City of Gladstone

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

PERMIT NO.: 101348

FILE NO.: 108016

February 28, 2017

Assisted by:

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City of Gladstone

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
MUNICIPAL SEPARATE STORM SEWER (MS4)
PERMIT RENEWAL APPLICATION PACKAGE

February 28, 2017

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

Jim Whynot, Public Works Director
City of Gladstone

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Section 1
Introduction and 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 an NPDES municipal separate storm sewer system (MS4) permit. Clackamas County was one of the jurisdictions required to obtain an NPDES MS4 permit, and the City of Gladstone is one of the 13 co-permittees on the Clackamas County NPDES MS4 permit.

1.1 Permit Background

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 a Stormwater Management Plan (SWMP), which included a number of Best Management Practices (BMPs) to address specific sources of pollutants. However, the requirements did not specify the number or type of BMPs that should be implemented. Instead, the requirement states that BMPs should be implemented to reduce the discharge of pollutants to the “maximum extent practicable”. The City of Gladstone (City) received its first NPDES MS4 permit from DEQ in 1995.

The permit period for the 1995 NPDES MS4 permit was 5 years during which time jurisdictions were responsible for implementation of their SWMPs. The 1995 NPDES MS4 permit required renewal at the end of the 5-year permit period. In March 2004, the NDPES MS4 permits were reissued to the six larger Oregon jurisdictions, including Clackamas County and its co-permittees. The 2004 NPDES MS4 permit included additional requirements such as the evaluation and refinement of the SMWPs, incorporation of specific monitoring elements, and inclusion of additional information with the annual reports.

Third-party groups requested DEQ to reconsider the 2004 permit to address total maximum daily load (TMDL) obligations. DEQ agreed to reconsider the permit, and as a result, some additional changes were made. The changes included more specific reporting of SWMP commitments, additional public involvement, and a 6-month extension for developing the revised SWMP.

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

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

1.2 Description of Permit Area and Coordination with Co-Permittees

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

1.2.1 Description of the City of Gladstone Permit Area

The City is located in Clackamas County, approximately 12 miles south of the City of Portland. The city occupies a total of 2.5 square miles and has approximately 12,000 residents (http://www.ci.gladstone.or.us/). The City is bordered by the Clackamas River to the south, the Willamette River to the west, unincorporated Clackamas County (Clackamas County Service District #1 or CCSD #1) to the north and east, and Oak Grove/ Oak Lodge Water Services District (OLWSD) to the north.

The City is primarily developed, with only about 10 percent of the city area identified as vacant. Vacant lands are scattered throughout the City, and a majority are publicly held (*Gladstone Stormwater Master Pla*n 2014).

Land use is primarily residential, with limited amounts of commercial and industrial land throughout the City. Commercial development is generally located along Oregon Highway 99E and at the intersection of 82nd Drive and Interstate 205. There are numerous areas of public use, including several parks and open space areas.

The City is divided into two primary watersheds that discharge to the Lower Willamette River and the Clackamas River. Rinearson Creek is a smaller tributary that flows east-west through the City to the Willamette River. The Willamette River and tributaries (including the Clackamas River and Rinearson Creek) currently have a TMDL in place for temperature, bacteria, and mercury.

1.2.2 Summary of City Coordination with Co-permittees

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

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

1.3 Organization of Document

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

Table 1-1. Permit Renewal Submittal Components

Submittal component	Permit requirement	Permit application section
Introduction 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 Appendix 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 Matrix Monitoring objectives matrix and updated Monitoring Plan	B.6.d	Section 7.0 and Appendix D
MS4 Maps	B.6.g	Appendix A

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Section 2
Maximum Extent Practicable Evaluation

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

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

b. The information and analysis necessary to support the Department's independent assessment that the co-permittee's stormwater management program addressed the requirements of the existing permit. Co-permittees must also describe how the proposed management practices, control techniques, and other provisions implemented as part of the stormwater program were evaluated using a co-permittee-defined and standardized set of objective criteria relative to the following MEP general evaluation factors:

   i. Effectiveness – program elements effectively address stormwater pollutants

   ii. Local Applicability – program elements are technically feasible considering local soils, geography, and other locale specific factors.

   iii. Program Resources – program elements are implemented considering availability to resources and the co-permittees stormwater management program priorities.

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

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

- Section 2.1: How the Existing Stormwater Management Program Addressed 2012 Permit Requirements
- Section 2.2: How the Proposed Stormwater Management Program Meets the MEP Requirement

2.1 How the Existing Stormwater Management Program Addressed 2012 Permit Requirements

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

2.1.1 Annual Adaptive Management Permit Requirements

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

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

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

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

Each annual report submitted to DEQ includes a section to summarize implementation of the adaptive management process and any resulting proposed SWMP changes. During this permit term, given the maturity of the stormwater program, no refinements were made to the 2012 SWMP. Changes that did occur with respect to the program were related to staffing transitions. During the last two reporting years, the City of Gladstone underwent substantial staffing changes, city-wide. With the hiring of a Public Works Director in December 2015, the City designated specific staff to oversee stormwater management activities and implement improved tracking procedures to monitor the progress of the SWMP. The City initiated a more proactive and scheduled system maintenance program, including catch basin cleaning and structural stormwater facility maintenance.

2.1.2 Stormwater Program Compliance with Permit Requirements

Per Schedule A.2 of the permit:

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

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

Table 2-1. 2012 Permit Requirements			
Requirement	**Permit section**	**Due date**	**Status**
Illicit Discharge Detection and Elimination • Document an enforcement response plan for responding to illicit discharges	A.4.a.ii	11/1/2012	• Enforcement response is part of the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure,* which was submitted to DEQ by 11/1/2012.
• Document pollutant parameter action levels and report them to DEQ in an enforcement response plan	A.4.a.iii	11/1/2012	• Pollutant parameter action levels were documented in the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure.*
• Annual dry weather field screening activities must include identified priority locations, which are identified on a map	A.4.a.iv and xi	11/1/2012	• Dry weather field screening locations are mapped and referenced in the City's *Illicit Discharge Detection and Elimination Standard Operating Procedure.*
Industrial and Commercial Facilities Implement an updated strategy to reduce pollutants to the MS4 from industrial and commercial facilities identified as sources that contribute significant pollutant loads to the MS4	A.4.b.iii	7/1/2013	A strategy was completed and implementation initiated.
Construction Site Runoff Control The construction site runoff control program must apply to activities that result in a land disturbance of 1,000 square feet or greater	A.4.c.i	11/1/2014	The City has an intergovernmental agreement (IGA) with Clackamas County Service District #1 (CCSD#1) for erosion control services.
Education and Outreach Conduct or participate in an effectiveness evaluation to measure the success of public education activities	A.4.d.vi	7/1/2015	The City participated in a regional public education effectiveness evaluation and submitted it to DEQ by 7/1/2015.
Public Involvement and Participation Provide opportunities for public comments on the 2012 monitoring plan, annual reports, SWMP revisions, and the TMDL pollutant load reduction benchmark development	A.4.e	9/1/2012 (monitoring plan)	The 2012 monitoring plan was provided for public review and comment and submitted to DEQ by 9/1/2012. Annual reports, proposed SWMP revisions, and pollutant load reduction benchmarks have also been provided to the public for review and comment.
Post-construction Site Runoff • Implement a post-construction site runoff program that meets designated permit conditions	A.4.f	11/1/2014	• The City references CCSD#1's standards.
• Identify, minimize, or eliminate barriers in ordinances, code, and development standards that inhibit LID/green infrastructure	A.4.f.ii	11/1/2014	• Updates to the City's public works standards are currently underway.
• Develop or reference an enforceable post-construction stormwater management manual or equivalent document	A.4.f.iii	11/1/2014	• See first bullet.

Table 2-1. 2012 Permit Requirements			
Requirement	**Permit section**	**Due date**	**Status**
Pollution Prevention for Municipal Operations Inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that treat, store, or transport municipal waste	A.4.g.iii	7/1/2013	The City submitted a document titled *Stormwater Pollution Prevention Strategies for Municipal Operations* to DEQ on 7/1/2013 and has initiated implementation of the strategies.
Stormwater Management Facilities O&M Activities Inventory and map stormwater management facilities and controls and implement a program to verify that stormwater management facilities and controls are inspected, operated, and maintained	A.4.h.i	7/1/2013	The City implements an inspection and maintenance procedure that was previously documented in 2009. Refinement of mapping of stormwater management facilities was conducted in conjunction with pollutant load modeling for benchmarks.
Hydromodification Assessment Conduct assessment and submit report	A.5	7/1/2015	The City submitted the *Hydromodification Assessment* report to DEQ on 9/1/2015, per the extension letter submitted to DEQ in June 2015.
Stormwater Retrofit Strategy Development • Identify 1 stormwater quality improvement project	A.6.c	7/1/2014	• A retrofit project was identified to construct a rain garden for runoff from the parking lot at Dahl Beach City Park.
• Initiate, construct, or implement the project	A.6.c	Permit expiration	• Constructed the identified retrofit project listed in the bullet above during the summer of 2016.
• Develop a retrofit strategy and submit plan to DEQ	A.6.b	7/1/2015	• The City developed a retrofit strategy/plan as part of development of their stormwater master plan, which was completed November 2014.
Monitoring and Reporting Requirements • Submit draft plan to DEQ for review	B.2	9/1/2012	• The updated *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan (CCCSMP)* was submitted to DEQ on 9/1/2012.
• Implement the approved plan	B.2	10/1/2012	• Implementation of the updated *Comprehensive Clackamas County NPDES MS4 Monitoring Plan* was initiated on 10/1/2012.
Annual Reporting Submit annual reports each year from the time frame 7/1 of the previous year through 6/30 of the same year	B.5	11/1 (annually)	All annual reports for the permit term were submitted to DEQ.

Table 2-1. 2012 Permit Requirements			
Requirement	**Permit section**	**Due date**	**Status**
Permit Renewal Application Package Submit permit renewal application package	B.6	9/2/2016 (180 days before permit expiration)	The City will be submitting by 2/28/2017 (at permit expiration) in accordance with NPDES MS4 permit, Schedule F, Section A.4.
303(d) Listed Pollutants Submit evaluation report in the 4th annual report	B.5.k D.2	11/1/2015 (4th annual report)	The City submitted by 11/1/2015.
Total Maximum Daily Loads • Submit a wasteload allocation attainment assessment	B.5.k D.3.b	11/1/2015 (4th annual report)	• The City submitted the *Wasteload Allocation Attainment Assessment* on 2/1/2016, per the extension letter submitted to DEQ in October 2015.
• Submit a TMDL pollutant load reduction evaluation	B.5.k D.3.c	11/1/2015 (4th annual report)	• The City submitted the *Pollutant Load Reduction Evaluation* on 2/1/2016, per the extension letter submitted to DEQ in October 2015.
• Submit TMDL benchmarks	D.3.d	9/2/2016 (180 days before permit expiration)	• Provided in Section 5 of this permit renewal application (see above bullet regarding the permit renewal package deadline).
Adaptive Management Submit an adaptive management approach	D.4	11/1/2012	The City submitted to DEQ on 11/1/2012.
SWMP Revisions Revise to include new permit requirements	D.5 and D.8	5/1/2012	The City revised the SWMP accordingly and submitted it to DEQ on 5/1/2012.
Conduct Stormwater Master Planning Complete and submit a stormwater master plan	D.6	1/1/2014	The City submitted an interim draft to DEQ by 1/1/2014. The final stormwater master plan was approved by City Council in November 2014. The final stormwater master plan was adopted by City Council in November 2015.

2.2 How the Proposed Stormwater Management Program Meets the MEP Requirement

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

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

2.2.1 Maximum Extent Practicable Background

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

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

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

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

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

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

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

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

2.2.2 Maximum Extent Practicable Evaluation Factors and Criteria

The purpose of this section is to address the permit requirement in Schedule B.6.b to describe how the proposed management practices, control techniques, and other provisions

implemented as part of the stormwater program were evaluated using a permittee-defined and standardized set of objective criteria relative to the following MEP general evaluation factors:

i. *Effectiveness – program elements effectively address stormwater pollutants.*

ii. *Local Applicability – technically feasible considering local soils, geography, etc.*

iii. *Program Resources – program elements are being implemented considering availability to resources and the co-permittee's stormwater management program priorities.*

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

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

- Program effectiveness:
  - The program includes a range of BMPs that encompass pollution prevention, source control, and treatment approaches.
  - The program includes BMPs that are technically feasible, effective, and implementable.
- Local applicability:
  - The program is consistent with local ordinances and current legal authority.
  - Stormwater design standards implemented as part of the program reflect local conditions specific to soils, rainfall, infiltration rates, and stream conditions.
- Program resources:
  - The program is included in the current budget allocations.
  - The program considers implementation costs and practicability within the overall context of permittee priorities and resources.

2.2.3 Program Assessment and Results for the Permit Renewal

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

1) **Review of annual assessments:** A summary of the annual adaptive management approach and results from the annual adaptive management process is provided in Section 2.1.1 above. Significant staffing changes over this permit term factored into the ability of the City to be consistent in annual reporting. No refinements were made to the SWMP as a result of annual assessments.

2) **Review of monitoring information (i.e., trends results):** In 2015, a summary of water quality trends was submitted to DEQ based on the results of environmental monitoring conducted under this permit. The City, via an IGA with Clackamas County Water Environment Services, has been collecting instream water quality monitoring data since 2008 from one site on Rinearson Creek. The trends analysis is provided as an appendix to

the *TMDL Pollutant Load Evaluation and TMDL Benchmarks Report*, which is provided as Appendix C to this permit renewal application.

Based on the results from this trends analysis, the majority of pollutants that were analyzed showed no trend in either direction (i.e., either improving or degrading). Bacteria showed a declining (i.e., improving water quality) trend. No changes were made to the monitoring plan or SWMP as a result of this analysis.

3) **Evaluations and reports:** As stated in the City's adaptive management process, specific deliverables required under the current permit were reviewed and considered with respect to stormwater program updates. The permit deliverables that were reviewed and submitted during the permit term included the following:
   - A hydromodification assessment (Schedule A.5),
   - A stormwater retrofit strategy (Schedule A.6),
   - A 303(d) list evaluation (Schedule D.2),
   - A total maximum daily load (TMDL) wasteload allocation attainment assessment (Schedule D.3.b)
   - A TMDL pollutant load reduction evaluation and establishment of benchmarks (Schedule D.3.c and d)
   - A public education program effectiveness evaluation (Schedule A.4.d)

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

   The hydromodification assessment included recommendations to:
   - Establish a schedule and funding mechanism to support implementation of stormwater capital improvement projects (CIPs) to minimize flooding and improve natural stream conditions
   - Establish a maintenance schedule that includes annual inspections and removal of sediment and debris around culverts and structures on Rinearson Creek
   - Conduct annual documentation of stream channel conditions in locations of proposed and completed in-stream projects
   - Update existing stormwater design standards for consistency with current Clackamas County (County) standards.

   The retrofit strategy was incorporated into the City's recent (2014) stormwater master plan. The master plan resulted in 18 CIPs to address water quality and flood control objectives. Five of the CIPs addressed both objectives. Ten of the CIPs were focused on addressing water quality objectives. Another objective of the stormwater master plan was to provide the information needed to develop a dedicated stormwater funding source.

   As a result of these two studies, over the upcoming permit term, the City will be focused on establishing a dedicated funding source to support implementation of recommended water quality projects. In addition, the City will be updating their existing stormwater design standards in conjunction with updates to their public works standards.

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

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

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

Section 3
Summary of Proposed SWMP Modifications

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

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

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

This section of the permit renewal application provides the proposed changes to the City's 2012 Stormwater Management Plan (SWMP), in conjunction with results of the maximum extent practicable (MEP) evaluation documented in Section 2.0.

The City's 2012 SWMP is organized into eight program components, consistent with the NPDES MS4 permit. Each program component includes best management practices (BMPs), and each BMP has measurable goals and tracking measures. The City intends to maintain the same SWMP organization when the SWMP is updated in the next permit term, provided the next NPDES MS4 permit uses the same eight program components.

Table 3-1 below summarizes the proposed changes to the 2012 SWMP. City staff used the 5-year adaptive management process to identify proposed changes. Changes have been organized into the following three categories to aid in the review:

O	**(Organizational change)**	SWMP organizational change.
R	**(Removed activity)**	Task/activity had a discrete timeline and has been completed. Task/activity is proposed for removal from the SWMP.
I	**(Implementation change)**	Implementation change affecting task description, measurable goals, or tracking measures. Change is due to improved efficiencies and adjustments to internal processes and procedures.

The proposed 2017 SWMP is included in its entirety in Appendix B of this permit renewal application.

