median**		
			95% LCL	**Median**	**95% UCL**
Total phosphorus (mg/L)	Commercial[a]	26	0.23	0.28	0.31
	Industrial	25	0.36	0.47	0.65
	Open space[b]	8	0.08	0.09	0.09
	Residential[c]	36	0.16	0.21	0.23
Parameter	**Land use**	**Count[d]**	**Bootstrapped geometric mean**		
			95% LCL	**Mean**	**95% UCL**
E. coli, CFU/100 mL (geomean)	Commercial[a]	52	573	1,247	2,409
	Industrial	58	154	438	1,004
	Open space[b]	9	57	87	124
	Residential[c]	65	970	1,656	2,651

Note: Data range (+/- 95%) provided by the City of Portland. Based on modified ACWA data set (2008), as described with the City's 2008 Permit Renewal Application.

a. Land use EMCs for commercial are also used to simulate pollutant loads in runoff from areas of institutional land use.

b. Land use EMCs for open space are also used to simulate pollutant loads in runoff from areas of vacant land use.

c. Land use EMCs for residential are also used to simulate pollutant loads in runoff from areas of multifamily residential.

d. 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 has a comparable pollutant load. This occurred for the vacant, multi-family, and institutional 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, ecoroofs, and porous pavement as options in the pollutant loads model. The mean and median BMP effluent concentration values are provided in Table 3-8.

Table 3-8. BMP Effluent Concentration Values Used in the Loads Model

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.

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 WLAs in the Tualatin Subbasin TMDL are identified as seasonal concentrations. The summer season WLAs in the Tualatin River, Fanno Creek, and Oswego Lake subbasins were evaluated based on a seasonal rainfall of 6.82 inches. The winter season WLA in the Oswego Lake Subbasin was evaluated based on an assumed seasonal rainfall of 33.18 inches, calculated based on the annual rainfall and summer seasonal rainfall.

The TSS WLA in the Tualatin Subbasin TMDL is identified as a summer seasonal percent reduction and was evaluated based on a summer seasonal rainfall of 6.82 inches.

The Lower Willamette Subbasin TMDL includes WLAs for bacteria. 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 40 inches.

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.

Parametrix (as a subcontractor to BC) performed necessary GIS analysis and data processing to establish base data for the models. The resulting data used as the basis for this analysis were provided to the City for review and have been compiled into a geodatabase (LoadsAssessment_2016.gdb) to provide a record for City files and future modeling efforts. The geodatabase includes the following feature classes that reflect the data processing and compilation needed to conduct the pollutant loads modeling:

- ModelArea: Reflects the Lake Oswego urban service area with the ODOT ROW, major water bodies, and SWMACC service area removed. This is an intermediate data set used for the model.
- LandUse_Modeled: Reflects a simplified land use layer clipped to the model area. This is a final data set used for the model.
- BMP_DrainageArea_AllAttributes: Reflects the merged 2008 and 2015 BMP drainage area data sets and the UIC area data sets. Drainage area overlaps are corrected. This is an intermediate data set used for the model.
- BMP_DrainageArea_Simple_Modeled_2015Analysis: Reflects a simplified version of the BMP_DrainageArea_AllAttributes feature class.
- ModeledBMPDrainageArea_Through2022: Reflects drainage areas modeled in the 2015 PLRE analysis plus new BMP drainage areas and projected drainage areas for CIPs anticipated through 2022. Where new BMP drainage areas overlapped with old (pre-2015) drainage areas, the old BMP drainage areas remained in place and the new BMP drainage areas were reduced accordingly.

Section 4

Pollutant Load Reduction Evaluation Results

PLRE model results for each TMDL subbasin, 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 existing 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 Subbasin

The Tualatin Subbasin TMDL includes 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 Tualatin Subbasin WLAs apply to the Lower Tualatin River TMDL subbasin and the Fanno Creek TMDL subbasin.

The PLRE shows that the City's structural BMPs are estimated to be meeting the WLAs for bacteria in both TMDL subbasins and likely meeting the WLA for TSS in the Lower Tualatin River TMDL subbasin. Additional load reduction will be needed to achieve the WLAs for total phosphorus in both subbasins and the WLA for TSS in the Fanno Creek TMDL subbasin. Detailed results of the PLRE for each pollutant in each TMDL subbasin are described in the following subsections.

4.1.1 Lower Tualatin River

The Lower Tualatin River TMDL subbasin area includes approximately 300 acres along the southern portion of the city on the edge of the city limits and urban services boundary. The area is largely composed of single-family residential and parks and open space land uses with a few areas identified for future infill development. Many developments in the Tualatin River TMDL subbasin area have been constructed with stormwater management facilities in place to provide flow detention and water quality treatment. Current structural BMP coverage is approximately 33 percent.

Figures 4-1 and 4-2 show that Lake Oswego is currently estimated to be meeting the WLAs for bacteria in the Lower Tualatin River TMDL subbasin. 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 of each seasonal event. The current, with-BMP pollutant load estimates equate to a concentration range between 621 and 1,612 counts per 100 mL, which is lower than both seasonal event WLAs.

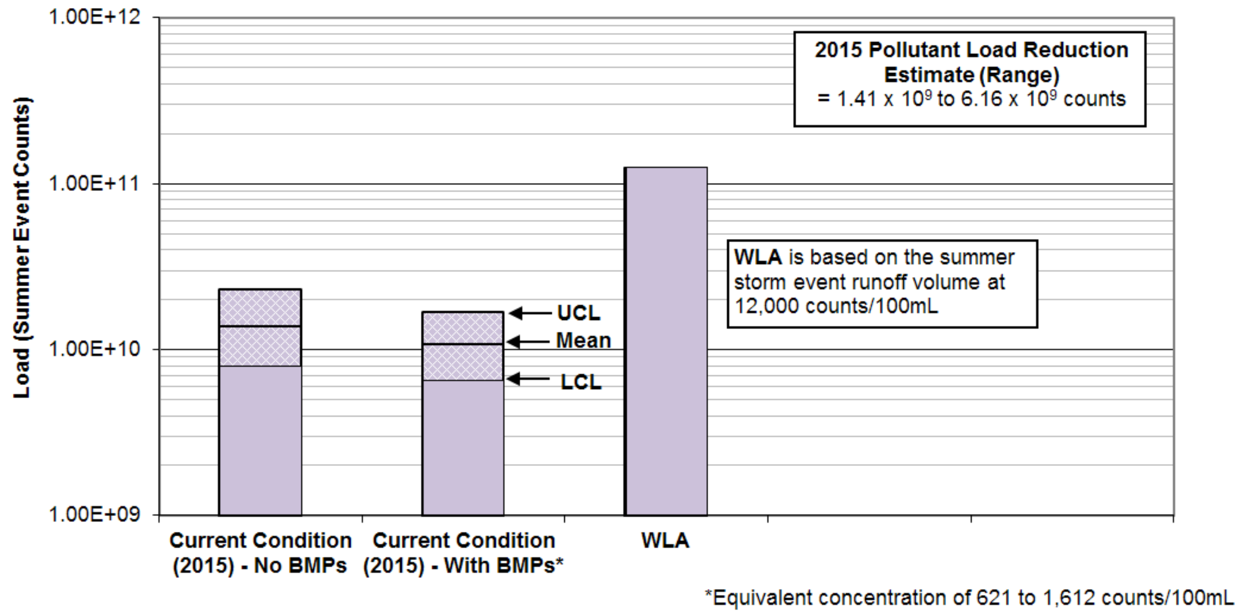

Figure 4-1. *E. coli* PLRE results for the Lower Tualatin River TMDL subbasin (summer event)

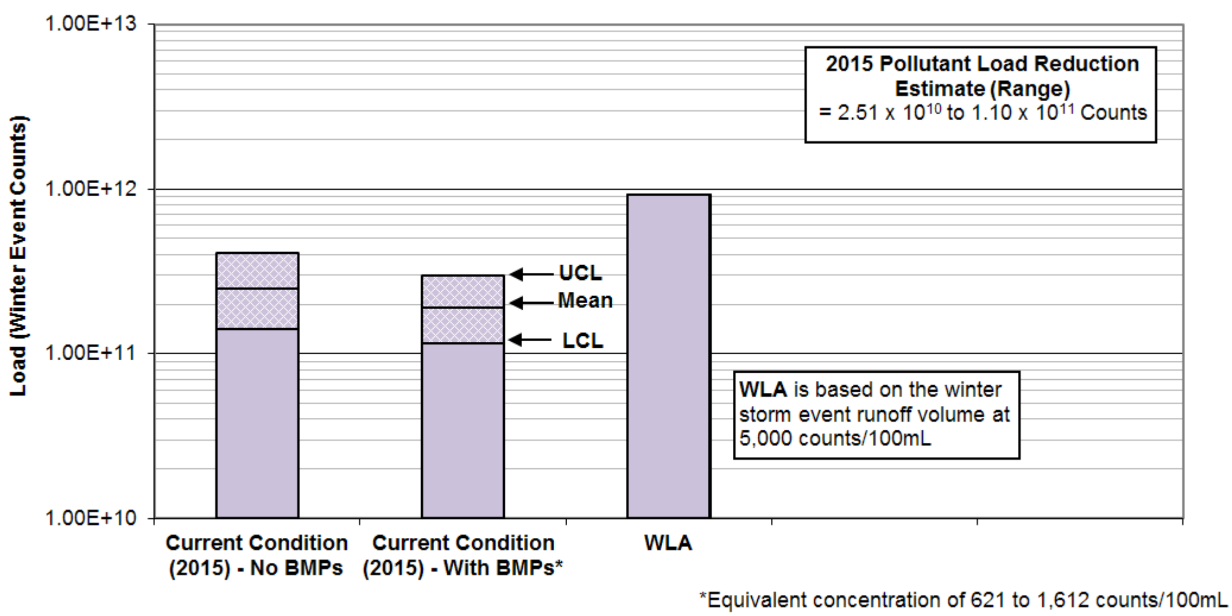

Figure 4-2. *E. coli* PLRE results for the Lower Tualatin River TMDL subbasin (winter event)

Figure 4-3 shows that Lake Oswego is not currently estimated to be meeting the WLA for total phosphorus in the Lower Tualatin River TMDL subbasin. Total phosphorus is a surrogate parameter for pH and chlorophyll a. 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, based on the total summer season runoff volume. The current pollutant load estimates with BMP coverage range from 20.5 to 29.0 pounds, which equates to a concentration range between 0.16 and 0.23 mg/L, which is above the WLA.

Additional load reduction would be needed beyond current structural BMP implementation to achieve the WLA for total phosphorus. Section 4.5 describes some of the non-structural BMPs that are implemented in this subbasin, 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.

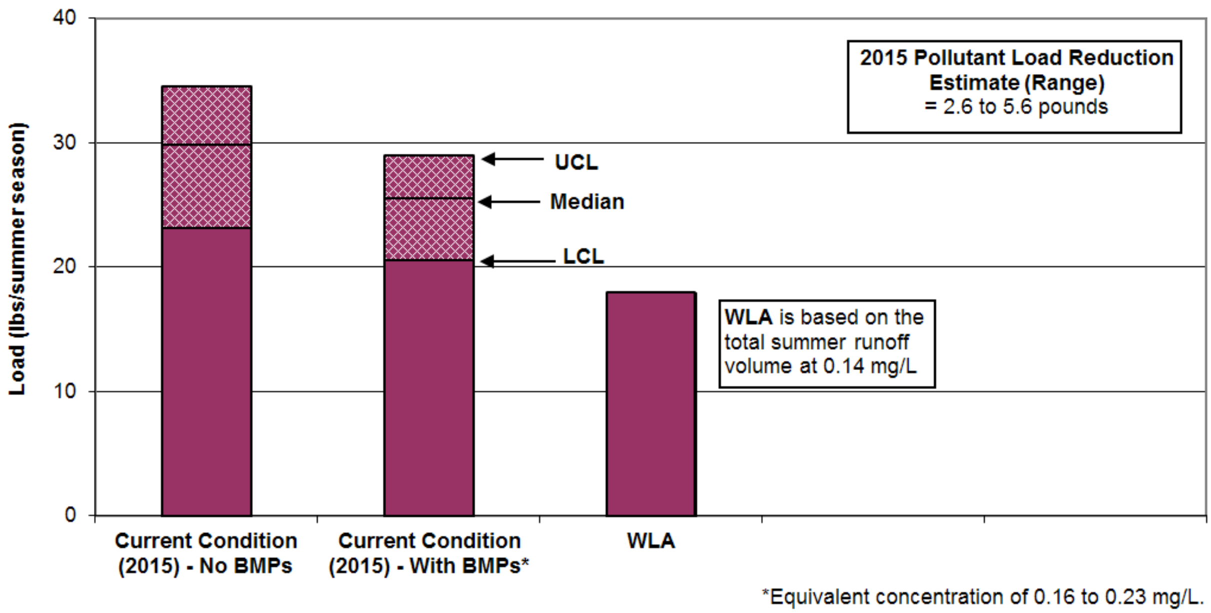

Figure 4-3. Total phosphorus PLRE results for the Lower Tualatin River TMDL subbasin (summer season)

Figure 4-4 shows that Lake Oswego is estimated to be meeting the WLA for TSS in the Lower Tualatin River TMDL subbasin. TSS is a surrogate for SVS and SOD, associated with reduced DO. The PLRE shows a pollutant load reduction range of 898 to 3,230 pounds. This pollutant load reduction range equates to a percent load reduction between 13.7 and 21.9 percent for comparison to the WLA of 20 percent. Lake Oswego's structural BMPs are effective at reducing TSS, and non-structural BMPs, as described in Section 4.5, likely add additional TSS removal beyond what is calculated for this evaluation.

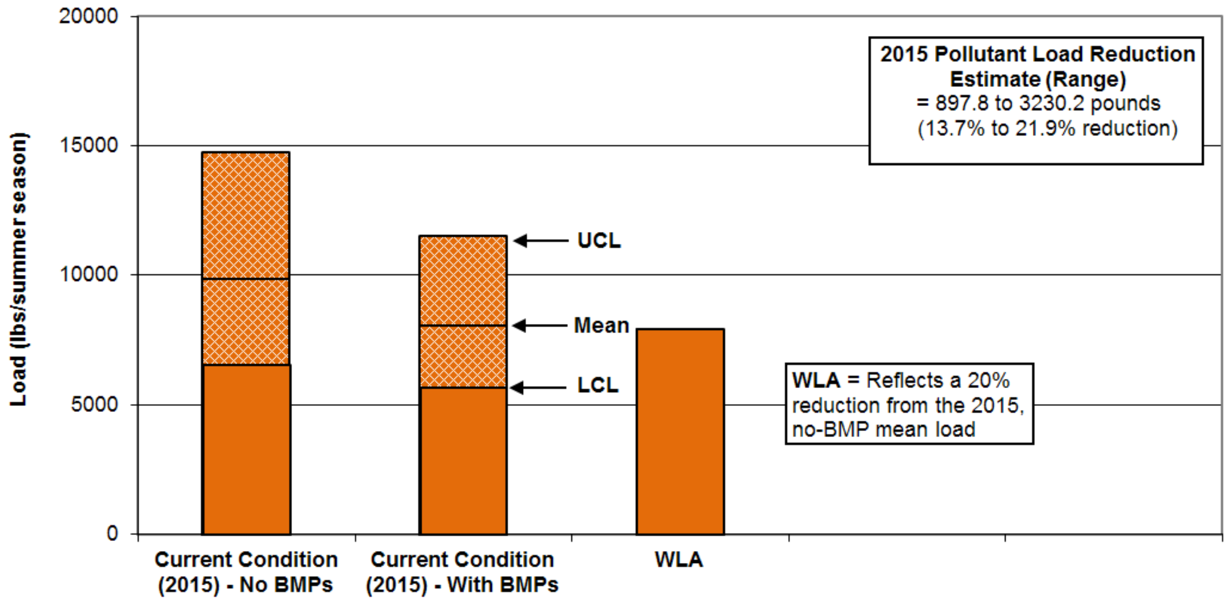

Figure 4-4. TSS PLRE results for the Lower Tualatin River TMDL subbasin (summer season)

4.1.2 Fanno Creek

The Fanno Creek TMDL subbasin area includes approximately 1,100 acres in the northeast portion of the city. The area drains east out of the city limits before entering Fanno Creek and eventually the Tualatin River. This area has had more recent development, so many neighborhoods have been constructed with stormwater management facilities in place to provide flow detention and/or water quality treatment. Current structural BMP coverage is 36 percent.

Figures 4-5 and 4-6 show that Lake Oswego is currently estimated to be meeting the WLAs for bacteria in the Fanno Creek TMDL subbasin. As in the Lower Tualatin River, for the purposes of presenting graphical results, the WLAs as concentrations have been converted to loads, based on the total runoff volume of each seasonal event. The current, with-BMP pollutant load estimate equates to a concentration range between 703 and 1,861 counts per 100 mL, which is lower than both seasonal event WLAs.

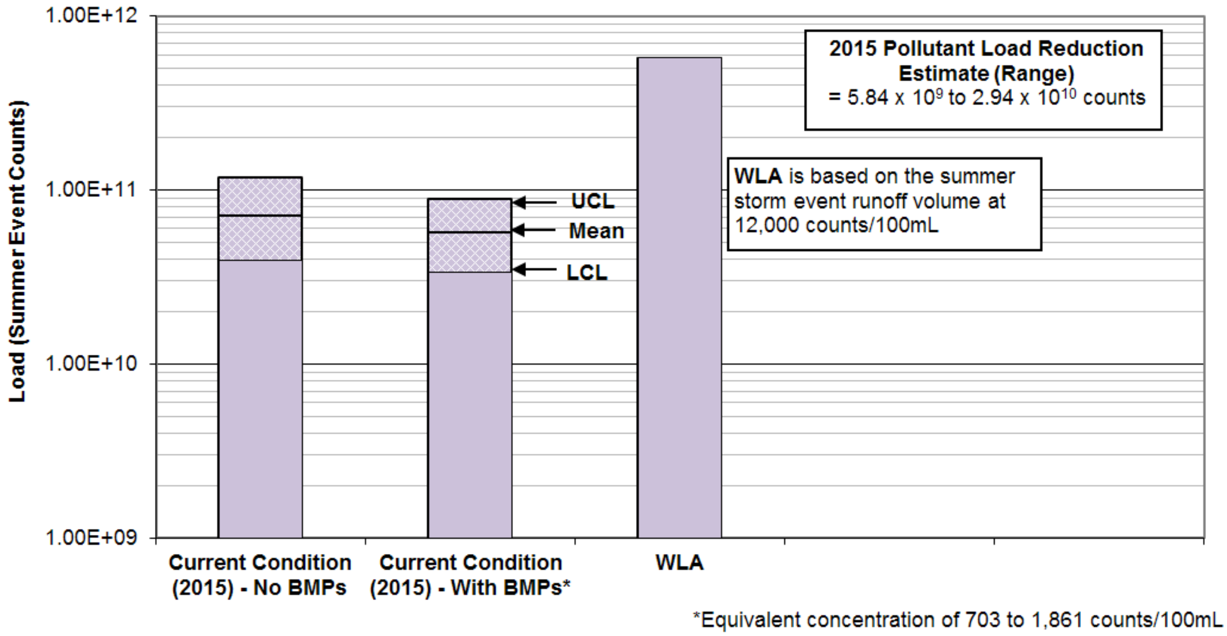

Figure 4-5. *E. coli* PLRE results for the Fanno Creek TMDL subbasin (summer event)

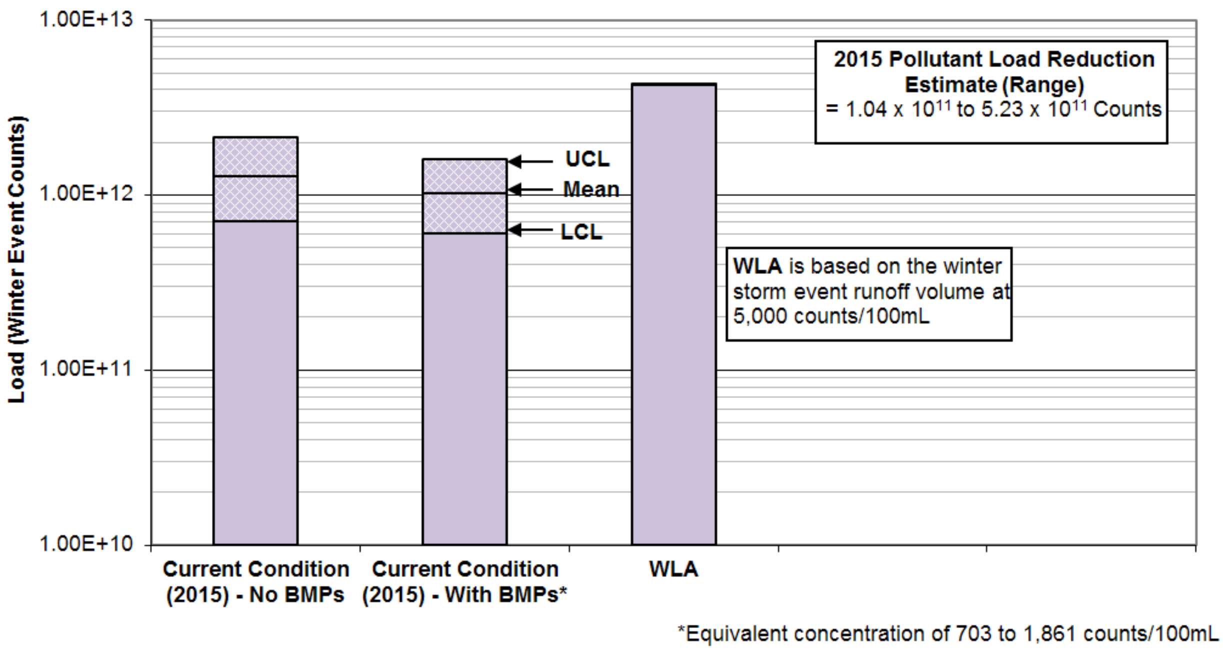

Figure 4-6. *E. coli* PLRE results for the Fanno Creek TMDL subbasin (winter event)

Figure 4-7 shows that the City is not currently estimated to be meeting the WLA for total phosphorus in the Fanno Creek TMDL subbasin. The total phosphorus WLA for Fanno Creek is written as a concentration of 0.13 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, based on the total summer seasonal runoff volume. The current pollutant load estimates with BMP coverage range from 93.6 to 122.3 pounds, which equates to a concentration range between 0.16 and 0.21 mg/L, which is above the WLA.

Additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA for total phosphorus. Section 4.5 describes some of the non-structural BMPs that are implemented in this subbasin, 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.

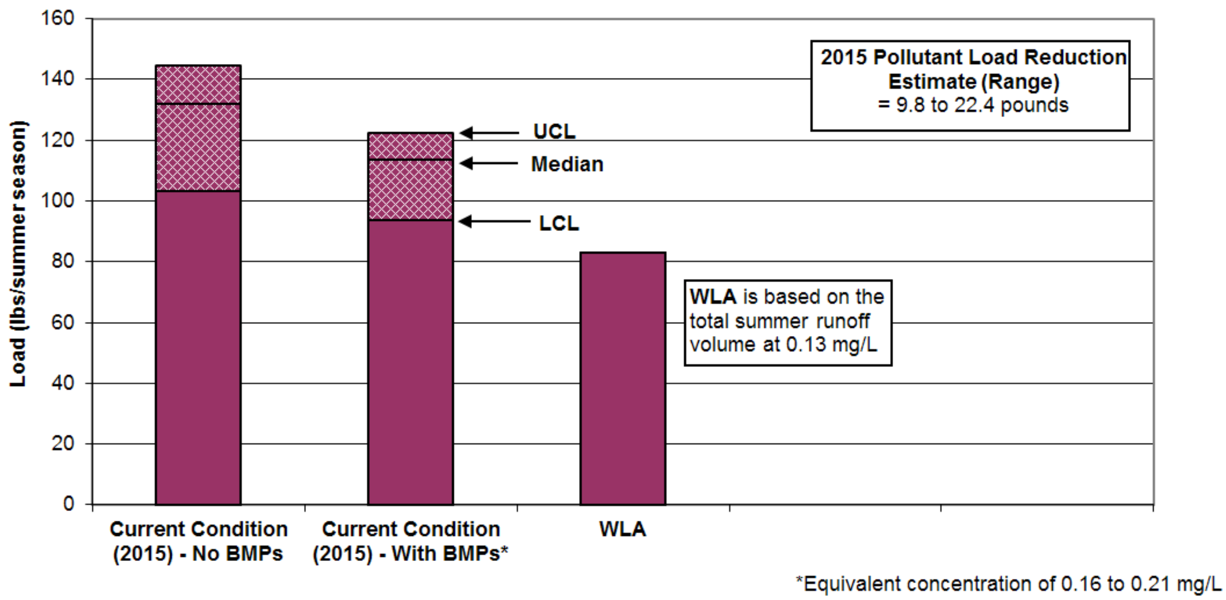

Figure 4-7. Total phosphorus PLRE results for the Fanno Creek TMDL watershed (summer season)

Figure 4-8 shows that Lake Oswego is not currently estimated to be meeting the WLA for TSS in the Fanno Creek TMDL subbasin. The PLRE shows a pollutant load reduction range of 4,526 to 12,922 pounds. This pollutant load reduction range equates to a percent load reduction between 15.9 and 22.3 percent, in comparison to the WLA of 50 percent.

Additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA for TSS. Section 4.5 describes some of the non-structural BMPs that are implemented in this subbasin, 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.

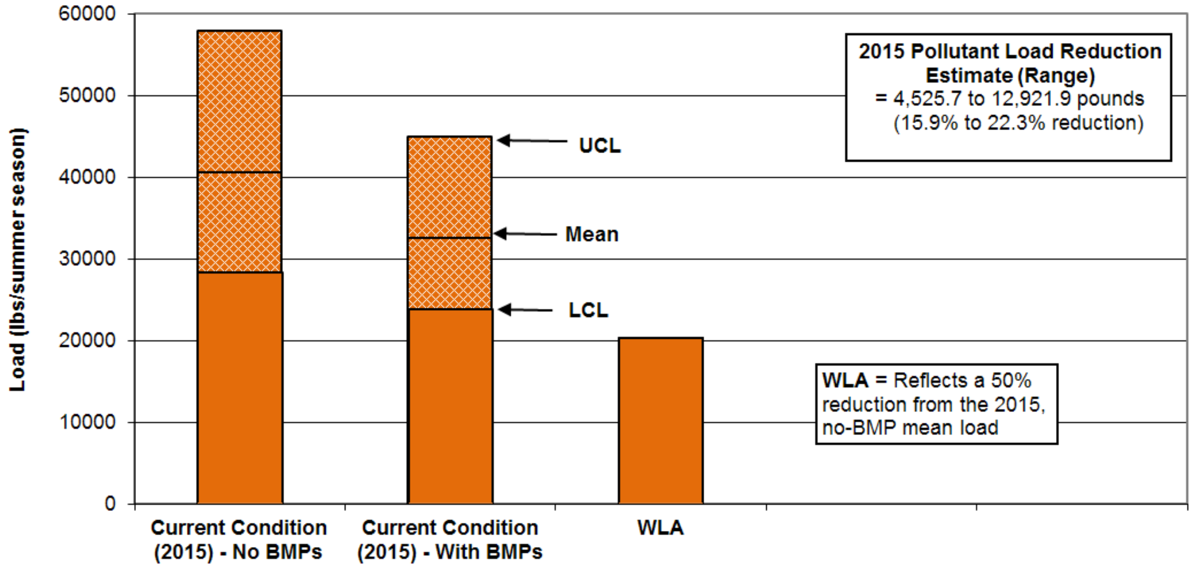

Figure 4-8. TSS PLRE results for the Fanno Creek TMDL subbasin (summer season)

4.2 Oswego Lake Subbasin

The Oswego Lake Subbasin TMDL includes WLAs for total phosphorus for the summer and winter seasons. The Oswego Lake Subbasin TMDL is included within the Tualatin Subbasin TMDL document, but for purposes of this PLRE is documented independently, as the Oswego Lake subbasin itself is also incorporated into the Willamette Basin TMDL and Lower Willamette TMDL subbasin area for bacteria.

The Oswego Lake TMDL subbasin area includes area that discharges directly to Oswego Lake and area that discharges to Springbrook Creek (as a tributary to Oswego Lake). It is approximately 3,700 acres and is the largest TMDL subbasin within the city. The area includes more than 2,300 acres of single-family residential development and a mix of all other land use types. The Oswego Lake TMDL subbasin includes some of the early developments in the city, so most neighborhoods were constructed prior to the establishment of stormwater management standards. Current structural BMP coverage is 18 percent.

Figures 4-9 and 4-10 show that Lake Oswego is not currently estimated to be meeting the WLAs for total phosphorus in the Oswego Lake TMDL subbasin. Total phosphorus is a surrogate parameter for pH and chlorophyll-a. The total phosphorus WLA is written as a concentration of 0.09 mg/L during the summer season (May 1 through October 31) and 0.15 mg/L during the winter season (considered to be between November 1 and April 30). For the purposes of presenting graphical results, the seasonal concentrations have been converted to seasonal loads, based on the equivalent seasonal runoff volumes. The current pollutant load estimate with BMP coverage ranges from 288 to 405 pounds during the summer season and from 1,400 to 1,970 pounds during the winter season. Both summer and winter seasonal loadings equate to a concentration range between 0.16 and 0.23 mg/L, which is higher than the WLAs.

Additional load reduction would be needed beyond the current structural BMP implementation to achieve the WLA for total phosphorus. Although non-structural BMPs are implemented in this subbasin (and not directly considered in the pollutant load reduction estimate), it is unlikely that the additional pollutant removal achieved would result in meeting the WLAs. The WLAs are considered to be the ultimate discharge goals.

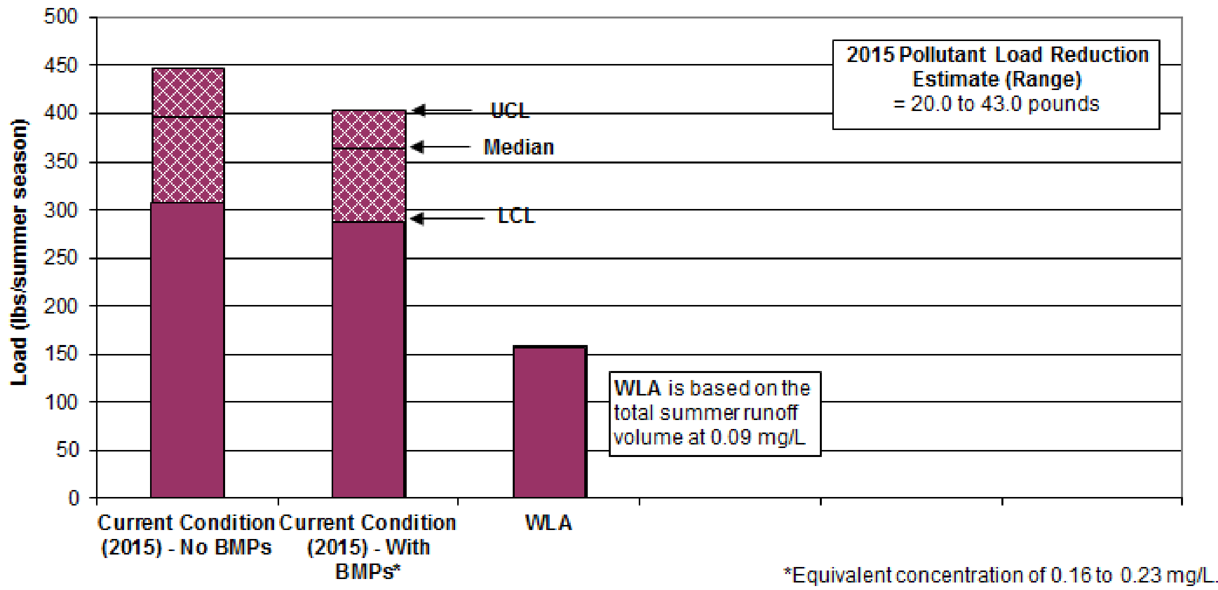

Figure 4-9. Total phosphorus PLRE results for the Oswego Lake TMDL subbasin (summer season)

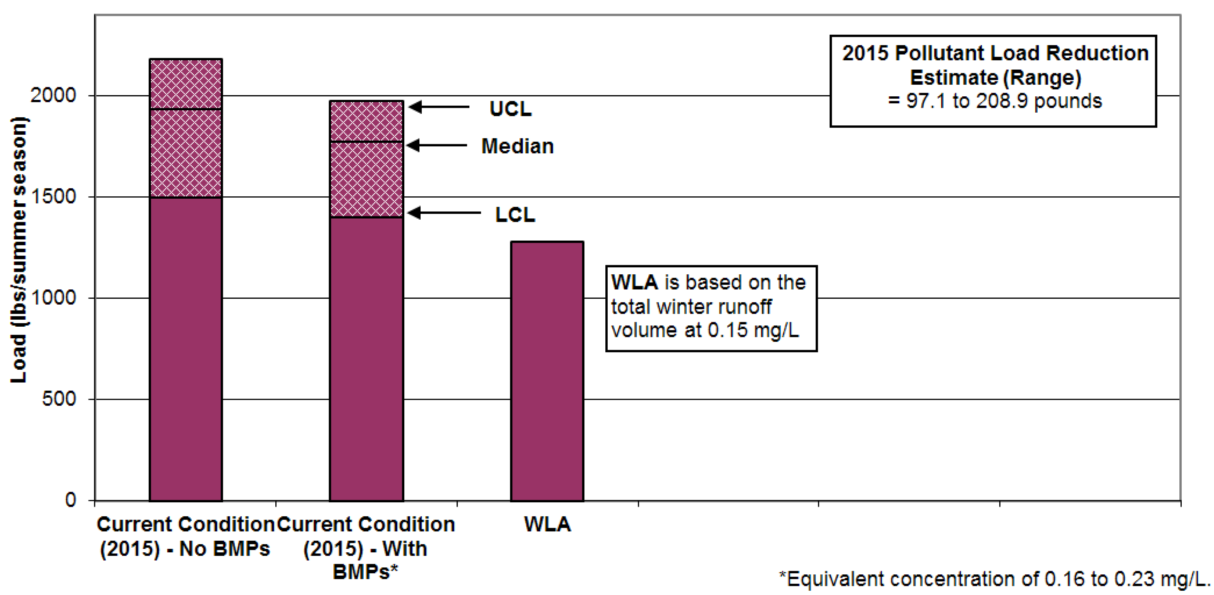

Figure 4-10. Total phosphorus PLRE results for the Oswego Lake TMDL subbasin (winter season)

4.3 Lower Willamette Subbasin

The Willamette Basin TMDL, specifically the Lower Willamette Subbasin TMDL, includes annual WLAs for bacteria. For this PLRE, separate evaluations were conducted for the Lower Willamette TMDL subbasin (which includes area that discharges directly to Oswego Lake), Springbrook Creek TMDL subbasin, and Tryon Creek TMDL subbasin.

When combined, these three TMDL subbasins cover the majority of the City's MS4 permit area, including over 3,600 acres of single-family residential development. This combined area includes Lake Oswego's downtown and other commercial areas, along with numerous residential neighborhoods constructed north of downtown, around Oswego Lake, and on the hills above the Willamette River. Because of topographic constraints and the age of development, the drainage infrastructure that was installed did not include stormwater management facilities to provide water quality treatment. Current structural BMP coverage is estimated to range from 12 percent in the Springbrook Creek TMDL subbasin to 19 percent in the Lower Willamette TMDL subbasin.

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

Results of the PLRE are described in the following sections for each TMDL subbasin.

4.3.1 Lower Willamette River

Figure 4-11 shows that the City is not currently estimated to be meeting the WLA for bacteria in the Lower Willamette TMDL subbasin. The PLRE shows a mean load decrease of approximately 7.12×10^{12} counts when comparing conditions with and without BMPs. This equates to a mean pollutant load reduction of 10 percent as compared to the WLA of 78 percent.

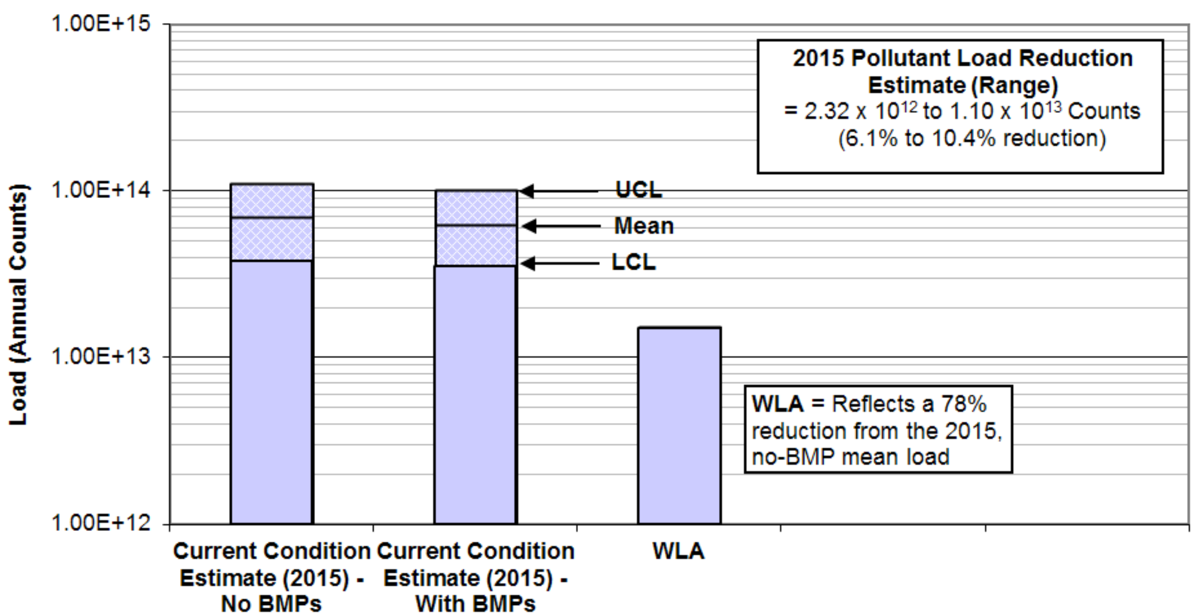

Figure 4-11. *E. coli* PLRE results for the Lower Willamette River TMDL subbasin

4.3.2 Tryon Creek

Figure 4-12 shows that Lake Oswego is not currently estimated to be meeting the WLA for bacteria in the Tryon Creek TMDL subbasin. The PLRE shows a mean load decrease of approximately 1.75×10^{12} counts when comparing conditions with and without BMPs. This equates to a mean pollutant load reduction of 9 percent as compared to the WLA of 78 percent.

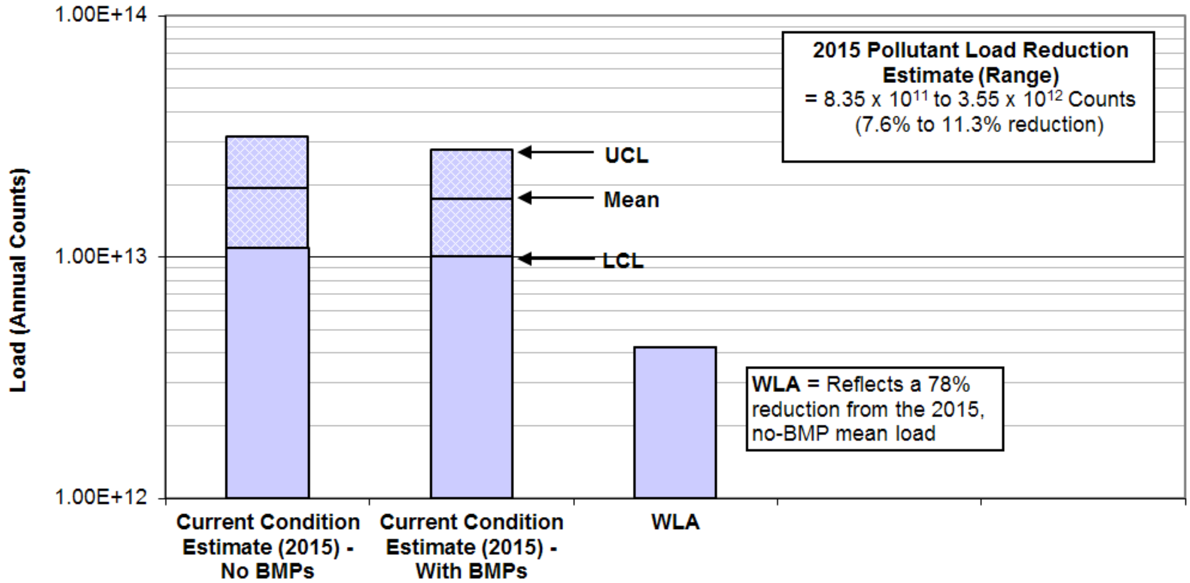

Figure 4-12. *E. coli* PLRE results for the Tryon Creek TMDL subbasin

4.3.3 Springbrook Creek

Figure 4-13 shows that Lake Oswego is not currently estimated to be meeting the WLA for bacteria in the Springbrook Creek TMDL subbasin. The PLRE shows a mean load decrease of approximately 1.36 x 10^{12} counts when comparing conditions with and without BMPs. This equates to a mean pollutant load reduction of 7 percent compared with the WLA of 80 percent.

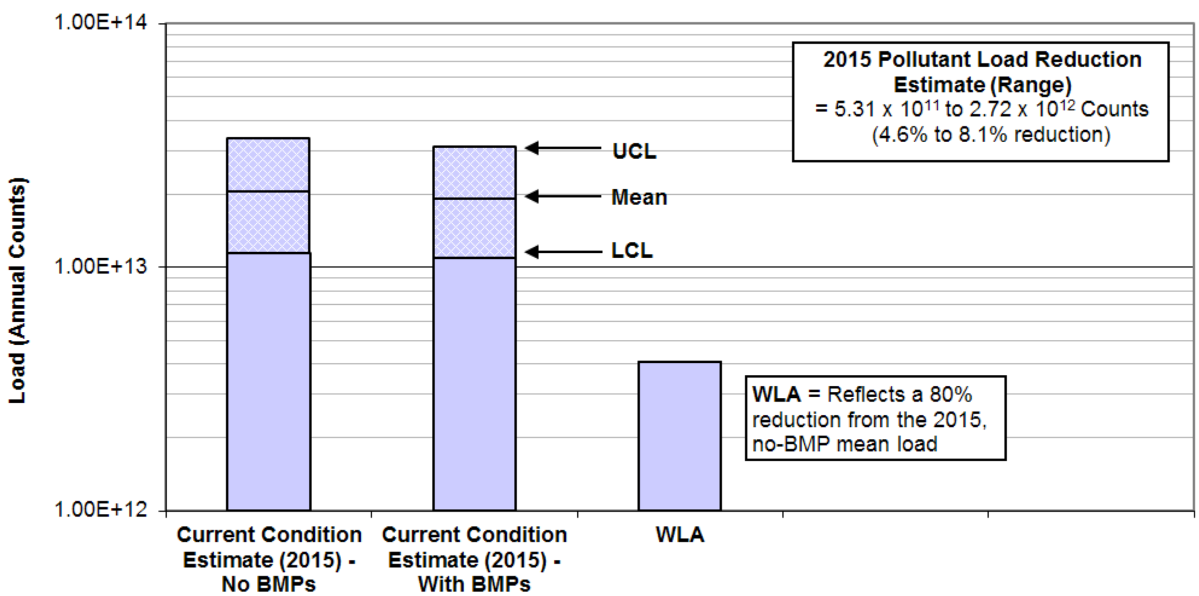

Figure 4-13. *E. coli* PLRE results for the Springbrook Creek TMDL subbasin

4.4 Benchmark Comparison

As part of the PLRE effort, pollutant load reduction estimates must be compared to previously established 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 development conditions and associated BMP implementation 5 years in the future, or approximately 2013. Economic conditions in 2008-2010 slowed development over then historic rates. While development has returned to levels similar to those in 2006-2007, far fewer large parcels are available for development now than were then. Most current development is occurring as small (2-4 lot) partitions or replacements of individual single family residences.

Table 4-1 shows the difference in modeled areas and BMP coverage areas between the 2008 benchmark development and the current modeling effort. Changes in model areas are largely a result of annexations, exclusion of the SWMACC service area from the City's model area in the present analysis, and an improved representation of drainage basin boundaries. Exclusion of the SWMACC service area reduced the model area in the Oswego Lake TMDL watershed, Tualatin River TMDL watershed, and Fanno Creek TMDL watershed.

Table 4-1. Benchmark Assumptions Comparison

TMDL watershed	Assumption	2008 benchmark effort		2015 PLRE effort
		2008 (actual)	2013 (projected)	
Lower Tualatin River[a]	Model area (ac)	1,718.2	1,718.2	299.1
	BMP coverage (%)	26.5	27.3	33.0
Fanno Creek[a]	Model area (ac)	-	-	1,113.7
	BMP coverage (%)	-	-	36.4
Oswego Lake	Model area (ac)	3,944.7	3,944.7	3,668.8
	BMP coverage (%)	11.3	13.0	17.8
Lower Willamette[b]	Model area (ac)	5,049.7	5,049.7	3,508.7
	BMP coverage (%)	11.6	13.7	18.6
Tryon Creek[b]	Model area (ac)	-	-	1,237.9
	BMP coverage (%)	-	-	14.9
Springbrook Creek	Model area (ac)	1,219.1	1,219.1	1,171.9
	BMP coverage (%)	7.0	13.7	12.4

a. *For the 2008 benchmark effort, the Lower Tualatin River and Fanno Creek TMDL watersheds were combined for reporting of land use and BMP coverage.*

b. *For the 2008 benchmark effort, the Lower Willamette and Tryon Creek TMDL watersheds were combined for reporting of land use and BMP coverage.*

This PLRE included significant changes to the mapping of BMP coverage areas compared with the 2008 assumptions. In the 2008 modeling effort, some 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 purposes of managing or treating stormwater and have not been reflected in this PLRE. Also, 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 PLRE, the City accounted for most new public and private facilities installations since 2008 and has taken a conservative approach of refining the drainage areas delineated in 2008 to better reflect updated mapping. Collectively, the City is showing an increase in overall BMP coverage from 2008 assumptions. However, in the Springbrook Creek TMDL watershed, development activities and refined mapping results in a BMP coverage that is less than projected in 2008 for 2013.

Numeric pollutant load reduction benchmarks were established in 2008 for four out of the six applicable TMDL subbasins, based on projected 2013 land use and BMP coverage. Benchmarks for the Tualatin River TMDL subbasin assumed the inclusion of the Fanno Creek TMDL subbasin area in the overall Tualatin TMDL watershed, and benchmarks for the Lower Willamette TMDL subbasin assumed the inclusion of the Tryon Creek TMDL subbasin area. This modeling assumption from 2008 is not appropriate given the establishment of specific WLAs for each TMDL subbasin, and it has been corrected for this PLRE. Therefore, a direct and numeric comparison to benchmarks cannot be provided for these TMDL subbasins.

Because the differences in TMDL subbasin designations have a direct impact on the City's ability to show achievement of numeric benchmarks, achievement of numeric benchmarks for the Lower Tualatin River, Fanno Creek, Tryon Creek, and Lower Willamette TMDL subbasins was assessed based on BMP coverage and an area-weighted pollutant load comparison. Per Table 4-1, BMP coverage in 2015 is an increase from the actual (2008) and projected (2013) BMP coverage estimates in each TMDL watershed. As such, increased pollutant load reduction and the achievement of benchmarks are likely because BMP coverage increased from the coverage assumed for 2013 (the basis for the benchmark calculations). When looking at the benchmarks on an area-weighted basis (for a more direct comparison to the 2015 pollutant load reduction estimates), the 2015 pollutant load reduction estimates are within the range of the area-weighted 2008 benchmarks. Thus, the benchmarks appear to be met.

Table 4-2 presents the results of the benchmark comparison. With the statistical variability of the underlying data, the current pollutant load reduction estimates and 2013 benchmarks are presented as ranges in loading. The following guidelines were developed for this benchmark comparison effort:

- Where the mean 2015 pollutant load reduction estimate falls within the benchmark range, the benchmarks are interpreted to likely be met
- Where changes in model assumptions did not allow for direct comparison of numeric benchmarks, the benchmarks are interpreted to possibly be met.

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 a numeric effluent limit.

