Oak Lodge Sanitary District
Surface Water Management Program

2014-2015
Annual Report

For
National Pollutant Discharge Elimination System (NPDES)
Municipal Separate Storm Sewer System (MS4)
Permit Compliance
Permit #108016

Prepared by:
Oak Lodge Sanitary District, Surface Water Management Program

October, 2015

2015 Oak Lodge Sanitary District
March 2012 MS4 Permit
ANNUAL REPORT REQUIREMENTS

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1. Background

The Board of Directors of Oak Lodge Sanitary District created a Surface Water Management program with the adoption of Ordinance 1001 in May of 1993. The purpose of the Surface Water Management Program is to:

- prevent pollutants from entering rivers, lakes, and streams;
- maintain and/or improve water quality; and
- restore or enhance properly functioning conditions in the watersheds.

Program development began officially on July 1, 1993, with the collection of Surface Water Management fees based on impervious surface area.

Permit History

The Department of Environmental Quality issued a National Pollutant Discharge Elimination System Waste Discharge (NPDES) Permit No. 101348 dated December 15, 1995 to the District as a joint permit with Clackamas County. This five-year permit required the District to implement a stormwater management program to reduce the contribution of stormwater pollutants to the maximum extent practicable and to discharge stormwater to public waters through a municipal separate storm sewer system in conformance with the conditions in the permit.

That original NPDES permit expired on November 30, 2000 and the State of Oregon Department of Environmental Quality (DEQ) issued a new permit in March 2004 (NPDES Permit 108016). Due to public comment, the DEQ reopened the permit in June 2004. After a public comment process, the DEQ issued the final Municipal Stormwater Permit on July 25, 2005. This permit was appealed by third party groups, and the Oregon Court of Appeals upheld the issued permit in 2010; the Oregon Supreme Court did not allow further review.

The District was issued another MS4 Permit on March 15, 2011. Based upon the new permit, the District prepared a revised Surface Water Management Plan and Surface Water Monitoring Plan. The Clackamas County MS4 permit was appealed after issuance by a co-permittee. The current MS4 permit was issued to the co-permittees in March, 2012, and that permit is the basis for this annual report.

2. Report Organization

This report is organized based on the requirements of the March, 2012 NPDES permit, Schedule B.5.a through B.5.k. The numbers listed after the report headings indicate the portion of the permit schedule that the section addresses. The report covers the activities of the district from July 1, 2014 to June 30, 2015. Information about implementation of required BMP's is summarized in Table 1. Brief summaries of each topic are described in this document.

3. Status of SWMP Program and Associated Elements (B.5.a)

The Oak Lodge Sanitary District (OLSD) implemented the Surface Water Management Plan in 2012 and was based on the two permits because the new/current permit was issued mid-cycle in March 2012. However, for the purpose of the annual report preparation, implementation of the SWMP is being reported based on the requirements in the current permit (permit 108016). This information is summarized in Table 1 of this report.

4. Status of Public Education Effectiveness Programs (B.5.b)

OLSD has a series of ongoing methods to communicate information to the community about the various elements associated with surface water. These efforts are summarized in Table 1. Overall, the District has implemented a wide variety of methods to communicate with, and educate, the community about surface water issues. We are learning that some methods appear to be more effective in changing behavior than others and efforts are underway to begin a careful effectiveness evaluation process for public outreach. For example, citizens indicate that they read the newsletter that they receive with their bimonthly bills. Please see the BMP's for Public Education listed in Table 1 for full detail on the District's progress toward public education and outreach efforts.

The current approach for an effectiveness evaluation will be to focus on illicit dumping and discharge. This program has been modeled off of a similar (and successful) program that was initiated in Washington's Kitsop County. OLSD's new program, called "Dump Smart" is being utilized for this effort. OLSD's approach has been to educate and inform both service providers and home owners utilizing those services likely to create accidental waste. OLSD focused on carpet cleaners, painters, and power washing as all three have significant mobile capabilities and can impact waterways across our District and watershed. OLSD designed brochures and an education campaign which was highlighted in our newsletter, on our website, and face-to-face with business owners offering these types of services. Since then, identification of detrimental dumping practices has increased, indicated by the more specific language used during service calls and many businesses have been educated on the negative effects their actions could have.

5. Adaptive Management Process (B.5.c)

Over time, OLSD will continue to evaluate the overall health of local watersheds using the information collected through the monitoring program. That information provides a valuable 'snapshot' of water quality in the district, and provides District program management the opportunity to determine where to focus limited financial resources for program implementation. The District will target water quality issues that are trending toward exceeding state water quality standards; adjustments can be made to focus the messaging to the community about different water quality problems being observed. The anticipated outcome would be a reversal of negatively trending water quality factors because of actions taken by the District. Examples of actions might include stepped up inspection and enforcement in areas with documented water quality issues, targeted public outreach to smaller neighborhood or watershed groups that are the source of the problem, and targeted monitoring activities to try to minimize the area where the source of the water quality problems are coming from.

6. Proposed Changes to SWMP (B.5.d)

OLSD amended the SWMP during the 2012-2013 permit year as a result of the special conditions required of OLSD and Clackamas County related to public infrastructure maintenance. The SWMP amendment was approved by DEQ. There are currently no proposed changes to the SWMP anticipated.

7. Summary of SWM Program Expenditures (B.5.e)

Oak Lodge Sanitary District is a sanitary district formed and operating under Oregon Revised Statutes. The District's principal act is ORS 450. Oak Lodge Sanitary District began enactment of a surface water management program in July 1993. At that time, the District adopted Ordinance No. 1001, codified as Oak Lodge Sanitary District Rules and Regulations for Surface Water Management. This ordinance and subsequent revisions provides the regulatory framework for developing and implementing a surface water management plan and program with the District's jurisdictional boundary.

Also included in the ordinance are provisions for the assessment and collection of fees and charges associated with operating the program. Monthly service charges are collected from each developed property within the District as incurred charges for the provision, operation, maintenance, repair and replacement of surface water management services. Additional fees are assessed for new and redevelopment plan review, and compliance determination. The revenue generated by these fees and charges is applied to the cost of providing the various services and activities contained in the surface water management program including capital facility construction. All revenue generated by the fees and charges associated with the surface water management program are retained within the program. All expenses generated within the surface water management program are funded through program generated fees and charges. FY2015 fees were $7.00 per month for residential households, and a calculated rate for commercial and industrial users based on their area of impervious surface.

For the 2014-2015 Fiscal Year, OLSD's expenditures for the surface water program totaled $906,815. The majority of expenditures ($867,254) were operational expenditures.

8. Summary of SWM Program Monitoring (B.5.f)

Surface water sampling occurred four times annually as is required in the NPDES permit. The sites sampled included instream samples from each site, and two outfalls. In reviewing the water quality data, water quality elements for sediment and bacteria are elevated, with periodic exceedances of the state standard for e Coli.

Other testing elements appear to be within DEQ range, and program monitoring will continue per the procedures outlined in the 2012 Monitoring Plan.

Sample results are provided in Appendix A.

9. Proposed Modifications to Monitoring Plan (B.5.g)

OLSD's monitoring plan is current as of September 1, 2012, and no modifications are proposed at this time.

10. SWMP Enforcement (B.5.h)

OLSD routinely inspects the various elements of the Surface Water system within the District. A summary of the inspections, enforcements, and ongoing activities related to illicit discharges can be found in Table 1.