Table 3-1. 2017 Summary of Proposed SWMP Changes

O = Organizational change *R= Removed activity* *I = Implementation change*

Change category	2017 BMP Name	Summary of changes to 2012 BMP	Rationale/reason
R, I	Implement the Illicit Discharge Detection and Elimination Program	• The BMP description was updated to reference implementation of the 2012 Illicit Discharge Detection and Elimination (IDDE) standard operating procedures (SOP). • Removed the measureable goal and tracking measure reference to the development of an IDDE SOP.	• The City developed their IDDE SOP in November 2012. It contains information related to the identification of high priority field screening locations, field screening procedures, and code and enforcement authority. Implementation activities are now listed specifically in the IDDE SOP. • The City hired a Public Works Director in 2015 who is responsible for enforcing code related to the City's NPDES MS4 permit.
R, I, O	Conduct Annual Dry Weather Field Screening	• The BMP description was updated to reference the IDDE SOP for inspection procedures and activities. • Adjusted the measureable goal to reflect inspection of high priority field screening locations instead of major and minor outfalls. • Changed enforcement authority from the City Administrator to the Public Works Director.	
I	Spill Response	• The BMP description was updated to reflect the current, non-emergency phone number for the Fire Department.	• Updated for consistency with current implementation efforts.
R, I, O	Conduct Inspections of High Priority Facilities	• The BMP description was updated to reference implementation of the City of Gladstone's Industrial/ Commercial Facility Inspection Program document. • The BMP description and measureable goal were updated to reflect use of windshield surveys and onsite business inspections, in conjunction with the new Program document. • Changed enforcement authority from the City Administrator to the Public Works Director.	• The City developed its Industrial/ Commercial Facility Inspection Program document in July 2013. It contains information related to the identification of potential high pollutant source facilities, inspection procedures, identification of potential industrial stormwater permittees, and code and enforcement authority. Implementation activities are now listed specifically in the Program document. • The City hired a Public Works Director in 2015 who is responsible for enforcing code related to the City's NPDES MS4 permit.
I	Require Erosion Control for New and Redevelopment	• The BMP description was updated to accurately reference Clackamas County (CCSD #1) responsibility for plan review and permit issuance. • The BMP description was updated to reference DEQ (and not WES) implementation of the 1200-C permit. • The BMP measurable goal was updated to reflect future code revisions in conjunction with the development of Public Works Standards.	• Updated for consistency with current implementation efforts (by the City and Clackamas County).
I	Educational Training Measures for Construction Site Operators	• The BMP description and measurable goal were updated to reflect providing a link to contractors for the Erosion Prevention and Sediment Control Planning and Design Manual, instead of a hardcopy.	

Table 3-1. 2017 Summary of Proposed SWMP Changes

O = Organizational change *R= Removed activity* *I = Implementation change*

Change category	2017 BMP Name	Summary of changes to 2012 BMP	Rationale/reason
I	Conduct Erosion Control Inspection and Enforcement	• The BMP description was updated to accurately reference Clackamas County (CCSD #1) responsible for inspections and enforcement.	• Updated for consistency with current implementation efforts (by the City and Clackamas County).
I	Provide Public Education and Outreach Materials Regarding Stormwater Management	• The BMP description, measurable goal and tracking measure were updated to reflect installation of decals on catch basins and not stenciling. The tracking measure was updated to record the number of decals installed and not the percentage of total.	• Updated for consistency with current implementation efforts.
R	Participate in a Public Education Effectiveness Evaluation	• Removed reference to the development of a public education effectiveness evaluation.	• The City coordinated with other Phase I permittees to complete this requirement and submitted an evaluation report to DEQ by July 1, 2015.
O, I	Provide for Public Participation in Submittals	• Updated the responsible department to specify staff responsibility. • The BMP description was updated to remove reference to a 30-day public review period for SWMP updates and benchmarks.	• The City would like to remove the 30-day public review period timeframe given that this timeframe is limiting and not required by the permit, CFRs, or City code.
I	Review and Update the Applicable Code and Development Standards Related to Stormwater Control	• Updated the BMP description, measurable goal, and tracking measure to reflect an update of the stormwater design standards with development of Public Works Standards.	• The City implements stormwater design standards consistent with Clackamas County Service District #1 (CCSD #1). Current stormwater design standards need to be revised for consistency with current plan review activities and CCSD#1's updated design and construction standard language.
I	Street Maintenance	• The BMP description and measurable goal were updated to remove reference to the City providing weekly curbside yard debris pick up. • The measurable goal was updated to reflect a minimum sweeping frequency of three times per year, consistent with the existing BMP description.	• The City provides scheduled winter leaf pick up to residents, but yard debris pick up is provided by a third party garbage and recycling service.
I, R	Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	• The BMP description and measurable goals were updated to reference implementation of the City of Gladstone's Stormwater Pollution Prevention Strategy for Municipal Facilities (SWPPS). • Adjusted the BMP description and measurable goals to reference annual review and implementation of short and long term strategies as outlined in the SWPPS. • Adjusted the tracking measure to updates or modifications to the SWPPS.	• The City developed their SWPPS in June 2013. It contains site-specific BMPs aimed at reducing the discharge of pollutants from municipal facilities.

Table 3-1. 2017 Summary of Proposed SWMP Changes

O = Organizational change *R= Removed activity* *I = Implementation change*

Change category	2017 BMP Name	Summary of changes to 2012 BMP	Rationale/reason
I, R	Control Infiltration and Cross Connections to the Stormwater Conveyance System	• The BMP description and measurable goals were updated to reflect development of the City's Sanitary Sewer Master Plan and implementation of smoke testing in select basins. • Removed the measurable goal to maintain a contract with Clackamas County for I&I investigations.	• I&I investigations are no longer being conducted by Clackamas County on behalf of the City. • Smoke testing needs have been identified during the sanitary master planning effort in order to identify cross connections and immediate I&I issues. The City wishes to use resources towards implementation of recommendations in the sanitary master plan.
R	Coordinate with the Local Fire Department related to Pollutant Discharge from Fire Fighting Training Activities	• The BMP description and measurable goal were updated to remove reference to contacting the fire department by November 1, 2012 to discuss pollutant minimization measures during firefighting training activities.	• Initial contact with the fire department was completed by November 1, 2012, as required.
I, R	Implement the Stormwater Master Plan for Water Quality Improvements	• This BMP name was updated from "Conduct Master Planning for Stormwater Quality Improvements" to "Implement the Stormwater Master Plan for Water Quality Improvements". • The BMP description, measurable goals, and tracking measures were updated to reflect ongoing efforts to establish a stormwater utility rate and SDC.	• The City completed its Stormwater Master Plan in 2014 and adopted it in November 2015. • Rates were not adopted as part of the Master Plan, so BMP implementation activities have been refined to reflect efforts to establish a rate and implement the Master Plan instead of developing the Master Plan.
I	Stormwater Conveyance System Cleaning and Maintenance	• The BMP description and measurable goal were updated to reflect implementation of a rotating inspection and maintenance cycle for catch basins. • The BMP measurable goals were updated to reflect annual inspections for public culverts and ditches. • A BMP tracking measure was added to record the number of catch basins maintained annually.	• Catch basins located in the downstream (western) portion of the City required more frequent maintenance than those in the upstream (eastern) portion of the City. The City initiated a zone designation process for street sweeping efforts to efficiently address areas with more frequent maintenance needs. The City wishes to implement the same zone designation for catch basin maintenance.
I	Structural and Pollution Control Cleaning and Maintenance	• The BMP description was updated to remove reference to specific BMP facilities, as more have been installed in the City. • The BMP description and measurable goals were updated to reflect annual mailings to owners of private stormwater facilities, reminding them of maintenance obligations.	• Implementation of current stormwater design standards includes a requirement to complete and record an operations and maintenance form for all private stormwater BMPs, reflecting annual maintenance requirements and obligations.

Section 4
Service Area Expansions and Total Annual Pollutant Load Estimate

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

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

c. An updated estimate of total annual stormwater pollutant loads for applicable TMDL pollutants or applicable surrogate parameters, and the following pollutant parameters: BOD_5, COD, nitrate, total phosphorus, dissolved phosphorus, cadmium, copper, lead, and zinc. The estimates must be accompanied by a description of the procedures for estimating pollutant loads and concentrations, including any modeling, data analysis and calculation methods.

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

This section of the permit renewal application provides both the description of anticipated service area expansions and an updated estimate of total annual stormwater pollutant loads. In accordance with the methodology and assumptions detailed in the City's 2008 permit renewal application, the updated estimate of total annual stormwater pollutant loads needs to account for projected annexations through the end of the permit term. Therefore, these two evaluations are provided together in this section.

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

- Section 4.1: Description of Service Area Expansions
- Section 4.2: Updated Estimate of Total Annual Pollutant Loads

4.1 Description of Service Area Expansions

The City's NPDES MS4 permit area or "service area" is defined as the area included within its city limits for which the City has responsibility for implementing a stormwater management program. Historically, this area has excluded open water bodies and waterways and areas operated by another NPDES MS4-permitted entity. The Oregon Department of Transportation (ODOT) has its own NPDES MS4 permit covering rights-of-way (ROW) associated with state highways and freeways. Therefore, the City's service area excludes ODOT ROW.

As of January 2017, the City's NPDES MS4 permit area was calculated to be 1,462 acres. Maps of the City's NPDES MS4 permit area are included in Appendix A of this permit renewal submittal.

In Gladstone, annexations are rare and are typically applicant-driven. The City and City Council do not typically initiate annexation of property outside of the city limits into the city. At present time, no service area expansions have been identified that would result in a potential change to the City's MS4 service area, intensity, or pollutant load generation; therefore, no service area expansions are reflected in the total annual pollutant load estimates (Section 4.2).

4.2 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 1,471 acres, which reflected area within the current (2008) city limits. A spreadsheet loads model, using the U.S. Environmental Protection Agency (EPA) simple method equation, was developed and used for the 2008 analysis.

4.2.1 Model Parameters

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 was approved by EPA on September 29, 2006 and includes waste load allocations (WLAs) for bacteria (E. coli). Therefore, bacteria is included as a pollutant parameter.

The comprehensive list of pollutant parameters included in this analysis are:

- TSS
- *E. coli*
- 5-day biochemical oxygen demand (BOD_5)
- Chemical oxygen demand (COD)
- Nitrate
- Total and dissolved phosphorus
- Total Cadmium
- Total Copper
- Total Lead
- Total Zinc

4.2.2 Model Area

Total annual pollutant loads were calculated for the City's current NPDES MS4 service area. The total modeled MS4 permit area is 1,462 acres, consistent with the City's current NPDES MS4 service area as outlined in Section 4.1. The reduction in permit area from 2008 reflects mapping refinements.

4.2.3 Modeling Methods and Assumptions

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.

A spreadsheet pollutant loads model using the EPA simple method was used for the pollutant load calculations. The spreadsheet loads model is consistent with the model used in 2008 and contains baseline land use event mean concentrations (EMCs), which were developed in 2008

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

The spreadsheet loads model and land use EMCs per Table 4-1 were also used to develop the 2015 pollutant load reduction evaluation (PLRE) and calculate the 2017 TMDL benchmarks (see Section 5 and Appendix C of this permit renewal application).

Table 4-1. Land Use EMC Values used in the Total Annual Pollutant Load Estimate

Parameter	Land use	Count[a]	Bootstrapped values		
			95% LCL	Mean	95% UCL
TSS, mg/L	COM	72	64	82	103
	IND	48	117	184	284
	POS	10	16	31	50
	Residential[b]	65	44	66	99
E. coli, CFU/100 mL (geomean)	COM	52	573	1,247	2,409
	IND	58	154	438	1,004
	POS	9	57	87	124
	Residential[b]	65	970	1,656	2,651
BOD_5, mg/L	COM	22	8.5	11.9	16.6
	IND	23	26.1	39.6	56.1
	POS	3	2.4	3.3	4.2
	Residential[b]	28	5.9	8.1	10.8
COD, mg/L	COM	26	51.8	65.1	81.5
	IND	25	76.8	102.6	134.1
	POS	9	11.1	19.6	27.6
	Residential[b]	36	37.4	50.9	66.0
Nitrate, mg/L	COM	46	0.27	0.38	0.53
	IND	22	0.18	0.24	0.31
	POS	263	1.36	1.51	1.66
	Residential[b]	32	0.60	0.91	1.33
Total phosphorus, mg/L	COM	26	0.280	0.380	0.500
	IND	25	0.400	0.510	0.640
	POS	8	0.095	0.120	0.150
	Residential[b]	36	0.230	0.340	0.480
Dissolved phosphorus, mg/L	COM	46	0.09	0.11	0.14
	IND	21	0.10	0.17	0.27
	POS	261	0.04	0.04	0.04
	Residential[b]	30	0.08	0.11	0.15

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
Cadmium, total, µg/L	COM	53	0.75	1.11	1.56
	IND	23	2.27	3.47	5.00
	POS	131	0.10	0.11	0.13
	Residential[b]	45	0.41	0.53	0.66
Copper, total, µg/L	COM	26	20.8	28.6	38.2
	IND	26	33.8	45.5	58
	POS	10	2.0	2.5	3.0
	Residential[b]	33	10.5	13.4	17.1
Lead, total, µg/L	COM	25	37.8	54.0	72.7
	IND	22	32.7	48.3	67.0
	POS	9	0.6	0.8	1.1
	Residential[b]	28	11.0	17.7	27.6
Zinc, total, µg/L	COM	28	130.0	170.0	217.0
	IND	24	283.0	674.0	1,353.0
	POS	9	6.3	7.8	9.5
	Residential[b]	39	77.0	104.0	134.0

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

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

b. Land use EMCs for residential were used to simulate single and multi-family land use.

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

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 benchmarks, the runoff coefficients were calculated from estimated impervious percentages for each land use category. Impervious percentages by land use were based on values defined in the Gladstone Stormwater Master Plan (Gladstone 2014). Table 4-2 summarizes the modeled area by land use and associated impervious percentages used for this estimation of total annual pollutant loads.

Table 4-2. Modeled Area by Land Use and Impervious Percentage		
City zoning classification	**Model area (ac)**	**Modeled impervious percentage (%)**
SFR	959.2	55
MFR	75.2	75
COM	157.8	90
IND	115.6	70
POS	154.0	7
Total permit area	**1,461.8**	

The annual pollutant load estimates are based on an average annual rainfall volume of 47.06 inches, consistent with the rainfall volume assumed in the 2008 NPDES MS4 permit renewal.

4.2.4 Updated Estimate of Total Annual Pollutant Loads

Total annual pollutant loads, reflective of full-buildout conditions within the City's anticipated NPDES MS4 service area through the next permit term, are summarized below in Table 4-3 for applicable parameters. This updated estimate is presented in terms of a pollutant load range because of the inherent variability in stormwater runoff quality. Pollutant loads are shown in pounds (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 Gladstone			
Pollutant load parameter	**LCL (lbs. or counts)**	**Mean (lbs. or counts)**	**UCL (lbs. or counts)**
TSS	418,170	616,000	905,469
E. coli (counts)	2.83×10^{13}	5.06×10^{13}	8.44×10^{13}
BOD_5	63,863	90,820	124,504
COD	334,553	447,584	577,737
Nitrate	4,040	5,972	8,573
Total phosphorus	1,957	2,784	3,820
Dissolved phosphorus	643	888	1,224
Cadmium, total	5	7	9
Copper, total	111	146	189
Lead, total	135	205	298
Zinc, total	811	1,308	2,048

4.3 References

Brown and Caldwell, 2017. *Pollutant Load Reduction Evaluation and Benchmarks*, prepared for the City of Gladstone, January.

Gladstone. 2014. *Gladstone Stormwater Master Plan*.

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Section 5
Benchmarks

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

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

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

This section of the permit renewal application summarizes the City's total maximum daily load (TMDL) pollutant load reduction benchmarks in accordance with Schedule D.3.d of the City's NPDES MS4 permit.

Per Schedule D.3.d.ii (1-4), the TMDL benchmarks must reflect the City's commitment to achieving additional pollutant load reduction and progress toward achieving the TMDL wasteload allocation (WLA) during the next permit term. The TMDL 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.*

A detailed explanation of the four items above, including additional information related to pollutant modeling methods, assumptions, and results is provided in the City's *TMDL Pollutant Load Reduction Evaluation and Benchmarks* report (January 2016 and amended January 2017), which is included in Appendix C of this permit renewal application.

This section summarizes the relationship between the TMDL WLAs and benchmarks, lists the additional best management practices (BMPs) that will result in further reduction of TMDL pollutants, and summarizes the City's TMDL benchmarks. This section is organized as follows:

- Section 5.1: Relationship between TMDL WLAs and Benchmarks
- Section 5.2: BMP Identification
- Section 5.3: TMDL Benchmarks and Discussion

5.1 Relationship between TMDL WLAs and Benchmarks

The City must develop TMDL pollutant load reduction benchmarks for each TMDL parameter where existing BMP implementation is not estimated to be achieving the WLA. By definition, TMDL benchmarks are estimates of pollutant load reduction in the future. They reflect current BMP implementation and projected BMP implementation over the next permit term.

The City is a designated management agency (DMA) in the Willamette Basin TMDL (2006) due to urban stormwater discharges. The City's MS4 discharges runoff either directly or via tributaries to the Clackamas River, a tributary to the Lower Willamette River, or the Lower Willamette River itself. The applicable TMDL parameter for the Lower Willamette River and tributaries in the City is bacteria (*E Coli*).