Table 4-2. Lake Oswego Pollutant Load Reduction Benchmark Comparison							
TMDL watershed	Parameter (units)	2015 pollutant load reduction estimate[a]			2008 benchmarks based on projected 2013 conditions	Met WLA?	Met benchmarks?[b]
		LCL	Mean or median	UCL			
Lower Tualatin River	Bacteria (counts) summer event	1.4×10^9	3.1×10^9	6.2×10^9	3.3×10^9 to 1.8×10^{10}	Yes	Possibly met[c]
	Bacteria (counts) winter event	2.5×10^{10}	5.6×10^{10}	1.1×10^{11}	6.0×10^{10} to 3.2×10^{11}	Yes	Possibly met[c]
	Total phosphorus (lb) summer	2.6	4.3	5.6	9.4 to 16.5		Possibly met
	TSS (lb) summer	898	1,836	3,230	N/A[d]	Yes	N/A[d]
Fanno Creek	Bacteria (counts) summer event	5.8×10^9	1.4×10^{10}	2.9×10^{10}	N/A	Yes	Possibly met[c]
	Bacteria (counts) winter event	1.0×10^{11}	2.5×10^{11}	5.2×10^{11}	N/A	Yes	Possibly met[c]
	Total phosphorus (lb) summer	9.8	18.2	22.4	N/A		Possibly met
	TSS (lb) summer	4,526	8,064	12,922	N/A[d]		N/A[d]
Oswego Lake	Total phosphorus (lb) summer	20.0	32.5	43.0	10.6 to 21.3		Likely met
	Total phosphorus (lb) winter	97.1	158.1	208.9	51.9 to 103.7		Likely met
Lower Willamette	Bacteria (counts) annual	2.3×10^{12}	7.1×10^{12}	1.1×10^{13}	1.4×10^{12} to 7.0×10^{12}		Likely met
Tryon Creek	Bacteria (counts) annual	8.4×10^{11}	1.8×10^{12}	3.6×10^{12}	N/A		N/A
Springbrook Creek	Bacteria (counts) annual	5.3×10^{11}	1.4×10^{12}	2.7×10^{12}	2.0×10^{11} to 1.2×10^{12}		Likely met

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

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

c. *The WLAs for bacteria in the Lower Tualatin River TMDL watershed and Fanno Creek TMDL watershed are already 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.*

d. *The benchmarks established in 2008 for TSS in the Tualatin River TMDL watershed (including Fanno Creek) were incorrectly calculated based on a single summer event, rather than the full summer season runoff volume. However, the WLA for TSS in the Tualatin River TMDL watershed are already achieved.*

4.5 Pollutant Load Reduction Evaluation Summary

The pollutant load reduction benchmarks comparison presented in Table 4-2 shows that the City is making measurable progress toward achievement of WLAs. The results of this PLRE show that the WLAs are being met for bacteria in the Lower Tualatin River and Fanno Creek TMDL subbasins and for TSS in the Lower Tualatin River TMDL subbasin. Therefore, future pollutant load reduction benchmarks are not required for these parameters.

Pollutant load reduction benchmarks are estimated to be likely met for total phosphorus in the Oswego Lake TMDL subbasin and for bacteria in both the Lower Willamette and Springbrook Creek TMDL subbasins. Again, benchmarks were previously not calculated for the Tryon Creek TMDL subbasin independently.

The City's structural BMPs are estimated to be achieving the pollutant load reduction benchmarks for total phosphorus in the Lower Tualatin River and Fanno Creek TMDL subbasins. As described in Section 4.4, this conclusion is based on best professional engineering judgment and not a direct numeric load comparison because in 2008, the Lower Tualatin and Fanno Creek TMDL subbasin areas were combined to estimate pollutant load and pollutant load reductions and to establish benchmarks. For this PLRE, the Lower Tualatin River and Fanno Creek TMDL subbasins were evaluated separately.

Regardless of whether benchmarks were achieved, significant additional load reduction will be needed beyond the current structural BMP implementation to meet WLAs for bacteria in the Lower Willamette River, Tryon Creek, and Springbrook Creek TMDL subbasins. Additional reductions are also needed to achieve the WLAs for total phosphorus in the Lower Tualatin River and Fanno Creek TMDL subbasins and TSS in the Fanno Creek TMDL subbasin.

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 loads are expected to decrease due to the following:

- Continued implementation of stormwater design standards for 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
- Increased implementation of emerging technologies that results in reductions in cost (and therefore results in more frequent installations) of more effective treatment technologies

In addition, the pollutant load reduction estimates, as detailed for this 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, riparian vegetated buffer protection and enhancement, illicit discharge detection and elimination, street sweeping, catch basin cleaning, facility maintenance, operations and maintenance, pet waste programs, and public education. Addressing hydromodification issues raised in the City's recent *Hydromodification Assessment* (Lake Oswego 2015c) can also serve to address loads of phosphorus and suspended sediment, though may not appreciably affect bacteria loads. 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.

4.6 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 this 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 seven sites in Lake Oswego as identified in the *Comprehensive Sampling and Analysis Plan Municipal Separate Storm Sewer System Monitoring* (City 2014). The sites include locations on Ball Creek and Carter Creek in the Fanno Creek TMDL watershed, Boones Ferry Creek and Lost Dog Creek in the Oswego Lake TMDL subbasin, Nettle Creek in the Tryon Creek TMDL subbasin, and on Springbrook Creek itself. 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 separately for wet days and dry days 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 in-stream water quality trends evaluation for water bodies and parameters where observed trends are noted. Full documentation is included in Appendix A.

Results from the trends analysis indicate improving trends (decreasing concentrations) for several parameters in Carter Creek, Springbrook Creek, and Lost Dog Creek. Deteriorating trends (increasing concentrations) were observed for a number of parameters in Boones Ferry Creek. The trends occur during both wet and dry weather conditions.

Half of the data sets evaluated (31 out of 62 data sets) showed no statistically significant trend in the water quality sampling results. This trends analysis reflects a period when Lake Oswego grew in population by approximately 6 percent (United States Census Bureau 2016). Given that level of population growth and the potential impacts associated with the resulting development, seeing that water quality conditions have been maintained is a positive result, in keeping with Oregon's anti-degradation policy.

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.

Table 4-3. Summary of Water Quality Trends Analysis

TMDL watershed	Monitoring location	Improving trends (decreasing concentrations)		Deteriorating trends (increasing concentrations)	
		Dry days	Wet days	Dry days	Wet days
Fanno Creek	Ball Creek (Temple)	-	-	-	-
	Carter Creek (Bangy)	TSS Total phosphorus	TSS	-	-
Lower Willamette and Oswego Lake	Springbrook Creek (Springbrook)	*E. coli* Total copper	TSS *E. coli* Total copper	TSS Total zinc	Total phosphorus
	Lost Dog Creek (Lost Dog)	*E. coli* Total phosphorus	-	-	-
	Boones Ferry Creek (Bryant)	*E. coli*	*E. coli*	-	Dissolved zinc
	Boones Ferry Creek (Rosewood)	-	-	TSS Total phosphorus Total zinc	TSS *E. coli* Total phosphorus Total zinc Dissolved zinc
Tryon Creek	Nettle Creek (Tryon)	-	-	Total zinc	-

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

Section 5

Benchmarks

Based on results of the PLRE (Section 4), the City of Lake Oswego is required to establish new pollutant load reduction benchmarks for the following subbasins and parameters:

- Lower Tualatin – total phosphorus
- Fanno Creek – total phosphorus, TSS
- Oswego Lake, which includes the Oswego Lake Direct and Springbrook Creek subbasins – total phosphorus
- Lower Willamette, which includes the Oswego Lake Direct subbasin – bacteria
- Tryon Creek – bacteria
- Springbrook Creek – bacteria

As mentioned in Section 4, benchmarks for the following subbasins are not required due to the fact that the PLRE shows that these WLAs are being achieved.

- Lower Tualatin – bacteria and TSS
- Fanno Creek – bacteria

The proposed benchmarks presented in this section are based on projected structural BMP implementation by the end of the next NPDES MS4 permit term (anticipated to be 2022).

5.1 Benchmark Development

In accordance with Schedule D.3.d.i of the City's NPDES MS4 permit, each benchmark must reflect the pollutant load reduction necessary to achieve the previously established benchmarks for the current permit term (2008 benchmark) and additional progress toward the TMDL WLA for the upcoming permit term. As the City's current NPDES MS4 permit expires March 1, 2017, the next 5-year permit term is scheduled to cover the period from 2017 to 2022.

City staff identified anticipated stormwater facility installations associated with upcoming public works and transportation related projects in the 2015 Retrofit Strategy. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities since the PLRE analysis (Section 4) was completed. In total, 63 new structural stormwater BMPs are anticipated, representing the City's projection for stormwater facility installations through 2022. These facility drainage areas are 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 provides a summary of projected BMPs through 2022. Table 5-2 summarizes the City's current status in meeting the 2008 benchmarks and the WLAs (as repeated from Table 4-2) and lists the anticipated additional stormwater facility installations by TMDL subbasin, 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 schedules and uncertain nature of future public and private construction and development activities.

Table 5-1 Projected Stormwater Facilities and Drainage Areas for 2022 Benchmarks

Subbasin	Projected BMP types[a]	Approximate projected new drainage area (acres)
Fanno Creek	Lined planter - filtration raingardens	7.8
	Swales	2.6
Lower Willamette	Lined planter - filtration raingardens	3.3
Oswego Lake direct	Detention pond (dry)	1.3
	Infiltration raingarden	5.0
	Lined planter - filtration raingardens	9.9
	Retention pond (wet)	1.6
	Sedimentation manholes	0.9
	Swale	0.5
	UIC	0.5
Springbrook Creek	Lined planter - filtration raingardens	25.7
	Sedimentation manhole	0.6
	UIC	0.6
Tryon	Detention pond (dry)	0.7
	Infiltration raingardens	10.0
	Lined Planter - filtration raingardens	3.5
	Total	**74.5**

a. *The projected BMPs and drainage areas in this table are subject to change. They are current best estimates for the purposes of developing benchmarks.*

Table 5-2. TMDL Benchmark Parameters and Projected Stormwater Facility Installations through 2022

TMDL subbasin	Model time frame	Parameter	Current (2015) BMP drainage area (ac)	TMDL benchmark development		
				Projected BMP installations	Estimated additional BMP drainage area (ac)	Estimated future (2022) BMP drainage area (ac)
Lower Tualatin	Summer	Total phosphorus	98.6	NA[b]	NA[b]	98.6
Fanno Creek	Summer	Total phosphorus TSS	405.3	• Biolfiltration swale • Filtration/lined planters[a]	10.4	415.7
Oswego Lake	Summer	Total phosphorus	509.2	• Dry detention • Wet retention • Swale • Sedimentation manhole • Infiltration raingarden • Lined planter[a] • UIC	19.7	528.9
Lower Willamette	Annual	Bacteria	144.9	• Lined planter[a]	3.3	148.1

Table 5-2. TMDL Benchmark Parameters and Projected Stormwater Facility Installations through 2022						
TMDL subbasin	Model time frame	Parameter	Current (2015) BMP drainage area (ac)	TMDL benchmark development		
				Projected BMP installations	Estimated additional BMP drainage area (ac)	Estimated future (2022) BMP drainage area (ac)
Tryon Creek	Annual	Bacteria	184.3	• Dry detention • Infiltration raingarden • Lined planter[a]	14.3	198.6
Springbrook Creek	Annual	Bacteria	145.5	• Lined planter[a] • UIC	26.9	172.4

a. *In the City, projects constructed as planters are typically not lined at the bottom. Given the predominately tight soils in Lake Oswego, the planters were modeled as lined. This is a conservative assumption. It is likely that additional load reduction is achieved by these planters through any infiltration that may be occurring.*

b. *For this upcoming permit term, no new BMPs are proposed for the Lower Tualatin subbasin.*

5.2 TMDL Benchmark Results

The spreadsheet loads model developed 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 (2022) with-BMP scenario. Due to the variability in stormwater quality data, pollutant loads themselves are typically calculated and presented as a range. Pollutant loads estimates reflecting the current no-BMP, current with-BMP, and future (2022) with-BMP scenarios are provided in Appendix B.

Table 5-3 shows the WLAs and the proposed TMDL benchmarks for 2022.

Table 5-3. TMDL Benchmarks for 2017–22					
TMDL subbasin	Model time frame	Pollutant	WLA	TMDL benchmarks (load reduction)[a], range	TMDL benchmarks (in units matching the WLA)[d], range
Lower Tualatin	Summer	Total phosphorus	0.14 mg/L	NA	NA
Fanno Creek	Summer	Total phosphorus	0.13 mg/L	10.1 – 23.0 lbs	0.16 mg/L to 0.21 mg/L
	Summer	TSS	50% reduction	4,612 – 13,245 lbs	16.2% - 22.9% reduction
Oswego Lake[b]	Summer	Total phosphorus	0.09 mg/L	22.6 – 47.7 lbs	0.16 mg/L – 0.23 mg/L
	Fall/Winter/Spring		0.15 mg/L	110 .0 – 232.0 lbs	0.16 mg/L – 0.23 mg/L
Lower Willamette[c]	Annual	Bacteria	78% reduction	2.48×10^{12} - 1.16×10^{13} counts	7% - 11% reduction
Tryon Creek	Annual	Bacteria	78% reduction	9.83×10^{11} – 3.99×10^{12} counts	9% - 13% reduction
Springbrook Creek	Annual	Bacteria	80% reduction	7.59×10^{11} - 3.4×10^{12} counts	7% - 10% reduction

a. *The TMDL benchmarks are a load reduction, calculated as the difference between the current no-BMP scenario load and the future with-BMP scenario load.*

b. *The Oswego Lake subbasin includes both the Oswego Lake Direct and Springbrook Creek subbasins for the purposes of developing the total phosphorus benchmark.*

c. *The Lower Willamette subbasin includes the Oswego Lake Direct subbasin for the purposes of developing the bacteria benchmark.*

d. *The benchmarks have also been calculated as a percent reduction or as a concentration for direct comparison with the WLA.*

5.3 Discussion and Application of SWMP Implementation

The City's benchmarks reflect the inclusion of: 1) private BMPs that have been constructed since the PLRE was completed in 2015; and 2) projected installation of multiple new public structural BMPs through 2022. Together, these BMPs cover approximately 74.5 acres of newly treated impervious area. Not included in the model are stormwater facilities anticipated to be added during private development as the City further develops or – more commonly – redevelops. Private stormwater facilities are expected to provide treatment for approximately the same amount of new or redeveloped impervious area as public facilities, but are not planned with sufficient certainty to be included in the benchmark analysis.

While the projected BMP coverage area and resulting load reductions are significant, the resulting pollutant load reductions fall short of achieving the WLAs. Large areas of the City have already developed without structural BMPs or developed with structural stormwater BMPs that are not 100 percent effective in removing pollutants. The City prepared a WLA attainment assessment for DEQ in February 2016, which indicated that achieving the WLAs would require construction of facilities and associated maintenance costs that far exceed the City's definition of maximum extent practicable. Progress toward the WLA, and not achievement of the WLA, is the City's goal in setting benchmarks. Such progress is reflected in Table 5-3 and Appendix B.

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

- Non-structural BMPs, as described in Section 4.4
- Infiltration that is likely occurring in planter facilities given that they were modeled as lined planters as a conservative assumption to account for generally low infiltration rates or limitations across the City.
- Additional structural BMPs installed in conjunction with future redevelopment projects that have not yet submitted land use applications to the City.

Each of these efforts is expected to further reduce pollutant loads in runoff from the City's subbasins to below the levels indicated in these benchmark projections.

Brown AND Caldwell

Section 6

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Section 7

Limitations

This document was prepared solely for Lake Oswego in accordance with professional standards at the time the services were performed and in accordance with contracts between the City and Brown and Caldwell dated July 31, 2015 and November 15, 2016. This document is governed by the specific scopes 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 Lake Oswego, Oregon

Project Title: TMDL Evaluation for Stormwater Permit

Project No.: 148173.002.004

Technical Memorandum

Subject: Instream Water Quality Trends Analyses

Date: October 21, 2015

To: Anne MacDonald
Stormwater Quality Program Coordinator

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 Lake Oswego (City) 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 July 29, 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.

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 Lake Oswego (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 1997 from seven 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 of the City sites had some data sets with 30 or more observations. However, the data sets for TSS, copper, and zinc for some sites did not have 30 or more 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.

Table 1. Summary of Monitoring Sites and Data Review Statistics

Ball Creek (Temple)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	1997–2015	1997–2015	1997–2015	2012–15	2012–15	2001–15	2001–15
Number of observations	182	197	197	39	39	159	39
Wet-day detects	45	66	63	12	10	44	10
Wet-day non-detects	22	0	4	3	5	7	5
Wet-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	✓
Dry-day detects	64	131	124	9	4	90	7
Dry-day non-detects	51	0	6	15	20	18	17
Dry-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	-
Carter Creek (Bangy)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	1997–2015	1997–2015	1997–2015	2012–15	2012–15	2001–15	2001–15
Number of observations	193	196	199	36	36	156	36
Wet-day detects	52	68	63	11	9	45	10
Wet-day non-detects	17	0	8	7	9	7	8
Wet-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	✓
Dry-day detects	77	124	118	2	2	85	2
Dry-day non-detects	47	4	10	16	16	19	16
Dry-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	-

Table 1. Summary of Monitoring Sites and Data Review Statistics							
Springbrook Creek (Springbrook)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	1997–2015	1997–2015	1997–2015	2005–15	2012–15	2001–15	2012–15
Number of observations	276	292	298	130	70	255	69
Wet-day detects	73	98	98	35	14	75	13
Wet-day non-detects	30	0	7	9	13	12	14
Wet-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	✓	-	✓	-
Dry-day detects	90	194	190	48	2	116	2
Dry-day non-detects	83	0	3	38	41	52	40
Dry-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	✓	-	✓	-
Lost Dog Creek (Lost Dog)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2012–15	1997–2015	1997–2015	2012–15	2012–15	2001–15	2012–15
Number of observations	38	205	204	36	36	165	36
Wet-day detects	5	73	62	12	11	54	14
Wet-day non-detects	13	0	12	4	5	4	2
Wet-day data set at least 5 years, 10+ records and 50% or more detects	-	✓	✓	-	-	✓	-
Dry-day detects	4	132	120	7	8	100	15
Dry-day non-detects	16	0	10	13	12	7	5
Dry-day data set at least 5 years, 10+ records and 50% or more detects	-	✓	✓	-	-	✓	-
Boones Ferry Creek (Bryant)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	1997–2015	1997–2015	1997–2015	2012–15	2012–15	2001–15	2001–15
Number of observations	165	176	179	36	36	142	36
Wet-day detects	47	68	68	10	7	52	14
Wet-day non-detects	19	0	3	5	8	2	1
Wet-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	✓
Dry-day detects	68	106	107	2	2	82	15
Dry-day non-detects	31	2	1	19	19	6	6
Dry-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	✓
Boones Ferry Creek (Rosewood)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2000–15	1997–2015	1997–2015	2012–15	2012–15	2001–15	2001–15
Number of observations	161	173	176	37	36	155	32
Wet-day detects	34	56	57	9	7	46	11
Wet-day non-detects	24	1	2	5	7	6	3

Table 1. Summary of Monitoring Sites and Data Review Statistics							
Wet-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	✓
Dry-day detects	51	116	113	7	4	88	6
Dry-day non-detects	52	0	4	16	18	15	12
Dry-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	-
Nettle Creek (Tryon)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	1997–2015	1997–2015	1997–2015	2012–15	2012–15	2001–15	2012–15
Number of observations	191	197	198	36	36	150	36
Wet-day detects	71	75	73	9	6	51	4
Wet-day non-detects	6	0	4	6	9	8	11
Wet-day data set at least 5 years, 10+ records and 50% or more detects	✓	✓	✓	-	-	✓	-
Dry-day detects	86	122	112	2	1	69	2
Dry-day non-detects	28	0	9	19	20	22	10
Dry-day data set at least 5 years, 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 trend analysis 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 5 years of data, at least 50 percent detected values and at least 10 observations. When data were available and met these criteria for analysis, all non-detect data points as well as non-numerical non-detects (i.e., ND), zeros, or estimates were included and replaced with the respective minimum detection limit.

Of the 61 trends analyses completed, 56 were on data sets with 30 or more observations, and 5 were on data sets with 10 to 29 observations. Of the 61 trends analyses completed, 31 were conducted for wet-day data and 30 were conducted for dry-day data.

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 or less than 5 years of data
NA	Not enough uncensored values for analysis (<10)
	No trend was detected

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 3. Summary of Trends

TMDL watershed	Fanno Creek										L Willamette (Oswego Lake)				
Water body	Ball Creek					Carter Creek					Springbrook Creek				
Site/Station ID	Temple					Bangy					Springbrook				
2015 instream monitoring site	Ball Creek downstream of Kruse Oaks Blvd.					Carter Creek at Bangy Rd.					Springbrook Creek at Railroad Culvert				
		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	1997-2015	115		67		1997-2015	124	↓	69	↓	1997-2015	173	↑	103	↓
E. coli	1997-2015	131		66		1997-2015	128		68	⇩	1997-2015	194	↓	98	↓
TP	1997-2015	130		67		1997-2015	128	↓	71		1997-2015	193	⇧	105	↑
Total copper	2012-2015	24	NA	15		2012-2015	18	NA	18		2005-2015	86	↓	44	↓
Copper (diss.)	2012-2015	24	NA	15		2012-2015	18	NA	18	NA	2012-2015	43	NA	27	
Total zinc	2001-2015	108	⇧	51		2001-2015	104		52		2001-2015	168	↑	87	
Zinc (diss.)	2012-2015	24	NA	15		2012-2015	18	NA	18	↓	2012-2015	42	NA	27	

TMDL watershed	L Willamette (Oswego Lake)														
Water body	Lost Dog Creek					Boones Ferry Creek									
Site/Station ID	Lost Dog					Bryant					Rosewood				
2015 instream monitoring site	Lost Dog Creek at the end of Lake Front Rd.					Boones Ferry Creek at Lakeview Blvd.					Boones Ferry Creek behind 5189 Rosewood				
		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	2012-2015	20	NA	18	NA	1997-2015	99		66		2000-2015	103	↑	58	↑
E. coli	1997-2015	132	↓	73	⇩	1997-2015	108	↓	68	↓	1997-2015	116		57	↑
TP	1997-2015	130	↓	74		1997-2015	108	⇩	71		1997-2015	117	↑	59	↑
Total copper	2012-2015	20	NA	16		2012-2015	21	NA	15		2012-2015	23	NA	14	NA
Copper (diss.)	2012-2015	20	NA	16		2012-2015	21	NA	15	NA	2012-2015	22	NA	14	NA
Total zinc	2001-2015	107	⇧	58		2001-2015	88		54		2001-2015	103	↑	52	↑
Zinc (diss.)	2012-2015	20	NA	16	NA	2001-2015	21		15	↑	2001-2015	18	NA	14	↑

TMDL watershed	L Willamette (Tryon C)				
Water body	Nettle Creek				
Site/Station ID	Tryon				
2015 instream monitoring site	Nettle Creek at Iron Mountain Trail Rd.				
		No rain		Rain	
WQ parameter	Date range	N	Trend	N	Trend
TSS	1997-2015	114		77	
E. coli	1997-2015	122		75	
TP	1997-2015	121		77	
Total copper	2012-2015	21	NA	15	NA
Copper (diss.)	2012-2015	21	NA	15	NA
Total zinc	2001-2015	91	↑	59	
Zinc (diss.)	2001-2015	21	NA	15	NA

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 (7 declining trends) than during dry weather (9 declining trends).
- Given a significance level of 10 percent, the same number of improving water quality trends (i.e., decreasing pollutant concentrations) occurred during wet weather (8 improving trends) as during dry weather (8 improving trends).
- The majority of all of the trends analyses (33 out of 63, or 52 percent) showed a significant trend given a significance level of 10 percent. Half of the 16 declining water quality trends occurred for total and dissolved zinc (8 declining trends).
- Four declining water quality trends occurred for phosphorus, three for TSS, and one for bacteria.
- Seven of the 16 improving water quality trends (i.e., 44 percent) occurred for bacteria.
- Three improving water quality trends occurred for TSS, three for phosphorus, two for copper, and one for zinc.
- Carter Creek and Springbrook Creek had the most data sets with improving water quality trends, with five improving trends each.
- Boones Ferry Creek at the Rosewood site had the most data sets with declining water quality trends, with eight declining trends.
- Thirty-one of the 63 trends analysis (47%) showed no significant trend.

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 Lake Oswego grew in population by approximately 7% (since 1997). 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 is not necessarily practically significant with respect to how it impacts receiving waters.

Other factors can also be more practically significant with respect to water quality issues and watershed health. Examples include the magnitude and range of reported pollutant concentration values when compared to various water quality criteria and results of benthic macroinvertebrate surveys. The results of the trends analysis are one piece of an overall evaluation of water quality.