11. Development Activities (B.5.i)

Land within the Oak Lodge Sanitary District is largely built-out, with very little raw land available for new development and redevelopment activities are more common. Economic factors currently prohibit large scale redevelopment, although several permits were issued during this permit cycle. Table 1 summarizes the number and type of development activities that OLSD reviewed. At this time, there are no proposals for land annexations, and OLSD does not implement any part of the Urban Growth Boundary.

12. District Boundary Expansion (B.5.j)

The Oak Lodge Sanitary District is not currently expanding its boundary in any manner.

13. Special Requirements (B.5.k)

TMDL Pollutant Load Reduction Evaluation

TMDL Pollutant Load Reduction Evaluation

Prepared for

Oak Lodge Sanitary District

October 2015

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List of Abbreviations

ac	acre(s)
ACWA	(Oregon) Association of Clean Water Agencies
ASCE	American Society of Civil Engineers
BMP	best management practice(s)
COM	Commercial *(land use classification)*
DEQ	(Oregon) Department of Environmental Quality
District	Oak Lodge Sanitary District
EMC	event mean concentration
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
IND	Industrial *(land use classification)*
LCL	lower confidence limit
MFR	Multifamily Residential *(land use classification)*
mL	milliliter(s)
MS4	municipal separate storm sewer system
MUR	Mixed-use Residential
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
PLRE	pollutant load reduction evaluation
SFR	Single-family Residential *(land use classification)*
SOP	standard operating procedure
TMDL	total maximum daily load
UCL	upper confidence limit
UIC	underground injection control
VAC	Vacant *(land use classification)*
WLA	wasteload allocation

Definitions

Load allocation	The amount of pollutant allocated to existing nonpoint sources and natural background in a total maximum daily load (TMDL). (EPA, 2014, http://toxics.usgs.gov/definitions/tmdl.html)
Pollutant load reduction benchmark	A future pollutant load reduction estimate for a parameter or surrogate, where applicable, for which a wasteload allocation (WLA) is established. The benchmark is used to establish anticipated future progress toward achieving the WLA over an implementation period (typically 5 years).
Pollutant load reduction evaluation	An evaluation of current pollutant load generation, when compared to previous loads, for a parameter or surrogate, where applicable, for which a WLA is established. The pollutant load reduction evaluation (PLRE) is used to measure progress toward achieving a WLA or previously established benchmark.
Wasteload allocation	The amount of pollutant load allocated to a specified point source (e.g., a permitted sewage treatment plant, industrial facility, or stormwater discharge) in a TMDL. (EPA, 2014, http://toxics.usgs.gov/definitions/tmdl.html)

Section 1

Introduction

This report presents the 2015 total maximum daily load (TMDL) pollutant load reduction evaluation (PLRE) for the Oak Lodge Sanitary District (District), located in Clackamas County, Oregon. As required by the District'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 the District's NPDES MS4 permit area
- an evaluation of the pollutant load reduction based on the District's current use of structural water quality controls or best management practices (BMPs)
- a comparison of the current pollutant load reduction to quantitative pollutant load reduction benchmarks established by the District in a 2013 interim submittal to the Oregon Department of Environmental Quality (DEQ)

The PLRE results presented in Section 4 show that the District is estimated to be meeting the previously established quantitative pollutant load reduction benchmarks for *E. coli* in the Lower Willamette TMDL watershed. The District is also estimated to be meeting or making significant progress toward meeting the previously established qualitative benchmarks for non-structural BMP activities. However, significant additional pollutant reduction will be needed to achieve the wasteload allocation (WLA) defined in the TMDL.

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

It is anticipated that this document will be amended in 2016 to include new TMDL pollutant load reduction benchmarks, applicable for the next permit term.

1.1 Permit Requirements

The District is a co-permittee on Clackamas County NPDES MS4 permit 101348, issued on March 16, 2012. 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.(DEQ, 2012)*

Under Schedule D.7.a and D.7.b of the Clackamas County NPDES MS4 permit, the District completed an initial PLRE in 2013 to evaluate pollutant load reduction and establish TMDL benchmarks. The PLRE was based on 2010 development conditions and structural BMP implementation, and the established benchmarks were reflective of the end of the NPDES MS4 permit term (2015). A report titled *Pollutant Load Reduction Benchmarks, prepared for Oak Lodge Sanitary District* (Brown and Caldwell, 2013) was prepared and submitted to DEQ.

Per Schedule D.3.c of the Clackamas County NPDES MS4 permit, the District must now complete an updated 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 trend analysis, as sufficient data are available, and the relationship to stormwater discharges for receiving water bodies within the co-permittees jurisdictional area with an approved TMDL.*

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*.

1.2 TMDL Applicability

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

The U.S. Environmental Protection Agency (EPA) approved the Willamette Basin TMDL on September 29, 2006. The Willamette Basin TMDL addresses elevated in-stream temperatures, bacteria (E. coli), and mercury for the Willamette River and tributaries. Additional pollutant parameters are included in the Willamette Basin TMDL for select tributaries that are outside the District's jurisdictional boundary.

The District's jurisdictional boundary is located entirely within the Lower Willamette Subbasin. Stormwater runoff from the District enters the MS4 and various tributaries, including Boardman and River Forest creeks, prior to discharge to the Lower Willamette River.

WLAs were developed originally as a means to regulate discharges from well-defined point sources (industries and wastewater treatment plants) but, with implementation of the NPDES MS4 permits, WLAs are now used to regulate discharges from urban stormwater runoff covered by NPDES MS4 permits. In the Lower Willamette Subbasin, a common WLA of 78 percent bacteria load reduction was established for both nonpoint source (agriculture) and point source areas, including urban areas covered by an NPDES MS4 permit. The WLA for bacteria[1] (*E. coli*) was calculated based on the recreational water quality criterion, which is the monthly logarithmic mean concentration of 126 *E. coli* per 100 milliliters (mL). Additional background and limitations related to the bacteria WLA are described in the District's 2013 benchmark report (District, 2013).

The WLA of a 78 percent reduction in bacteria load and the pollutant load reduction benchmark established in 2013 are the two metrics compared in this 2015 PLRE. The 2013 benchmarks include both quantitative benchmarks related to estimated pollutant removal, and qualitative benchmarks related to the implementation of non-structural BMPs. It is important to note that quantitative benchmarks are not a numeric effluent limit; rather, they are a goal. Results of the comparison efforts are presented in Section 4.

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 currently DEQ has not completed its analysis and establishment of source-specific WLAs for mercury. No pollutant load analyses or pollutant load reduction benchmarks were calculated for mercury in 2013. Therefore, no pollutant load reduction estimates for mercury are required in this evaluation.

[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 District'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 District's NPDES MS4 permit area.

Section 2

PLRE Process and Methodology

In accordance with Schedule D.3.c of the District's NPDES MS4 permit, jurisdictions are required to conduct a PLRE for all applicable TMDL parameters, reflecting 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 structural and non-structural BMPs and show how BMPs are making progress toward achieving pollutant load reductions.

The overall process and methodology to conduct this PLRE, outlined below, is consistent with the process used to develop the 2013 benchmark report. Modeling assumptions and input data are detailed in Section 3.

In September 2016, the District must establish new pollutant load reduction benchmarks to be submitted with the next permit renewal application.

2.1 PLRE 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. Step 7 includes development of pollutant load reduction benchmarks for the upcoming permit term, and will be completed at a later date.