The City conducted a pollutant load reduction evaluation (PLRE) for bacteria in 2015. Based on results of the PLRE, the City is not estimated to be meeting TMDL WLAs for bacteria. Therefore, the City is required to establish TMDL pollutant load reduction benchmarks for bacteria for the next permit term.

5.2 BMP Identification

Gladstone Public Works staff defined projected future public stormwater facility installations based on upcoming anticipated capital projects. They also defined the pending, future private stormwater facility installations associated with in-progress land use approvals. These facilities collectively reflect projected stormwater facility installations through 2022. A total of six future stormwater facilities were identified, resulting in treatment of more than 50 acres (ac). Table 5-1 lists the proposed stormwater facility installations by TMDL watershed, facility type, and drainage areas.

Table 5-1. Projected Stormwater Facility Installations

TMDL watershed	Model time frame	Parameter	2017 TMDL benchmark development	
			Projected BMP installations	Estimated future BMP drainage area addition (ac)
Lower Willamette River	Annual	Bacteria	• Swales/vegetated filter strips	1.7
Clackamas River	Annual	Bacteria	• Swales/vegetated filter strips • Infiltration raingardens • Hydrodynamic separators	49.2

5.3 TMDL Benchmarks 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 5-2 provides TMDL benchmarks for the Lower Willamette and Clackamas River TMDL watersheds (Willamette Basin TMDL) both 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 5-2. TMDL Benchmarks for Bacteria (2017–2022)					
TMDL watershed	**Time frame**	**Pollutant (units)**	**WLA (% reduction)**	**TMDL benchmarks (load reduction)[a], range**	**TMDL benchmarks (% load reduction)[a], range**
Lower Willamette River	Annual	Bacteria (counts)	78%	2.40×10^{10} to 1.22×10^{11}	0.2 to 0.3
Clackamas River	Annual	Bacteria (counts)	78%	9.71×10^{10} to 4.63×10^{11}	0.8 to 1.3

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

The TMDL benchmarks presented in Table 5-2 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.
- Additional private structural BMPs, installed as retrofits.
- Additional public capital improvement projects, installed in conjunction with the City's 2014 Stormwater Master Plan.

The City prepared a WLA attainment assessment for DEQ in January 2016, which indicated that achievement of the WLA 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.

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Section 6
Fiscal Evaluation of Stormwater Expenditures

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

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

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

This section of the permit renewal application provides the fiscal evaluation including a summary of stormwater-related expenses incurred from fiscal year (FY) 2012-13 through FY 2015-16 and projections of stormwater-related expenses through FY 2021-22. This section is organized as follows:

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

6.1 Funding Summary for Current Permit Cycle

The City's stormwater management program costs for the current permit cycle (fiscal years 2012-2013 through 2015-2016) are shown in Table 6-1. Please note that the City's FY reflects a timeframe from July 1 to June 30. Therefore the current permit cycle is only represented by four full FY periods to date.

The City's stormwater management program is unique in that it is not funded by a separate stormwater utility. Currently it is funded entirely from rates paid by sewer customers, although the City is currently working development of a dedicated, stormwater utility and system development charge.

Stormwater expenditures and projected budget allocations are associated primarily with the Department of Public Works and include operating materials, equipment repair/maintenance, system maintenance, funding of existing IGAs for erosion control and stormwater design services, consultant fees to aid with NPDES MS4 compliance, and general administration.

Table 6-1. Stormwater Expenditures for the Current Permit Cycle *(2012-2016)*

Program	2012-2013	2013-2014	2014-2015	2015-2016	Permit #101348 expires 3/1/2017
Storm	$180,000	$180,000	$194,000	$255,000	
Total	$809,000				

6.2 Projected Program Allocations for Next Permit Cycle

Projected expenditures for the next permit cycle (estimated as fiscal years 2017-2022) are shown in Table 6-2.

Table 6-2. Projected Stormwater Expenditures for the Next Permit Cycle *(2017-2022)*

Program	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
Storm	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000
Total	$1,200,000					

Based upon the historic record, the City's stormwater program expects that the annual budget will continue to grow in order to keep up with inflation, but exact numbers are uncertain. The proposed SWMP modifications (see Section 3 of this permit renewal application) are proposed to be implemented within the City's existing budget.

Section 7
Monitoring Objectives Matrix

Permit Requirements

Schedule B.6: MS4 Permit Renewal Application Package

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

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

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

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

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

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

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

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

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Appendices

A MS4 Maps

B Proposed 2017 SWMP

C TMDL Pollutant Load Reduction Evaluation and Benchmarks

D Updated Comprehensive Clackamas County Stormwater Monitoring Plan (2017)

Appendix A: MS4 Maps

Zoning/Land Use	Impervious Percentage (%)	Runoff Coefficient
Single Family Residential	55	0.60
Multi Family Residential	75	0.80
Commercial	90	0.95
Industrial	70	0.75
Parks and Open Space	7	0.12
Vacant	3	0.08

N

0 750 1,500 3,000 4,500 6,000 Feet

1:18,000 scale

Zoning/Land Use

- Single Family Residential
- Multi Family Residential
- Commercial
- Industrial
- Parks and Open Space
- Vacant
- MS4 Outfalls
- NPDES 1200-Z Facility
- City Limits/MS4 Service Boundary
- ODOT ROW (not included in MS4 Service Boundary)
- Streams

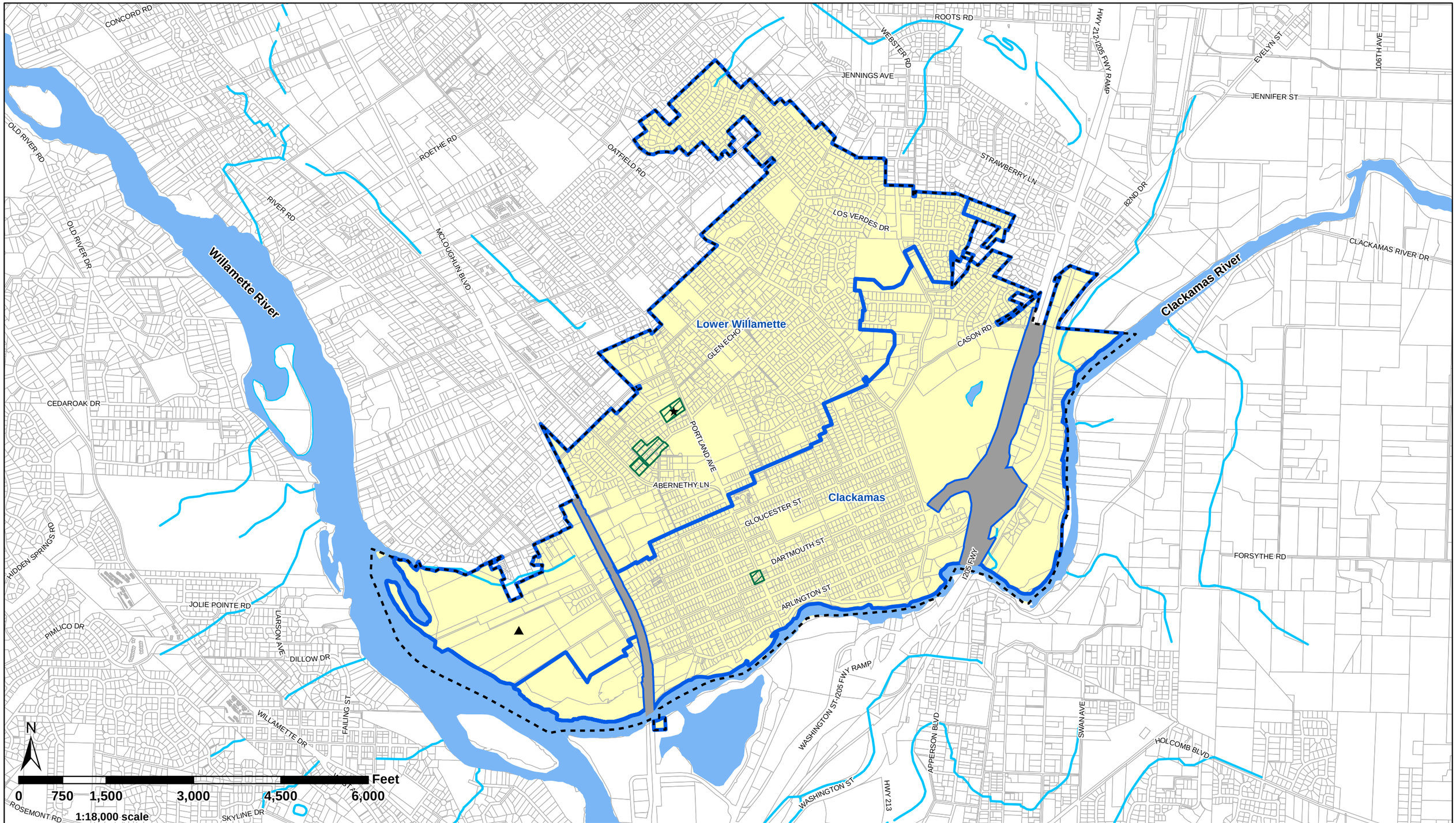
CITY OF GLADSTONE, OREGON

MS4 MAPS

Figure A-1: Service Area and Land Use

Brown AND Caldwell

Map Publication / Print Date: January 2017



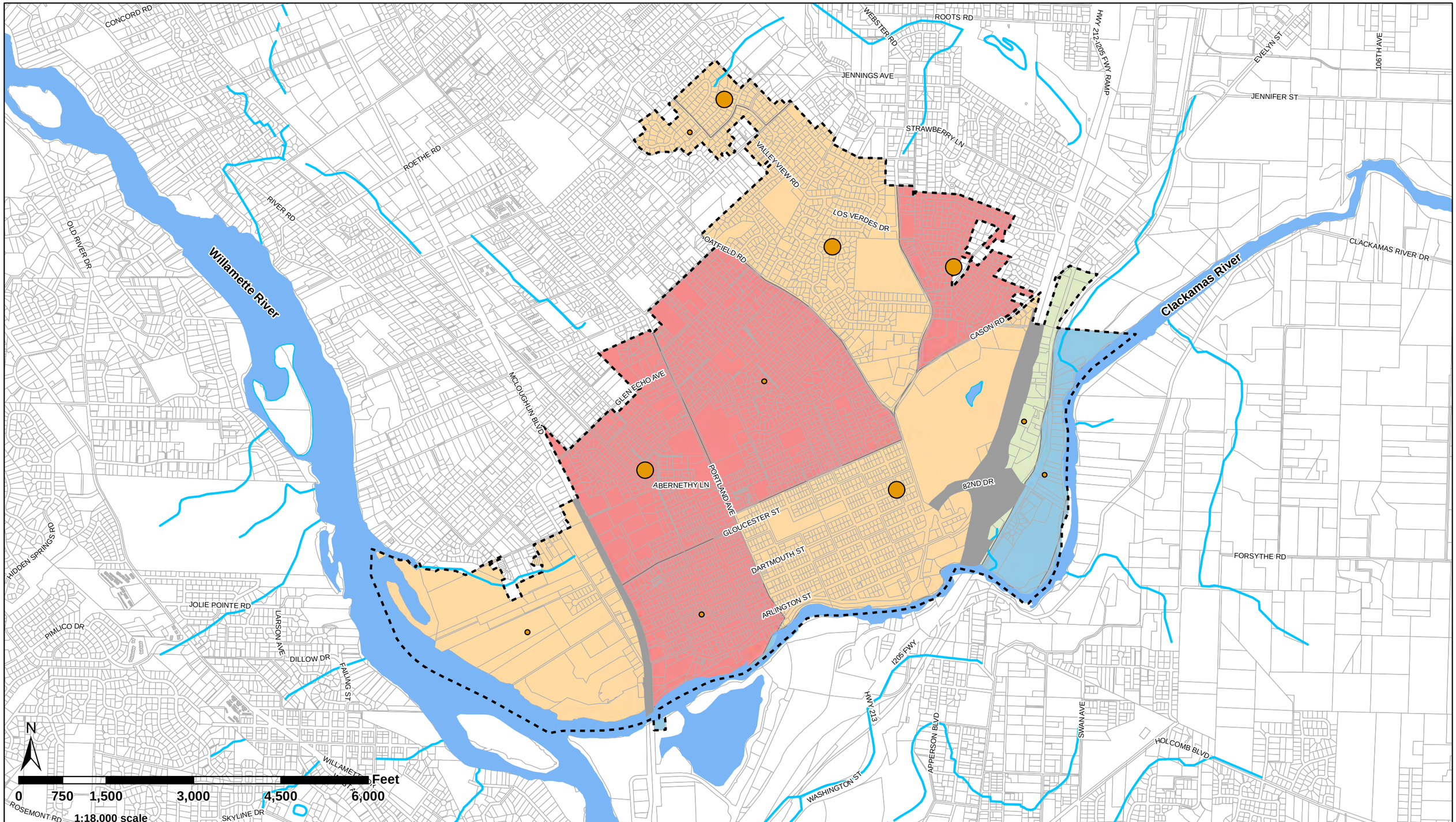
Map Publication / Print Date: January 2017

CITY OF GLADSTONE, OREGON

MS4 MAPS

Figure A-2: Public Facilities

- ODOT ROW (not included in MS4 Service Boundary)
- Major Watershed Boundaries
- Municipal Storage Facility
- Fleet Maintenance Facility
- Public Stormwater Facility Drainage
- City Limits/MS4 Service Boundary
- Streams



Map Publication / Print Date: January 2017

CITY OF GLADSTONE, OREGON

MS4 MAPS

Figure A-3: Population Density and Growth Projections

Population Density Per Square Mile (2010 Census)

< 1000 | 1000-3000 | 3000-5000 | >5000

Estimated 10-yr Population Growth by Population Block Group

- No Change
- < 10%
- > 10%
- ODOT ROW (not included in MS4 Service Boundary)
- City Limits/MS4 Service Boundary
- Streams

Appendix B: Proposed 2017 SWMP

CITY OF GLADSTONE'S
STORMWATER MANAGEMENT PLAN (2017)

SWMP Overview

In accordance with the City of Gladstone's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer (MS4) Permit, Permit number 101348, the City of Gladstone implements a Stormwater Management Plan (SWMP) to outline best management practices (BMPs) and activities to comply with permit requirements.

This version of the SWMP (dated 2017) reflects updates to the City's effective (2012) SWMP and was developed based on an 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. As such, this (2017) SWMP includes the permit language from the City's current NPDES MS4 permit (issued March 16, 2012). Future updates are anticipated to address any new requirements of the next reissuance of the NPDES MS4 permit.

City of Gladstone SWMP (2017)

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

Element #1: Illicit Discharge Detection and Elimination

Element #2: Industrial and Commercial Facilities

Element #3: Construction Site Runoff Control

Element #4: Education and Outreach

Element #5: Public Involvement and Participation

Element #6: Post-Construction Site Runoff

Element #7: Pollution Prevention for Municipal Operations

Element #8: Stormwater Management Facilities Operation and Maintenance Activities

SWMP Element #1
Illicit Discharge Detection and Elimination

NPDES permit requirements are listed below, followed by Gladstone's relevant BMPs that address the permit requirement. In some cases, listed permit requirements have been condensed. Applicable provisions are outlined under Schedule A.4.a for the City's 2012 NPDES MS4 Permit. **See Table 1** for the City of Gladstone's BMP fact sheets that address the permit requirements that are listed below.