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Appendix B: Summary of Loads

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Appendix B. City of Lake Oswego 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%	1.11×10^{14}	6.88×10^{13}	3.80×10^{13}	9.96×10^{13}	6.17×10^{13}	3.56×10^{13}	9.90×10^{13}	6.13×10^{13}	3.55×10^{13}	1.10×10^{13}	7.12×10^{12}	2.32×10^{12}	1.16×10^{13}	7.45×10^{12}	2.48×10^{12}	10%	11%	7%
Tryon	Annual	78%	3.15×10^{13}	1.92×10^{13}	1.09×10^{13}	2.79×10^{13}	1.74×10^{13}	1.01×10^{13}	2.75×10^{13}	1.72×10^{13}	9.94×10^{12}	3.55×10^{12}	1.75×10^{12}	8.35×10^{11}	3.99×10^{12}	2.01×10^{12}	9.83×10^{11}	13%	10%	9%
Springbrook	Annual	80%	3.37×10^{13}	2.03×10^{13}	1.14×10^{13}	3.10×10^{13}	1.90×10^{13}	1.09×10^{13}	3.03×10^{13}	1.85×10^{13}	1.07×10^{13}	2.72×10^{12}	1.36×10^{12}	5.31×10^{11}	3.40×10^{12}	1.77×10^{12}	7.59×10^{11}	10%	9%	7%
Lower Tualatin	Summer event	12,000 counts/100 mL	2.30×10^{10}	1.39×10^{10}	7.89×10^{9}	1.68×10^{10}	1.08×10^{10}	6.48×10^{9}	Future conditions analysis was not required. The WLA is estimated as being met under current conditions			6.16×10^{9}	3.14×10^{9}	1.41×10^{9}	N/A			N/A		
	Winter event	5,000 counts/100 mL	4.09×10^{11}	2.48×10^{11}	1.41×10^{11}	2.99×10^{11}	1.92×10^{11}	1.15×10^{11}	Future conditions analysis was not required. The WLA is estimated as being met under current conditions			1.10×10^{11}	5.58×10^{10}	2.51×10^{10}	N/A			N/A		
Fanno Creek	Summer event	12,000 counts/100 mL	1.19×10^{11}	7.11×10^{10}	3.97×10^{10}	8.96×10^{10}	5.72×10^{10}	3.38×10^{10}	Future conditions analysis was not required. The WLA is estimated as being met under current conditions			2.94×10^{10}	1.40×10^{10}	5.84×10^{9}	N/A			N/A		
	Winter event	5,000 counts/100 mL	2.12×10^{12}	1.27×10^{12}	7.07×10^{11}	1.60×10^{12}	1.02×10^{12}	6.03×10^{11}	Future conditions analysis was not required. The WLA is estimated as being met under current conditions			5.23×10^{11}	2.48×10^{11}	1.04×10^{11}	N/A			N/A		
Total Phosphorus (pounds)																				
Lower Tualatin	Summer seasonal	0.14 mg/L	35	30	23	29	26	21	No new BMPs are proposed for this watershed during this permit term.			5.6	4.3	2.6	N/A			N/A		
Fanno Creek	Summer seasonal	0.13 mg/L	145	132	103	122	113	94	122	113	93	22.4	18.2	9.8	23.0	18.7	10.1	0.21 mg/L	0.19 mg/L	0.16 mg/L
Oswego Lake	Summer seasonal	0.09 mg/L	448	397	308	405	365	288	400	361	285	43	32	20	48	36	23	61	57	45
Oswego Lake	Fall/winter/spring seasonal	0.15 mg/L	2,179	1,932	1,497	1,970	1,774	1,400	1,947	1,755	1,387	209	158	97	232	177	110	35	28	9
TSS (pounds)																				
Lower Tualatin	Summer seasonal	20%	14,749	9,874	6,547	11,519	8,039	5,649	Future conditions analysis was not required. The WLA is estimated as being met under current conditions			3,230	1,836	898	N/A			N/A		
Fanno Creek	Summer seasonal	50%	57,934	40,610	28,381	45,012	32,547	23,855	44,689	32,366	23,769	12,922	8,064	4,526	13,245	8,245	4,612	23%	20%	16%

a. The current (2015) no-BMP and with-BMP load estimates are presented in graphical form in Figures 4-1 to 4-13.

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 D:
Monitoring Plan

Comprehensive Sampling and Analysis Plan for the NPDES MS4 Permit

City of Lake Oswego, Oregon
NPDES Permit No.103348
File No. 108016

Prepared by

Ver. 2.0
February 2017

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Table of Contents

Index of Tables

Index of Figures

Acronyms and Abbreviations

DQO	data quality objective
EMC	event mean concentration
MEP	Maximum Extent Practicable
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oregon Department of Environmental Quality
PM	project manager
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	Relative percent difference
USEPA	U.S. Environmental Protection Agency

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1. Introduction

On March 16, 2012, the Oregon Department of Environmental Quality (ODEQ) issued the City of Lake Oswego and 12 other jurisdictions in the Clackamas County area their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. Schedule B(2) of the permit outlines the requirements of the monitoring plan and requires that the City of Lake Oswego "…*develop and implement and approved monitoring plan by October 1, 2012."* Schedule B(2) also stipulates that the monitoring plan "*…must be submitted to the Department for review no later than September 1, 2012…*" and incorporate the monitoring plan elements outlined in Schedule B(2)(a-f).

This Comprehensive Sampling and Analysis Plan presents the policies, organizations, objectives and practical activities/procedures for instream monitoring, stormwater monitoring-wet weather, instream biological monitoring, and special project monitoring of the municipal separate storm sewer system (MS4) for the City of Lake Oswego, Oregon.

1.1. Permit Requirements

As required by Schedule B(1)(a)(i-vi)) of the permit, the monitoring plan must incorporate the following six objectives:

> **B(1)(a)(i):** *Evaluate the sources of the 2004/2006 303(d) listed pollutants applicable to the copermittee's permit area;*
>
> **B(1)(a)(ii):** *Evaluate the effectiveness of Best Management Practices (BMPs) in order to help determine BMP implementation priorities;*
>
> **B(1)(a)(iii):** *Characterize stormwater based on land use type, seasonality, geography, or other catchment characteristics;*
>
> **B(1)(a)(iv):** *Evaluate status and long-term trends in receiving waters associated with MS4 stormwater discharges*
>
> **B(1)(a)(v):** *Assess the chemical, biological and physical effects of MS4 stormwater discharges on receiving waters; and,*
>
> **B(1)(a)(vi):** *Assess progress toward meeting TMDL Pollutant Load reduction benchmarks.*

The City submitted a MS4 Monitoring Matrix in April of 2010 to the Oregon Department of Environmental Quality to outline how the monitoring objectives in Schedule B(1)(a)(i-vi) would be addressed through the various monitoring elements (i.e. in stream monitoring, Stormwater Monitoring-Wet Weather, Stormwater Monitoring-Mercury, Instream Biological Monitoring, and Pesticide Monitoring). The revised monitoring matrix, based on Table B-1 from the issued permit, is included in Table 1 below.

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Table 1. Monitoring Objectives Matrix

Stormwater-Related Monitoring Activity/Program	Stormwater-Related Monitoring Activity/ Program Description	DEQ MS4 Monitoring Objectives					
		Evaluate the sources of the 303(d) listed pollutants as applicable.	Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities.	Characterize MS4 runoff discharges based on land use, seasonality, geography or other catchment characteristics.	Evaluate long-term trends in receiving waters associated with MS4 stormwater discharges.	Assess the chemical, biological, and physical effects of MS4 discharges on receiving waters.	Assess progress towards meeting TMDL pollutant load reduction benchmarks.
Environmental Monitoring Activities							
Instream Water Quality (discrete)	• Six locations. Twelve monitoring events annually (~ 50% during the wet weather season October - April). • Single grab samples. Field and lab parameters monitored.	N/A	N/A	N/A	Trends assessed by comparing instream sampling results over time.	Chemical effects of MS4 discharges may be assessed by comparing dry season and wet season results.	N/A
In-Stream Biological	• Ten locations. One sample and field assessment per site approximately every three years (2017, 2020, 2023, etc.).	N/A	N/A	N/A	Trends assessed by comparing results of invertebrate monitoring over time.	Biological effects assessed by comparing results of invertebrate monitoring over time with respect to monitoring location (by MS4 outfall location).	N/A
Wet Weather Stormwater Quality	• Two locations - representative land use. Three monitoring events annually (during storms). • Time-composite sampling (with grabs for E. coli). Field and lab parameters monitored and flow monitored.	Bacteria and organics (via TSS as a surrogate) are monitored.	Reese Rd. sampling will be used to characterize the effectiveness of the Boones Ferry Rd. stormwater improvements to be constructed 2018-2019.	Will be used to characterize the runoff quality for the respective contributing land use categories and catchment areas.	N/A	Chemical effects assessed by comparing wet-weather results with instream concentrations.	Comparisons between monitoring data for various land use categories and land use EMC data used in the benchmark pollutant loads model will be made to evaluate whether updates to the EMCs are needed.
Program Monitoring Activities							
MS4 Program Monitoring	• Measurable goals and tracking measures for BMPs.	N/A	Program monitoring may help evaluate effectiveness of source controls/ non-structural BMPs.	N/A	N/A	N/A	N/A
Dry-weather Field Screening	• Inspect designated outfalls annually during the dry weather season.	Based on results of inspection and monitoring (if applicable), may identify potential illicit discharges that could be sources of 303(d) parameters.	N/A	N/A	N/A	N/A	N/A
Pollutant Load/ Water Quality Modeling	• Loads modeling per MS4 permit to evaluate overall pollutant load generation and watershed-scale BMP effectiveness.	N/A	Results indicate overall effectiveness of structural BMPs, estimate effectiveness of non-structural BMPs, and highlight locations of high pollutant load generation (for future retrofits).	Pollutant load modeling provides estimated MS4 runoff discharge characteristics (per land use based on land use EMC data used in modeling).	N/A	N/A	Pollutant load modeling allows for development of new benchmarks and assessment of progress towards meeting existing benchmarks.
Literature Review	• Review of Stormwater Quality and BMP effectiveness literature (structural/source control/non structural) is referenced in order to inform management decisions and design standards updates.	N/A	Provides additional BMP effectiveness information to allow BMP implementation prioritization.	N/A	N/A	N/A	Can apply BMP effectiveness data obtained from literature into pollutant load model for benchmarks where applicable.

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1.2. Changes to the City's Monitoring Plan with This Submission

Since this plan was first developed, the City has been executing monitoring as required in the current MS4 permit. The City proposes four major changes to the monitoring program with this plan version:

a. The City's permit-required monitoring of mercury and pesticides has been completed and these elements were removed from the plan.
b. The City is proposing to discontinue instream monitoring at the Rosewood water quality monitoring station. This station was part of an upstream/downstream pair (with the downstream Bryant station) around a regional water quality facility (detention pond) constructed in the 1980s to treat runoff from improvements to Boones Ferry Rd. The water quality trends analysis through the 2014-2015 permit year (Lake Oswego, 2016a) submitted to ODEQ as required by the City's MS4 permit demonstrates that the facility is serving its purpose and improving water quality in Boones Ferry Creek prior to discharge to Oswego Lake.
c. The City proposes to increase wet weather monitoring to at least 3 storms/year, using time-composite methods previously approved by ODEQ. In particular, monitoring at the Reese Rd. site will enable the City to gauge the impact of stormwater facilities to be installed with the Boones Ferry Rd. rebuild, currently in design with partnership from the Oregon Department of Transportation. Increased sampling at the South Shore site will inform the City's response to hydromodification impacts to Lost Dog Creek.
d. The Oregon copper aquatic life criteria have changed to one that is based on the Biotic Ligand Model. So as to have a basis for understanding instream water quality relative to the new criteria, analytes needed by the biotic ligand model (total and dissolved organic carbon, cations, and anions) are being formally added to the instream monitoring program during 4 of the 12 monitoring episodes per year through permit/fiscal year 2018-2019. Additional details are provided in Section 2 below.

1.3. Monitoring Program Project Management for All Elements

The City has outlined how sampling for each monitoring element will be addressed in the following sections. During monitoring plan development, staff also reviewed the conditions outlined in Schedule F, Section C Monitoring and Records.

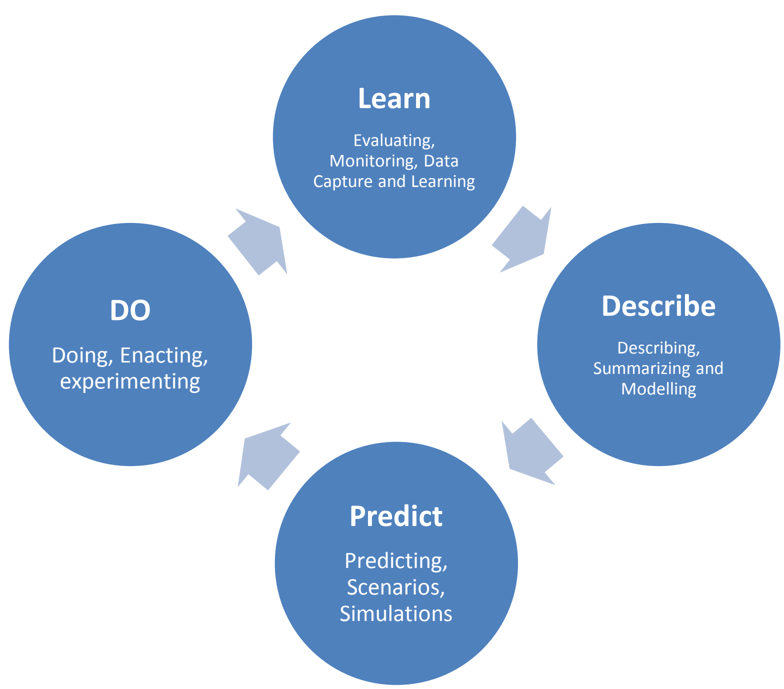
The Stormwater Quality Coordinator is the Project manager for monitoring related to the NPDES-MS4 permit and is responsible for maintaining the approved and official Comprehensive Sampling and Analysis Plan. The City of Lake Oswego's Comprehensive Sampling and Analysis Plan addresses the monitoring plan elements found in Schedule B(2), but also utilizes elements of EPA Requirements for Quality Assurance Plans, EPA QA/R-5 (United States Environmental Protection Agency, 2009) to outline project management, data generation and acquisition, assessment and oversight, and data validation and usability.

1.4. Role of Monitoring Program in Adaptive Management of the City's Stormwater Program

As required by Schedule B in the City of Lake Oswego's NPDES-MS4 permit, the City must "…continue to implement a monitoring program to support adaptive *stormwater management and the evaluation of stormwater management program effectiveness in reducing the discharge of pollutants from the MS4.*" The City's adaptive management strategy uses this Comprehensive Sampling and Analysis Plan to assist the City in identifying actions and data to inform future decisions and direction of the Stormwater program. The adaptive management of the NPDES-MS4 program will utilize the Comprehensive Sampling and Analysis Plan as the platform to collect data of a known quality to support programmatic and environmental decisions in the City's stormwater program, including limiting the amount of pollutants entering waterbodies within the jurisdiction of the City of Lake Oswego to the Maximum Extent Practicable (MEP). The monitoring elements described in this Comprehensive Sampling and Analysis Plan will also be used to evaluate the City's progress at reducing the discharge of pollutants, to the MEP. The general adaptive management process is outlined in Figure 1, and a summary of the connection of the Monitoring Plan to the adaptive management process is provided in Appendix A.

Figure 1. Adaptive Management Cycle -adapted from Adaptive Environmental Management

Source: (Allan & Stankey, 2009)



1.5. Relationship Between Environmental Monitoring and Long-Term Monitoring Strategy

Environmental monitoring is important to the City of Lake Oswego's long term stormwater strategy because it has been designed to assist the City in determining the impacts from stormwater as well as give insight to the mitigation strategies that may be effective in reducing stormwater pollution.

The City of Lake Oswego has developed this Comprehensive Sampling and Analysis Plan while considering its long term monitoring strategy. Some environmental programs continue to provide a wealth of information back to the stormwater program. For example, instream monitoring and biological monitoring has been an integral part of the City's program since 1997 and 2004, respectively. These monitoring programs allow for the long term assessment of receiving water. Stormwater Monitoring-Wet Weather sampling is a newer activity in Lake Oswego. The Stormwater Monitoring-Wet Weather stations have been located at sites where retrofitting and redevelopment are likely to be planned and potentially be constructed during the current permit term. The baseline data collected from these areas will assist the City in assessing the stormwater facilities and BMPs that are part of these retrofit projects.

1.5.1. Summary of 303(d) Listed Waterbodies Within the City of Lake Oswego

The Comprehensive Sampling and Analysis Plan was also developed with 303(d) listed and approved TMDLs in mind. The 2012 Integrated Report (EPA took action approving the submitted 303(d) listings and de-listings on December 22, 2016) was used to generate a list and was used to review waterbodies within the City of Lake Oswego's jurisdiction. The waterbodies within the City of Lake Oswego that have approved TMDLs or parameters on the 303(d) list are summarized in Appendix B. Where time and resources allow, the City will integrate the parameters listed in Appendix B into its monitoring program elements.

2. Instream Monitoring

2.1. Project Task Organization

Instream Monitoring is the monitoring of MS4 receiving creeks, rivers and streams. Instream sampling will be scheduled approximately once/month and samples will be collected utilizing a grab sample methodology. The City of Lake Oswego references both the Oregon Department of Environmental Quality's MOM's Manual (Oregon Department of Environmental Quality, 2009) for surface water quality sampling methods as well as the Washington Department of Ecology's Standard Operating Procedure for manually Obtaining Surface Water Samples (Washington Department of Ecology, 2010) for grab sample collection.

All instream samples requiring analysis will be sent to a contract laboratory that is recognized and accredited by either the National Environmental Laboratory Accreditation Program (NELAP), the Oregon Environmental Laboratory Accreditation Program (ORELAP), or Washington Department of Ecology for surface water and solids.

Instream Monitoring will be conducted by the City's Stormwater Quality Coordinator or designee. Principal data users include the City of Lake Oswego, Oregon Department of Environmental Quality, and various external stakeholders (e.g., Oswego Lake Corporation). The City of Lake Oswego's Stormwater Quality Coordinator will act as both the project manager and Project Quality Assurance Officer.

The City's instream monitoring activities are the responsibility of the Stormwater Quality Coordinator or designee. All designees will be trained using the adopted or referenced standard operating procedures by the Stormwater Quality Coordinator prior to conducting instream sampling.

Instream monitoring activities are scheduled at approximately the beginning of the fiscal year to account for available personnel, resources, budget, and requirements of the selected analytical laboratory(s). Instream monitoring is expected to occur during normal working hours for the staff performing the monitoring. Sample dates may be adjusted by the Stormwater Quality Coordinator due to unforeseen scheduling conflicts.

When scheduling the instream monitoring events, the staff involved in sampling shall schedule events while complying with the following permit language.

- Schedule B(3)(a)(i): "A minimum of 50 percent of the water quality sample events must be collected during the wet season (October 1 to April 30)."
- Schedule B(3)(a)(ii): "Each unique sample event must occur at a minimum of 14 days apart."

2.2. Monitoring Objectives

The monitoring objective for the instream monitoring element is to collect sufficient data sets from each of the monitoring stations to maintain long term trends for the principal data users and continue to move toward adequately characterizing parameters at each monitoring station (see section 2.2.3-Data Analysis Methodology).

Instream monitoring will directly and indirectly contribute to meeting the objectives found in Schedule B (1)(a)(i-vi), but is targeted at meeting the objectives of B(1)(a)(iv):

- Evaluate the long-term trends in receiving waters associated with MS4 discharges.

2.2.1. Monitoring Question

The principal monitoring question that will be addressed by instream monitoring is:

- What are the long-term trends in receiving water quality?

2.2.2. Monitoring Background

The City of Lake Oswego has been monitoring water quality at seven (7) monitoring stations for nineteen (19) years (see City of Lake Oswego, 2016a). The phase I of the City's initial NPDES-MS4 permit application identified monitoring locations for the purpose of "developing baseline data to be used for the evaluation of long term trends in surface water quality" and "complete the computations for seasonal loads as required by 40 CFR 122.26(d)(2(iii)(C) and to evaluate the results" (Clackamas County and Co-Applicants, 1993). These tasks were to be implemented during the first 5 year permit cycle. The proposed monitoring elements outlined in the initial (Clackamas County and Co-Applicants, 1993) piece of the monitoring also outlined phase II of the monitoring program which was to be planned and developed during the first permit cycle. The phase II tasks included "monitor[ing] select locations for developing a database to support water quality models and to identify the full range of chemical, physical, and biological water quality impacts" and "monitor a select group of structural controls to evaluate performance" (Clackamas County and Co-Applicants, 1993).

This instream monitoring element continues to exist as an integral part of the City's monitoring program today and has enabled the City to describe the watershed as well as analyze long term trends in receiving water through the use of various models and trends analyses. The monitoring stations were originally developed to meet the requirements of the MS4 permit, and continue to be used to establish baseline concentrations and loads of pollutants and observe long term trends within the City's jurisdiction.

2.2.3. Data Analysis Methodology

The City will continue to use standard data summary methods (i.e. mean, median, mode, Inter Quartile Range (IQR), skewness, variance, standard deviation) to describe the characteristics of the data for analytes at each station. The summary statistics will continue to be used in turn to describe the reliability of the data collected and the long term trends in receiving water.

The first step in the data analysis of the instream data is to locally describe instream and receiving water parameters being monitored as part of the NPDES MS4 permit. Since the City has almost 15 years of instream data in many cases, local characterization data exists for many parameters. Some parameters, those typically with low detection limits and high variance, require a larger number of samples to adequately characterize the parameter. The City uses the following formula (Burton & Pitt, 2002) to establish the estimated number samples needed to be collected to adequately characterize a parameter.

Equation 1. Number of Samples to Characterize Conditions

$$n = \left[\frac{COV(Z_{1-\alpha} + Z_{1-\beta})}{error}\right]^2$$

where,

n = number of samples needed;

COV = coefficient of variation;

$Z_{1-\alpha}$ = Z score corresponding to 1-α;

$Z_{1-\beta}$ = Z score corresponding to 1-β;

error = allowable error as a fraction of the true value of the mean.

Once a parameter has been collected with an adequate number of samples to be characterized, the City evaluates the mean values of the selected parameters for changes over time. To determine the number of samples required to estimate the mean, the City utilizes the following formula (Burton & Pitt, 2002).

Equation 2. Number of Samples Required for Estimating a Mean

$$n = \frac{(Z_{\alpha/2})\sigma^2}{d^2}$$

where,

n = number of samples;

Z = z statistic;

σ^2 = variance;

$\alpha/2$ = probability of a 95% confidence level;

d = distance between the center of the lower confidence bound and the center of the upper confidence bound.

Equation 2 will be used to approximate the sample number required to estimate the mean. Both of these sample number estimates (Equation 1 and Equation 2) and mean estimations assume a normal distribution of data (most water quality data is log normally distributed). Further analysis of the instream data may require the use of a bootstrapped mean or estimating a median value.

Trends analysis of instream parameters will be calculated once per permit term. Care will be given to this analysis to avoid perceived trends when no trend exits and to review analysis to ensure that the analysis itself is not masking the trend. The City will evaluate trends in instream parameters utilizing a Mann Kendall Test or a Seasonal Kendall Test, depending on the application.

The Mann-Kendall Test (Equation 3) evaluates the values being analyzed for a trend to increase or decrease with time (assesses a monotonic change) (Helsel & Hirsch, 2002).

Equation 3. Mann Kendall Test

$$H_0: Prob\left[Y_j > Y_i\right] = 0.5, where\ time\ T_j > T_i$$
$$H_1: Prob\left[Y_j > Y_i\right] \neq 0.5\ (i.e., a\ 2 - sided\ test)$$

The Seasonal Kendall test (see Equation 4) accounts for seasonality by computing the Mann Kendall Test on each of the "m" seasons separately, and then combining the results (Helsel & Hirsch, 2002). The Seasonal Kendal l test is represented by the following equation (Helsel & Hirsch, 2002):

Equation 4. Seasonal Kendall Test

$$S_K = \sum_{i=1}^{m} S_i$$

where,

$$\begin{cases} \dfrac{S_K - 1}{\sigma_{S_k}} & if\ S_K > 0; \\ 0 & if\ S_K = 0; \\ \dfrac{S_K + 1}{\sigma_{S_K}} & if\ S_K < 0; \end{cases}$$

$$\mu_{S_K} = 0;$$

$$\sigma_{S_K} = \sqrt{\sum_{i=1}^{m} (n_i/18) \times (n_i - 1) \times (2n_i + 5)}\ ;$$

and,

n_i = *number of data in the i-th season.*

2.2.4. Data Quality Criteria

Data Quality Objectives (DQOs) are the quantitative and qualitative statements describing the quality of data needed to support a specific decision or action. The five parameters commonly used to judge data quality:

- Precision
- Accuracy
- Representativeness
- Comparability
- Completeness

The City will continue to use these data quality objectives to describe the instream monitoring data collected as outlined in Table B-1 of MS4 permit.