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

As shown on Figure 2-1, three general categories of BMPs are considered in the process:

1. Structural BMP systems for which pollutant removal can be reported quantitatively and are based on the results of scientific research (i.e., effluent concentrations). These BMPs include traditional ponds, swales, infiltration facilities, proprietary treatment systems, and wetlands.
2. Structural and/or source control BMP applications or practices where pollutant removal 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.

The PLRE 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 PLRE.

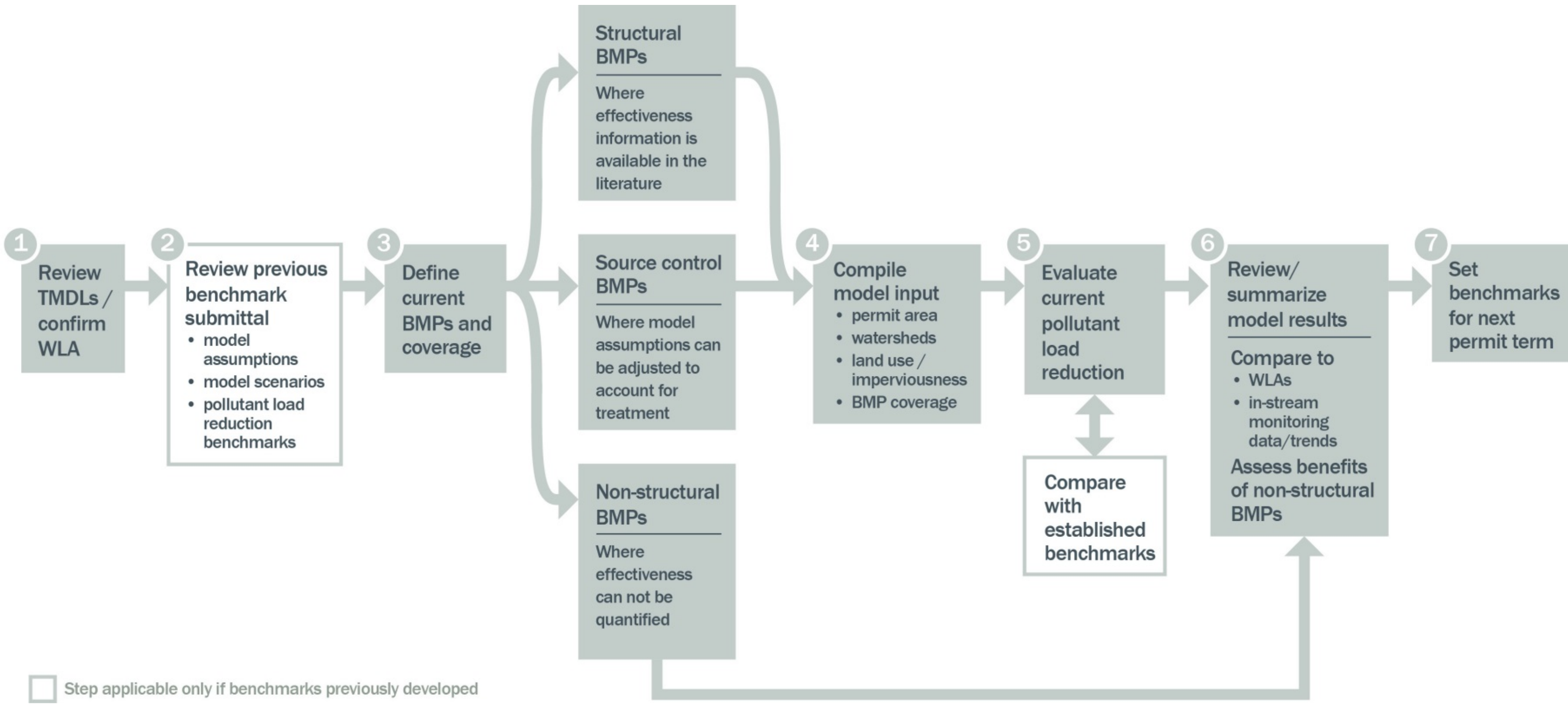


Figure 2-1. PLRE and relationship to benchmark development efforts (2015)

2.2 PLRE Model Methodology

This PLRE was conducted using a spreadsheet loads model that is based on the EPA simple method for pollutant load calculations. The model was originally developed in 2008 for multiple Oregon Phase I NPDES MS4 jurisdictions to calculate pollutant loads, and to develop pollutant load reduction benchmarks. The same spreadsheet loads model was used to conduct the District's 2013 PLRE and benchmarks and develop this 2015 PLRE with the following modifications:

- New BMP categories were added to account for the following BMP facility types not modeled in 2013: porous pavement, lined planters/filtration rain gardens, and eco roofs.
- BMP effluent concentration data were refined based on a collective effort among ACWA jurisdictions to update BMP effectiveness information with new literature information.

Rainfall, land use, and BMP coverage information was entered into the spreadsheet loads model. Using established land use EMCs, annual pollutant loads were calculated as counts for *E. coli*.

Pollutant load and pollutant load reduction calculations are based on modeling of land use pollutant load concentrations and BMP effluent concentrations, which were 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 "event mean concentrations" (EMCs), were originally developed in 2005 for Phase I jurisdictions and updated in 2008. The land use EMC data were developed using published, statistically verified national data, and data obtained by local jurisdictions. In each revision, the data were *bootstrapped*, a statistical method to estimate upper and lower confidence intervals.

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

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 District's stormwater design standards call for capture and treatment for all events up to half of the 2-year, 24-hour design storm. This equates to approximately 1.25 inches of rainfall over a 24-hour period. Similar design storms in the Portland metropolitan area have translated to capture and treatment of approximately 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 non-structural BMPs. Therefore, the effectiveness of non-structural BMPs was not included in the model, but non-structural BMPs are referenced as part of the comparison to qualitative benchmarks in Section 4.2.2.

Model simulations were conducted for each scenario (a no-BMP scenario and a with-BMP scenario). Pollutant loads and pollutant load reductions were calculated for the upper confidence limit (UCL), mean (or geometric mean for bacteria), and lower confidence limit (LCL), to yield a range in the resulting loads.

2.3 Model Output and Comparison to WLAs

Based on the pollutant modeling results, the no-BMP pollutant load range (LCL to UCL) reflects the baseline load condition, and the WLA (as a percentage) is applied to the mean, no-BMP pollutant load in order to calculate the WLA as a load for presentation purposes.

The estimated pollutant load reduction is calculated as the difference between the no-BMP and with-BMP pollutant loads, on an annual basis. Because loads are presented as a range, the pollutant load reduction is also identified as a range, reflecting the difference between the no-BMP and with-BMP pollutant loads for the UCL and the difference between the no-BMP and with-BMP pollutant loads for the LCL.

For graphic representation, the no-BMP loads and with-BMP loads are shown as a range. As mentioned previously, the WLA is shown as a single value, based on the mean, no-BMP load. The resulting graphs and discussion related to the pollutant modeling results are included in Section 4.

Section 3

Modeling Assumptions and Input Data

This section describes the modeling assumptions and input data associated with developing the spreadsheet loads model to simulate 2015 development conditions as part of this PLRE. Model input data were developed using updated geographic information system (GIS) data sets maintained by the District.

Modeled area and land use coverage show only minor changes from the 2013 model. BMP coverage is significantly increased because of improved mapping and tracking associated with both private and public structural BMPs.

The subsections below include information regarding the modeled area, land use and impervious area assumptions, structural BMP coverage, land use EMCs, and BMP effluent concentration data. As applicable, 2013 modeling assumptions are provided for comparison to show how modeled conditions have changed.