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

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

TABLE 1 – Illicit Discharge Detection and Elimination BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Implement the Illicit Discharges Elimination Program	**Responsible Department:** Gladstone Public Works Department **Permit Year:** Ongoing **BMP Description:** The City of Gladstone prohibits illicit discharges to their MS4 system in conjunction with Chapter 8 and Chapter 13 of the Gladstone Municipal Code (GMC). GMC Section 8.04 is related to nuisance abatement and GMC Section 13.15 provides authority to conduct appropriate response procedures and enforce against responsible parties. If an illicit discharge is discovered, the City will conduct appropriate action to remove the illicit discharge in accordance with the City's standard operating procedures (*City of Gladstone Illicit Discharge Detention and Elimination Standard Operating Procedure*). The standard operating procedure was originally developed in November 2012. It documents code and enforcement authority and identifies high priority outfall locations for conducting dry-weather field screening activities. Illicit discharges suspected and/ or identified by City staff (either independently or in conjunction with public reporting) are recorded on an illicit discharge inspection form (included in the City's standard operating procedure). Procedures for recording such discharges and appropriate follow up activities are also described in the standard operating procedure. **Measurable Goals:** • For identified illicit discharges, conduct appropriate actions to remove the discharge in conjunction with time frames outlined in the City's NPDES MS4 Permit and standard operating procedure.	(1) Track updates to the City's standard operating procedure.
Conduct Annual Dry Weather Field Screening	**Responsible Party:** Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone conducts illicit discharge inspections, monitoring, and investigations in accordance with procedures outlined in the City of Gladstone's Illicit Discharge Detection and Elimination Standard Operating Procedure. Dry weather field screening activities occur annually during the dry weather period of the year (typically August) at identified high priority field screening locations. City personnel complete data inspection forms during the inspection of each outfall.	(1) Track the number of outfalls inspected annually. (2) Indicate all illicit discharge inspection results and identify outfalls requiring monitoring (sampling) and/or investigation annually.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
	During the inspections, if the outfall is suspected of an illicit connection, sampling, analysis, and investigation are conducted according to the following stepwise procedures: 1) Collect a water sample and have it analyzed for the suspected contaminant group. 2) Identify the water quality problem and use a drainage map and other source identification data to locate the potential sources. 3) Investigate the potential sources using one or more of the following techniques: on-site inspections, smoke-testing drain lines, dye tracing potential connections, and/or TV inspection of lines. Public Works staff notify the Public Works Director of all positive identifications, and the appropriate actions are taken to eliminate the discharge. Actions generally include initial letter notifications, and if the illicit discharge is not removed, a formal citation with penalty. During annual dry-weather field screening activities, the City will update their high priority field screening locations as necessary. **Measurable Goals:** • Inspect all high priority field screening locations annually for illicit discharges. • Conduct appropriate follow-up procedures to identify the source of any illicit discharges discovered. • Notify the Public Works Director of all positive identifications of illicit discharges and take appropriate actions to eliminate the discharge. • Update the high priority field screening locations as necessary.	(3) Describe the resolution of any investigation activities conducted annually. (4) Track the status of outfall mapping activities.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Spill Response	**Responsible Party:** Gladstone Fire Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone has an "Emergency Operations Plan", which specifies appropriate procedures to contain and respond to chemical and hazardous waste spills within the City. Initial spill response within the City is the responsibility of the Gladstone Fire Department. When a spill is reported, the Fire Department is initially dispatched, and they determine whether or not to contact the DEQ Hazardous Materials Team for additional assistance and whether notification of the Oregon Emergency Response System is required. The Fire Department is trained and certified in accordance with OSHA Hazardous Materials Awareness and Response Level training. Generally, the Fire Department focuses on containment of spills and the protection of surface waters through the use of absorbent pads and booms. The Public Works Department may assist the Fire Department with containment and/or clean up, depending on the volume and hazardous rating of the spilled material. The non-emergency number for the Fire Department (503-655-8211) is the number provided to the public for reporting of spills. Notification of public works occurs as needed for spill response and follow-up. **Measurable Goal:** • Conduct spill containment and/or cleanup activities in coordination with the Fire Department and/or DEQ Hazardous Materials Team, depending on the volume and hazardous rating of spill.	(1) Indicate the number of spills reported to the Gladstone Fire Department annually. (2) Indicate spill sources, causes, and types of discharges resulting from spill activities annually.

SWMP Element #2
Industrial and Commercial Facilities

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

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

TABLE 2 – Industrial and Commercial Facility BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Screen Existing and New Industrial Facilities	**Responsible Department:** City of Gladstone Public Works Department **Permit Year:** Ongoing **BMP Description:** The City of Gladstone maintains a business license inventory of all local businesses, including industrial facilities, throughout the City. The inventory is updated annually as businesses submit their business license applications. Business license applications include a stormwater survey to help City staff identify site activities and potential pollutant discharges. Facilities that either have an industrial stormwater NPDES 1200-Z permit or may contribute increased pollutant loads to the stormwater system based on activities described on the stormwater survey are considered potential high source facilities and subject to inspection for stormwater related impacts. Annually, the City of Gladstone will review their business license inventory to determine whether any existing or new facilities may be subject to an industrial stormwater NPDES permit. This determination will occur based on a review of the facilities proposed activities and the applicable SIC codes related to the 1200-series NPDES permit. If a facility is identified that would be subject to an industrial stormwater NPDES permit, the facility and DEQ will be notified within 30 days. During review of the business license inventory, the City will also update, as necessary, their inventory of potential high source facilities identified based on their potential to contribute significant pollutant load to the MS4. **Measurable Goals:** • Notify DEQ of any existing or new industrial facilities within the City of Gladstone's jurisdiction that may potentially be subject to an industrial stormwater NPDES permit. • Maintain list of high potential pollutant source facilities.	(1) Track the number of existing or new facilities subject to a stormwater industrial NPDES permit during the permit term. (2) Track changes made to list of high potential pollutant generating facilities.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Conduct Inspections of High Priority Facilities	**Responsible Party:** City of Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone conducts inspections of industrial and commercial businesses in accordance with procedures outlined in the *City of Gladstone Industrial/ Commercial Facility Inspection Program*, originally developed in July 2013. The City maintains an inventory of potential high pollutant source facilities in conjunction with their BMP: Screen Existing and New Industrial Facilities. Guidelines outlining selection of such facilities or businesses are outlined in the *City of Gladstone Industrial/ Commercial Facility Inspection Program.* The inspection program is implemented by the City's Public Works Department. Windshield surveys are conducted annually. Onsite inspections shall be conducted based on results of the windshield surveys. The Public Works Department will conduct onsite inspections of a minimum of five high pollutant source facilities during the permit term for appropriate stormwater controls and surface water pollution prevention. A checklist is used during inspections, to assist the inspectors in checking for the appropriate stormwater controls. Inspection results are recorded on the inspection checklist and maintained on file. Facility inspections may also be initiated in accordance with illicit discharge investigations. If during the onsite inspection, a facility is discovered to be contributing to excessive pollutant discharges, the site is reported to the Public Works Director and the industry is required to either stop the discharge or monitor to ensure compliance with ambient water quality standards. **Measurable Goals:** • Conduct annual windshield surveys of high pollutant source facilities. • Conduct onsite inspections of a minimum of five high source facilities during the permit cycle. • Report any facilities found to contribute excessive stormwater pollutant discharges to the Public Works Director for follow-up.	(1) Indicate the number of high source facility inspections conducted during the permit cycle. (2) Report abatement measures for any facility found to be inappropriately discharging to the municipal stormwater system.

SWMP Element #3
Construction Site Runoff Control

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

SWMP Element #3: Construction Site Runoff Control			
	Applicable BMPs		
Schedule A.4.c Permit Requirement	Require Erosion Control for New and Redevelopment	Educational Training Measures for Construction Site Operators	Conduct Erosion Control Inspections and Enforcement
i. Include ordinances or other enforceable regulatory mechanisms that require erosion and sediment controls to be designed, implemented, and maintained to prevent adverse impacts to water quality and minimize the transport of contaminants to waters of the State. By November 1, 2014, the construction site runoff control program ordinances or other enforceable regulatory mechanism must apply to construction activities that result in a land disturbance of 1,000 square feet or greater.	■	■	
ii. Require construction site operators to develop site plans, and to implement and to maintain effective erosion and sediment control best management practices.	■	■	
iii. Require construction site operators to prevent or control non-stormwater waste that may cause adverse impacts to water quality, such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste.	■	■	

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

TABLE 3 – Construction Site Runoff Control BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Require Erosion Control for New and Redevelopment	**Responsible Party:** City of Gladstone Public Works, City of Gladstone Administration, and Clackamas County Service District #1 (CCSD#1), Clackamas County Water Environment Services (WES) **Permit Year**: Ongoing **BMP Description:** Erosion control standards were adopted into the Gladstone Municipal Code in 1996 (Gladstone Municipal Code – Section 15.06). The City coordinates with Clackamas County WES related to implementation of their erosion and sediment control program. The City of Gladstone has an IGA with CCSD#1 to provide erosion control services including review and approval of erosion control plans, attendance at pre-construction conferences, site inspections during construction activities, and notification to the City of enforcement needs. Erosion control is required for all development disturbing an area of 800 ft^2 or greater per the threshold implemented by CCSD#1. Erosion and sediment control plans must include methods (non-structural BMPs) or interim facilities (structural BMPs) to be constructed or used during construction activities. Plan review is conducted by CCSD#1. Provisions of Gladstone's Municipal Code indicate that CCSD#1 shall apply consistent standards and procedures as those applied within their jurisdiction. CCSD#1 issues local erosion and sediment control plan approval on the City's behalf for development 800 square feet (sf) or greater. As an approved 1200-CN jurisdiction, CCSD#1 issues 1200-CN permits for land disturbance between one and less than 5 acres. 1200-C permits for land disturbance of 5 acres or more are administered by DEQ. As implemented through the IGA with CCSD#1, the City's approved methods (structural and non-structural) for erosion prevention and sediment control are included in the "*Erosion Prevention and Sediment Control Planning and Design Manual"*. The manual also includes measures related to good housekeeping and control of non-stormwater waste that would need to be implemented. **Measurable Goals:** • Require erosion control measures for development disturbing areas of 800 ft^2 or greater. • Conduct review of erosion control plans, attend pre-construction meetings, and conduct erosion control site inspections through an IGA with CCSD#1. • Update City Municipal Code provisions related to erosion and sediment control by November 1, 2018 in conjunction with development of the City's Public Works Standards.	(1) Report any updates or modifications to the approved erosion control standards or the *Erosion Prevention and Sediment Control Planning and Design Manual*. (2) Report renewals of the IGA with CCSD#1 for erosion control services and document any changes made to the IGA. (3) Report updates or modifications to the Gladstone Municipal Code related to erosion and sediment control. (4) Track the number of erosion control plans reviewed for the City.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Educational Training Measures for Construction Site Operators	**Responsible Party:** City of Gladstone Public Works, Clackamas County Service District #1 (CCSD#1), Clackamas County Water Environment Services (WES) **Permit Year:** Ongoing **BMP Description:** An initial pre-construction conference is required as part of pre-construction activities for sites requiring land use approval per the City of Gladstone's Municipal Code. Typically, a City representative is in attendance as well as a CCSD#1 or WES representative. During the conference, the prime-contractor is given a link to the Erosion Prevention and Sediment Control Planning and Design Manual (Design Manual) and made aware of the City and County requirements regarding erosion control. **Measurable Goal:** • Provide a link to the Design Manual to all contractors and inform them of City and County requirements at pre-construction planning meetings.	(1) Track number of pre-construction planning conferences attended by City staff.
Conduct Erosion Control Inspections and Enforcement	**Responsible Party:** City of Gladstone Public Works, Clackamas County Service District #1 (CCSD#1), Clackamas County Water Environment Services (WES) **Permit Year:** Ongoing CCSD#1 conducts erosion control inspections on the City's behalf. Inspections are done on all sites disturbing a minimum area of 800 ft^2. During construction activities, sites will be inspected a minimum of three times during construction activities (initial, random, and final), consistent with CCSD#1's current inspection frequency. Sites are required to pass an initial inspection prior to beginning work, and a final inspection prior to final building inspections. Sites will be inspected more frequently if needed, specifically during periods of higher activity and greater soil disturbance. The City of Gladstone occasionally conducts windshield inspections of construction sites and will inform the County of any potential violations. CCSD#1 will then inspect that site promptly. As part of the IGA, CCSD#1 is responsible for enforcement of erosion control standards and informs the City of enforcement actions as necessary. For sites with an erosion control violation or where ineffective erosion control is observed, a Notice of Non-Compliance is issued, and contractors are required to install effective control measures. If not resolved within the required time frame, re-inspection fees and/or Stop Work Orders are issued. Fines may be imposed for continued non-compliance in accordance with procedures outlined in the City's Municipal Code (15.06.08).	(1) Report the number of erosion control inspections conducted annually. (2) Report the number of erosion control inspections where violations were observed, and describe methods used to resolve the issue. (3) Report number of fines and Stop Work Orders issued.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
	Measurable Goals: • Inspect all sites requiring erosion control a minimum of three times (conducted through an IGA with CCSD#1). • Impose penalties such as fines and stop work orders if corrective actions aren't taken. • Require sites to pass a final erosion control inspection prior to receiving a final building inspection (conducted through an IGA) with CCSD #1.	

SWMP Element #4
Education and Outreach

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

SWMP Element #4: Education and Outreach		
	Applicable BMPs	
Schedule A.4.d Permit Requirement	Provide Public Education and Outreach Materials Regarding Stormwater Management	Ensure Municipal Staff Training for Stormwater Pollution Prevention
i. Continue to implement a documented public education and outreach strategy that promotes pollutant source control and a reduction of pollutants in stormwater discharges….The public education and outreach strategy may incorporate cooperative efforts with other MS4 regulated permittees or efforts by other groups or organizations provided a mechanism is developed and implemented to track the public education and outreach efforts within the MS4 regulated area and the results of such efforts are reported annually.	■	
ii. Provide educational materials to the community or conduct equivalent outreach activities describing the impacts of stormwater discharges on water bodies and the steps or actions the public can take to reduce pollutants in stormwater runoff.	■	
iii. Provide public education on the proper use and disposal of pesticides, herbicides, fertilizers and other household chemicals.	■	

SWMP Element #4: Education and Outreach		
	Applicable BMPs	
Schedule A.4.d Permit Requirement	Provide Public Education and Outreach Materials Regarding Stormwater Management	Ensure Municipal Staff Training for Stormwater Pollution Prevention
iv. Provide notice to construction site operators concerning where education and training to meet erosion and sediment control requirements can be obtained.	See Element #3: Construction Site Runoff Control BMP: Educational Training Measures for Construction Site Operators	
v. Conduct or participate in an effectiveness evaluation to measure the success of public education activities during the term of this permit. The effectiveness evaluation must focus on assessing changes in targeted behaviors. The results of the effectiveness evaluation must be used in the adaptive management of the education and outreach program and reported to the Department no later than July 1, 2015.	■	
vi. 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.		■
vii. Promote, publicize and facilitate public reporting of illicit discharges through the use of newspapers, newsletters, utility bills, door hangers, radio public service announcements, videos, televised council meetings, brochures, signs, posters or other effective methods.	■	

TABLE 4 – Education and Outreach BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Provide Public Education and Outreach Materials Regarding Stormwater Management	**Responsible Party:** City of Gladstone Public Works and City Administration **Permit Year**: Ongoing **BMP Description:** The City of Gladstone continues to implement a public education strategy aimed at reducing the discharge of pollutants associated with a variety of activities including but not limited to: 1. Application of pesticides, herbicides, and fertilizers by citizens. 2. Illicit discharges and dumping of waste material into the storm drainage system. 3. Disposal of waste oil and toxic material. The City of Gladstone coordinates with a number of local agencies and organizations to provide outreach materials to residents regarding stormwater quality. As a member of the *Clean River Partners of Clackamas County*, the City of Gladstone participates in the *Regional Coalition for Clean Rivers and Streams*. Outreach materials provided as a result of participation include articles in local newspapers, various mailings including the *Trash Talk and Streamlines* newsletter, and various bill inserts. Topics addressed with the materials include natural lawn care practices, landscaping techniques for clean water, recycling, and waste reduction. Gladstone also uses the City newsletter to provide information regarding stormwater protection and quality to City residents. Messaging builds on findings from the coordinated public education effectiveness evaluation (completed as part of an ACWA study conducted in 2015 on behalf of Phase I communities). The City newsletter is generated monthly and mailed to City residents as well as made available on the City website. Articles and information are provided related to methods, rates, and equipment for pesticide and fertilizer application; locations and hours of waste disposal facilities; contact information for City Hall for public reporting of illicit discharges; recycling and litter control tips; and general water quality concerns. To aid in public education as related to proper disposal of waste materials, the City of Gladstone also applies catch basin decals to City catch basins during catch basin cleaning. **Measurable Goals:** • Utilize newsletters, brochures, bill inserts, and local newspapers to promote public awareness of stormwater quality issues and sources, including reporting of illicit discharges. • Continue as a member of Clean River Partners of Clackamas County and participate in the Regional Coalition of Clean Rivers and Streams. • Apply decals to public catch basins annually, if needed.	(1) Track the number and content of informational articles published in the City newsletter annually. (2) Record the decals applied to public catch basins each year.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Ensure Municipal Staff Training for Stormwater Pollution Prevention	**Responsible Department:** City of Gladstone Public Works and City Administration **Permit Year:** Ongoing **BMP Description:** The City of Gladstone is a member of various local organizations (i.e. *Regional Coalition of Clean Rivers and Streams*, Willamette River Water Coalition, and ACWA) that are focused on improving local water quality conditions, and as a result attends various educational meetings, presentations and conferences. Additionally, the City coordinates with Clackamas County and other Clackamas County co-permittees regarding regional water quality and stormwater management efforts. Specific areas of coordination include monitoring and public education and outreach. In addition, the City will conduct staff meetings one to two times per year for staff with BMP implementation responsibilities. Meetings will be used to track progress on BMP implementation and to present training type materials related to stormwater quality and the NPDES MS4 permit requirements. **Measurable Goals:** • Conduct staff meetings one to two times per year. • Continue coordination with other co-permittees regarding regional water quality efforts. • Continue participation with agencies and groups involved in water quality issues.	(1) Track the number of employees receiving training in stormwater management annually. (2) Track staff participation in professional organizations. (3) Track regular stormwater staff meetings conducted.