2.2.4.1. Precision

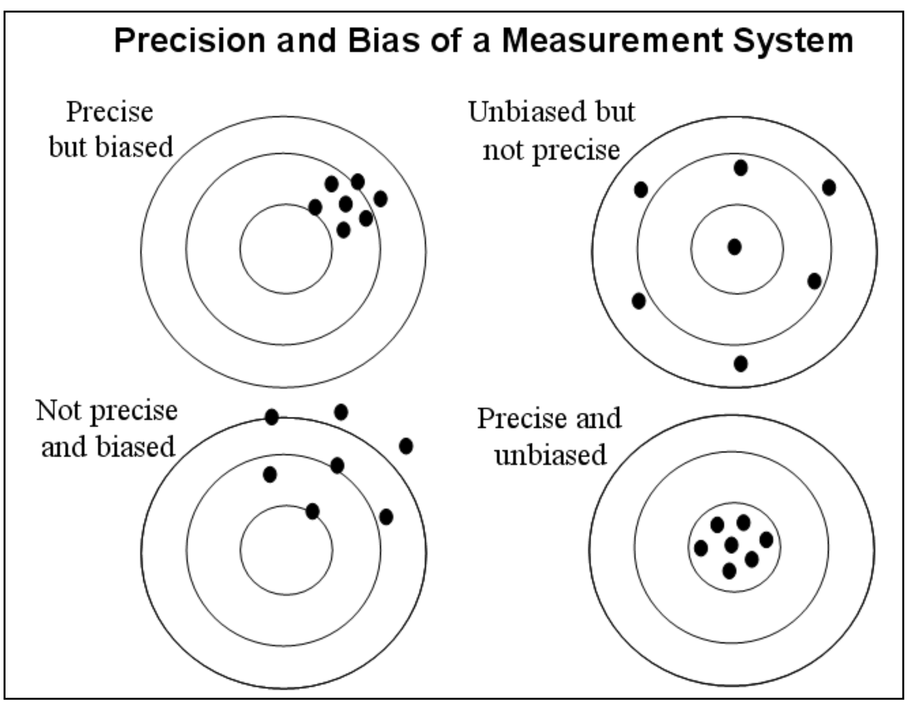
Precision is a measure of the reproducibility of the result and depends on how well we can compensate for random errors, such as instrumental error or sample variation (Oregon Department of Environmental Quality, 2009). See Figure 2 below.

Precision will be measured by collecting duplicate samples as outlined in 2.7.1. Duplicate samples are collected as independent samples using the same sampling procedures. A duplicate field sample can consist of two samples collected at the same. The variability in the results obtained from duplicate samples is a sum of the sampling and analytical variability and variability inherent in the sample (Oregon Department of Environmental Quality, 2009).

The City of Lake Oswego will evaluate precision of instream sampling by comparing duplicate samples with “primary” samples collected. If laboratory measurements of the duplicate sample do not agree with those of the “primary” sample, the City will request the contract laboratory to reanalyze the duplicate (and/or primary) sample to confirm or deny the disagreement in results. Duplicate field measurements will be collected in the field. Any disagreement or re-measurements will be recorded on the field data sheet; (see Appendix C) do not cross out the original results (Oregon Department of Environmental Quality, 2009).

Figure 2. Precision and Bias of a Measurement System

(http://aaq.auburn.edu/Metrology-Module)



2.2.4.2. Accuracy

Accuracy is a measure of how close the measured value is to the true value and depends on how well we can control systematic errors, such as faulty equipment calibration or observer bias (Oregon Department of Environmental Quality, 2009). Increasingly, however, some scientists, especially those involved with statistical analysis of measurement data, have begun to use the term "bias" to reflect this error in the measurement system and to use "accuracy" as indicating both the degree of precision and bias. For the purpose of this document, the term "accuracy" will be used to encompass “bias” (Oregon Department of Environmental Quality, 2009). See Figure 2.

Accuracy will be assessed by analyzing “blank” samples. This verifies that the measured or analyzed value is true and not influenced by the sampling method or equipment. One equipment blank sample will be submitted for each reporting year. Blank water shall be obtained by the City of Lake Oswego via the contract laboratory. Blank water will be drawn from the sinks equipped with deionizing system taps in the laboratory. Blank water will be processed and transported exactly as are regular samples. All field water quality measurements, except dissolved oxygen, will be performed on blank samples (Oregon Department of Environmental Quality, 2009). The City of Lake Oswego will evaluate the accuracy of the instream field measurements as well as laboratory results via a comparison of the blank water results to “true” values.

2.2.4.3. Representativeness

Collecting a sample representative of the true environmental conditions requires proper sampling, handling, preservation, and transport (Oregon Department of Environmental Quality, 2009). For instream sampling, discrete grab samples will be collected to best represent instream conditions. Standard Operating Procedures for Manually Obtaining Surface Water Samples (Washington Department of Ecology, 2010) as well as the Oregon DEQ grab sample methodology (Oregon Department of Environmental Quality, 2009) will be followed where applicable.

2.2.4.4. Comparability

Data comparability is essential to interpret results from samples collected at different times and locations. Carefully following documented procedures is one of the most important steps in maintaining data comparability (Oregon Department of Environmental Quality, 2009). Grab samples collected by the City of Lake Oswego during instream events will follow the handling requirements found in the Washington Department of Ecology’s Standard Operating Procedures for Manually Obtaining Surface Water Samples (Washington Department of Ecology, 2010).

2.2.4.5. Completeness

Completeness of a study is based on a comparison of the amount of valid data expected and the amount actually generated from the study (Oregon Department of Environmental Quality, 2009). Completeness of sampling each fiscal year and over the permit term will be evaluated using Equation 5.

Equation 5. Data Quality-Percent Completeness

$$\% \text{ Completeness} = \frac{(\text{number of valid measurements obtained}) \text{ x } 100}{(\text{number of measurements expected})}$$

Special conditions may prevent the instream samples from being collected as acknowledged in B(2)(e)(i) of the permit. These circumstances include personnel illness or turnover, equipment malfunction, safety issues, vandalism and situations that are out of the control of the City of Lake Oswego (i.e. extreme weather conditions, earthquake, acts of god, etc.). If a situation out of the City's control prevents the collection of discrete instream samples, the Stormwater Quality Coordinator will record the information in a dedicated field notebook used for instream monitoring and reschedule the monitoring event if practicable.

The data quality objectives for field measurements are outlined in Table 2.

Table 2. Instream Field Parameter Quality Objectives

Field Analyte	Accuracy	Precision
Temperature	± 0.5°C	± 0.5°C
Specific Conductivity	± 7% of standard value	± 10%
pH	± 0.2 SU	± 0.3 SU
Dissolved Oxygen	± 0.2 mg/L	± 0.3 mg/L
Turbidity	± 5%	± 5%

Data quality objectives of laboratory data will be outlined in the laboratory's quality manual. This manual can be provided upon request.

2.2.5. Assumptions and Rationale

It is assumed that the instream data represents average ambient instream conditions within the City of Lake Oswego. Each of the monitoring locations are at the base of a "stormshed" (i.e., the drainage area as delineated by both topography and stormwater infrastructure), and thus this study design is assumed to represent the ambient instream conditions of the areas upstream of the drainage area.

2.3. Documentation and Record Keeping Procedures

The quality of data often depends not on the analysis, collection, or measurement, but the documentation that accompanies (or doesn't accompany) the sample. Obvious examples are sample location, time, date, and required analyses. Corrections will be made by drawing a single line through the mistake, writing in the correction, and initialing the correction. Documentation of weather conditions and all anomalous conditions, such as extremely high or low flow or construction equipment or wildlife in the sample reach of the stream, etc. will assist in interpretation of instream monitoring data (Oregon Department of Environmental Quality, 2009). The following record keeping procedures will be followed for each instream monitoring event.

2.3.1. Instrument Calibration Data

Instrument calibration data will continue to be kept in dedicated notebooks for each field instrument. The City is also developing a spreadsheet to store field instrument calibration data. Field equipment will be calibrated before each sample event according to the manufacturer's specifications.

2.3.2. Instream Field Analytical Data

The City uses Field Data Collection Sheets for each instream monitoring event. The Stormwater Quality Coordinator or designee responsible for collecting instream monitoring field data are responsible for filling out the field data collection sheets.

Staff shall contact the City's contract laboratory in advance of sampling to schedule bottle receipt and schedule shipping of sample bottles.

2.3.3. Chain-of-Custody

Current chain-of-custody forms are found in Appendix D, Figures D-1 through D-3, for instream samples. These forms are used with all MS4 sampling activities. A chain of custody is filled out for each sample event and kept with the samples at all times. All staff responsible for collecting and shipping samples must read, understand, and implement the chain of custody procedures outlined by the contract laboratory's quality manual. The contract laboratory quality manual outlines the policies and operational procedures associated with the contract laboratory. Specific protocols for sample handling, storage, chain-of-custody, laboratory analyses, data reduction, corrective action, and reporting are described. All policies and procedures must be structured in accordance with the National Environmental Laboratory Accreditation Conference (NELAC) standards and applicable EPA requirements, regulations, guidance, and technical standards.

2.3.4. Field/Laboratory Results

Laboratory results from instream sampling events will be stored by fiscal year in three ring binders and archived according to the State of Oregon's records retention schedule. Field and laboratory data will be entered into the City's Water Quality database specifically designed for water quality samples and hard copies of field data and laboratory reports will be archived according to the State of Oregon's records retention schedule.

2.4. Monitoring Process/Study Design

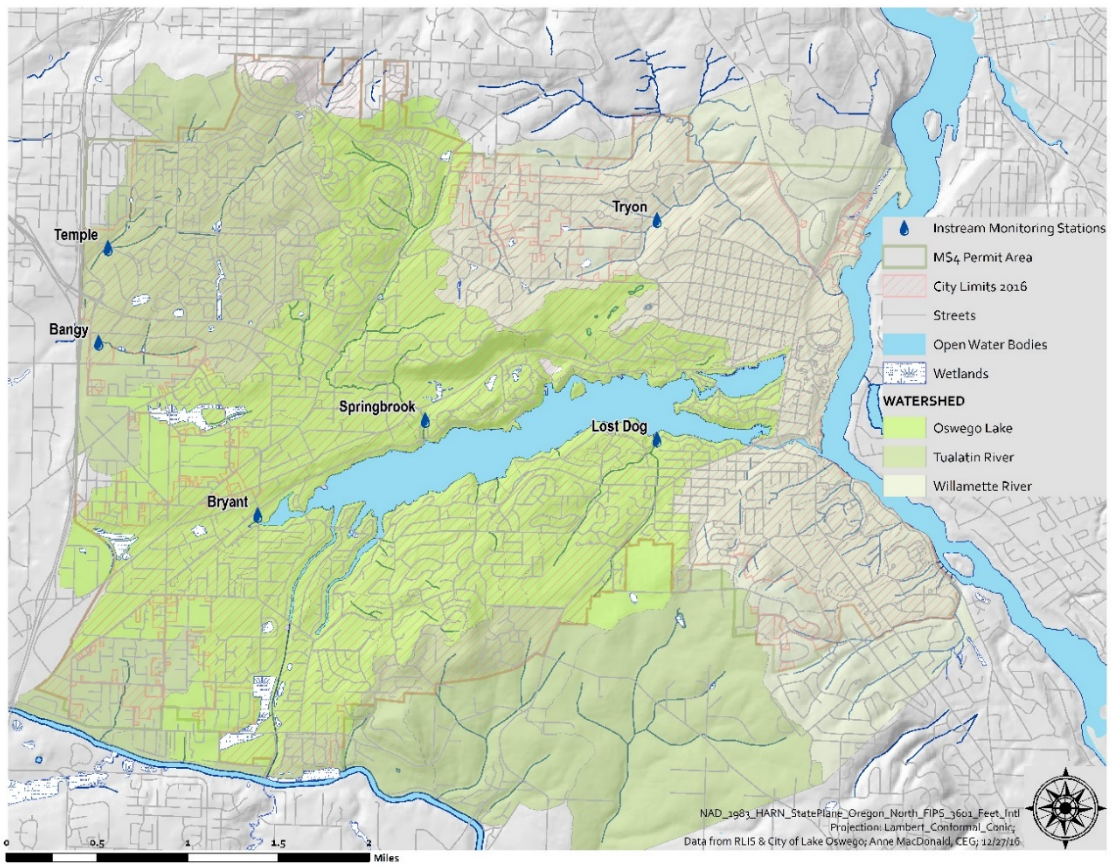
2.4.1. Monitoring Locations

The newly proposed sampling locations are listed in Table 3 below and depicted in Figure 3. As noted in Section 1.2 above, the City is proposing to discontinue the Rosewood station.

Table 3. Instream Sample Locations

Site Description	Station ID	Watershed
Ball Creek downstream of Kruse Oaks Blvd	Temple	Fanno Creek/ Tualatin
Boones Ferry Creek at Lakeview Blvd	Bryant	Oswego Lake/ Lower Willamette
Carter Creek at Bangy Road	Bangy	Fanno Creek/ Tualatin
Lost Dog Creek at the end of Lake Front Road	Lost Dog	Oswego Lake/ Lower Willamette
Springbrook Creek at Railroad Culvert	Springbrook	Oswego Lake/ Lower Willamette
Nettle Creek at Iron Mountain Trail Access	Tryon	Tryon Creek/ Lower Willamette

Figure 3. Instream Sampling Locations



2.4.2. Sample Event Criteria

Instream samples will be collected to represent the ambient instream conditions. Samples can be collected at any time of day and in any station order; sample locations will be visited in a randomized order, if practicable. Normal sample collection will occur during the normal business hours of 8am and 5pm Monday through Friday.

Schedule B(3)(a)(i) outlines that a minimum of 50% of the instream sample events must be collected during the wet season (October 1 to April 30). Careful planning, preparation and flexibility in the staff schedule are important to the successful completion/collection of wet season instream samples. During the wet season, the City endeavor to schedule sampling during precipitation events and active runoff conditions where practical; for purposes of defining a precipitation event, the permit definition of events will be used: precipitation > 0.1 inch of rainfall over the previous 24 hours, with an antecedent dry period of at least 24 hours. Staff will reference the Instream Wet Weather Decision Tree in Figure 4 before wet weather season instream sampling events.

2.4.3. Monitoring Frequency and Duration

Twelve (12) instream samples will be collected yearly at each of the stations listed in Table 3. Instream sample collection will be reviewed at the beginning of each month to allow for resource or weather adjustments that may arise as the sample date draws near.

Samples collected during October-April will be collected with consideration to the following permit conditions where practicable and as outlined in Figure 4.

- Schedule (B)(3)(a)(i) "[Instream Monitoring] *A minimum of 50 percent of the water quality sample events must be collected during the wet season"*
- Schedule (B)(3)(a)(ii) "[Instream Monitoring] *each unique sample event must occur at a minimum of 14 days apart."*

2.4.4. Identification of Sampling Coordinator

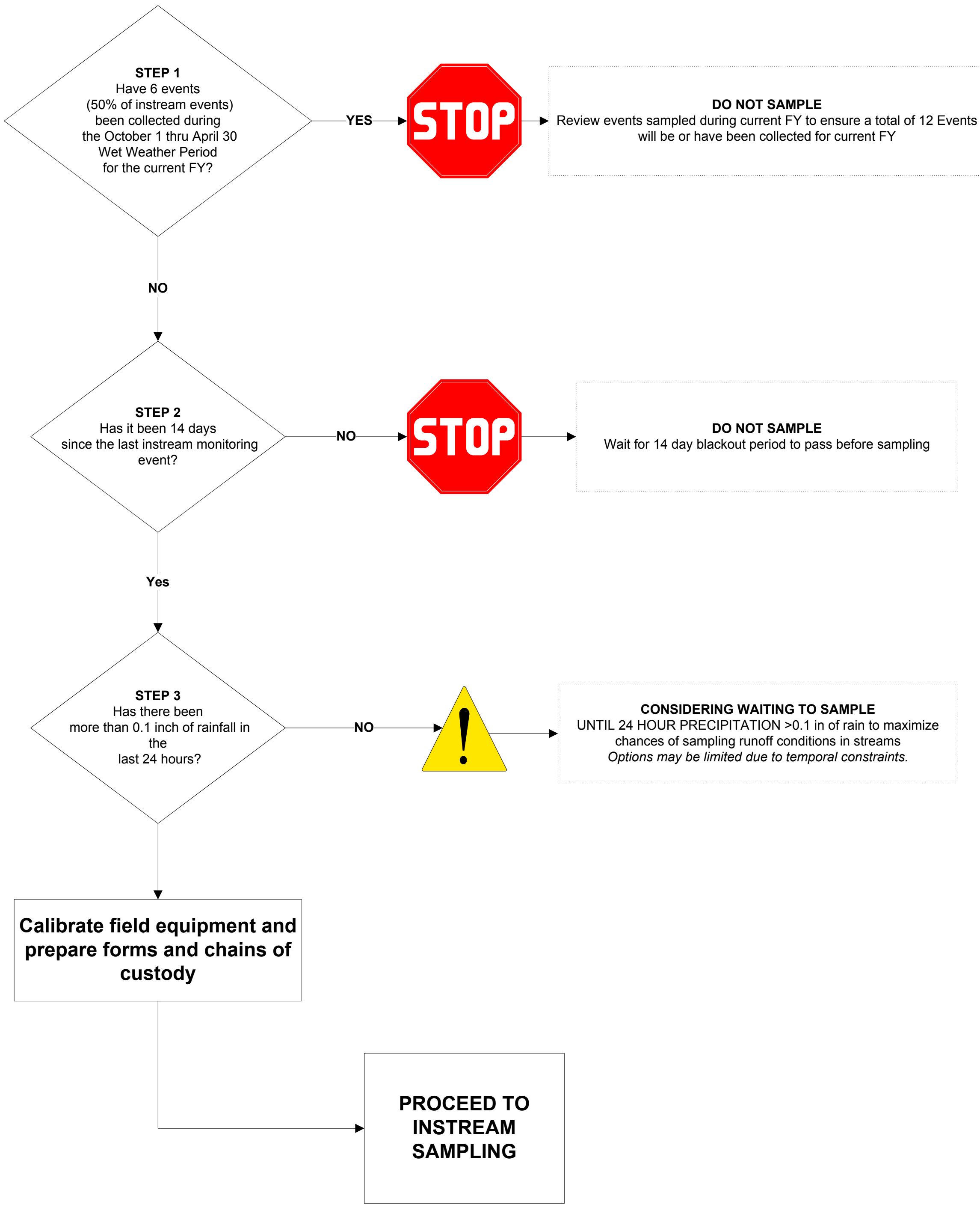
Instream sampling will be coordinated by the Engineering Division's Stormwater Quality Coordinator.

2.5. Sample Collection Methods and Handling/Custody Procedures

Sample collection involves following the applicable grab sample procedures for surface waters found in the Water Monitoring and Assessment Mode of Operations Manual (Oregon Department of Environmental Quality, 2009) and Washington Department of Ecology (2010).

Field data collection procedures follow the applicable procedures for temperature, dissolved oxygen, specific conductivity, turbidity and pH outlined in Chapter 4, Field Analytical Methods, found in the Oregon DEQ Mode of Operations Manual (Oregon Department of Environmental Quality, 2009) and manufacturer's guidelines.

Figure 4. Instream Monitoring During October-April- Decision Tree



2.6. Analytical Methods

Instream sampling analytical methods are outlined in Table 4 below. The City of Lake Oswego added alkalinity to the analyte list for two reasons. First, this allows the City to address the effects of stormwater and surface water mixing when comparing ammonia values to the criteria listed in the Oregon Toxics Standards Rule (OAR 340-41-0033, Table 20 of this rule) (Oregon Department of Environmental Quality, 2011). Second, alkalinity is a required component of the Biotic Ligand Model based aquatic freshwater copper standards (OAR 340-041-0033, 340-041-8033, effective November 2, 2016). Alkalinity is not required by Table B-1, but necessary to evaluate the long term trends in ammonia and copper.

Table 4. Instream Monitoring- Surface Water Analytes, Methods and Holding Times

Constituent	Target Method	Sample Collection Method	Holding Time
Escherichia coli (E.coli)	SM 9223B	Grab	**8 hrs.**
Hardness	EPA 130.1 or 2340 B or C	Grab	>48 hrs.
Alkalinity	SM 2320 B	Grab	>48 hrs.
BOD_5	SM 5210 B	Grab	**48 hrs.**
Total Suspended Solids (TSS)	SM 2540 D	Grab	>48 hrs.
Total Dissolved Solids (TDS)	SM 2540 BD	Grab	>48 hrs.
Volatile Solids (VS)	SM 2540 EG	Grab	>48 hrs.
Nitrate-Nitrogen (NO_3-N)	EPA 300.0 or SM4500-NO3 F	Grab	**48 hrs.**
Ammonia Nitrogen (NH_3-N)	SM 4500-NH3 or EPA 350.1	Grab	>48 hrs.
Total Phosphate-phosphorus (TPO_4-P)	EPA 365.X or SM 4500-P F	Grab	>48 hrs.
Ortho-Phosphate-Phosphorus (O-PO_4-P)	EPA 365.X or SM 4500-P F	Grab	**48 hrs.**
Total Recoverable Zinc	EPA 200.8	Grab	>48 hrs.
Dissolved Zinc	EPA 200.8	Grab	**24 hrs.**
Total Recoverable Copper	EPA 200.8	Grab	>48 hrs.
Dissolved Copper	EPA 200.8	Grab	**24 hrs.**
Total Recoverable Lead	EPA 200.8	Grab	>48 hrs.
Dissolved Lead	EPA 200.8	Grab	**24 hrs.**
Total Organic Carbon*	SM 5310B	Grab	>48 hrs.
Total Dissolved Carbon*	SM 5310B	Grab	>48 hrs.
Cations: Ca, Na, K, Mg*	EPA 200.7	Grab	>48 hrs.
Anions: Cl, SO_4*	EPA 300.0	Grab	>48 hrs.

**Through 2018-2019 permit year only.*

Note: holding times based on field collection and sample handling/preservation methods described in this document, e.g., holding times for dissolved metals assume laboratory filtration. Methods and holding times may change based on laboratory selection.

The 303(d) listed parameters found in Appendix B will also be included in instream analyses to the maximum extent practicable. Anions, cations, and organic carbon will be analyzed on 4 sample sets per year through the 2018-2019 permit year to evaluate copper concentrations using the recently approved biotic ligand model-based water quality standard.

2.7. Quality Control Procedures

2.7.1. Duplicate Samples

Instream duplicate samples will be collected once per sampling event. Duplicate samples will be collected as discrete samples (Oregon Department of Environmental Quality, 2009).

2.7.2. Instrument Calibration

All field instrument calibrations are performed in accordance with the manufacturer’s recommendations. All field meters are calibrated prior to use in the field. Laboratory instrument calibrations are outlined in the contract laboratory’s quality manual.

2.7.3. Inspection and Maintenance

Field instrumentation and equipment will be inspected and maintained according to manufacturer’s recommendations. Laboratory equipment inspection and maintenance is the responsibility of the laboratory and outlined in the contract laboratory’s Quality Manual.

2.7.4. Calibration of Instrumentation and Equipment

Field equipment will be calibrated according to the manufactures direction prior to each sampling event. Instream monitoring will require the use of the field equipment in Table 5, or equivalent.

Table 5. Instream Monitoring Equipment

Field Parameter	Field meter
Temperature	Dissolved Oxygen or Specific Conductivity Meter
pH	Beckman 210
Specific Conductivity	YSI Pro 2030
Dissolved Oxygen	YSI Pro 2030
Turbidity	HACH 2100Q

Calibration of laboratory equipment is the responsibility of the contract laboratory and outlined in the respective quality manual.

2.8. Data Management

High-quality data management is as important to a project as is high quality sampling and analysis. Improperly handled data can result in misreporting or omission of data, ultimately leading to misinformed water quality management decisions. “Data Management” includes time spent collecting and recording sample project and sample event meta-data, creating new stations in the database, entering field and laboratory data into the water quality database, verifying data, performing QA/QC checks on data, and transferring data between various databases. Spending the time and resources necessary to assure high-quality data management will maintain the integrity and total quality management of data collected. (Oregon Department of Environmental Quality, 2009).

Instream sampling data are kept in the City's water quality database. The administration of this database is the responsibility of the City's Stormwater Quality Coordinator. Hard copies of laboratory reports are kept in a three ring binder. Three ring binders are organized by fiscal year. Electronic copies of laboratory reports are stored in the City's water quality database. Laboratory data is transcribed and transferred into the water quality database. Field data recorded on field data sheets are also kept in the three ring binders and data is transcribed into the water quality database by the Stormwater Quality Coordinator or designee.

2.8.1. Review

Sample events are entered into the City's water quality database when laboratory results are available from the contract laboratory. Field data and laboratory results are reviewed by the Stormwater Quality Coordinator for errors and omissions as well as data that may indicate outliers. Errors and omissions are noted in the water quality database. Laboratory QC data is included with laboratory reports and QC flags are noted in the water quality database.