A map showing model input data is included as Figure 3-1.

3.1 Model Area and Land Use

The District's NPDES MS4 permit covers "all existing and new discharges of stormwater from the MS4 within the service boundaries of incorporated cities and within the service areas of Clackamas County Service District No. 1, Oak Lodge Sanitary District, and the portion of Surface Water Management Agency of Clackamas County in the UGB" (DEQ, 2012). As such, the modeled area for this PLRE has been defined to include all areas within the District's service district boundary as of August 2015.

It should be noted that the District's defined MS4 permit area (and modeled area reflected in this PLRE) reflects areas that discharge directly to the MS4, and areas that may discharge directly to receiving waters without first entering the MS4.

Areas within the District that are the responsibility of the Oregon Department of Transportation (ODOT), specifically the Highway 99E corridor, were omitted from the modeled area, as ODOT has a separate NPDES MS4 permit for discharges from these areas.

Areas within the District's service area boundary that are covered under an NPDES 1200-Z permit for stormwater runoff are also omitted from the model. NPDES 1200-Z permits include the following industries:

- Oak Lodge Wastewater Treatment Plant (tax lot 21E02CA00900)
- Stanley Tool (tax lot 21E13A02600)
- Blout, Inc. (tax lot 21E13A00722 and 21E13A00731)

The water body area of River Forest Lake was also excluded from the modeled areas because water bodies are assumed to have no pollutant load generation from urbanized sources. These exclusions are consistent with modeling assumptions from the 2013 analysis.

An updated land use coverage GIS layer was created to align current (2015) land use conditions with the land use categories available in the pollutant loads model. The land use coverage also incorporated vacant land data from Metro, which is based on 2015 aerial photos.

Table 3-1 compares the total modeled area and land use for this 2015 PLRE to the 2013 model input data. Slight changes in the modeled areas between the 2013 modeling assumptions and 2015 are due to improved mapping, and the designation of additional vacant lands per the 2015 Metro vacant lands inventory.

Table 3-1. Summary of 2015 Model Input Parameters (Land Use)

Model Year	Total modeled area (ac)[a]	Land use breakdown (ac)						
		Commercial	Industrial	Single-family residential	Mixed-use residential	Multi-family residential	Vacant	Parks and open space
2013	3,298	275	42	2,415	7	347	154	58
2015 (current)	3,296	268	39	2,379	7	340	194	69

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

3.2 Land Use Impervious Areas

This 2015 PLRE modeling effort used the same impervious area assumptions from the 2013 model, as shown in Table 3-2.

Table 3-2. Modeled Land Use Impervious Area

District zoning classification	Estimated impervious percentage
Single-family residential (SFR)	30
Multi-family residential (MFR)	82
Mixed-use residential (MUR)	82
Commercial (COM)	88
Industrial (IND)	87
Vacant (VAC)	1
Parks and open space	48

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 x 0.009 (percent impervious)

The 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 and EMC as described in Section 3.4.

3.3 BMP Coverage

The District currently does not operate any public regional water quality facilities or detention facilities. The District does manage the public BMP facilities along the Trolley Trail, a public walking/bike path that includes multiple swale/rain garden features for water quality improvement. The District also has responsibility for maintaining wet ponds located at the new TriMet park-and-ride facility, which were added to the BMP inventory in 2015.

In conjunction with the District's 2013 PLRE, an inventory of private structural water quality facilities was conducted. Facilities with active maintenance agreements were mapped and included in the 2013 modeling. Since 2013, the District has identified and mapped a number of additional private structural BMPs. The District also re-categorized BMPs and refined mapping and drainage area delineations for private structural BMPs located in the District. As an example, the 2013 PLRE accounted for 12.3 acres of area draining to sumped catch basins as part of the structural BMP coverage area. The District chose not to include sumped catch basins as a structural BMP category in the 2015 model.

Where BMP drainage areas overlap, the area was assigned to the structural BMP that appears to be the farthest downstream, and provides the better overall treatment (i.e., lower BMP effluent concentrations). This method does not give credit for additional load removal likely achieved with BMPs that perform in series and likely results in conservative load reduction estimates.

The modeled BMP categories are based on the category types with available BMP effluent concentrations, as described in Section 3.4. In some cases, the District's GIS classification of BMPs differed from the modeled categories. Table 3-3 shows how the District's BMP categories were associated with model categories, and Table 3-4 shows the breakdown of BMP coverage in each modeled TMDL watershed. BMP coverage is also mapped in Figure 3-1.

Table 3-3. Structural BMP Categories Used in Pollutant Loads Modeling

District's structural BMP designation	2015 modeled BMP category
Filter	Media filter
Dry detention pond	Dry, detention pond
Wet retention pond	Wet, retention pond
Swale	Biofiltration swale/vegetated filter strip
Sediment Manhole	Sedimentation manhole
Drywell	Drywell/UIC
Infiltration trench Infiltration rain garden Infiltration planter	Infiltration rain garden/porous pavement/soakage trench

Table 3-4. Summary of BMP Coverage

Model year	BMP coverage area (% model area)	BMP coverage (ac)							
		Media filter	Dry, detention ponds	Wet, retention pond	Swale	Sedimentation manhole	Sumped catch basin	Drywell/ UIC	Infiltration rain garden
2013	1.5%	-	2.9	0.6	3.8	14.8	12.3	-[a]	27.8[a]
2015	2.7%	1.4	33.4	9.4	0.7	2.7	N/A[b]	14.0	26.5

a. *The 2013 model combined BMP coverage for infiltration rain gardens and drywells. The 2015 model accounts for each BMP separately.*

b. *Sumped catch basins are not included as a structural water quality BMP in the 2015 PLRE.*

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

It is assumed that additional structural BMP facilities that do not currently have a private facility maintenance agreement registered with the District may exist on private property. While such facilities may provide additional pollutant load reduction, they are not currently mapped or tracked by the District and are not accounted for in the model.

3.4 Runoff Concentrations and BMP Effluent Data

In 2014, NPDES MS4 Phase I jurisdictions worked together to review and refine land use EMC data, BMP categories, and BMP effluent concentrations for use in pollutant modeling efforts.

Land use concentration data, including the upper and lower confidence intervals, are provided in Table 3-5. These values are consistent with the District's 2013 model assumptions. Analysis of *E. coli* is conducted via use of a geometric mean.