SWMP Element #5
Public Involvement and Participation

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

SWMP Element #5: Public Involvement and Participation	
Schedule A.4.e Permit Requirement	**Applicable BMPs** **Provide for Public Participation in Submittals**
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.	■

TABLE 5 –Public Involvement and Participation

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

SWMP Element #6
Post-Construction Site Runoff

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

SWMP Element #6: Post-Construction Site Runoff		
	Applicable BMPs	
Schedule A.4.f Permit Requirement	Review New and Redevelopment Plans for Stormwater Components	Review and Update the Applicable Code and Development Standards Related to Stormwater Control
i. By November 1, 2014, the post-construction stormwater pollutant and runoff control program applicable to new development and redevelopment projects that create or replace impervious surfaces must meet the conditions described in this subsection. The minimum project threshold….is identified in Table A-1. The post construction site runoff permit conditions are as follows: 1) Incorporate site-specific management practices that target natural surface or predevelopment hydrologic functions as much as practicable; 2) Minimize site specific post-development stormwater runoff volume, duration, and rates of discharges to the municipal separate storm sewer system (MS4)…; 3) Prioritize and implement 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.	■	■
ii. The co-permittee must identify, and where practicable, minimize or eliminate ordinance, code and development standard barriers within their legal authority that inhibit design and implementation techniques intended to minimize impervious surfaces and reduce stormwater runoff (e.g., Low Impact Development, Green Infrastructure). Such modifications to ordinance, code, and development standards are only required to the extent they are permitted under federal and state laws. The co-permittee must review ordinance, code and development standards for modification, minimization or elimination, and appropriately modify ordinance, code or development standard barriers by November 1, 2014. If an ordinance, code or development standard barrier is identified at any time subsequent to November 1, 2014, the applicable ordinance, code or development standard must be modified within three years.	■	■

SWMP Element #6: Post-Construction Site Runoff		
	Applicable BMPs	
Schedule A.4.f Permit Requirement	Review New and Redevelopment Plans for Stormwater Components	Review and Update the Applicable Code and Development Standards Related to Stormwater Control
iii. To reduce pollutants and mitigate the volume, duration, time of concentration and rate of stormwater runoff, the co-permittees 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 identification of 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.	■	■
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.	■	■
v. Where a new development or redevelopment is characterized by factors limiting use of on-site stormwater management methods to achieve post-construction site runoff performance standards… the Post-Construction Stormwater Management program must require equivalent pollutant reduction measures, such as off-site stormwater quality management. Off-site stormwater quality management may include off-site mitigation…, a stormwater quality structural facility mitigation bank or a payment-in-lieu program.	■	■
vi. A description of the inspection and enforcement response procedures the co-permittee will follow when addressing project compliance issues with the enforceable post-construction stormwater management performance standards.	■	■

TABLE 6 – Post-Construction Site Runoff BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Review New and Redevelopment Plans for Stormwater Components	**Responsible Party:** Gladstone Public Works Department, Clackamas County Department of Transportation and Development (DTD), and Clackamas County Service District #1 (CCSD #1) **Permit Year:** Ongoing **BMP Description:** The City of Gladstone is primarily a developed city with minimal new development and only limited redevelopment activities occurring. In 2009, the City adopted design standards for stormwater treatment and detention in coordination with Clackamas County Water Environment Services current (at the time) stormwater management requirements. The design standards are outlined in the City's NPDES MS4 Implementation Guide and the City's Municipal Code (Chapter 17.56). The City of Gladstone has an intergovernmental agreement (IGA) with Clackamas County DTD and CCSD #1 for assistance with development review activities including land use planning, zoning, grading, and erosion control. The City also has contracts established with engineering consulting firms to assist with development review activities related to stormwater drainage for private development and for all other public improvements on the City's behalf. **Measurable Goals:** • Require all new and redevelopment to meet stormwater quality provisions as outlined in the Municipal Code. • Maintain IGA with DTD and CCSD #1 or other contract mechanisms to continue to conduct planning and design review activities on behalf of the City.	(1) Record the number of development applications reviewed for compliance with the stormwater regulations annually.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Review and Update the Applicable Code and Development Standards Related to Stormwater Control	**Responsible Department:** Gladstone City Administration and Public Works Department **Permit Year:** Ongoing **BMP Description:** The City of Gladstone is reviewing their existing stormwater treatment design standards and applicable code provisions in conjunction with the development of City-specific Public Works Standards. As part of the review, the City will review and consider for adoption, other jurisdiction's stormwater management manuals for consistency with current permit language. **Measurable Goals:** • Review the City's current stormwater quality standards for compliance with NPDES MS4 permit language. • Develop Public Works Standards to minimize and eliminate barriers related to the use of LID or GI techniques. • Update the City's existing post-construction stormwater design standards and code language by November 1, 2018.	(1) Track progress related to the update of the City's code and stormwater design standards in conjunction with development of City-specific Public Works Standards.

SWMP Element #7
Pollution Prevention for Municipal Operations

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

SWMP Element #7: Pollution Prevention for Municipal Operations						
	Applicable BMPs					
Schedule A.4.g Permit Requirement	Street Maintenance	Minimize Impacts Associated with Landscape Maintenance Activities	Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	Control Infiltration and Cross Connections to the Stormwater Conveyance System	Coordinate with the Local Fire Department related to Pollutant Discharge from Fire Fighting Training Activities	Implement the Stormwater Master Plan for Stormwater Quality Improvements
i. Operate and maintain public streets, roads and highways in a manner designed to minimize the discharge of stormwater pollutants to the MS4, including pollutants discharged as a result of deicing activities;	■					
ii. Implement a management program to control and minimize the use and application of pesticides, herbicides and fertilizers on co-permittee-owned properties;		■				
iii. By July 1, 2013, inventory, assess, and implement a strategy to reduce the impact of stormwater runoff from municipal facilities that treat, store or transport municipal waste, such as yard waste or other municipal waste not already covered under a 1200 series NPDES permit, a DEQ solid waste permit, or other permit designed to reduce the discharge of pollutants;			■			

SWMP Element #7: Pollution Prevention for Municipal Operations						
	Applicable BMPs					
Schedule A.4.g Permit Requirement	Street Maintenance	Minimize Impacts Associated with Landscape Maintenance Activities	Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	Control Infiltration and Cross Connections to the Stormwater Conveyance System	Coordinate with the Local Fire Department related to Pollutant Discharge from Fire Fighting Training Activities	Implement the Stormwater Master Plan for Stormwater Quality Improvements
iv. Limit infiltration of seepage from the municipal sanitary sewer system to the MS4;				■		
v. Implement a strategy to control the release of materials related to fire-fighting training activities; and,					■	
vi. Assess co-permittee flood control projects to identify potential impacts on the water quality of receiving water bodies and determine the feasibility of retrofitting structural flood control devices for additional stormwater pollutant removal. The results of this assessment must be incorporated and considered along with the results of the Stormwater Retrofit Assessment required by this permit;						■

TABLE 7 – Pollution Prevention for Municipal Operations BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Street Maintenance	**Responsible Party:** Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone conducts street sweeping throughout the City. Each city street is swept approximately 3 – 6 times per year. Sweeping is typically conducted once every two to three months, but is conducted twice during leaf pick up activities when there is the most debris on the roads. The City also conducts scheduled winter leaf pick up (October to January). Weekly curbside collection of yard debris with garbage collection is available to residents in order to minimize flooding and prevent transport of organics into the stormwater conveyance system. Road repair activities are conducted during the dry season to minimize transport and runoff of sediment and other pollutants. When possible, phased construction will occur to minimize the disturbed area and limit erosion. Occasional deicing activities occur throughout the City during the winter months. The City generally applies crushed aggregate to roadway areas and avoids the use of chemicals. Following application of aggregate the City recycles the applied material for use during general construction activities and sweeps the roadway for residual materials. **Measurable Goals:** • Sweep each City street a minimum of three times per year. • Provide scheduled winter leaf pickup for city residents.	(1) Track the number of city-wide sweeps conducted each year. (2) Estimate the proportion of residences participating in the winter leaf collection program.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Minimize Impacts Associated with Landscape Maintenance Activities	**Responsible Party:** Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone conducts landscape maintenance and pest management activities on public park, roadside, and open space areas. The City maintains copies of MSDS sheets for chemicals used on City property, and provides them to the public on request. There is currently one City employee that applies pesticides and fertilizers within the City. This employee is trained and certified in accordance with OSHA requirements. As an informal guide, the City of Gladstone refers to the Portland Integrated Pest Management (IPM) Program, which defines appropriate pesticide and fertilizer application procedures and protocols. Provisions of the Portland IPM Program are outlined in the City's NPDES MS4 Implementation Guide and include activities generally focused on low pollutant generating practices including the manual removal of non-native vegetation species and the avoidance of herbicide application near waterways. Educational activities associated with pest management are described under Element #4, Table 4. **Measurable Goals:** • Require all City employees that apply herbicides within the City to be OSHA trained and certified. • Implement the City's IPM guidelines on all public parks, roadsides, and open space areas.	(1) Estimate the relative volume of herbicides applied by the City, based on purchasing records each year. (2) Track the manual removal of non-native vegetation from parks and ditch lines.
Implement a Program to Reduce the Impact of Stormwater Runoff from Municipal Facilities	**Responsible Department:** Gladstone Public Works Department **Permit Year:** Ongoing **BMP Description:** The City of Gladstone currently owns and operates two maintenance facilities that have the potential to treat, store, or transport municipal waste. In 2013, the City prepared the *City of Gladstone Stormwater Pollution Prevention Strategy for Municipal Facilities (SWPPS),* which outlines facility specific BMPs aimed at reducing the discharge of pollutants to the MS4. These BMPs include programmatic, procedural, maintenance, and source control activities and structural treatment facilities. Annually, the City will review short-term strategies in the SWPPS to identify activities that can be done with current available funding. With development of a stormwater utility rate and SDC (in progress), long term strategies will be reviewed and considered in conjunction with prioritized capital improvement projects (CIPs). **Measurable Goals:** • Annually review and incorporate identified short and long term strategies per the SWPPS into the public works budget and capital improvement program.	(1) Report any updates or modifications to the City's SWPPS. (2) Track strategies used to minimize pollutant discharges at municipal facilities.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Control Infiltration and Cross Connections to the Stormwater Conveyance System	**Responsible Party:** City of Gladstone Public Works Department and various departments of Clackamas County **Permit Year**: Ongoing **BMP Description:** During review and inspection for new development, the City verifies all new sanitary connections to ensure no cross connections are installed. In addition, the City's coordination with Clackamas County DTD and the City's illicit discharge inspection and investigation program all work to prevent and resolve any possible cross-connections of sanitary and storm lines. In conjunction with development of the sanitary master plan (2015-2017), sanitary lines will be smoke tested for any cracking or breakage that would result in infiltration to and/or from the storm system. This effort will help prioritization of CIPs per the sanitary master plan. Smoke testing activities were most recently conducted in 2004. The City's illicit discharge inspections and investigations also help in preventing and resolving any existing cross-connections. **Measurable Goals:** • Conduct smoke testing in Basins B, C, and D over the next permit term to prioritize sewer lines/ joints for repair and replacement in conjunction with the sanitary CIPs. Repair/resolve cross-connections once discovered, in conjunction with the timeframes documented in Schedule A.4.a.vii.	(1) Indicate any cross-connections discovered during the plan review process or during illicit discharge investigations and describe resolution activities. (2) Report on the progress of smoke testing efforts over the permit term.
Coordinate with the Local Fire Department related to Pollutant Discharge from Fire Fighting Training Activities	**Responsible Department:** Gladstone Public Works Department **Permit Year:** Ongoing **BMP Description:** As necessary or as new staff are hired at the Fire Department, the City will contact the City's fire marshal to review activities conducted to minimize pollutant discharge associated with firefighting training activities. If applicable, the City will provide educational materials to assist the fire department in reducing pollutant discharges. **Measurable Goals:** • As applicable, provide educational information to the City fire department.	(1) Track communications with the fire department.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Implement the Stormwater Master Plan for Water Quality Improvement	**Responsible Party:** Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone prepared a stormwater master plan in 2014 to outline CIPs for stormwater quality and quantity control. Implementation of the City's stormwater master plan is currently driven by available funding. A stormwater utility rate and SDCs have not yet been developed. In the interim, stormwater-related public works projects are constructed to address flooding and water quality needs using available grant funding opportunities. Per the City's stormwater design standards, such standards would be applied as necessary to public works projects to address water quality. **Measurable Goals:** • Incorporate water quality into public works projects as funding is available. • Implement public processes to initiate development of a stormwater utility rate and SDC by November 2017.	(1) Track the status of development of a stormwater utility rate and SDC. (2) Track completion of any public works projects that address stormwater collection, conveyance, and treatment.

SWMP Element #8
Stormwater Management Facilities Operation and Maintenance Activities

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

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

TABLE 8 – Structural Stormwater Facilities Operations and Maintenance BMPs

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Stormwater Conveyance System Cleaning and Maintenance	**Responsible Party:** Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone inspects, maintains and/or repairs stormwater conveyance system components including culverts, conveyance ditches, and catch basins. Culverts and conveyance ditches are inspected annually and cleaned as needed, as determined by the Public Works Supervisor. Culverts are inspected for cracking or breakage that would limit the structural integrity and performance of the system. If repair or replacement is necessary, the Public Works Supervisor will schedule the appropriate activity following inspection. Conveyance ditches are inspected for trash and debris that may prevent stormwater from freely discharging through the conveyance system. Typical maintenance activities include the removal of garbage and vegetative debris and the removal or reshaping of soil to re-establish the channel and flow path. Public catch basins are inspected and cleaned annually, in conjunction with scheduled cleaning operations by zone. There are eight zones delineated in the City. Zones 1 and 3 are located furthest downstream (towards the Willamette River) and generally see the most trash accumulation and require the most frequent maintenance. At a minimum, the City will inspect and maintain catch basins in four zones of the City. Zones 1 and 3 will be inspected and maintained annually, and the other zones will be inspected and maintained on an annual rotating cycle. More frequent maintenance needs may be identified by the Public Works Director, and the inspection/ maintenance schedule adjusted accordingly. Catch basin maintenance includes removal of trash, sediment, and debris from the grate and catch basin sump. Additionally, the majority of inlet grates throughout the City are cleaned after major rainfall events. Stormwater conveyance systems inspection and maintenance guidelines are outlined in the City's NPDES MS4 Implementation Guide. **Measurable Goals:** • Inspect all public culverts and conveyance ditches annually. • Conduct maintenance of public culverts and conveyance ditches based on inspection results. • Inspect and maintain public catch basins annually in accordance with the scheduled, rotating cycle.	(1) Record the length or number of conveyance system components (ditches, culverts) maintained annually. (2) Record the number of catch basins maintained annually. (3) Estimate the volume of debris removed during catch basin cleaning annually. (4) Track changes to the inspection and maintenance procedures.

City of Gladstone BMP Name	BMP Implementation	Tracking Measures
Structural and Pollution Control Facility Cleaning and Maintenance	**Responsible Party:** Gladstone Public Works Department **Permit Year**: Ongoing **BMP Description:** The City of Gladstone inspects, maintains and/or repairs public structural control facilities within the City. Inspection and maintenance guidelines for pollution control facilities are outlined in the City's NPDES MS4 Implementation Guide. Per the City's stormwater design standards, private stormwater facility maintenance agreements will be submitted to the City in conjunction with building permit applications and as a condition of plan approval for new private structural controls. Such agreement will establish a record of private facilities within the City. Annually, the City will mail letters to private stormwater facility owners reminding them of their maintenance obligation. Annually, the City will also conduct spot inspections of private structural control facilities within the City to notify owners if maintenance is required. This effort may be conducted in conjunction with the high priority facility inspections. The City currently has a GIS inventory of their public and private structural control facilities and will continue to update the inventory as new facilities are constructed. **Measurable Goals:** • Inspect the public structural stormwater quality control facilities annually and maintain as necessary. • Annually, mail reminder letters to owners of private structural stormwater control facilities, reminding them of their maintenance obligations. • Conduct annual spot inspections of private structural stormwater quality control facilities. • Require signed maintenance agreements for new private structural stormwater facilities as a condition of plan approval.	(1) Record the structural control inspection and maintenance activities that occur annually. (2) Track new (public and private) structural control facilities installed within the City on an annual basis.

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Appendix C: TMDL Pollutant Load Reduction Evaluation and Benchmarks

TMDL Pollutant Load Reduction Evaluation and Benchmarks

Prepared for
Gladstone, Oregon
January 2016
Amended to include benchmarks: January 2017

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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(s)
CFU	colony forming unit(s)
City	City of Gladstone
COM	commercial
DDT	dichlorodiphenyltrichloroethane
DEQ	(Oregon) Department of Environmental Quality
EMC	event mean concentration
EPA	United States Environmental Protection Agency
GIS	geographic information system
I-205	Interstate 205
IND	industrial
LCL	lower confidence limit
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
ODOT	Oregon Department of Transportation
ORCA	Outdoor Recreation Conservation Area
PLRE	pollutant load reduction evaluation
SFR	single-family residential
TMDL	total maximum daily load
TSS	total suspended solids
UCL	upper confidence limit
UIC	underground injection control
WLA	wasteload allocation
WPCF	water pollution control facility

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).