2.8.2. Validation and Verification

Instream data are validated by the Stormwater Quality Coordinator. Final review and verification shall be performed by the Stormwater Quality Coordinator. Field data and chain of custody information will be reviewed and verified after data is entered into the water quality database.

Laboratory data that is outside the historical range of data collected will be flagged in the water quality database and the contract laboratory QC information will be reviewed. QC information from the contract laboratory will be included in the data entered into the City's water quality database.

3. Stormwater Monitoring-Wet Weather (SWQ-WW)

Stormwater Monitoring-Wet Weather (SWQ-WW) monitoring is the monitoring of flow and stormwater quality during precipitation and runoff events. The City will collect SWQ-WW samples outlined in Table B-1 of the permit. Samples will be collected at two separate sample sites (see Table 6 and Figure 5).

3.1. Project Task Organization

SWQ-WW Monitoring will follow the monitoring provisions set for in schedule B(3)(b). SWQ-WW sampling also requires that monitoring follow the provisions set forth in the Schedule B(3) of the permit. Specifically:

- ***B(3)(b)(i)*** *All water quality samples must be collected during a storm event that is greater than 0.1 inch of rainfall.*
- ***B(3)(b)(ii)*** *When possible, samples must be collected after an antecedent dry period of a minimum of 24 hours.*
- ***B(3)(b)(iii)*** *The intra-event dry period must not exceed 6 hours, unless a 24-hr flow-weighted composite sample collection method is employed.*
- ***B(3)(b)(iv)*** *Sample Collection Method: A flow-weighted composite sample must be collected during stormwater runoff producing events that represent the local or regional rainfall frequency and intensity, including event types that may be expected to yield high pollutant loads/concentrations.*

  A time-composite sampling method or grab sampling method may be used for an environmental monitoring type, project or task, if the monitoring plan identifies the infeasibility of the flow-weighted composite sampling method or flow-weighted composite sampling is scientifically unwarranted based upon the development of plan requirements identified in Schedule B.2.d. For time composite sampling or grab sampling to be considered valid for the purpose of this permit requirement, the rationale for the use of these alternative sampling methods and sampling procedures must be described in the monitoring plan.

  1. *The flow-weighted sampling method requirement is not applicable to the collection of samples for the pollutant parameters requiring the grab sampling method, such as bacteria, oil & grease, pH or volatiles or for samples collected for purposes of insecticide, herbicide and fungicide monitoring.*
  2. *Grab samples may be collected during any part of a storm event which produces sufficient runoff for sampling. The grab samples must be collected in a manner to minimize any potential bias in the results.*

- ***B(3)(b)(v).*** *Flow or rainfall data must be collected, estimated or modeled for each stormwater monitoring event, including storm events when mercury monitoring is conducted. If flow or rainfall is modeled or estimated, the procedure must be described in the monitoring plan.*

Three rain events will be monitored at each station each reporting year using time-weighted composite sampling except where grab sampling is necessary (e.g., bacteria sampling). The City's SWQ-WW activities are responsibility of the Stormwater Quality Coordinator or designee. All staff assigned this task will be trained prior to conducted SWQ-WW sampling. Sample dates will depend on storm events and may be adjusted by the Stormwater Quality Coordinator due to unforeseen scheduling conflicts.

The City will evaluate whether flow-weighted sample collection is desirable and feasible, and coordinate any requested changes with DEQ. If the City is able to reliably perform flow-weighted sample collection, the City will reference the standard operating procedures in "Standard Operating Procedure for Automatic Sampling for Stormwater Monitoring" (Washington Department of Ecology, 2009) to the extent applicable.

3.2.Monitoring Objectives

SWQ-WW monitoring will directly and indirectly contribute to meeting the objectives found in Schedule B (1)(a)(i-vi), but is targeted at meeting the objectives of B(1)(a)(i), B(1)(a)(iii), B(1)(a)(v), B(1)(a)(vi).

- **B(1)(a)(i):** Evaluate the source(s) of the 2004/2006 303(d) listed pollutants applicable to the co-permittee's permit area;
- **B(1)(a)(iii):** Characterize stormwater based on land use type, seasonality, geography or other catchment characteristics;
- **B(1)(a)(v):** Assess the chemical, biological, and physical effects of MS4 stormwater discharges on receiving waters;
- **B(1)(a)(vi):** Assess progress towards meeting TMDL pollutant load reduction benchmarks.

The main objective of the SWQ-WW monitoring is:

- Collect time proportioned composites samples during at least 3 discrete storm events from each of the two monitoring locations during the permit term;

3.2.1. Monitoring Question(s)

The principal monitoring question(s) that will be addressed by wet weather monitoring are:

- What are the average storm event concentrations of pollutants like bacteria and TSS at the monitoring sites?
- What are the characteristics of the average storm event concentrations at monitoring sites? How do these local sites compare to the regional sites in the NSQD?
- How do the average storm event concentrations of storm events in Lake Oswego compare regionally to storms of similar land use and precipitation? How do these concentrations compare to instream constituent concentrations?

3.2.2. Monitoring Background

The City began wet weather monitoring in 2009. Results from SWQ-WW sampling efforts during the last permit term were reported in the annual report (City of Lake Oswego 2016b.

3.2.3. Data Analysis Methodology

The City will use standard data summary methods (i.e. mean, median, mode, Inter Quartile Range (IQR), skewness, variance, standard deviation) to describe the characteristics of the data collected for analytes at each station.

3.2.4. Data Quality Criteria

The City will continue to use these data quality objectives to describe the SWQ-WW monitoring data collected as outlined in Table B-1 of MS4 permit.

3.2.4.1. Precision

Precision (see Figure 2) of SWQ-WW will be determined by the collection of a duplicate sample at least once during a sampling expedition, as outlined in section 3.6.1.

3.2.4.2. Accuracy

Accuracy will be assessed by analyzing "blank" samples. This will be fulfilled with the use of trip blanks in the field. A trip blanks will verify that the measured or analyzed value is true and not influenced by the sampling method or equipment. One equipment blank sample will be submitted for each sampling event. Blank water will be provided by the contract laboratory. Trip blanks will be processed and transported exactly as regular samples. All field water quality measurements except dissolved oxygen shall be performed on blank samples (Oregon Department of Environmental Quality, 2009).

3.2.4.3. Representativeness

For SWQ-WW sampling, a representative sample is defined as meeting the wet weather monitoring requirements in Table B-1 of the NPDES-MS4 Permit (Schedule B(2)(b)(i-iv)) and collecting the required number of aliquots to produce a sufficient composite sample.

3.2.4.4. Comparability

SWQ-WW samples collected during wet weather events will carefully follow the procedures and handling requirements found in this monitoring plan and applicable references. The City intends to make this sampling comparable to other Clackamas co-permittees. Carefully following documented procedures is one of the most important steps in maintaining data comparability (Oregon Department of Environmental Quality, 2009).

3.2.4.5. Completeness

Completeness of sampling will be evaluated each fiscal year, as well as at the end of the permit term using Equation 5.

Special conditions may prevent the samples from being collected as acknowledged in B(2)(e)(i) of the permit. These circumstances include personnel illness or turnover, equipment malfunction, safety issues, vandalism and situations that are out of the control of the City of Lake Oswego (e.g., extreme weather conditions, earthquake, acts of god, etc.). If a situation out of the City's control prevents the collection of SWQ-WW samples, the Stormwater Quality

Coordinator will reschedule the monitoring event if practicable. The City will provide ODEQ with a 30-day notice of the proposed modification to the monitoring plan per B(2)(e).

3.2.5. Assumptions and Rationale

Time proportional composites were chosen by the City to represent the stormwater runoff condition in the stormwater conveyances monitored, as the best compromise given City resources. It is also assumed that monitoring concentrations obtained by the City will be compared to regional data, assisting the City in adaptively managing its stormwater program.

3.3. Documentation and Record Keeping Procedures

The record keeping procedures for each SWQ-WW monitoring event are outlined below.

3.3.1. Instrument Calibration Data

Calibration records will be kept in dedicated notebooks, identified by equipment serial number.

3.3.2. Stormwater -Wet Weather Field and Analytical Data

Paper copies of field data, laboratory results and other meter data collected as part of SWQ-WW sampling will be kept in three ring binders or dedicated field notebooks. Field data will be transferred to the water quality monitoring database.

3.4. Monitoring Process/Study Design

The study design for SWQ-WW monitoring will incorporate the use of time weighted composite samples.

3.4.1. Monitoring Locations

SWQ-WW monitoring locations are listed in Table 6 and represented in Figure 5. Stations were selected to ensure that the data collected is representative of the conveyance system as well as the upstream drainage area, is relatively well mixed, and has relatively uniform flow. Both sites in Table 6 were chosen to best represent the stormwater runoff at the station location. Site selection included evaluation of locations where the stormwater runoff is relatively well mixed and relatively “stable” and “uniform” (Washington Department of Ecology, 2009). Based on the results of the site selection, the two sites in Table 6 were selected.

The City of Lake Oswego has located one SWQ-WW monitoring site on the downstream conveyance of part of the Lake Grove Village Center Urban Renewal Area. As part of this urban renewal plan, one of the projects that have been identified includes the redevelopment of Boones Ferry Road (City of Lake Oswego, Oregon, 2012a). The plan includes green street medians, sustainable street design and shared stormwater facilities. The City will be conducting SWQ-WW monitoring of part of this redevelopment site on Boones Ferry Road (Lake Grove Ave at Reese Road, Asset ID E08C-019D; see Figure 5). It is the intent of the City to utilize the SWQ-WW monitoring during this permit term to establish baseline data for comparison to a post construction condition of the same area.

The second station that was chosen was at Palisades Terrace Drive and South Shore Blvd, asset ID E09D-094D (see Figure 5). This station was chosen because of its accessibility, upstream land use (primarily residential with large recreational open spaces), slopes (all typical in Lake Oswego), and its receiving waterbody (Lost Dog Creek and Oswego Lake). These data will be used to further characterize the Lost Dog Creek Watershed.

Figure 5. Wet Weather Stations

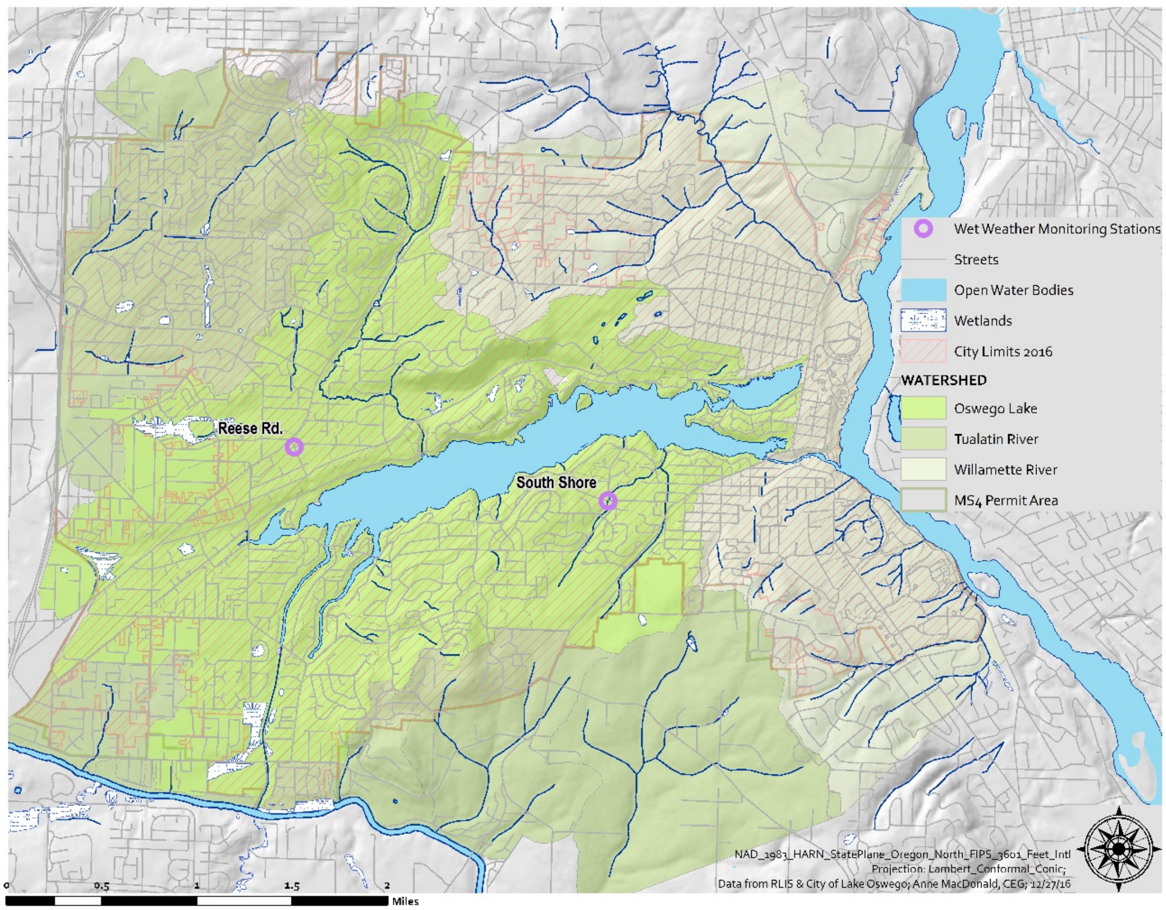


Table 6. SWQ-WW Sample Stations

Station Description	Asset ID	Receiving Waterbody	Latitude	Longitude
Lake Grove Ave. at Reese Road	E08C-019D	Reese Road Creek->Oswego Lake	45.410167	-122.718455
Palisades Terrace Drive at South Shore Blvd.	E09D-094D	Lost Dog Creek ->Oswego Lake	45.406807132	-122.68433282

3.4.2. Sample Event Criteria

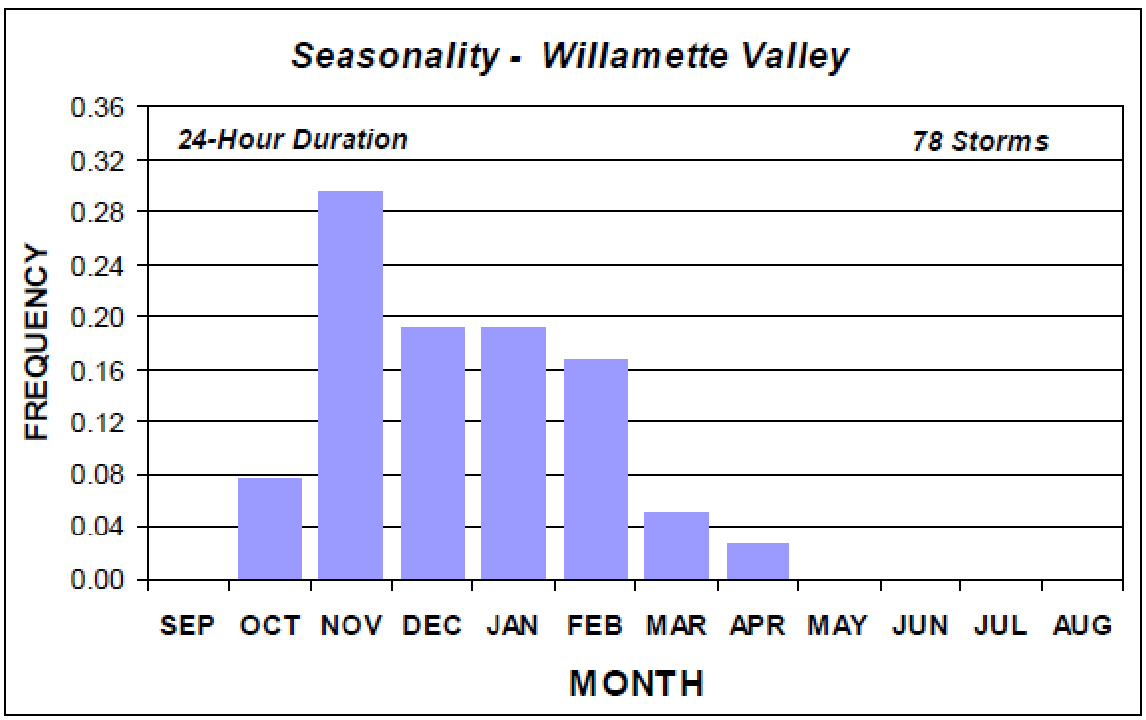
SWQ-WW samples will be collected to represent selected storm events. A storm event is defined in B(3)(b)(i-iii). Sample events will also target long duration and short duration storms as represented in Figure 6 and Figure 7 below.

3.4.3. Storm Selection Criteria

The City will target a range (of both predicted depth and intensity) of long and short duration storms. Long-duration storms in western Oregon are characterized by prolonged low to moderate precipitation intensities where continuous or intermittent precipitation occurs over a period from roughly 24-hours to 72-hours (see Figure 6). These storms are important for design of new stormwater facilities and assessment of existing stormwater facilities where both peak discharge and runoff volume are important considerations (OTAK, 2009). Monitoring years of long duration storms are outlined in Table 7.

Figure 6. Seasonality of Storm Occurrence for Storms Exceeding 20-year Recurrence Interval at 24-Hour Duration for the Willamette Valley and Western Oregon Lowlands

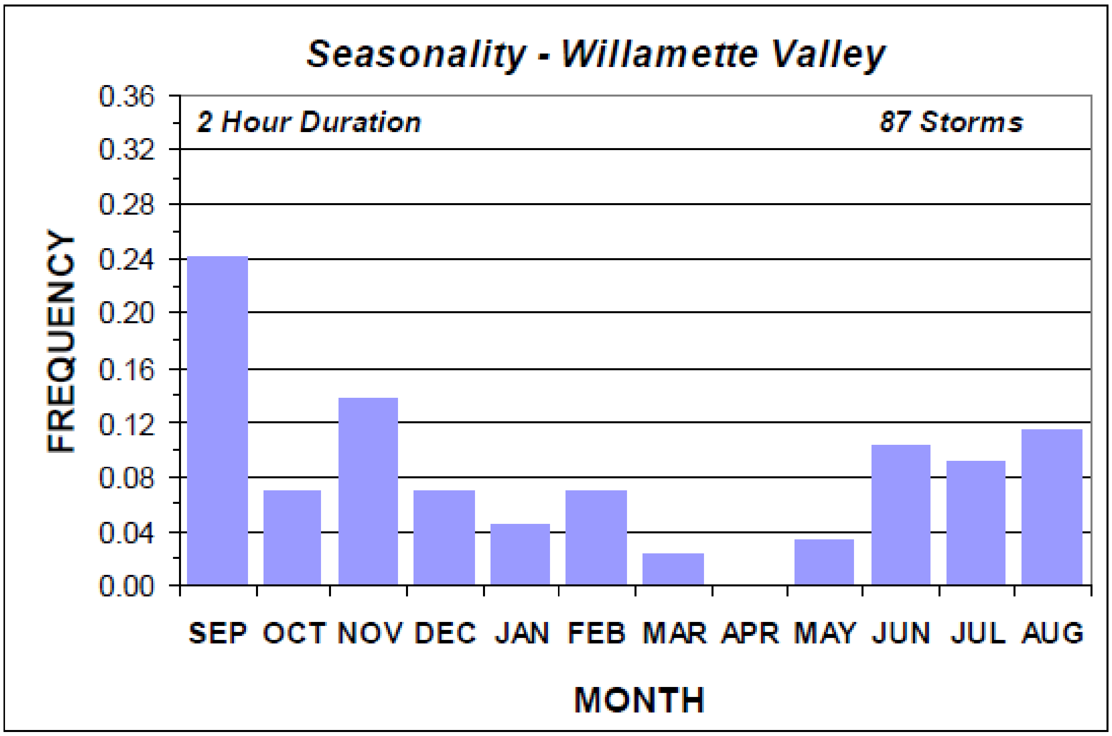
Source: Adapted from MGS study in Lake Oswego Clean Streams Plan (OTAK, 2009).



Short duration storms generally occur over a limited time period of several hours with the majority of the precipitation occurring over 10-minutes to 30-minutes. These storms occur more frequently in the warm seasons, are isolated in terms of areal coverage, and are characterized by moderate to high precipitation intensities for short periods of time (see Figure 7). The high rates of precipitation are produced by convective cells that may be isolated or embedded in organized weather systems. These storms are capable of producing high runoff rates and are used in the design and assessment of conveyance systems such as pipes and culverts (OTAK, 2009). Base flow monitoring will occur as time and resources allow. Targeted conditions for each permit year are outlined in Table 7.

Figure 7. Seasonality of Storm Occurrence for Storms Exceeding 20-year Recurrence Interval at 2-Hour Duration for the Willamette Valley and Western Oregon Lowlands

Source: Adapted from MGS study in Lake Oswego Clean Streams Plan (OTAK, 2009).



The City will also target and evaluate base flow at each of the sampling sites during the permit term to compare long and short duration storm events and loading. Observations to date indicate that there is no base flow at the Reese Rd. site, while the South Shore site maintains baseflow except during late summer in some years. During the monitoring year 2018-2019, periodic inspections of both stations will be conducted to observe base flow. Base flow monitoring will occur during suitable flow conditions, as time and resources allow. Monitoring years of base flow are outlined in Table 7.

Local weather stations (accessible on the City's website, click here for link, plus the City of Portland's rain gauge at the Sylvania Campus of Portland Community College) and the National Oceanic and Atmospheric Administration (NOAA) Northwest River Forecast Center-10 Day Meteorological Forecasts site (click here for link) will be used to select potential long duration and short duration storms as well as initiate samplers and sampling protocol.

Table 7. Types of Storms Targeted for SWQ-WW Monitoring

Monitoring Year	SWQ-WW Condition Targeted	Lake Grove Ave at Reese Road (E08C-019D)	Palisades at South Shore (E09D-094D)
2017-2018	*LONG DURATION*		
	SHORT DURATION	X	X
	Base flow		
2018-2019	*LONG DURATION*	X	X
	SHORT DURATION	X	X
	Base flow	X	X
2019-2020	*LONG DURATION*	X	X
	SHORT DURATION	X	X
	Base flow		
2020-2021	*LONG DURATION*	X	X
	SHORT DURATION	X	X
	Base flow	X	X
2022-2023	*LONG DURATION*	X	X
	SHORT DURATION	X	X
	Base flow		

3.4.4. Monitoring Frequency and Duration

The City will collect at least three SWQ-WW monitoring events, at each station in Table 6, each reporting year. For SWQ-WW sampling, a representative sample is defined as meeting the wet weather monitoring requirements in Table B-1 of the NPDES-MS4 Permit, Schedule B(2)(b)(i-iv), as well as collecting the adequate number of aliquots produce a sufficient composite sample (based on sample volumes need for analysis by the City's contract laboratory). The sampling goals include collecting 75% of the storm event hydrograph and the collection of sufficient aliquots for a minimum of at least two times the time of concentration of the drainage area (Washington Department of Ecology, 2010). At least 4 liters of sample is required for each composite sample.

3.4.5. Identification of Sampling Coordinator

SWQ-WW sampling will be coordinated by the Engineering Department's Stormwater Quality Coordinator.

3.5. Sample Collection Methods and Handling/Custody Procedures

3.5.1. Storm Event Staff Deployment

Field crews will be fully equipped and prepared (i.e., appropriate staff is available to sample and maintain equipment, personal protective gear ready, and equipment is ready to be initiated, etc.) prior to deployment when a qualifying storm event has been forecasted. The City will use the National Oceanic and Atmospheric Administration's Northwest River Center-10 Day Meteorological Forecasts web page (NOAA, n.d.) to initially identify potential storms that will meet the storm event criteria outlined in Schedule B(3)(b) of the NPDES MS4 Permit as well as the targeted conditions outlined in Table 7.

Within 24 hours of a forecasted storm arrival, staff will be notified of deployment and equipment will be activated. Staff will perform field checks of sampler and field meter equipment recorded in a dedicated field notebook for the station. Staff will alternate between each station to collect the minimum of three aliquots of sample for the site composites.

For safety reasons, sampling will occur only during daylight hours on regularly scheduled work days. The City's Public Works Operations staff may be asked to provide traffic control at the Reese Rd. site. Otherwise, signage indicating work within the roadway will be deployed on Reese Rd. (northbound and southbound) and on Lake Grove Avenue. Traffic control is not generally needed at the South Shore site. However, a 3-person field crew may be needed to manage sample collection from the deep culvert at this location.

All site activities will be logged in the field notebook.

3.5.2. Time Proportion Composite

A time proportion methodology will be employed by the City, consistent with others in the Clackamas MS4 permit group. A minimum of three aliquots per storm will be collected as grab samples at least 30 minutes apart in sample-dedicated 1L plastic bottles, and immediately after collection transferred to a container for E. coli grab samples and a larger (appx. 4L) container from which composite sample bottles will be filled. Flow depth in the upstream pipe will be recorded, and flow will be estimated based on culvert hydraulics. For long duration storms, City staff may elect to collect multiple composite samples and *E.coli* grabs over a period of approximately 24-72 hours.