Table 3-5. Land Use-Based Pollutant Load Concentration Values Used in the PLRE

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

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

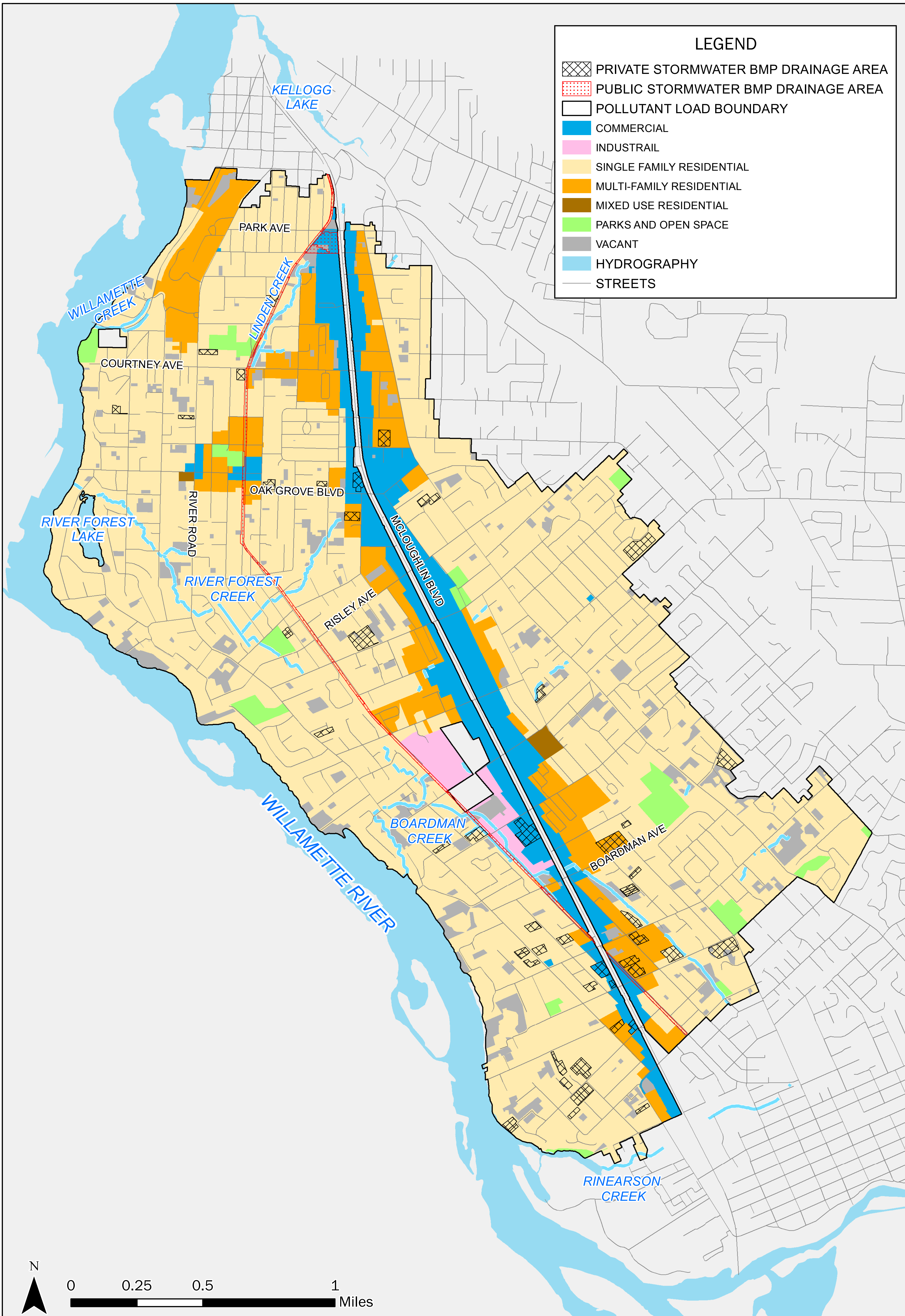
a. *Land use EMCs for open space are used to simulate pollutant loads from impervious areas of vacant land use.*

b. *Land use EMCs for residential are used to simulate pollutant loads from impervious areas of single-family residential, multi-family residential, and mixed-use residential.*

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

The land use EMCs listed in Table 3-5 do not include all 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 single-family residential, mixed-use residential, 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 include lined planters/filtration rain gardens, eco roofs, and porous pavement. The mean BMP effluent concentration values are provided in Table 3-6.



POLLUTANT LOAD REDUCTION EVALUATION

FIGURE 3-1. LAND USE AND BMP COVERAGE

OAK LODGE SANITARY DISTRICT, OREGON

OCTOBER 2015

Table 3-6. BMP Effluent Concentration Values Used in the PLRE												
		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
Parameter	Units	Mean [a]										
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

a. *Most values are consistent with the ACWA data set (2008) and consistent with 2013 data assumptions. Shaded values are updated values per the 2014 ACWA Stormwater Committee reanalysis of BMP effectiveness. Underlined values reflect an increase from 2013 values. Values in black background are new values per the 2014 ACWA Stormwater Committee reanalysis of BMP effectiveness. Effluent concentrations shown as N/A are provided for BMP facilities that achieve 100% flow reduction, as no effluent is generated with which to analyze.*

3.5 Annual and Seasonal Rainfall

The Willamette Basin TMDL reflects the bacteria WLA for the Lower Willamette Subbasin as a single percent reduction, evaluated on an annual basis. The WLA applies to area that discharges directly to the Lower Willamette River or via an unspecified tributary to the Lower Willamette River. For purposes of this evaluation, an annual rainfall volume of 40 inches was used to evaluate pollutant loads.

The modeled rainfall volume is consistent with assumptions from the 2013 PLRE and benchmark development.

Section 4

Pollutant Load Reduction Evaluation Results

Pollutant load model results, including comparison of model results to the benchmarks established in 2013, are described below. Model results include a numeric estimate of the current pollutant load reduction range (Schedule D.3.c.ii), a comparison of the current pollutant load reductions to established benchmarks (Schedules D.3.iv and D.3.viii), 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).

Pollutant load model results include estimates of the incremental improvements associated with the implementation of structural BMPs (Schedule D.3.c.ii). The pollutant load model results are not reflective of full implementation of the District's stormwater program, which includes additional non-structural BMP activities. Therefore, model results are assumed to be conservative estimates of the pollutant removal achieved through the District's stormwater program.

This section also includes a summary of the District's water quality trends analysis as required under Schedule D.c.vii.

4.1 Lower Willamette River Results

Figure 4-1 shows that the District is not currently estimated to be meeting the WLA for bacteria in the Lower Willamette watershed area. The PLRE shows a mean pollutant load reduction of 1.5 percent compared with the WLA of 78 percent. The PLRE shows a mean load reduction of approximately 1.13×10^{12} counts when comparing conditions with and without BMPs.

The District's service area is primarily residential land use with commercial and industrial land use along the Oregon Highway 99E corridor. Structural BMP implementation has increased since the 2013 model because of the identification and mapping of additional structural BMPs and refinements to the BMP drainage areas. The structural BMPs implemented in the District's service area are primarily ponds (detention ponds) and infiltration rain gardens. Smaller areas are served by drywells or media filters. Collectively, these structural BMPs have varying effectiveness for bacteria removal. In general, infiltration-based structural BMPs achieve the greatest bacteria removal through volume reduction. Filters also achieve significant bacteria removal.

As shown in Figure 4-1, 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. As described in Section 4.4, the District's structural BMP implementation is estimated to be achieving the pollutant load removal benchmarks established in 2013.