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 Gladstone (City). The City is subject to TMDLs in two receiving waterbodies: the Clackamas River and the Lower Willamette River.

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 stormwater quality controls or best management practices (BMPs)
- A comparison of the current estimated pollutant load reduction to the pollutant load reduction 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 Gladstone results in the reduction of TMDL pollutant loads in the Lower Willamette and Clackamas River TMDL watersheds. However, it is estimated that significant additional pollutant reduction would be needed to achieve the wasteload allocations (WLAs) for bacteria in these watersheds. 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 two watersheds are presented in Section 5 and Appendix B.

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

1.1 Permit Requirements

The City is a co-permittee on 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.*

1.1.1 PLRE Requirements

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

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

ii. *An estimate of current pollutant loadings without considering BMP implementation, and an estimate of current pollutant loadings considering BMP implementation for each TMDL parameter with an established WLA.*

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

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

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

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

vii. *A water quality trends analysis, as sufficient data are available, and the relationship to stormwater discharges for receiving water bodies within the co-permittees jurisdictional area with an approved TMDL.*

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

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

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 in-stream 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).

Gladstone is located in Clackamas County, adjacent to the Lower Willamette River. The relevant TMDL is the Willamette Basin TMDL, approved on September 29, 2006, by the United States Environmental Protection Agency (EPA) (DEQ 2006). In Gladstone, the Willamette Basin TMDL document covers direct discharge to the Lower Willamette River and discharge to both specified and unspecified tributaries to the Lower Willamette River, including the Clackamas River.

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

1.2.1 TMDL Pollutant Summary

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

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

Mercury is identified as a pollutant with direct ties to stormwater runoff, but DEQ has not yet completed its analysis to establish source-specific WLAs for mercury. No pollutant load analyses or pollutant load reduction benchmarks were calculated for mercury in 2008. Therefore, no pollutant load reduction estimates for mercury are required in this evaluation.

1.2.2 TMDL WLAs

In the Willamette Basin TMDL, the WLAs for bacteria[1] (*E. coli*) are calculated as a percent load reduction for general land use categories. The MS4 contribution is assumed to equate to the urban land use category, and WLAs are defined for annual loads as shown in Table 1-1. 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.

The City conducted a PLRE and established pollutant load reduction benchmarks as part of its Phase I NPDES MS4 permit renewal submittal in September 2008 (City 2008). The WLAs shown in Table 1-1, below, and the benchmarks established in 2008 are two metrics used to evaluate whether the City's current pollutant load reductions are meeting regulatory obligations.

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

Table 1-1. Gladstone Applicable WLAs		
TMDL water body	Parameter	WLA
Lower Willamette	Bacteria *(E. coli)*	78% reduction (annual)
Clackamas River	Bacteria *(E. coli)*	78% reduction (annual)

The Clackamas River is a specified tributary under the Lower Willamette Subbasin TMDL. Although the WLA for bacteria is consistent between the Lower Willamette River and the Clackamas River, the evaluation was conducted separately for each TMDL water body in order to maintain consistency with the description in the TMDL, and allow for comparison with the TMDL pollutant load reduction benchmarks submitted in 2008.

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 current (2015) development conditions. The PLRE must include estimates of current pollutant loading both with and without BMP implementation. Results of the PLRE must be compared to previously established pollutant load reduction benchmarks and applicable WLAs. The PLRE can be used to estimate the effectiveness of stormwater management facilities and show how BMPs are making progress toward achieving pollutant load reductions.

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

The PLRE was conducted and benchmarks were developed for bacteria in each TMDL watershed listed in Table 1-1. The overall process and methodology in conducting the PLRE and establishing new benchmarks is described below. Modeling assumptions and input data are described in Section 3.

2.1 PLRE and Benchmark Process

Figure 2-1 depicts the process for conducting the PLRE, and the relationship to the pollutant load reduction benchmarks. Steps 1 through 6 are associated with the PLRE, and include review of TMDL assumptions, data compilation, pollutant load calculations, and comparison of pollutant loads with WLAs and benchmarks previously established for the current permit period. Step 7 includes development of new pollutant load reduction benchmarks for the upcoming permit period.

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

As shown on Figure 2-1, below, 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 downspout disconnection programs, street sweeping, and catch basin cleaning. These BMPs may be reflected in the modeling effort by simulating their specific coverage area with adjusted impervious areas, runoff coefficients, or land use 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, illicit discharge detection programs, and spill prevention.

This process results in a conservative estimate of pollutant removal because it considers only those BMPs with quantitative pollutant removal effectiveness information (Category 1) and selected structural/source-control BMPs under Category 2. Implementation of non-structural or non-quantifiable BMPs (Category 3) has the potential to reduce pollutant loads further than is reflected in this evaluation.

2.2 Model Methodology

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

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

- Transportation was not included as a modeled land use category. Instead, transportation corridors were assigned land use based on the zoning of the adjacent tax lots.
- Updated impervious percentages were assigned for each modeled land use category in conjunction with assumptions used to develop the City's *Stormwater Master Plan* (BC 2014a).
- New BMP categories were added to account for the following BMP facility types not included in the previous loads models but that the City may install: porous pavement, lined planters/filtration rain gardens, and eco roofs.
- BMP effluent concentration data were refined based on a collective effort among ACWA jurisdictions to update BMP effectiveness information with new literature information.

Rainfall, land use, and BMP coverage information were entered into the spreadsheet loads model. Using established land use EMCs, annual pollutant loads were calculated for each TMDL watershed as shown in Table 1-1. As bacteria (*E. coli*) are the applicable pollutant parameter, pollutant loading is reflected in annual counts.

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 2008 land use data was developed to reflect baseline conditions and has been used in all subsequent pollutant load evaluations.

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 for bacteria due to the implementation of structural BMPs in each TMDL watershed.

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.

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 was not included in the model, but is qualitatively incorporated in the pollutant load evaluation based on best professional judgment and summarized in Section 4.4.

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

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 bacteria for each TMDL watershed. This current no-BMP load range 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 Gladstone, the WLAs for bacteria are defined as an annual percent reduction. The WLA (as a load) was calculated as the specified percent load reduction from the current no BMP, mean pollutant load.

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). The City previously developed TMDL benchmarks as part of the Phase I NPDES MS4 permit renewal submittal in September 2008. The 2008 benchmarks are presented in Section 4 as a pollutant load reduction range and are directly comparable with the PLRE results.

2.3.2 Calculating 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 Table B-1 in Appendix B for all modeled scenarios and TMDL watersheds.

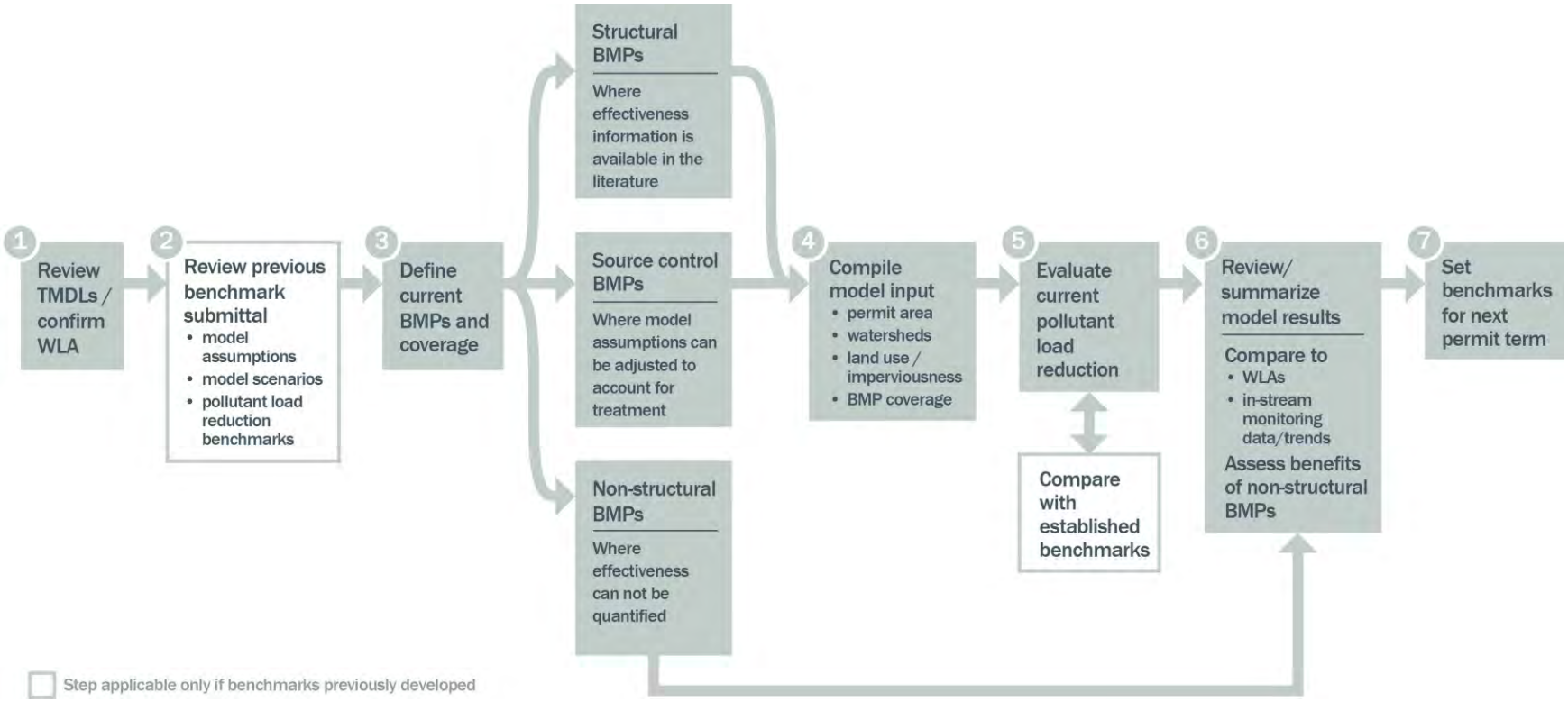

Figure 2-1. PLRE and relationship to benchmark development efforts

Section 3

Modeling Assumptions and Input Data

This section describes the assumptions and input data associated with developing the spreadsheet loads model for this PLRE and benchmark analysis. Model input data calculations were performed by Parametrix, as a subconsultant to BC, for the PLRE and updated by BC for the benchmark analysis. Model input data is based on updated geographic information system (GIS) data sets originally developed as part of the City's *Stormwater Master Plan* (BC 2014a).

The total modeled area, land use coverage, and BMP drainage areas show only minor changes from the 2008 model assumptions. However, improved mapping resulted in a correction to the watershed delineation as the 2008 model inaccurately designated some of the model area to the Lower Willamette TMDL watershed instead of the Clackamas River TMDL watershed.

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

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

3.1 Model Area

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

Areas within the city that are the responsibility of the Oregon Department of Transportation (ODOT) were omitted from the modeled area, as ODOT has a separate NPDES MS4 permit for discharges from these areas. For Gladstone, this included Oregon Highway 99E and Interstate 205 (I-205) corridors. In addition, the open-water areas of the Willamette River and Clackamas River were excluded from the modeled areas. These exclusions are consistent with modeling assumptions from the 2008 analysis.

As described in Section 1, individual WLAs are defined for two TMDL watersheds: the Lower Willamette River and the Clackamas River. As shown in Figure 3-1, the Lower Willamette TMDL watershed area includes area in the northern portion of the city that drains directly to the Lower Willamette River or drains to an unspecified tributary to the Lower Willamette River, including Kellogg Creek and Rinearson Creek. The Clackamas River TMDL watershed area includes area along the southern city boundary. As mentioned previously, the 2008 model inaccurately attributed area east of I-205 to the Lower Willamette TMDL watershed instead of the Clackamas River TMDL watershed. This adjustment results in a fairly even distribution of the city's modeled area between the Clackamas River and Lower Willamette TMDL watersheds.

Table 3-1, below, compares the 2015 total modeled area by TMDL watershed to the 2008 total modeled area for each TMDL watershed. 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 3-1. Modeled Areas		
TMDL watersheds	2015 PLRE, total modeled area (ac)[a]	2008 PLRE, total modeled area (ac)[a]
Lower Willamette River	768.6[b]	919.1
Clackamas River	693.1	551.7

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

b. *Includes Kellogg Creek and Rinearson Creek tributary areas.*

3.2 Land Use and Impervious Areas

Land use coverage for the PLRE was developed based on Metro's 2015 zoning coverage as of October 2015, and refined based on information contained in Metro's tax lot, Metro's Outdoor Recreation Conservation Areas (ORCAs), and Metro's vacant-lands data inventory.

The zoning categories were grouped into general land use categories for modeling. There is no zoning category for open space (i.e., parks and natural areas), yet they represent a unique land use and associated impervious coverage in Gladstone. Metro's ORCAs data inventory was used to identify open-space areas for inclusion in the model.

Metro's 2013 vacant-lands data were reviewed in conjunction with aerial photography to confirm vacant areas, parks, and natural areas. Identified vacant lands were merged with the updated zoning coverage to create the citywide 2015 land use coverage for modeling.

Table 3-2 lists the impervious percentage for each modeled land use category based on the values reflected in the 2014 *Stormwater Master Plan* (BC 2014a). Vacant lands were not independently reflected in the 2014 *Stormwater Master Plan*; therefore, the vacant parcels were reviewed against aerial imagery, and observed impervious area was digitized in order to calculate an impervious percentage for the vacant land use coverage.

Table 3-2. Modeled Land Use Categories	
2015 modeled land use category	2015 modeled impervious percentage
Parks and open space (POS)	7%
Commercial (COM)	90%
Industrial (IND)	70%
Single-family residential (SFR)	55%
Multi-family residential (MFR)	75%
Vacant (VAC)	3%

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

Runoff coefficient = 0.05 + 0.009 (percent impervious)

Rainfall is 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 watershed is outlined in Table 3-3 and shown in Figure 3-1, below.

CITY OF GLADSTONE

Figure 3-1:
BMP Drainage Areas and Land Use

January 2017

- City Limit (MS4 Service Area)
- Model Area
- Model Watershed
- Tax Lot
- Water Body
- Current BMP Drainage Area
- Future BMP Drainage Area

2015 Modeled Land Use

- Commercial
- Industrial
- Single Family Residential
- Multi Family Residential
- Open Space
- Vacant

Miles

0 0.25 0.5

Willamette River

Clackamas River

Lower Willamette Clackamas

Lower Willamette Clackamas

Service Layer Credits: Sources: Esri, HERE, DeLorme, 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
City of Portland, Oregon

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Table 3-3. Summary of 2015 Model Input Parameters (Land Use)							
TMDL water body	Total modeled area (ac)	Land use breakdown (ac)					
		Commercial	Industrial	Multi-family residential	Single-family residential	Parks and open space	Vacant
Lower Willamette River	768.6	38.7	13.6	62.4	528.5	99.3	26.1
Clackamas River	693.1	98.1	100.8	12.5	385.4	50.4	45.9

3.3 BMP Coverage

The City maintains an inventory of public and private stormwater treatment facility installations that is updated as new facilities are constructed or identified. The 2015 PLRE modeling effort included development of an updated GIS coverage of drainage areas reflective of each existing facility. Development of the GIS coverage of drainage areas required assistance from the City in order to accurately define the BMP category and reflect the contributing area. Section 4.3 provides a comparison of the BMP coverage areas assumed in the 2008 model and the 2015 PLRE model.

Table 3-4 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 categories. Table 3-4 shows how City BMP categories were associated with model categories, and Table 3-5 and Figure 3-1 show the 2015 BMP coverage in each modeled TMDL watershed 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.

Table 3-4. Structural BMP Categories Used in Gladstone's Pollutant Loads Model	
City BMP category	BMP category available for modeling
Detention pond	Detention pond (dry)
Oil water separator (coalescing plate and baffle)	Sediment manhole
StormFilter	Filters (leaf, sand, other)
CDS unit	Hydrodynamic devices
Rain garden	Soakage trench/infiltration rain garden/UIC Lined planter/filtration rain garden
Bioswale	Swales, filter strips

Table 3-5. Summary of Model Input Parameters (2015 BMP Coverage)								
TMDL water body	BMP coverage area (% model area)	BMP coverage (drainage area acreage)						
		Detention pond (dry)	Sediment manhole	Filters (leaf, sand, other)	Hydrodynamic devices	Soakage trench/ infiltration rain garden/UIC	Lined planter/ filtration rain garden	Swales, filter strips
Lower Willamette River	0.1.1	1.6	2.0	0.0	4.6	0.5	0.0	0.0
Clackamas River	1.2	0.0	0.0	0.3	0.0	2.1	0.8	4.8

Gladstone is relatively built out with limited potential for BMP installations that would be associated with new developments and limited available area for large retrofit BMP facilities. It is assumed that additional onsite structural BMP facilities exist in Gladstone that are not currently included in the City's structural BMP tracking system. While such facilities (presumably associated with private property) may be providing additional pollutant load reduction, they would likely be limited to a single tax lot or limited drainage area and are not currently inventoried by the City. Therefore, they are not accounted for in this modeling effort.