3.5.3. Grab Samples (E.coli)

E.coli samples will be collected as discrete grab samples and follow the procedures outlined in the Oregon MOMs manual (Oregon Department of Environmental Quality, 2009) and the Washington DOE standard operating procedure for grab samples (Washington Department of Ecology, 2010). A minimum of three *E.coli* grabs will be collected during the storm event; grab sampling of individual (non-composited) *E. coli* samples will continue as long as aliquots for the composite sample of other constituents are collected.

3.5.4. SWQ-WW Analytical

All SWQ-WW samples requiring analysis will be sent to a contract laboratory that is recognized and accredited for non-potable water analyses by either the National Environmental Laboratory Accreditation Program (NELAP), the Oregon Environmental Laboratory Accreditation Program (ORELAP), or Washington Department of Ecology. Staff shall contact the City's contract laboratory and mail service in advance of sampling to schedule bottle receipt and schedule shipping of sample bottles. Stormwater quality – wet weather analytical methods are outlined in Table 8.

Table 8. Stormwater Quality-Wet Weather (SWQ-WW) Monitoring - Surface Water Analytes, Methods and Holding Times

Variable	Target Method	Sample Collection Method	Holding Time
Escherichia coli (E.coli)	SM 9223B	Grab	**8 hrs.**
Hardness	EPA 130.1 or 2340 B or C	Composite	>48 hrs.
Alkalinity	SM 2320 B	Composite	>48 hrs.
BOD_5	SM 5210 B	Composite	**48 hrs.**
Total Suspended Solids (TSS)	SM 2540 D	Composite	>48 hrs.
Total Dissolved Solids (TDS)	SM 2540 BD	Composite	>48 hrs.
Volatile Solids (VS)	SM 2540 EG	Composite	>48 hrs.
Nitrate-Nitrogen (NO_3-N)	EPA 300.0 or SM4500-NO3 F	Composite	**48 hrs.**
Ammonia Nitrogen (NH_3-N)	SM 4500-NH3 or EPA 350.1	Composite	>48 hrs.
Total Phosphate-phosphorus (TPO_4-P)	EPA 365.X or SM 4500-P F	Composite	>48 hrs.
Ortho-Phosphate-Phosphorus (O-PO_4-P)	EPA 365.X or SM 4500-P F	Composite	**48 hrs.**
Total Recoverable Zinc	EPA 200.8	Composite	>48 hrs.
Dissolved Zinc	EPA 200.8	Composite	**24 hrs.**
Total Recoverable Copper	EPA 200.8	Composite	>48 hrs.
Dissolved Copper	EPA 200.8	Composite	**24 hrs.**
Total Recoverable Lead	EPA 200.8	Composite	>48 hrs.
Dissolved Lead	EPA 200.8	Composite	**24 hrs.**

Note: holding times based on field collection and sample handling/preservation methods described in this document, e.g., holding times for dissolved metals assume laboratory filtration. Methods and holding times may change based on laboratory selection.

E. coli samples will be delivered within holding times to the contract laboratory. Sample collection will follow the procedures outlined in Washington Department of Ecology-Standard Operating Procedure for manually Obtaining Surface Water Samples (Washington Department of Ecology, 2010) and the Oregon Department of Environmental Quality's MOMs manual (Oregon Department of Environmental Quality, 2009).

Principal data users include the City of Lake Oswego, Oregon Department of Environmental Quality and various external stakeholders.

3.5.5. Chain of Custody

The *Chain-of-Custody Form* is used to record sample custody (see Appendix D). These forms are always used with MS4 sampling activities. A chain of custody is filled out for each sample event and kept with the samples at all times. All staff responsible for collecting and shipping samples must read, understand, and implement the chain of custody procedures outlined by the contract laboratory's quality manual. The contract laboratory quality manual outlines the policies and operational procedures associated with the contract laboratory. All policies and procedures must be structured in accordance with the National Environmental Laboratory Accreditation Conference (NELAC) standards and applicable EPA requirements, regulations, guidance, and technical standards.

3.6. Quality Control Procedures

3.6.1. Internal Duplicate Sample Collection

Duplicate samples will be collected once per sampling event from the South Shore station. Collection of duplicate samples will be collected by separating out aliquots from the composite sample collected. The sample composite must be thoroughly agitated to avoid bias in the analysis.

3.6.2. Travel Blank Sample

A travel blank sample will be collected during each sampling event. This shall consist of de-ionized water that is poured into equivalent sample containers at the time of collection of the natural sample. This will be performed in conjunction with sampling at the Reese Rd. station.

3.6.3. Field Meter Inspection and Maintenance

Inspection and maintenance of field meters will follow manufacturer's recommendations. This includes the documentation of battery levels, and visual inspections of equipment for signs of excessive wear or damage.

3.6.4. Calibration of Instrumentation and Equipment

Calibration of instrumentation and equipment will follow manufacturer's recommendations.

3.7. Data Management

SWQ-WW sampling data will be stored in the City's water quality database. Hard copies of laboratory reports and field notes are kept in a three ring binder. Three ring binders are organized by permit year. Electronic copies of laboratory reports are stored in the City's water quality database. Laboratory data is transcribed in to the water quality database. Field data recorded on field data sheets are also kept in the three ring binders and dedicated field notebooks. Field data shall be transcribed into the water quality database.

Back up files of the electronic data will be saved in a flat file format (i.e. .csv). Electronic files will be kept according to the State of Oregon Records Retention Schedule (OAR-166-200).

3.7.1. Review

Data will be reviewed by the Stormwater Quality Coordinator. Review will include review of laboratory reports, field data and equipment data (sampler and flow meter records). An original "raw" data file from the sampler and flow meter will be stored in the City's water quality database. Any corrections will be documented and kept as a separate file.

Review of laboratory data will be completed as part of the contract laboratory's QA procedures outlined in their respective quality assurance manual.

3.7.2. Validation and Verification

SWQ-WW information collected in the field is validated by the Stormwater Quality Coordinator. Final review and verification shall be performed by the Stormwater Quality Coordinator. Time series data, if obtained, will be pre-processed (signals trimmed and joined), QA/QC'd (flagged and graded), and corrected based on validated and verified field data obtained during surface water sampling events. An uncorrected "original" file will be kept in the water quality database. Field data and chain of custody information will be reviewed and verified after data is entered into the water quality database.

Laboratory data that is outside the historical range of data collected will be flagged in the water quality database and the contract laboratory QC information will be reviewed. QC information from the contract laboratory will be included in the data entered into the City's water quality database.

4. Instream Biological Monitoring

The City expanded its monitoring in 2004 to include biological monitoring to assess the biological impact on receiving water quality. The biological indicators that were chosen were macroinvertebrates. Macroinvertebrates have been successfully used to evaluate watershed health in various forms including watershed imperviousness, land use, temperature (Wang & Kanehl, 2003; Stepenuck, Wang, & Crunkilton, 2002) and hydrologic alteration (DeGasperi, et al., 2009). The biological evaluations that have been conducted by the City in 2004, 2007, 2009 and 2013 indicate streams with low model scores and the presence of sediment tolerant taxa; all of this information confirms from a biological perspective that streams have been impacted by urbanization. The City will continue to use periodic (approximately every 3 years) macroinvertebrate monitoring during this permit cycle to evaluate the biological condition of streams impacted by urbanization and stormwater as well as to evaluate how BMPs utilized in the watershed may contribute to the biological condition of receiving waterbodies.

4.1. Project Task Organization

The City of Lake Oswego will perform instream biological monitoring at 10 monitoring sites once per permit term. The instream biological monitoring will be performed by a contractor. The City of Lake Oswego's Stormwater Quality Coordinator will act as the project manager for the contract and all field work.

4.2. Monitoring Objectives

As outlined in Table 1, the biological monitoring is focused on evaluating the long term trends in receiving waters associated with MS4 stormwater discharges, as well as assessing the chemical, biological and physical effects of MS4 discharges on receiving waters.

4.2.1. Monitoring Question

There two monitoring questions being addressed by the instream biological monitoring.

- What are the trends in macroinvertebrate communities over time?
- Can any biological effects (stressors) be assessed by comparing the results of macroinvertebrates overtime? Are there surrogate measures of that can be used to assess biological condition?

4.2.2. Monitoring Background

Macroinvertebrates have long been sampled to describe biological communities in stream systems. King County, Washington lists several key reasons why macroinvertebrates are valuable indicators of water quality (King County Washington, 2011). These include:

- **Nutrient Cycle:** Bugs (macroinvertebrates) play a crucial role in the stream nutrient cycle. If bug populations are suffering it will affect the whole ecosystem.
- **Pollution Tolerance.** Some insects (macroinvertebrates) are tolerant of pollution, whereas others are not. The presence or absence of tolerant and intolerant types can indicate the condition of the stream. For example, the order *Plecoptera*, or stoneflies, are very sensitive to pollution, so their absence in a stream can signal a problem.
- **Population Fluctuations.** Because many bug (macroinvertebrate) life cycles are short (sometimes one season in length), we can detect population fluctuations in a short period of time. Population fluctuations might indicate that a change (positive or negative) may have occurred in the stream.

The effects of urbanization on streams are well documented and include significant and substantial changes in basin hydrology, channel morphology, and physiochemical water quality. The advantages to using macroinvertebrate surveys to evaluate urbanization include (Faulkner, C.; et al., 2012):

- Biological communities reflect overall ecological integrity (i.e., chemical, physical, and biological integrity). Therefore, biosurvey results directly assess the status of a waterbody relative to the primary goal of the Clean Water Act (CWA).
- Biological communities integrate the effects of different stressors and thus provide broad measure of their aggregate impact. (Identification of stressors or combinations of urban water resources stressors is a current topic of many researchers)
- Communities integrate the stresses over time and provide an ecological measure of fluctuating environmental conditions. Routine monitoring of biological communities can be relatively inexpensive, particularly when compared to the cost of assessing toxic pollutants, either chemically or with toxicity tests.
- The status of biological communities is of direct interest to the public as a measure of a pollution free environment.

- Where criteria for specific ambient impacts do not exist (e.g., nonpoint-source impacts that degrade habitat), biological communities may be the only practical means of evaluation.

4.2.3. Data Analysis Methodology

The City of Lake Oswego (via a contractor) has been collecting information on macroinvertebrate communities since 2004 and has typically used a Clackamas index of biological integrity, the DEQ Multimetric index and the PREDATOR models to assess macroinvertebrate communities.

The City will continue to collect macroinvertebrate and associated habitat information to fulfill the data needs of the Clackamas Lowlands IBI, the DEQ Multimetric Index and PREDATOR models.

The City may also explore additional data analysis methodologies that can provide feedback about the types of biological stressors that are shaping the macroinvertebrate communities. The City will also continue to examine the use of additional models to evaluate surrogate stressor measures that may be useful in the adaptive management of the City's Biological Monitoring and stormwater program.

4.2.4. Assumptions and Rationale

It is assumed that the biological and habitat data collected represents average conditions within the City of Lake Oswego. Each of the monitoring locations are at the base of a "stormshed" (drainage area delineated by topographic +stormwater infrastructure), and thus this study design is assumed to represent the biological conditions of the areas upstream of the drainage area.

4.3. Documentation and Record Keeping Procedures

Data documentation and record keeping procedures will utilize DEQ's Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams (Oregon Department of Environmental Quality, 2009) guidance. Contractors will follow the applicable sample tracking and record keeping procedures outlined in DEQ's *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams*.

4.4. Monitoring Process/Study Design

Macroinvertebrates will be collected using DEQ's Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams (Oregon Department of Environmental Quality, 2009). The macroinvertebrate and habitat data collection will continue to use a targeted methodology too identify sampling locations.

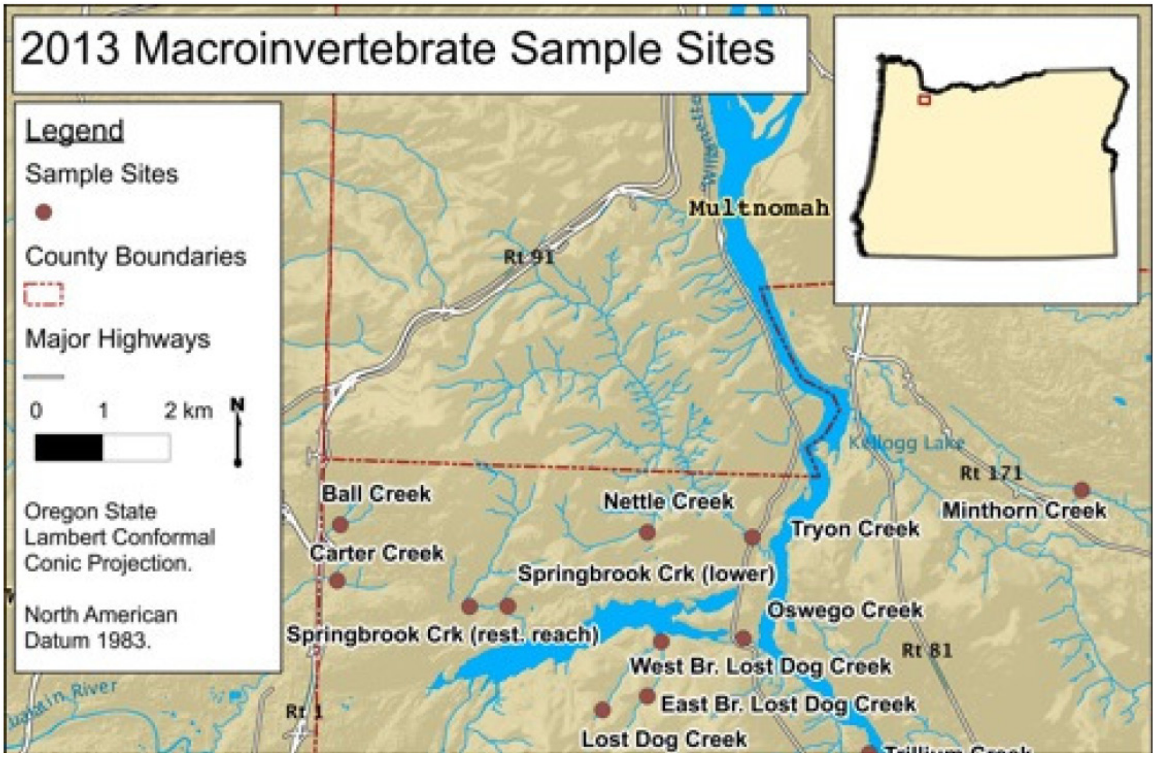
4.4.1. Monitoring Locations

The City will be using historical macroinvertebrate monitoring sites (see Figure 8) as a start to locate the sample sites for the anticipated sampling in the fall of 2017, and approximately every three years thereafter. If additional funding is identified, additional sites may be identified.

Consultation with the City's contractor for this monitoring element will identify the final site locations.

Figure 8. Stream Reaches Sampled for Macroinvertebrates in and Adjacent to the City of Lake Oswego, in Fall 2013

Source: Cole, 2014



4.4.2. Monitoring Frequency and Duration

The City will be completing one macroinvertebrate sampling, at ten (10) sites, during the permit term. The sampling is tentatively planned for the fall of 2017.

4.4.3. Identification of Sampling Coordinator

Biological monitoring will be coordinated by the Stormwater Quality Coordinator. The sampling will be conducted by a contractor.

4.5. Sample Collection Methods and Handling/Custody Procedures

The City's contractor will follow the sampling collection, handing and custody procedures outlined in DEQ's *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* (Oregon Department of Environmental Quality, 2009).

4.5.1. Macroinvertebrate Identification

The City's contractor will use the Macroinvertebrate identification method outlined in the *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* (Oregon Department of Environmental Quality, 2009).

4.6. Evaluation and Modeling Methods

The City's contractor will be using three separate models to assess the macroinvertebrate communities. They are the DEQ Multimetric Index, the Clackamas Lowlands IBI and the RIVPACS (Predator) models.

4.6.1. DEQ Multimetric Index

Macroinvertebrate taxonomic data will be analyzed using DEQ's Multimetric analysis for western Oregon streams to determine the condition of macroinvertebrate communities. Multimetric analysis employs a set of metrics, each of which describes an attribute of the macroinvertebrate community that is known to be responsive to one or more types of pollution or habitat degradation. Each community metric is then converted to a standardized score; standardized scores of all metrics are then summed to produce a single Multimetric score that is a numeric measure of overall biological integrity (Cole & Lemke, 2009; Cole, 2014).

4.6.2. Clackamas Lowlands B-IBI

A set of metrics has been developed to specifically examine the condition of macroinvertebrate communities in lowland streams of Clackamas County. This index, referred to as the Benthic Index of Biotic Integrity (B-IBI), employs a different set of metrics and scoring criteria specifically developed from and for use with benthic data from Clackamas County lowland streams. Metrics will be calculated from raw taxonomic data, a total B-IBI score computed, and corresponding biological impairment levels will be assigned based on total B-IBI scores (Cole & Lemke, 2009; Cole, 2014).

4.6.3. RIVPACS

RIVPACS (also regionally known as PREDATOR) is a predictive model that evaluates benthic community conditions based on a comparison of taxa observed (O) at a site versus those expected (E) to occur at a site in the absence of disturbance. Impairment to the community is determined by comparing the O/E score to the distribution of reference site O/E scores. Using the scoring criteria derived from the distribution of reference site scores for western Oregon, riffle-sample O/E scores in this study of less than 0.75 (>95thpercentile of reference site scores) were classified as "poor" (severely impaired), between 0.75 and 0.90 (90–95th percentile of reference site scores) as "fair" (or slightly impaired), and greater than 0.90 (<90th percentile of reference site scores) as "good" (unimpaired). The Marine Western Coastal Forest (MWCF) RIVPACS model will be used for this analysis (Cole & Lemke, 2009).

4.7. Quality Control Procedures

The City will reference the quality assurance procedures outlined in DEQ's *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* (Oregon Department of Environmental Quality, 2009).

4.7.1. Field Sample Collection QA

Ten percent of all stream sites sampled, or one sample per survey, whichever is greater, will have a duplicate set of field samples collected. The duplicate sample is from the same sample reach.

Field QA samples look at the natural variability within a riffle and insure that the field sampling method is repeatable. This sample is sorted and identified the same as any other sample. (Oregon Department of Environmental Quality, 2009)

4.7.2. Subsampling QA

The City of Lake Oswego's contractor will follow Subsampling protocol in DEQ's *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* (Oregon Department of Environmental Quality, 2009)

4.7.3. Identification Review

The City of Lake Oswego's contractor will follow identification review protocol in DEQ's *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* (Oregon Department of Environmental Quality, 2009)

4.8. Data Management

The City will reference the data management procedures outlined in DEQ's *Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams* (Oregon Department of Environmental Quality, 2009) to the extent practicable.

Final reports and raw data will be archived according to state retention schedules (minimum) and City needs.

4.8.1. Validation and Verification

Final review and verification shall be performed by the contractor and Stormwater Quality Coordinator. Field Data and chain of custody information will be reviewed and verified after data is entered into the water quality database.

5. Special Projects

The City anticipates continuing to participate in special projects as opportunities arise.

For instance, a City staff member currently sits on the board of the Stormwater Technology Testing Center (STTC) managed by the Oregon Department of Transportation. The STTC is intended to operate in a manner complimentary to the Washington Department of Ecology's TAPE program, but will focus on maintenance requirements of proprietary stormwater treatment technologies. At this time, participation by the City does not include monitoring to be performed by the City. Once the STTC is fully operating, testing results for specific treatment facility/devices will be able to contribute to the overall technical literature and information available to guide BMP selection and guidance. The City may elect to support specific tests, monitoring protocols, or device certification at this facility.

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Appendix A. Connection of Monitoring Plan to Adaptive Management Process

	Learn	Describe	Predict	Do
Instream Monitoring	*What are the long-term trends in receiving water quality?*	Data analysis and Trend Methodology - Section 2.2.3	extending in stream trend analysis beyond the extent of observations is beyond the scope of this monitoring plan. Empirical obersvations in trends will assist in characterizing the instream monitoring locations	BMP implementation, documentation and modification to adress long term trends in water quality
Stormwater Monitoring-Wet Weather	*What are the average storm event concentrations (EMCs) of pollutants like bacteria and TSS at the monitoring sites?* *What are the characteristics of the average storm event concentrations at monitoring sites? How do these local sites compare to the regional sites in the NSQD?* *How does Event Mean Concentrations (EMCs) of storm events in Lake Oswego compare regionally to storms of similar land use and precipitation? How do EMC concentrations compare to instream constituent concentrations?*	Data analysis and Trend Methodology - Section 3.2.3	Over time, wet weather monitoring will enable to compared its baseline condition to similar municipalities both regionally and nationally. These comaprisons may shed light on BMPs that are having measureable impacts of reducing pollutants to the MEP.	BMP implementation, documentation and modification to address pollutants
Instream Biological Monitoring	*What are the trends in macroinvertebrate communities over time?* *Can any biological effects (stressors) be assessed by comparing the results of macroinvertebrates overtime? Are there surrogate measures of that can be used to assess biological condition?*	Data analysis and Trend Methodology - Section 5.2.3	extending biological trend analysis beyond the extent of observations is beyond the scope of this monitoring plan	BMP implementation, documentation and modification to address long term trends in water quality

Appendix B. TMDL and 303(d) Listed Parameters

Waterbody	Aquatic Weeds or Algae	Aldrin	Ammonia	Chlorophyll-a	Dieldren	Fecal Coliform	Biological Criteria	Temperature	Dissolved Oxygen	E. Coli	Phosphorus	pH	PCBs	PAHs	DDT/DDE	TCE	Arsenic	Copper	Iron	Lead	Mercury	Thalium	Zinc
TMDL																							
Oswego Lake/ Oswego Creek	●								●		●	●									○		
Fanno Creek			●				●	●	●	●	●										○		
Springbrook Creek						●			●		●										○		
Tryon Creek								●													○		
Tualatin River	●		●	●				●	●		●	●									○		
Lower Willamette River (and tributaries)								●		●											○		
303(d) List (2012; effective Dec. 2016)																							
Oswego Lake/ Oswego Creek																							
Fanno Creek																●							
Springbrook Creek								●															
Tryon Creek				●														●	●	●	●		
Tualatin River																		●	●	●	●		●
Lower Willamette River (and tributaries)		●		●	●		●						●	●	●			●	●	●	●		

○ Phased TMDL
● Listed Constituent

Appendix C. Instream Field Data Collection Sheet

City of Lake Oswego Field Data Collection Sheet

*Sampler Name:(print)*____

*Sampler Signature:*____

			Field Parameters									
Sample ID/Description	Date Sampled	Time Sampled	Temperature (°C)	Specific Conductivity (µS/cm)	pH(S.U.)	Dissolved Oxygen (mg/L)-YSI 550	Turbidity (NTU)	Total Dissolved Solids		Stage (ft)	Site Notes	Lab Analyses
Tryon												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn
Springbrook												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn
S'brook Duplicate												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn
Bryant												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn
Lost Dog												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn
Temple												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn
Bangy												E. Coli; Hardness; BOD5; TSS/TVS/TDS; NH_3/NO_3; P/OP; T/D Cu, Pb, Zn

Field Notes (Weather, other site conditions, changes in sampling locations, etc.):

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Appendix D. Laboratory Chain of Custody

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Figure D-1. Instream Chain of Custody/Sample Analysis Request Form: Normal Ambient Sampling Event

CHAIN OF CUSTODY / ANALYSIS REQUEST (PLEASE COMPLETE ALL APPLICABLE SHADED SECTIONS)

PAGE_____ OF _______

REPORT TO: LAKE OSWEGO, CITY OF	BILL TO: LAKE OSWEGO, CITY OF	**FOR LAB USE ONLY**	
ADDRESS: 380 A AVENUE	ADDRESS: 380 A AVENUE	REF#	
CITY: LAKE OSWEGO STATE: OR ZIP: 97034	CITY: LAKE OSWEGO STATE: OR ZIP: 97034	**CHECK REGULATORY PROGRAM**	
ATTN: ANNE MACDONALD	PHONE: FAX:	☐ SAFE DRINKING WATER ACT	
PHONE: (503)675-3999 FAX: (503)635-0269	P.O.#: EN16041 ATTN: Donna Broadhurst	☒ CLEAN WATER ACT	
EMAIL: amacdonald@ci.oswego.or.us	☐ VISA ☐ M/C CARD# EXPIRES /	☐ RCRA / CERCLA	
PROJECT NAME: MS4 AMBIENT	EMAIL: dbroadhurst@ci.oswego.or.us	☐ OTHER	

EDGE ANALYTICAL LABORATORIES

Corporate
1620 South Walnut St.
Burlington, WA 98233
1.800.755.9295

Portland Lab
9150 SW Pioneer Ct. Ste W
Wilsonville, OR 97070
503.682.7802

INSTRUCTIONS
1. USE ONE LINE PER SAMPLE LOCATION.
2. BE SPECIFIC IN TEST REQUESTS.
3. NEW LIST EACH METAL INDIVIDUALLY. NEW
4. CHECK OFF ANALYSIS TO BE PERFORMED FOR EACH SAMPLE LOCATION.
5. ENTER NUMBER OF CONTAINERS.