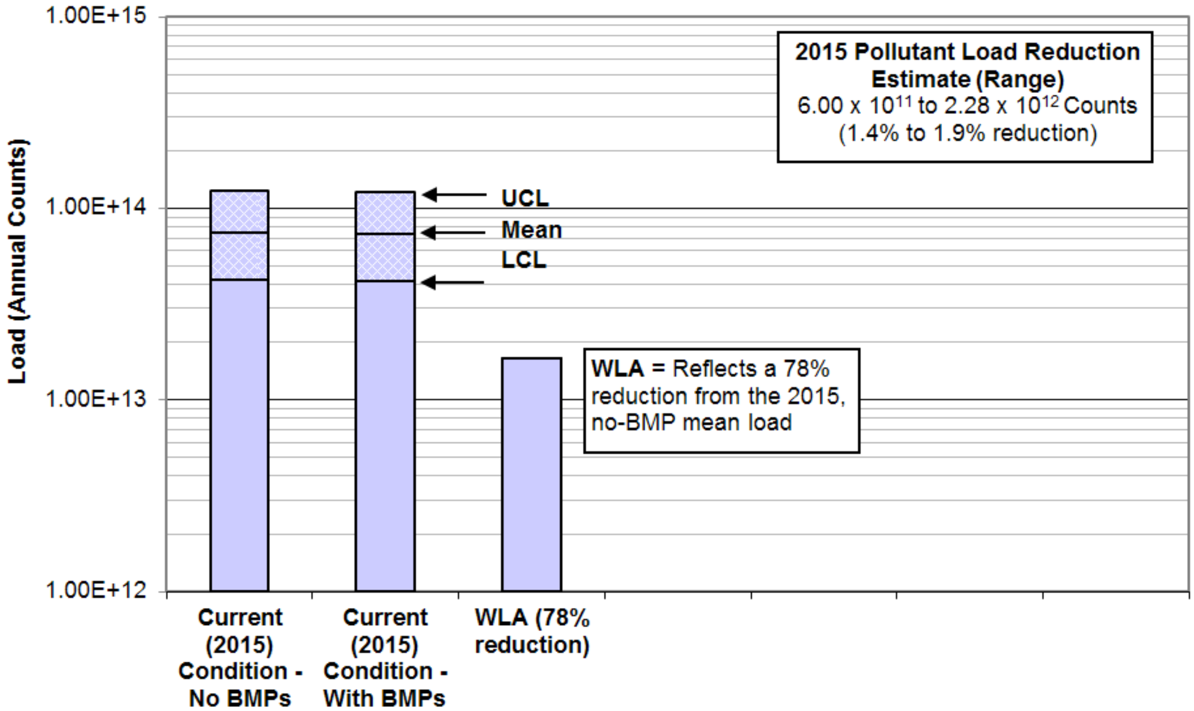


Figure 4-1. Oak Lodge Sanitary District: *E. coli* PLRE results for Lower Willamette River TMDL watershed

4.2 Lower Willamette Benchmark Comparison

The District's 2013 bacteria benchmarks for the Lower Willamette Subbasin include the quantitative load reduction predicted with the pollutant load modeling and also qualitative benchmarks related to the implementation of non-structural BMPs.

Benchmarks are pollutant load reduction estimates for anticipated future conditions, so they can be used as a tool and a goal for guiding adaptive management activities. Benchmarks are not considered a numeric effluent limit.

4.2.1 Quantitative Benchmarks

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 District submitted a PLRE and TMDL pollutant load reduction benchmarks in October 2013 to comply with conditions outlined in Schedule D.7 of the District's NPDES MS4 permit. These permit conditions required the PLRE to be based on land use and BMP coverage reflective of 2010 development conditions. The established pollutant load reduction benchmarks were based on projected development conditions and associated BMP implementation in 2015.

Table 4-1 shows the difference in modeled areas and BMP coverage areas between the 2013 PLRE and this current, 2015 PLRE. To develop the benchmarks reflecting 2015 conditions, the District anticipated completion of the Boardman Creek Improvement Project, a capital improvement project that would construct two water quality treatment swales to treat runoff in the public right-of-way. While that particular project did not occur as planned, the District identified and mapped additional public and private structural BMPs that were not included in the previous evaluation. Therefore, the overall BMP coverage has increased from 1.5 to 2.7 percent between 2010 and 2015.

Table 4-1. Benchmark Assumptions Comparison

Assumption	2013 PLRE and benchmark effort		2015 PLRE effort
	2010 (actual)	2015 (projected)	
Model area (ac)	3,298	3,298	3,296
BMP coverage (%)	1.5	1.5	2.7

Table 4-2 presents the results of the benchmark comparison, showing that the bacteria benchmarks were achieved based on structural BMP implementation in the District. Pollutant load reductions are an order of magnitude greater than the benchmarks. The counts equate to a pollutant load reduction range between 1.5 and 1.8 percent when compared to the no-BMP loads.

Table 4-2. District Pollutant Load Reduction Benchmark Comparison

TMDL watershed	Parameter (units)	2015 pollutant load reduction estimate[a]			2013 benchmarks based on projected 2015 conditions	Met benchmarks
		UCL	Mean	LCL		
Lower Willamette River	Bacteria (counts)	2.28×10^{12}	1.14×10^{12}	6.00×10^{11}	5.09×10^{9} to 2.31×10^{10}	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.*

4.2.2 Qualitative Benchmarks

In addition to the quantitative PLRE presented in Section 4.4.1, the District's 2013 benchmark submittal included a list of qualitative load reduction benchmarks, related to the implementation of non-structural BMPs and stormwater program activities. Progress toward implementation of non-structural BMPs is documented in the District's NPDES Annual Report, submitted each year to DEQ. Based on activity reports in the District's 2014/15 Annual Report, the District is meeting all qualitative benchmarks established in 2013. Table 4-3 documents the results of the qualitative benchmark evaluation.

Table 4-3. Qualitative Benchmark Comparison		
Benchmark	**Status**	**Comment**
Implement a rotating cycle for catch basin cleaning, targeted at five maintenance zones with the goal of inspecting and cleaning one zone each year.	Met	District has implemented a new catch basin cleaning schedule
Require new development and redevelopment to provide infiltration (up to the first 0.5 inch of rainfall). Prioritize vegetated water quality treatment facilities, including swales, filter strips, constructed wetland, and detention ponds.	In progress	In progress
Participate in the ACWA public education effectiveness study	Met	District participated in the ACWA study in the 2013/14 permit year
Refine procedure and protocols for the illicit discharge detection and elimination program	Met	District has SOPs for illicit discharge response and enforcement
Develop a stormwater retrofits strategy and retrofit plan by July 1, 2015	Met	District developed and submitted a stormwater retrofit strategy and plan to DEQ on June 29, 2015

4.3 Pollutant Load Reduction Evaluation Summary

The pollutant load reduction benchmarks comparison presented in Tables 4-2 and 4-3 show that the District is estimated to be meeting previously established quantitative bacteria benchmarks based on implementation of structural water quality BMPs. The District is also meeting or making progress toward all qualitative benchmarks established to account for non-structural BMPs.

As shown in Figure 4-1, significant additional bacteria load reduction is needed beyond the current structural BMP implementation to achieve the WLA. Because of the variable nature of stormwater runoff and the variety of sources contributing to bacteria discharge in stormwater, there are inherent difficulties in quantitatively tracking pollutant load reduction to show progress toward WLAs.

In conducting this PLRE, the District chose a conservative approach to avoid overestimating the effectiveness of structural BMPs and stormwater program activities. Greater reductions are likely currently achieved because of implementation of non-structural BMPs. Over time, additional pollutant load reductions are expected because of:

- continued implementation of stormwater design standards for new development and redevelopment projects, resulting in construction of additional structural BMPs
- stormwater retrofit efforts to install structural BMPs in untreated areas
- new technologies and scientific advances
- increased implementation that results in reductions in cost of more effective treatment technologies

While numeric values for non-structural BMP effectiveness were not specifically quantified or accounted for in the pollutant loads models, the pollutant load estimates are presented as a range, and this range reflects the variable nature of stormwater runoff. This range may account for or reflect non-structural and source control practices implemented throughout the model area.