Non-structural BMPs were not directly included in the model simulations. Non-structural BMPs include street sweeping, illicit discharge investigations, public education, and other operational and/or programmatic actions. The model also did not account for private implementation of industrial source controls such as 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. For Gladstone, land use concentration data and BMP effluent concentrations are required for *E. coli*.

Land use concentration data, including the upper and lower confidence intervals, are provided in Table 3-6. These values are consistent with the City's 2008 data assumptions.

Table 3-6. Land Use-Based Pollutant Load Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Land use	Count[c]	Bootstrapped geometric mean		
			95% LCL	Mean	95% UCL
E. coli, CFU/100 mL (geometric mean)	Commercial	52	573	1,247	2,409
	Industrial	58	154	438	1,004
	Open space[a]	9	57	87	124
	Residential[b]	65	970	1,656	2,651

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

a. Land use EMCs for open space were also used to simulate pollutant loads associated with vacant land use.

b. Land use EMCs for residential were used to simulate pollutant loads associated with both single- and multi-family residential land uses.

c. Reflects the number of samples used/available for the source land use concentration data.

The land use EMCs listed in Table 3-6 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 and multi-family land use categories as described in the table footnotes.

BMP categories and BMP effluent concentrations were updated in 2014 based on additional information contained in the American Society of Civil Engineers (ASCE) BMP database, and locally obtained data. New BMP categories included the addition of lined planters/filtration rain gardens, eco roofs, and porous pavement as options in the pollutant load model. The mean BMP effluent concentration values used in the model are provided in Table 3-7, below.

Table 3-7. BMP Effluent Concentration Values Used in the PLRE and Benchmark Analysis

Parameter	Unit	Centrifugal separator hydrodynamic devices	Filters (leaf/sand/other)	Ponds: dry vegetated detention ponds	Ponds: wet retention basin	Swales: vegetated filter strips	Water quality wetlands	Sedimentation manhole	Green roofs	Porous pavement/UIC	Soakage trenches/infiltration rain gardens	Lined planters/filtration rain gardens
		Mean										
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

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 it is assumed these facilities would have no discharges.

3.5 Rainfall Values

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

In the Lower Willamette and Clackamas River TMDL watersheds, the bacteria WLAs are identified as an annual percent reduction. For the purposes of this evaluation, bacteria were evaluated on an annual basis with an estimated average annual rainfall of 47.06 inches.

3.6 Model Input Files

GIS shapefiles were generated to populate the pollutant loads model with areal information reflecting model area, model land use, and BMP coverage. Data processing calculations were performed to establish base data for the models. The resulting data used as the basis for this analysis was provided to the City for review and has been compiled into a geodatabase (Gladstone_NPDES_PLRE_BM_2016.gdb) to provide a record for City files and future modeling efforts. The geodatabase includes the following applicable layers (shapefiles) reflecting the data processing and compilation needed to conduct the modeling:

- CityLimit_MS4ServiceArea: total NPDES MS4 permit area.
- ModelArea: city limits, excluding ODOT right-of-way and water bodies.
- LandUse_Modeled_2016: Metro zoning simplified into model land use categories and combined/amended with Metro's "Vacant" dataset and ORCAs data sets.
- BMP_DrainageAreas: Current (2015) and future BMP drainage areas as delineated by the City on paper and clipped to tax lot lines. BMP facility attributes are joined with the GIS feature class.

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Section 4

Pollutant Load Reduction Evaluation Results

This section provides a summary of the PLRE results for each TMDL watershed. The results include a numeric estimate of the current (2015) pollutant load reduction range (Schedule D.3.c.ii), a comparison of current loads to the benchmarks established in 2008 (Schedule D.3.c.iv), 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). In addition, a summary of water quality trends is provided (Schedule D.3.c.vii).

PLRE 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 Lower Willamette River

Figure 4-1, below, shows that Gladstone is not currently estimated to be meeting the WLA for bacteria in the Lower Willamette River TMDL watershed. The PLRE shows a mean pollutant load reduction of less than 1 percent compared with the WLA of 78 percent.

The Lower Willamette TMDL watershed covers approximately half of Gladstone's modeled area. The modeled area includes more than 500 acres of residential development and nearly 100 acres of parks and open space, primarily associated with Meldrum Bar Park. The City identified several small areas of development that are managed with stormwater treatment facilities including the high school and the City's public works yard. Current structural BMP coverage is estimated at 1 percent.

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

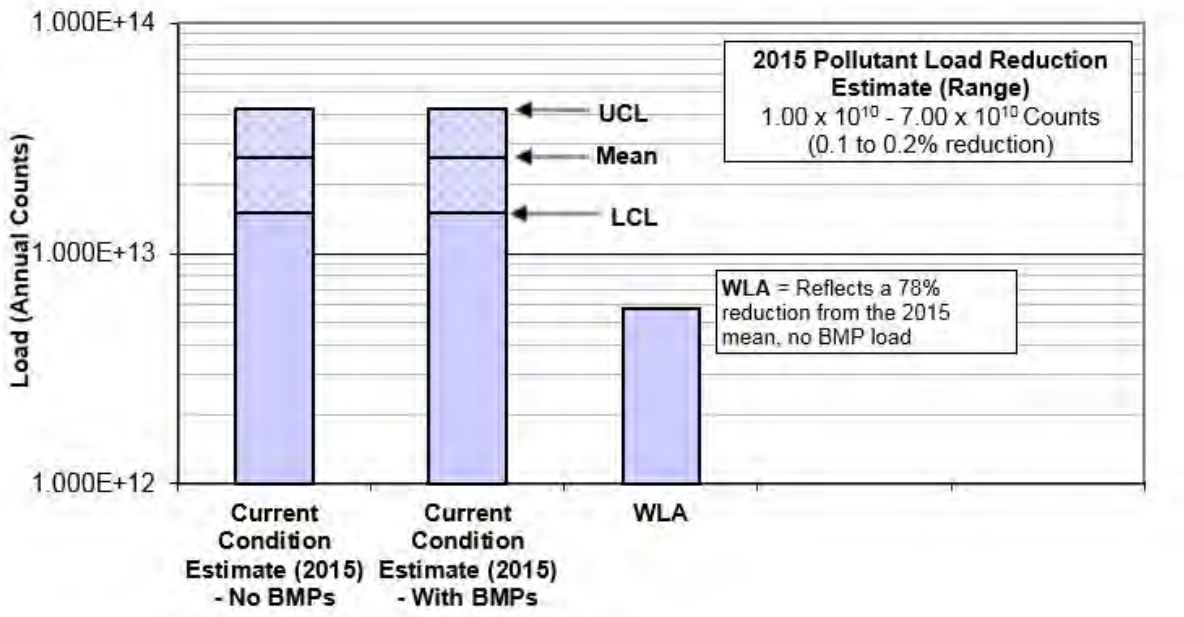

Figure 4-1. Gladstone: *E. coli* PLRE results for Lower Willamette River TMDL watershed

4.2 Clackamas River

Figure 4-2, below, shows that Gladstone is not currently estimated to be meeting the WLA for bacteria in the Clackamas River TMDL watershed. The current PLRE shows a mean pollutant load reduction of approximately 1 percent, compared with the WLA of 78 percent.

The Clackamas River TMDL watershed comprises about half of the city's modeled area. As with the Lower Willamette TMDL watershed area, a majority of the land use is residential. There is a significant area (approximately 100 acres) of commercial land use along the 99E and I-205 corridors. Many developments were constructed prior to implementation of stormwater treatment requirements. Structural BMP facilities identified include those associated with more recent redevelopment or infill development. Structural BMP coverage in the Clackamas River TMDL watershed is approximately 1 percent.

Significant additional load reduction would be needed to achieve the bacteria WLA in this watershed. Additional load reductions could be achieved through non-structural BMPs (which are not quantified in this PLRE), or through the construction of additional structural BMPs as a result of redevelopment, or retrofit activities. Even with significant retrofit projects identified in the City's Stormwater Master Plan, such as the Green Streets Pilot Project, it is unlikely that the additional pollutant removal achieved would result in meeting the WLA. As with the Lower Willamette TMDL watershed, the WLA is considered to be an ultimate discharge goal.

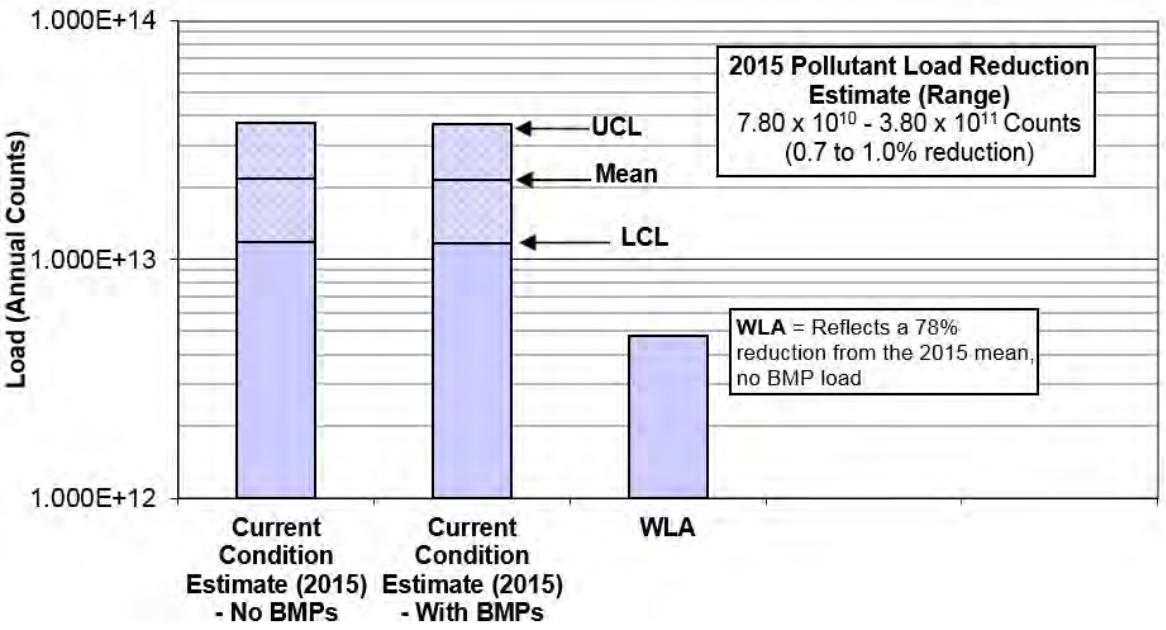

Figure 4-2. Gladstone: *E. coli* PLRE results for Clackamas River TMDL watershed

4.3 Benchmark Comparison

As part of this PLRE effort, pollutant load reduction estimates must be compared to previously established pollutant load reduction benchmarks (Schedule D.3.c.iv). The City submitted a 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 into the future (i.e., 2013).

Table 4-1 shows the difference in modeled areas and BMP coverage areas between the 2008 benchmark development and the 2015 PLRE. Changes in modeled area and BMP coverage are observed because of the revision in the TMDL watershed delineation assumptions as documented in Section 3.1.

Table 4-1. Benchmark Assumptions Comparison

TMDL watershed	Assumption	2008 benchmark effort		2015 PLRE effort
		2008 (actual)	2013 (projected)	
Lower Willamette River	Model area (ac)	919.1	919.1	768.6
	BMP coverage (%)	2.3	2.3	0.8
Clackamas River	Model area (ac)	551.7	551.7	693.1
	BMP coverage (%)	0.0	0.1	1.2

Numeric pollutant load reduction benchmarks were established in 2008 for the Clackamas River and Lower Willamette TMDL watersheds. The benchmarks were not reflective of significant additional planned structural BMP installations or retrofits from 2008 to 2013, but only the additional structural BMPs installed with new development (i.e., conversion of vacant land to a developed land).

Table 4-2 presents the results of the benchmark comparison. The benchmarks were established based on land use and BMP coverage projected for the year 2013. Assuming that the TMDL watershed delineation was constant, the benchmarks would be directly comparable to the 2015 pollutant load reduction estimates. However, the changes in the TMDL watershed delineation documented in Section 3.1 have a slight but direct impact on the City's ability to show achievement of numeric benchmarks for TMDL parameters.

Because of the statistical variability of the underlying data, the current pollutant load reduction estimates and 2013 benchmarks are presented as ranges in loading. For purposes of this benchmark comparison effort, the following guidelines apply:

- Where the mean 2015 pollutant load reduction estimate falls within the benchmark range, the benchmarks are interpreted to likely be met
- Where the UCL of the 2015 pollutant load reduction estimate falls within the benchmark range, 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. Gladstone Pollutant Load Reduction Benchmark Comparison

TMDL watershed	Parameter (units)	2015 pollutant load reduction estimate[a]			2008 benchmarks based on projected 2013 conditions	Met benchmarks[b]
		LCL	Mean	UCL		
Lower Willamette River	Bacteria (counts)	1.0×10^{10}	3.0×10^{10}	7.0×10^{10}	5.2×10^{10}–2.9×10^{11}	Possibly met
Clackamas River	Bacteria (counts)	7.8×10^{10}	1.7×10^{11}	3.8×10^{11}	1.8×10^{10}–1.1×10^{11}	Likely met

a. The UCL estimate is the difference between the no-BMP and with-BMP pollutant loads for the UCL; the mean estimate is the difference between the no-BMP and with-BMP pollutant loads for the mean; 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, changes in the model area assumptions due to changes in the TMDL watershed delineation have a significant impact on the ability to simulate pollutant reductions representative of the benchmarks.

4.4 Pollutant Load Reduction Evaluation Summary

The pollutant load reduction benchmark comparison presented in Table 4-2 shows that benchmarks are estimated to likely be met for bacteria in the Clackamas River TMDL watershed and possibly met for bacteria in the Lower Willamette TMDL watershed. Changes in the TMDL watershed delineation assumptions and associated structural BMP installation locations have a significant impact on the ability to simulate pollutant reduction consistent with the 2008 benchmarks. Regardless of mapping changes, significant additional load reduction would be needed beyond the current structural BMP implementation to achieve WLAs for bacteria in the Lower Willamette and Clackamas River TMDL watersheds.

Due to the variable nature of stormwater runoff and the variety of undefined sources contributing to stormwater pollutant discharges, there are inherent difficulties in applying WLAs to MS4 discharges and quantitatively tracking pollutant loads to show progress toward WLAs. In conducting a quantitative PLRE, the City chose a conservative approach to avoid overestimating the effectiveness of the programs. Over time, pollutant load reductions are expected to increase because of the following:

- Continued implementation of stormwater design standards for redevelopment projects, resulting in construction of additional structural BMPs

- Stormwater retrofit efforts to install structural BMPs in untreated areas
- New technologies and scientific advances

In addition, the pollutant load reduction estimates in 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 pollutant reduction. Such activities include erosion control, illicit discharge detection and elimination, street sweeping, catch basin cleaning, operations and maintenance, pet waste programs, and public education. While numeric values for non-structural and source-control BMP effectiveness were not specifically accounted for in the pollutant loads models, pollutant loads are presented as a range, and this range reflects the variable nature of stormwater runoff and may potentially account for non-structural and source-control practices implemented upstream.

4.5 Water Quality Trends Analysis

In accordance with Schedule D.3.c.vii of the City's NPDES MS4 permit, the City prepared a water quality trends analysis as part of the PLRE. The City's overall monitoring program includes in-stream water quality monitoring and biological monitoring. For the water quality trends analysis, in-stream monitoring data were evaluated to assess trends in receiving water quality. For Gladstone, 6 years of data were evaluated (2008 to 2014).

In-stream water quality trends were calculated for one site in Gladstone as identified in the *Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan* (BC 2014b). Gladstone's in-stream monitoring site is on Rinearson Creek at Risley Road. Rinearson Creek is a tributary to the Lower Willamette River and located in the Lower Willamette TMDL watershed. The following pollutant parameters were included in the water quality trends analysis:

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

Each parameter was analyzed as a data set (i.e., there were seven data sets). The analyses were performed for only wet weather conditions because the wet weather data set met the minimum criteria for sample size. Analysis of the wet weather condition data sets allows for the potential influence of MS4 discharges on receiving water quality to be evaluated.

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.

Six out of the seven data sets (i.e., parameters) evaluated showed no statistically significant trends in the water quality sampling. Given a significance level of 5 percent, results from the trends analysis indicate the following:

- Improving trends (i.e., decreasing concentrations) were observed for bacteria during wet weather conditions
- No detectable trends for the other parameters were observed during wet weather conditions
- Not enough data were available to evaluate trends during the dry weather conditions for any parameter

Full documentation is included in Appendix A.