TURN AROUND TIME REQUIRED
- ☐ STANDARD
- ☐ HALF-TIME (50% SURCHARGE)
- ☐ QUICKEST (100% SURCHARGE) PHONE CALL REQ.
- ☐ EMERGENCY (PHONE CALL REQUIRED)

ANALYSIS REQUESTED

	SAMPLE/SITE ID	LOCATION	GRAB/ COMP.	SAMPLE MATRIX*	DATE	TIME	BOD-5	TSS, DS, VS	O-Phos, NO3	Total-P, NH3	Cu, Pb, Zn, Hardness	Diss. Cu, Pb, Zn	E.coli (MPN) SM9223B	NUMBER OF CONTAINERS	SPECIAL INSTRUCTIONS/ CONDITIONS ON RECEIPT
1	Tryon	Tryon	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
2	Springbrook	Springbrook	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
3	Springbrook Dup.	Springbrook	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
4	Bryant	Bryant	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
5	Lost Dog	Lost Dog	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
6	Temple	Temple	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
7	Bangy	Bangy	Grab	SW			☒	☒	☒	☒	☒	☒	☒		
8							☒	☒	☒	☒	☒	☒	☒		
9							☒	☒	☒	☒	☒	☒	☒		
10							☒	☒	☒	☒	☒	☒	☒		

SAMPLED BY: PHONE: FAX: EMAIL: ◄TOTAL CONTAINERS

SAMPLE RECEIPT REQUESTED (MUST INCLUDE FAX OR EMAIL) ☒

*W- WATER DW- DRINKING WATER SW- SURFACE WATER GW- GROUND WATER WW- WASTE WATER S- SOIL OL- OIL OTHER__________

RELINQUISHED BY	DATE	TIME	RECEIVED BY	DATE	TIME

	YES	NO	N/A
EVIDENCE OF COOLING	☐	☐	☐
SAMPLE TEMP_____°C SATISFACTORY	☐	☐	☐
SAMPLES RECEIVED INTACT/IN HOLD TIME	☐	☐	
CHAIN OF CUSTODY & LABELS AGREE	☐	☐	

Figure D-2. Instream Chain of Custody/Sample Analysis Request Form: Expanded (aka Quarterly) Ambient (add to COC in Figure D-1)

CHAIN OF CUSTODY / ANALYSIS REQUEST (PLEASE COMPLETE ALL APPLICABLE SHADED SECTIONS)

PAGE 2 OF 2

REPORT TO: LAKE OSWEGO, CITY OF	BILL TO: LAKE OSWEGO, CITY OF	FOR LAB USE ONLY
ADDRESS: 380 A AVENUE	ADDRESS: 380 A AVENUE	REF#
CITY: LAKE OSWEGO STATE: OR ZIP: 97034	CITY: LAKE OSWEGO STATE: OR ZIP: 97034	CHECK REGULATORY PROGRAM
ATTN: ANNE MACDONALD	PHONE: FAX:	☐ SAFE DRINKING WATER ACT
PHONE: (503)675-3999 FAX: (503)635-0269	P.O.#: EN16041 ATTN: Donna Broadhurst	☒ CLEAN WATER ACT
EMAIL: amacdonald@ci.oswego.or.us	☐ VISA ☐ M/C CARD# EXPIRES /	☐ RCRA / CERCLA
PROJECT NAME: MS4 QUARTERLY ADDITIONAL	EMAIL: dbroadhurst@ci.oswego.or.us	☐ OTHER

EDGE ANALYTICAL LABORATORIES
Corporate
1620 South Walnut St.
Burlington, WA 98233
1.800.755.9295
Portland Lab
9150 SW Pioneer Ct. Ste W
Wilsonville, OR 97070
503.682.7802

INSTRUCTIONS
1. USE ONE LINE PER SAMPLE LOCATION.
2. BE SPECIFIC IN TEST REQUESTS.
3. NEW LIST EACH METAL INDIVIDUALLY. NEW
4. CHECK OFF ANALYSIS TO BE PERFORMED FOR EACH SAMPLE LOCATION.
5. ENTER NUMBER OF CONTAINERS.

TURN AROUND TIME REQUIRED
- ☐ STANDARD
- ☐ HALF-TIME (50% SURCHARGE)
- ☐ QUICKEST (100% SURCHARGE) PHONE CALL REQ.
- ☐ EMERGENCY (PHONE CALL REQUIRED)

ANALYSIS REQUESTED

	SAMPLE/SITE ID	LOCATION	GRAB/ COMP.	SAMPLE MATRIX*	DATE	TIME	TOC	DOC	Alkalinity	Ca, Na, K, Mg	Cl, SO4			NUMBER OF CONTAINERS	SPECIAL INSTRUCTIONS/ CONDITIONS ON RECEIPT
1	Tryon	Tryon	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
2	Springbrook	Springbrook	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
3	Springbrook Dup.	Springbrook	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
4	Bryant	Bryant	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
5	Lost Dog	Lost Dog	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
6	Temple	Temple	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
7	Bangy	Bangy	Grab	SW			☒	☒	☒	☒	☒	☐	☐		
8							☒	☒	☒	☒	☒	☐	☐		
9							☒	☒	☒	☒	☒	☐	☐		
10							☒	☒	☒	☒	☒	☐	☐		

SAMPLED BY: PHONE: FAX: EMAIL: ◄TOTAL CONTAINERS

SAMPLE RECEIPT REQUESTED (MUST INCLUDE FAX OR EMAIL) ☒

*W- WATER DW- DRINKING WATER SW- SURFACE WATER GW- GROUND WATER WW- WASTE WATER S- SOIL OL- OIL OTHER________

RELINQUISHED BY	DATE	TIME	RECEIVED BY	DATE	TIME

	YES	NO	N/A
EVIDENCE OF COOLING	☐	☐	☐
SAMPLE TEMP_____ºC SATISFACTORY	☐	☐	☐
SAMPLES RECEIVED INTACT/IN HOLD TIME	☐	☐	
CHAIN OF CUSTODY & LABELS AGREE	☐	☐	

FORM: COC 01-06-2009

Figure D-3. Wet Weather Chain of Custody/Sample Analysis Request Form

CHAIN OF CUSTODY / ANALYSIS REQUEST (PLEASE COMPLETE ALL APPLICABLE SHADED SECTIONS)

PAGE_____ OF ______

REPORT TO: LAKE OSWEGO, CITY OF	BILL TO: LAKE OSWEGO, CITY OF	FOR LAB USE ONLY
ADDRESS: 380 A AVENUE	ADDRESS: 380 A AVENUE	REF#
CITY: LAKE OSWEGO STATE: OR ZIP: 97034	CITY: LAKE OSWEGO STATE: OR ZIP: 97034	CHECK REGULATORY PROGRAM
ATTN: ANNE MACDONALD	PHONE: FAX:	☐ SAFE DRINKING WATER ACT
PHONE: (503)675-3999 FAX: (503)635-0269	P.O.#:EN16041 ATTN: Donna Broadhurst	☒ CLEAN WATER ACT
EMAIL: amacdonald@ci.oswego.or.us	☐ VISA ☐ M/C CARD# EXPIRES /	☐ RCRA / CERCLA
PROJECT NAME: MS4 WET WEATHER	EMAIL: dbroadhurst@ci.oswego.or.us	☐ OTHER

EDGE ANALYTICAL LABORATORIES
Corporate
1620 South Walnut St.
Burlington, WA 98233
1.800.755.9295
Portland Lab
9150 SW Pioneer Ct. Ste W
Wilsonville, OR 97070
503.682.7802

INSTRUCTIONS
1. USE ONE LINE PER SAMPLE LOCATION.
2. BE SPECIFIC IN TEST REQUESTS.
3. NEW LIST EACH METAL INDIVIDUALLY. NEW
4. CHECK OFF ANALYSIS TO BE PERFORMED FOR EACH SAMPLE LOCATION.
5. ENTER NUMBER OF CONTAINERS.

TURN AROUND TIME REQUIRED
- ☐ STANDARD
- ☐ HALF-TIME (50% SURCHARGE)
- ☐ QUICKEST (100% SURCHARGE) PHONE CALL REQ.
- ☐ EMERGENCY (PHONE CALL REQUIRED)

ANALYSIS REQUESTED

	SAMPLE/SITE ID	LOCATION	GRAB/ COMP.	SAMPLE MATRIX*	DATE	TIME	BOD-5	TSS, DS, VS	O-Phos, NO3	Total-P, NH3	Cu, Pb, Zn, Hardness	Diss. Cu, Pb, Zn	E.coli (MPN) SM9223B	NUMBER OF CONTAINERS	SPECIAL INSTRUCTIONS/ CONDITIONS ON RECEIPT
1	WW-1	Reese	Comp	SW			☒	☒	☒	☒	☒	☒	☐		
2	WW-2	South Shore	Comp	SW			☒	☒	☒	☒	☒	☒	☐		
3	WW-3	South Shore	Comp	SW			☒	☒	☒	☒	☒	☒	☐		
4	WW-4	Reese	Comp	SW			☒	☒	☒	☒	☒	☒	☐		
5	WW-1A	Reese	Grab	SW			☐	☐	☐	☐	☐	☐	☒		
6	WW-1B	Reese	Grab	SW			☐	☐	☐	☐	☐	☐	☒		
7	WW-1C (etc.)	Reese	Grab	SW			☐	☐	☐	☐	☐	☐	☒		
8	WW-2A	South Shore	Grab	SW			☐	☐	☐	☐	☐	☐	☒		
9	WW-2B	South Shore	Grab	SW			☐	☐	☐	☐	☐	☐	☒		
10	WW-2C	South Shore	Grab	SW			☐	☐	☐	☐	☐	☐	☒		

SAMPLED BY: PHONE: FAX: EMAIL: ◄TOTAL CONTAINERS

SAMPLE RECEIPT REQUESTED (MUST INCLUDE FAX OR EMAIL) ☒

*W- WATER DW- DRINKING WATER SW- SURFACE WATER GW- GROUND WATER WW- WASTE WATER S- SOIL OL- OIL OTHER___________

RELINQUISHED BY	DATE	TIME	RECEIVED BY	DATE	TIME

	YES	NO	N/A
EVIDENCE OF COOLING	☐	☐	☐
SAMPLE TEMP_____ºC SATISFACTORY	☐	☐	☐
SAMPLES RECEIVED INTACT/IN HOLD TIME	☐	☐	
CHAIN OF CUSTODY & LABELS AGREE	☐	☐	

FORM: COC 01-06-2009

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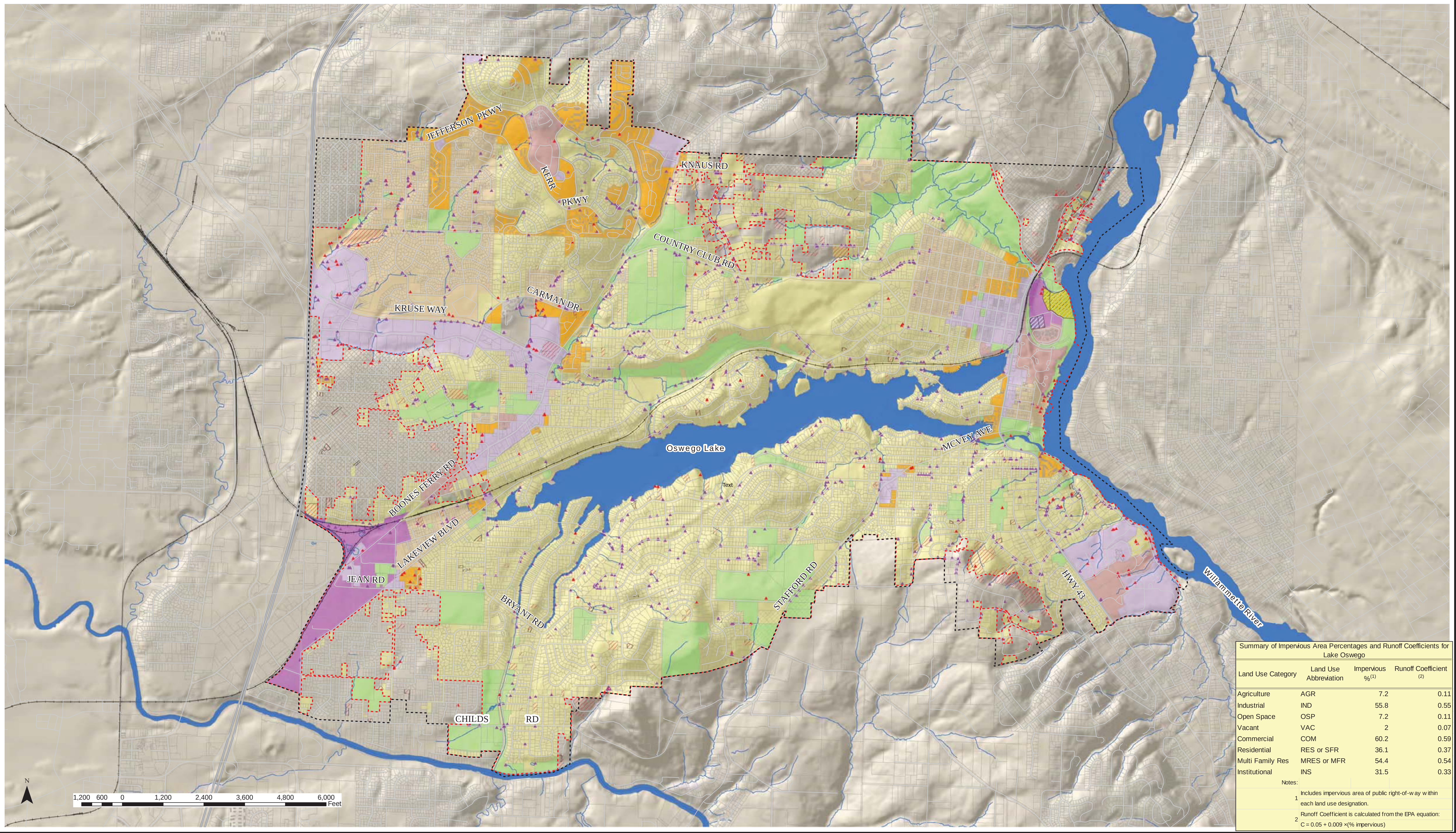
Appendix E:
MS4 Maps



Summary of Impervious Area Percentages and Runoff Coefficients for Lake Oswego			
Land Use Category	Land Use Abbreviation	Impervious %(1)	Runoff Coefficient (2)
Agriculture	AGR	7.2	0.11
Industrial	IND	55.8	0.55
Open Space	OSP	7.2	0.11
Vacant	VAC	2	0.07
Commercial	COM	60.2	0.59
Residential	RES or SFR	36.1	0.37
Multi Family Res	MRES or MFR	54.4	0.54
Institutional	INS	31.5	0.33
Notes:			
1	Includes impervious area of public right-of-way within each land use designation.		
2	Runoff Coefficient is calculated from the EPA equation: C = 0.05 + 0.009 ×(% impervious)		

Data Source: City of Lake Oswego GIS

CITY OF LAKE OSWEGO, OREGON

MS4 Maps

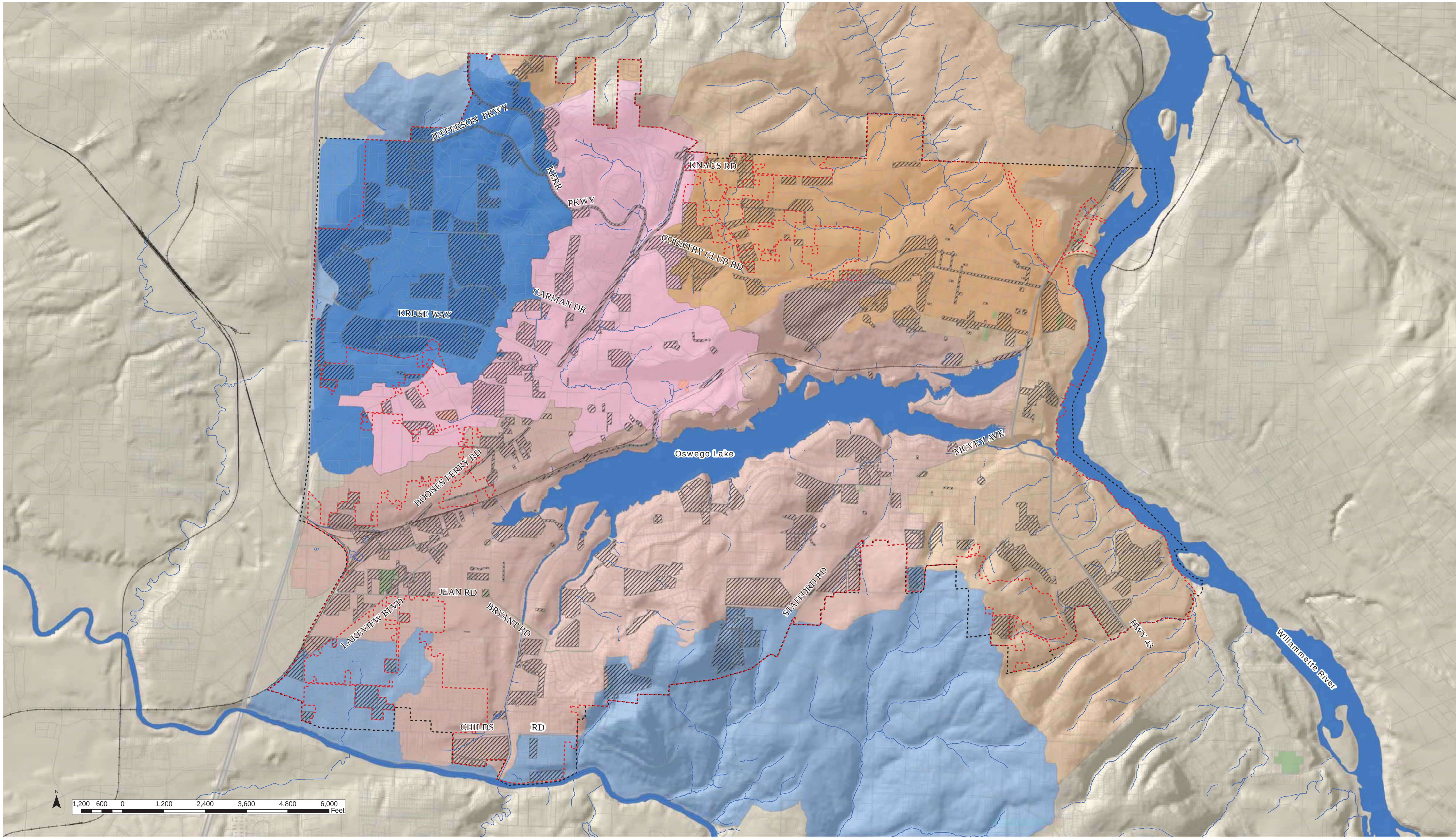
Figure **E**-1: Service Area and Land Use

Urban Services Boundary
City Limits
Streets
Highways
Water Bodies
Outfall Public
Outfalls Private
Property Boundaries
Unincorporated

Zoning/Land Use

WWTP 1200Z
Cement Plant 1200A
Vacant Land
High Density Residential
Medium Density Residential
Low Density Residential
Mixed Use
Parks/Open Space
Industrial
Commercial

Document Path: H:\Surface Water\MS4_2017\Map1.mxd



Data Source: City of Lake Oswego GIS

CITY OF LAKE OSWEGO, OREGON

MS4 Maps

Figure **E**-2: Public Facilities

Streams
Water Bodies
Public Stormwater Facility Drainage Area
Lake Oswego Facilities

Basins

Fanno Creek
Springbrook Creek
Tryon

Watersheds

Oswego Lake
Tualatin River
Willamette River

Lake Oswego City Limits
City Limits & Urban Services Boundary
Streets
Interstate
Landfills Construction Debris (Closed)

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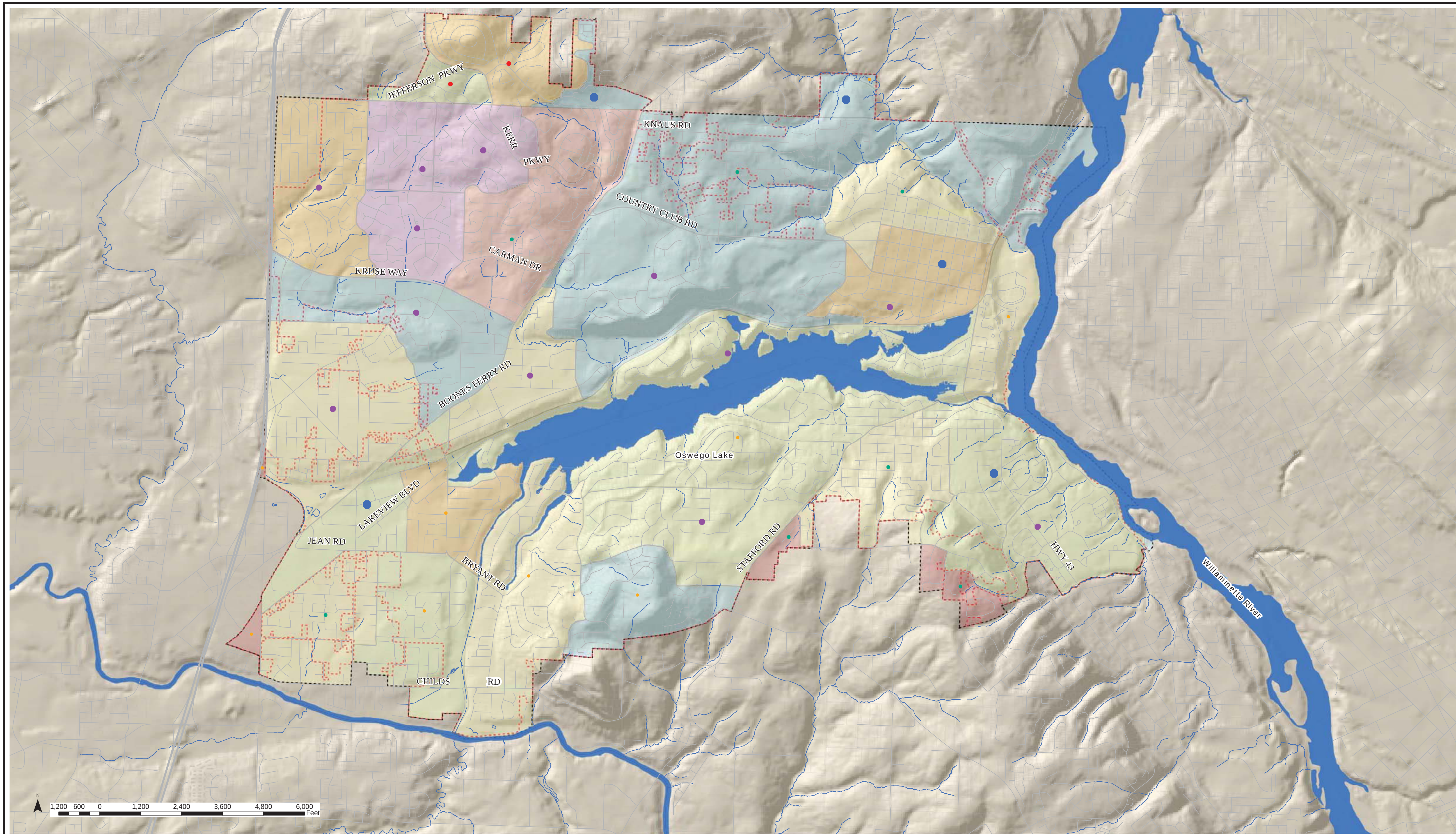

Data Source: City of Lake Oswego GIS and US Census Bureau

CITY OF LAKE OSWEGO, OREGON

MS4 Maps

Figure E-3: Population Density and Growth Projections

Estimated 10-yr Population Growth by Population Block Group

- -10%
- -5%
- 0%
- 0-5%
- 5-10%
- Water Bodies
- Streams
- City_limit_outline
- Interstate
- Streets

Population Density Per Square Mile (2010 Census)

0 - 1000, 1000 - 2000, 2000 - 3000, 3000 - 4000, 4000 - 5000, 5000 - 6000, 6000 - 7500

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THE RIVER STARTS HERE

LAKE OSWEGO

healthy watersheds

Stewardship for a Sustainable Future