In addition to the non-structural BMPs described as part of the qualitative benchmark comparison, the District conducts a variety of additional programmatic activities that are directly attributable to bacteria reduction. Such activities include erosion control, facility maintenance, pet waste programs, and public education. Roadway maintenance programs implemented by Clackamas County include street sweeping and additional pollution reduction measures. Finally, the District manages the sanitary sewer system and wastewater treatment plant, which operate under a separate NPDES permit. By jointly managing the sanitary sewer and stormwater systems, the District has opportunities to address cross-connections and other direct discharges into the stormwater system. These actions will have a direct impact on reducing bacteria contributions to the MS4.

4.4 Water Quality Trends Analysis

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

In-stream water quality trends were calculated for 3 sites in the District where instream water quality monitoring data is collected. The following pollutant parameters were included in the initial data analysis:

- total suspended solids
- *E. coli*
- total phosphorus
- total and dissolved copper
- total and dissolved zinc

Of those parameters, only total suspended solids, *E. coli* and total phosphorus had enough data points to conduct a statistically valid trends analysis.

Each parameter was analyzed for both the wet season (October 1 through April 30) and dry season (May 1 through September 30) conditions to help assess the potential influence of MS4 discharges on receiving water quality. The Mann-Kendall test was used for analysis on data sets that were sorted into seasons by sampling date.

Table 4-4 summarizes results of the 2015 in-stream water quality trends evaluation for water bodies and parameters where observed trends are noted. Full documentation is included in Appendix B of this PLRE.

Table 4-4. Summary of Water Quality Trends Analysis

Monitoring location	Improving trends (decreasing concentrations)		Deteriorating trends (increasing concentrations)	
	Wet season	Dry season	Wet season	Dry season
River Forest Creek at SE Fairoaks Boulevard	None	None	None	*E. coli*
Lower Boardman Creek at SE Walta Visa	None	Total phosphorus	None	*E. coli*
Linder Creek north of SE Park	*E. coli*	None	None	None

Note: Reporting for trends where $p < 0.05$.

Results from the trends analysis indicate a mixture of improving and deteriorating trends with most seasonal parameters showing no trend. Seasonal collection and analysis of instream water quality samples is not a conclusive means to determine the impacts of stormwater runoff on downstream water quality. For most parameters, the District has not collected enough in stream water quality samples to evaluate long term water quality trends. Ongoing instream water quality sampling will continue in compliance with the NPDES MS4 permit.

Section 5

References

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

Brown and Caldwell. 2013. *Pollutant Load Reduction Benchmarks*, prepared for Oak Lodge Sanitary District, October 16.

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

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

Oak Lodge Sanitary District (District), Surface Water Management Program. 2015. 2014–15 Annual Report, for NPDES MS4 Permit Compliance, Permit 3108016, October.

District. 2013. Stormwater Management Plan, MS4 Permit 108016, May.

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

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

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

Section 6
Limitations

This document was prepared solely for Oak Lodge Sanitary District (District) in accordance with professional standards at the time the services were performed and in accordance with the master services agreement between the District and Brown and Caldwell dated June 21, 2013. This document is governed by the specific scope of work authorized by the District; 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 District and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Appendix A: Water Quality Trends Analysis

6500 SW Macadam Avenue, Suite 200
Portland, OR 97239

T: 503.244.7005
F: 503.244.9095

Prepared for:	Oak Lodge Sanitary District
Project Title:	NPDES Permit Compliance
Project No.:	148271.004

Technical Memorandum

Subject:	Instream Water Quality Trends Analyses
Date:	October 28, 2015
To:	Jason Rice Manager of Planning and Engineering, OLSD
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 Oak Lodge Sanitary District (District). This data review and trends analysis was completed to comply with one of the District's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit requirements.

The District is a Phase 1 co-permittee on the Clackamas County 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 District must evaluate the overall effectiveness of its stormwater management program by conducting a pollutant load reduction evaluation (Schedule D.3 of the permit). This evaluation includes a requirement to conduct an instream water quality trends analysis including a summary of the relationship of identified trends to stormwater discharges.

The District has been collecting instream water quality monitoring data since 2007 from three creek sites. Brown and Caldwell (BC) was retained to review these instream environmental monitoring data and develop the trends analysis that is provided in this TM. This TM includes a summary of the review and processing of the data, a summary of the Mann-Kendall statistical analysis, and a summary of the results.

Data Review and Pre-Processing

BC reviewed the instream data collected within the District's watersheds in order to summarize and pre-process the data sets. Pre-processing of data was conducted to determine which data sets were sufficient to perform a statistically valid water quality trends analysis. Each record in the data (i.e., data point) 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 the wet weather season or dry weather season. 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 District's data sets included 30 or more observations; some of the data sets had 10 or more observations. Based on the review of the District's data, BC completed the analysis based on the following refined/updated ACWA criteria:

- Data were analyzed separately for wet season and dry season data given that information regarding the occurrence of rainfall in association with data collection was not readily available.
- The threshold for the trends analysis was reduced to data sets with 10 or more observations in order to evaluate trends for some of the parameters.
- 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-season 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-season conditions (October 1 – April 30) or dry-season conditions (May 1 – September 30), in accordance with the current NPDES MS4 permit definition;
- Number of non-detects
- Summary of monitoring frequency
- Summary of the monitoring sites and parameters with adequate data for a trends analysis

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

Table 1 provides the data summary for the parameters from the original data set provided to BC.

None of the District sites had data sets with 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. The District had 12 data sets with 10 or more observations.

Table 1 shows a check mark (✓) for each data set that met the criteria for conducting a Mann-Kendall trends analysis. As a result of the data review and pre-processing of instream water quality monitoring data, a total of 12 trends analyses were completed, including 6 trends analyses for the dry season, and 6 trends analyses for the wet season.

Table 1. Summary of Monitoring Sites and Data Review Statistics

River Forest Creek (SW 15)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Dissolved copper	Zinc	Dissolved zinc
Monitoring date range	2007–15	2007–15	2012–15	2012–15	2012–15	2012–15	2012–15
Number of observations	33	33	12	13	12	13	12
Wet-season detects	13	17	7	6	5	8	7
Wet-season non-detects	4	0	0	2	2	0	0
Wet-season data set 10+ records and 50% or more detects	✓	✓	-	-	-	-	-
Dry-season detects	16	16	5	3	3	5	5
Dry-season non-detects	0	0	0	2	2	0	0
Dry-season data set 10+ records and 50% or more detects	✓	✓	-	-	-	-	-
Lower Boardman Creek (SW 12)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Dissolved copper	Zinc	Dissolved zinc
Monitoring date range	2005–15	2005–15	2005–15	2012–15	2012–15	2012–15	2012–15
Number of observations	42	42	42	12	12	13	12
Wet-season detects	20	22	16	6	6	7	7
Wet-season non-detects	2	0	6	1	1	0	0
Wet-season data set 10+ records and 50% or more detects	✓	✓	✓	-	-	-	-
Dry-season detects	16	20	20	4	4	6	5
Dry-season non-detects	4	0	0	1	1	0	0
Dry-season data set 10+ records and 50% or more detects	✓	✓	✓	-	-	-	-