The results of this trends analysis are not a definitive statement of the overall quality of sampled streams or water quality characteristics of MS4 runoff, but rather one piece of information to be considered within the larger watershed context. The City will continue to conduct in-stream water quality sampling in compliance with the NPDES MS4 permit.

Section 5

Benchmarks

Based on results of the pollutant load reduction evaluation (Section 4), the City of Gladstone is required to establish new pollutant load reduction benchmarks for bacteria in the Clackamas River and Lower Willamette River TMDL watersheds.

The proposed benchmarks presented in this section are based on projected structural BMP implementation at the end of the next NPDES MS4 permit term (anticipated to be 2022). The benchmarks presented in Table 5-2 show total anticipated bacteria load reductions between 0.2 and 1.3 percent, depending on the watershed and projected BMP coverage. Additional pollutant load reduction is expected to be achieved through non-structural measures.

5.1 Benchmark Development

Benchmarks are required for bacteria in the Clackamas River and Lower Willamette River TMDL watersheds. 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 during the next permit term.

The benchmarks reflect current BMP implementation and projected BMP implementation over the upcoming permit term. As the City's current NPDES MS4 permit expires March 1, 2017, the next 5-year permit term is anticipated to be 2017 to 2022.

The City's Public Works staff identified stormwater facility installations associated with upcoming public works projects. They also identified pending and constructed private stormwater facility installations associated with recent or in-progress development activities since the PLRE analysis was conducted in December 2015. In total, 6 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, below, summarizes the City's current status in meeting the previous (2008) benchmarks and the WLAs (as repeated from Table 4-2) and lists the anticipated stormwater facility installations by TMDL watershed, facility type, and drainage area.

Additional public and private facility installations beyond those shown in Figure 3-1 are likely but have not been projected. This conservative assumption is due to the variable schedules of private development activities and the unknown content and issuance date for the City's reissued NPDES MS4 permit.

Table 5-1. TMDL Benchmark Status and Projected Stormwater Facility Installations

TMDL watershed	Model time frame	Parameter	2015 pollutant load reduction estimate results		2017 TMDL benchmark development	
			Met TMDL WLA? (Y/N)	Met (2008) benchmark? (Y/N)	Projected BMP installations	Estimated future BMP drainage area addition (ac)[a]
Lower Willamette River	Annual	Bacteria	N	Y	• Swales/Vegetated Filter Strips	1.7
Clackamas River	Annual	Bacteria	N	Y	• Swales/Vegetated Filter Strips • Infiltration raingardens • Hydrodynamic Separators	49.2

a. The future BMP drainage area includes 1) potential areas to be treated by new BMPs and 2) area currently being treated by a structural BMP, but expected to receive treatment by a more effective BMP (through retrofit of existing systems or installation of downstream BMPs).

5.2 TMDL Benchmark Results

The spreadsheet loads model used for the PLRE was used to simulate future BMP implementation in accordance with modeling methods and assumptions described in Section 3.

The benchmarks were calculated as the difference between the modeled loads associated with the current no-BMP scenario and the future with-BMP scenario. Due to the variability in stormwater quality data, pollutant loads themselves are typically calculated and presented as a range. Pollutant load estimates reflecting the current no-BMP, current with-BMP, and future with-BMP scenarios are provided in Appendix B.

Table 5-2 shows the WLAs and the new TMDL benchmarks for bacteria as both a load reduction and percentage load reduction.

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

TMDL watershed	Time frame	Pollutant (units)	WLA (% reduction)	TMDL benchmarks (load reduction)[a], range	TMDL benchmarks (% load reduction)[a], range
Lower Willamette River	Annual	Bacteria (counts)	78%	2.40×10^{10} to 1.22×10^{11}	0.2 to 0.3
Clackamas River	Annual	Bacteria (counts)	78%	9.71×10^{10} to 4.63×10^{11}	0.8 to 1.3

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

5.3 Discussion and Application of SWMP Implementation

The City's benchmarks reflect the projected installation of 6 new structural BMPs, covering approximately 43 acres of new drainage area.

While the projected BMP coverage area is significant, the resulting pollutant load reductions fall short of achieving the WLAs. Large areas of the City have already developed without structural BMPs and structural stormwater BMPs are not 100 percent effective in removing bacteria. Specifically, two of the new structural BMPs that are covering a majority of the new drainage area are hydrodynamic separators installed in the ROW. This type of facility may be effective at trash and debris removal but is not effective for bacteria removal.

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 5-2, above, and Table B-1 in 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 4.5
- Future stormwater program enhancements to target TMDL parameters as pollutants of concern, to be identified in future SWMP updates.
- Additional structural BMPs installed in conjunction with future redevelopment projects that have not yet submitted land use applications to the City.
- New water quality facilities installed with public improvement projects.

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

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Section 6

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Section 7

Limitations

This document was prepared solely for the City of Gladstone in accordance with professional standards at the time the services were performed and in accordance with the contract between the City of Gladstone and Brown and Caldwell dated February 1, 2005. This document is governed by the specific scope of work authorized by the City of Gladstone; 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 of Gladstone 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 Gladstone, Oregon

Project Title: 2011 MS4 NPDES Permit Assistance

Project No.: 141197.101.001

Technical Memorandum

Subject: Instream Water Quality Trends Analyses

Date: January 20, 2016

To: Jim Whynot, Public Works Director and Eric Swanson, City Administrator

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

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 Gladstone (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 storm-water discharges.

The City has been collecting instream water quality monitoring data since 2008 from one creek site. 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 by the City 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, none 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 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 WES as they provide data analysis services for the City.

None of the City's data sets had 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

Rinearson Creek (at Risley Road)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Copper (diss.)	Zinc	Zinc (diss.)
Monitoring date range	2008–14	2008–14	2008–14	2008–14	2008–14	2008–14	2008–14
Number of observations	17	17	17	17	17	17	17
Wet-day detects	16	16	12	16	16	16	16
Wet-day non-detects	0	0	4	0	0	0	0
Wet-day data set 10+ records and 50% or more detects	✓	✓	✓	✓	✓	✓	✓
Dry-day detects	1	1	1	1	1	1	1
Dry-day non-detects	0	0	0	0	0	0	0
Dry-day data set 10+ records and 50% or more detects	-	-	-	-	-	-	-

Mann-Kendall Trends Analysis

Temporal trends in water quality were evaluated using the Mann-Kendall test, a non-parametric method that is used for identifying monotonic (though not necessarily linear) trends. The Mann-Kendall test is particularly well-suited for analyzing environmental data because (1) it allows for missing values and unevenly spaced measurements, (2) there are no distributional assumptions, (3) outliers have minimal effect, and (4) some non-detects can be present in the data. The Mann-Kendall test is described in a number of references including Gibbons (1994), Gilbert (1987), Hollander and Wolfe (1973), and U.S. EPA (2006).

The null and alternative hypotheses for this analysis are:

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

The null hypothesis (Ho) of "no trend" was rejected if the absolute value of the test statistic (p-value) exceeded the critical p-value. The critical p-value depends on the number of observations and the desired significance level of the results. Significance levels of both 5 and 10 percent were selected for this analysis

(i.e., there is at most a 5 or 10 percent chance that the trend observed is not actually a trend but due to variability of the data). P-values less than 5 percent were assumed to demonstrate a statistically significant trend. P-values between 5 and 10 percent were assumed to demonstrate a marginally significant trend. P-values corresponded to a two-sided analysis where there is interest in both upward and downward trends.

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

A negative value indicates a downward trend with time and a positive value indicates an upward trend. When the null hypothesis is rejected, the conclusion is that the Kendall score (and the temporal trend) is not significantly different from zero.

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

To provide quality assurance on the automated processing of the site data, the Mann-Kendall test was also conducted in ProUCL for selected data sets. ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency (EPA) for analysis of environmental data (U.S. EPA, 2013). Because of the inability to automate the processing of data sets in ProUCL, ProUCL was used solely to spot-check selected results from the R package. The Kendall Score and p-value from the ProUCL Mann-Kendall 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 data sets that had at least 50 percent detected values and at least 10 observations. The seven trends analyses completed were on data sets with 16 observations. All seven trends analyses were for wet-day data.

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

Table 2. Legend for Summary of Trends

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

Table 3. Summary of Trends					
TMDL watershed	L Willamette (Rinearson)				
Water body	Rinearson				
Site/Station ID	Rinearson				
2015 instream monitoring site	At Risley Rd.				
		No rain		Rain	
WQ parameter	Date range	N	Trend	N	Trend
TSS	2008-2014	1		16	
E. coli	2008-2014	1		16	↓
TP	2008-2014	1		16	
Total copper	2008-2014	1		16	
Copper (diss.)	2008-2014	1		16	
Total zinc	2008-2014	1		16	
Zinc (diss.)	2008-2014	1		16	

Summary/Conclusions

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

- Given a significance level of 10 percent, one improving water quality trend occurred during wet weather.
- The majority of all of the trends analyses (six out of seven, or 86 percent) showed no trend given a significance level of 10 percent.
- The single improving water quality trend was for bacteria.

These trends results should be evaluated in the context of where samples were collected and what watershed influences may be affecting water quality, 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.

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 stream, 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 water.

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 values 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 Pollutant Loads

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Table B-1. City of Gladstone Bacteria Load Summary (for use with the PLRE and TMDL Benchmarks)

Waterbody	Season	WLA (% reduction or concentration)	Pollutant loading estimate (counts)									Pollutant load reduction estimate (counts)[b]								
			Current, no BMPs			Current, with BMPs			Future, with BMPs[a]			Current conditions			Future conditions[c]			Future conditions (% reduction)[c]		
			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)
Clackamas River	Annual	78%	3.72×10^{13}	2.17×10^{13}	1.18×10^{13}	3.68×10^{13}	2.16×10^{13}	1.18×10^{13}	3.67×10^{13}	2.15×10^{12}	1.17×10^{13}	3.80×10^{11}	1.70×10^{11}	7.80×10^{10}	4.63×10^{11}	2.01×10^{11}	9.71×10^{10}	1.3%	0.9%	0.8%
Lower Willamette River	Annual	78%	4.24×10^{13}	2.61×10^{13}	1.50×10^{13}	4.24×10^{13}	2.60×10^{13}	1.50×10^{13}	4.23×10^{13}	2.60×10^{13}	1.50×10^{13}	7.00×10^{10}	3.00×10^{10}	1.00×10^{10}	1.22×10^{11}	4.70×10^{10}	2.40×10^{10}	0.3%	0.2%	0.2%

a. 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 benchmarks.

b. 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.

c. The future condition pollutant load reduction estimates are the TMDL Benchmarks. Benchmarks have been calculated as a load reduction (for comparison to future PLRE evaluations) and also as a percentage load reduction (to compare to the WLAs).

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Appendix D: Updated Comprehensive Clackamas County Stormwater Monitoring Plan (2017)

Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan

January 2017

Implementation start: July 1, 2017

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Comprehensive Clackamas County NPDES MS4 Stormwater Monitoring Plan

Prepared for

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

January 2017

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List of Figures

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List of Tables

List of Abbreviations

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

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Section 1 Introduction

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

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

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

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

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

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

Section 2 Objectives

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

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

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

Section 3 Development and Implementation of the Plan

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

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

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

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

have the resources to address the new monitoring objectives without substantial additional effort beyond the "maximum extent practicable" requirement.

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

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

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

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

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

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

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

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

Section 4 Data Gathering Strategies

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

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

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

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

Section 5 Monitoring Activities

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

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

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

5.1 Instream Monitoring

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

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

Instream monitoring activities will attempt to address the following questions:

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

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

5.1.1 Description of Instream Monitoring Locations

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

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

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

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

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

DDE = dichlorodiphenyldichloroethylene

DDT = dichlorophenyltrichloroethane

PAH = polycyclic aromatic hydrocarbon

PCB = polychlorinated biphenyl

TCE = trichloroethylene

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

Paired instream monitoring locations were selected when possible. Paired monitoring locations include one upstream location that represents more baseflow and/or rural conditions, generally located close to the co-permittee's MS4 permit area boundary, and one downstream location that

represents urban MS4 stormwater runoff and baseflow conditions generated inside of the co-permittee's MS4 permit boundary. Paired monitoring was selected to help identify the effects of urban development on receiving water quality.

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

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

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

5.1.2 Sample Collection Methods

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

5.1.2.1 Targeted Sample Collection

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

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

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

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

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

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

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

Table 3. Targeted Instream Monitoring Site Summary

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

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

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

NORTH

TUALATIN RIVER

CLACKAMAS RIVER

WILLAMETTE RIVER

0 1 2 4 Miles

Brown AND Caldwell

JANUARY 2017

FIGURE 1. INSTREAM MONITORING LOCATIONS

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

Instream Monitoring Locations

Urban Growth Boundary

Oak Lodge Sanitary District

CCSD #1

Rivergrove

SWMACC

Gladstone

Happy Valley

Milwaukie

Oregon City

West Linn

Wilsonville

5.1.2.2 Routine Sample Collection Methods

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

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

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

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

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

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

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

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

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

5.1.3 Additional Instream Monitoring Efforts

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

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

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

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

5.2 Stormwater System Monitoring Efforts

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

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

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

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

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

5.2.1 Description of Stormwater Monitoring Locations

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

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

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

Table 5. Summary of the Clackamas County Co-permittee Stormwater Monitoring Efforts		
Upstream land use	Number of outfalls monitored	Total number of samples collected per year
Residential	4	12
Multifamily residential	1	3
Commercial	2	6
Mixed use	3	9
Industrial	1	3
Total	11	33

5.2.2 Sample Collection Methods

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

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

Stormwater sampling procedures are as follows:

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

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

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

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

NORTH

CLACKAMAS RIVER

TUALATIN RIVER

WILLAMETTE RIVER

0 1 2 4 Miles

Brown AND Caldwell

JANUARY 2017

FIGURE 2. OUTFALL MONITORING LOCATIONS

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

Outfall Monitoring Locations

Urban Growth Boundary

Oak Lodge Sanitary District

CCSD #1

Rivergrove

SWMACC

Gladstone

Happy Valley

Milwaukie

Oregon City

West Linn

Wilsonville

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

Table 6. Stormwater System Monitoring Site Summary

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

5.3 Biological Monitoring Efforts

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

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

Biological monitoring activities will attempt to address the following questions:

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

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

5.3.1 Description of Biological Monitoring Locations

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

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

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

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

Table 7. Biologic Monitoring Site Summary

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

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

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

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

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

NORTH

CLACKAMAS RIVER

TUALATIN RIVER

WILLAMETTE RIVER

0 1 2 4 Miles

Brown AND Caldwell

JANUARY 2017

FIGURE 3. MACROINVERTEBRATE MONITORING LOCATIONS

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

Macroinvertebrate Monitoring Sites

Urban Growth Boundary

Oak Lodge Sanitary District

CCSD #1

Rivergrove

SWMACC

Gladstone

Happy Valley

Milwaukie

Oregon City

West Linn

Wilsonville

5.3.2 Sample Collection Methods

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

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

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

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

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

5.3.3 Connection to Physical Condition Monitoring

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

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

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

5.4 BMP Monitoring Efforts

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

2. *Evaluate the effectiveness of BMPs in order to help determine BMP implementation priorities; and,*
6. *Assess progress towards meeting TMDL pollutant load reduction benchmarks.*

BMP monitoring activities will attempt to address the following questions:

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

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

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

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

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

5.4.1 BMP Monitoring (Environmental)

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

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

and application of these findings provides a more cost-effective means of addressing monitoring objective 2.

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

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

Table 8. Structural BMP Monitoring Site Summary

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

5.4.2 BMP Monitoring (Programmatic)

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

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

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

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

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

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

6.1 Sampling Parameters and Analytical Methods

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

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

Table 9. Pollutant Parameters and Analytical Methods

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

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

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

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

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

6.2 Quality Assurance and Quality Control Procedures

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

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

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

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

Section 7 Monitoring Data Management and Plan Modifications

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

7.1 Data Management

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

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

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

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

7.2 Plan Modifications

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

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

Appendix A: Field QA/QC Procedures

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

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SOP A-1: Field Sample Collection Procedures

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

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

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

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

Grab Sampling Procedures

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

Bottle preparation

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

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

Grab sampling technique

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

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

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

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

Composite Sampling Procedures

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

Bottle preparation

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

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

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

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

Composite sampling technique

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

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

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

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

QA/QC Sampling Procedures

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

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

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

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

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

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

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

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

The procedures for filling out these forms are as follows.

Before and during Sample Collection

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

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

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

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

After Sample Collection

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

At the Laboratory

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

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

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

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

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

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

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

Field Dissolved Oxygen/Temperature Procedure

Meter preparation

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

Analysis timeline

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

Technique

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

QA/QC

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

Field pH Procedure

Meter preparation

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

Analysis timeline

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

Technique

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

QA/QC

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

Field Conductivity Procedure

Meter preparation

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

Analysis timeline

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

Technique

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

QA/QC

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