Table 1. Summary of Monitoring Sites and Data Review Statistics							
Linder Creek (SW 3)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Dissolved copper	Zinc	Dissolved zinc
Monitoring date range	2009–15	2009–15	2009–15	2012–15	2012–15	2012–15	2012–15
Number of observations	24	24	23	12	12	12	12
Wet-season detects	9	13	5	5	6	7	7
Wet-season non-detects	4	0	7	2	1	0	0
Wet-season data set 10+ records and 50% or more detects	-	✓	-	-	-	-	-
Dry-season detects	7	11	5	2	2	5	4
Dry-season non-detects	4	0	6	3	3	0	1
Dry-season 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 wet-season and dry-season data sets that had at least 50 percent detected values and at least 10 observations. The 12 trends analyses completed were for data sets with 10 to 29 observations. Of the 12 trends analyses completed, 6 were conducted for wet-season data and 6 were conducted for dry-season 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														
Water body	River Forest Creek					Lower Boardman Creek					Linder Creek				
Site/Station ID	SW15					SW12					SW3				
2015 instream monitoring site	SE Fairoaks Blvd.					SE Walta Vista					E 99E and North of SE Park; outfall of 5' x 5' box culvert				
		Dry Season		Wet Season			Dry Season		Wet Season			Dry Season		Wet Season	
WQ parameter	Date range	N	Trend	N	Trend	Date range	N	Trend	N	Trend	Date range	N	Trend	N	Trend
TSS	2007-2015	16		17		2005-2015	20		22		2009-2015	11		13	
E. coli	2007-2015	16	⇧	17		2005-2015	20	↑	22		2009-2015	11		13	⇩
TP	2012-2015	5		7		2005-2015	20	⇩	22		2009-2015	11		12	
Total copper	2012-2015	5		8		2012-2015	5		7		2012-2015	5		7	
Copper (diss.)	2012-2015	5		7		2012-2015	5		7		2012-2015	5		7	
Total zinc	2012-2015	5		8		2012-2015	6		7		2012-2015	5		7	
Zinc (diss.)	2012-2015	5		7		2012-2015	5		7		2012-2015	5		7	

Summary/Conclusions

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

- Given a significance level of 5 percent, as recommended per the ACWA guidance, no improving water quality trends (i.e., decreasing pollutant concentrations) were observed and one deteriorating trend during the dry weather season was observed.
- Given a significance level of 10 percent, the number of improving water quality trends (i.e., decreasing pollutant concentrations) were the same for the dry weather and wet weather seasons with one improving trend for each.
- The majority of all of the trends analyses conducted (8 out of 12, or 75 percent) showed no trend given a significance level of 10 percent.
- The two deteriorating water quality trends occurred for *E coli.*
- The two improving water quality trends occurred; one for total phosphorus and one for *E coli*.

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

It should be noted that water quality data from grab samples represent conditions during a specific snapshot in time and the results can be influenced by many factors. Although there is evidence that stormwater management activities can have a measurable impact on reducing pollutants in stormwater, correlating data from instream and outfall water quality sampling with stormwater management activities is a challenging task because of the myriad of other influences on water quality. The results of the trends analyses presented here are not a definitive statement of the overall quality of the sampled streams, but rather one piece of information to be considered within the larger watershed context. Both the number of data points in a data set and the scatter of the data affect the results of the Mann-Kendall trends analysis. Data sets with more data may be more likely to exhibit a trend (if the data are not widely scattered) than data sets with fewer data points (McBride et al., 1993). In addition, a statistically significant result is not necessarily practically significant.

Other factors such as the magnitude and range of reported values compared to various water quality criteria can also be more practically significant, as well as longer-term indicators of watershed health such as benthic macroinvertebrate survey results. The results of the trends analysis are one piece of an overall evaluation of water quality.

References

Gibbons, R.D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons, Inc., New York, N.Y., 286 pages.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company, New York, N.Y.

Hollander, M. and D.A. Wolfe. 1973. Nonparametric Statistical Methods. John Wiley and Sons, New York, N.Y.

McBride, G. et al. 1993. What Do Significance Tests Really Tell Us About the Environment? *Environmental Management.* 17:423–432.

McLeod, A.I. 2011. Kendall rank correlation and Mann-Kendall trend test. Package "Kendall" version 2.2.

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

U.S. EPA. 2013. ProUCL Statistical Support Software for Site Investigation and Evaluation. Office of Research and Development, United States Environmental Protection Agency, Washington, D.C. March 2013. Accessed October 2015: < http://www2.epa.gov/sites/production/files/2015-03/documents/proucl_one_page_fact_sheet.final_.pdf >

U.S. EPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners EPA QA/G-9S. Office of Environmental Information, United States Environmental Protection Agency, Washington, D.C. February 2006. Document number EPA/240/B-06/003.

6500 SW Macadam Avenue, Suite 200
Portland, OR 97239

T: 503.244.7005
F: 503.244.9095

Prepared for: Oak Lodge Sanitary District

Project Title: NPDES Permit Compliance

Project No.: 148271.004

Technical Memorandum

Subject: Instream Water Quality Trends Analyses

Date: October 28, 2015

To: Jason Rice Manager of Planning and Engineering, OLSD

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 Oak Lodge Sanitary District (District). This data review and trends analysis was completed to comply with one of the District's National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) permit requirements.

The District is a Phase 1 co-permittee on the Clackamas County 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 District must evaluate the overall effectiveness of its stormwater management program by conducting a pollutant load reduction evaluation (Schedule D.3 of the permit). This evaluation includes a requirement to conduct an instream water quality trends analysis including a summary of the relationship of identified trends to stormwater discharges.

The District has been collecting instream water quality monitoring data since 2007 from three creek sites. Brown and Caldwell (BC) was retained to review these instream environmental monitoring data and develop the trends analysis that is provided in this TM. This TM includes a summary of the review and processing of the data, a summary of the Mann-Kendall statistical analysis, and a summary of the results.

Data Review and Pre-Processing

BC reviewed the instream data collected within the District's watersheds in order to summarize and pre-process the data sets. Pre-processing of data was conducted to determine which data sets were sufficient to perform a statistically valid water quality trends analysis. Each record in the data (i.e., data point) 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 the wet weather season or dry weather season. 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 District's data sets included 30 or more observations; some of the data sets had 10 or more observations. Based on the review of the District's data, BC completed the analysis based on the following refined/updated ACWA criteria:

- Data were analyzed separately for wet season and dry season data given that information regarding the occurrence of rainfall in association with data collection was not readily available.
- The threshold for the trends analysis was reduced to data sets with 10 or more observations in order to evaluate trends for some of the parameters.
- 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-season 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-season conditions (October 1 – April 30) or dry-season conditions (May 1 – September 30), in accordance with the current NPDES MS4 permit definition;
- Number of non-detects
- Summary of monitoring frequency
- Summary of the monitoring sites and parameters with adequate data for a trends analysis

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

Table 1 provides the data summary for the parameters from the original data set provided to BC.

None of the District sites had data sets with 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. The District had 12 data sets with 10 or more observations.

Table 1 shows a check mark (✓) for each data set that met the criteria for conducting a Mann-Kendall trends analysis. As a result of the data review and pre-processing of instream water quality monitoring data, a total of 12 trends analyses were completed, including 6 trends analyses for the dry season, and 6 trends analyses for the wet season.

Table 1. Summary of Monitoring Sites and Data Review Statistics

River Forest Creek (SW 15)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Dissolved copper	Zinc	Dissolved zinc
Monitoring date range	2007–15	2007–15	2012–15	2012–15	2012–15	2012–15	2012–15
Number of observations	33	33	12	13	12	13	12
Wet-season detects	13	17	7	6	5	8	7
Wet-season non-detects	4	0	0	2	2	0	0
Wet-season data set 10+ records and 50% or more detects	✓	✓	-	-	-	-	-
Dry-season detects	16	16	5	3	3	5	5
Dry-season non-detects	0	0	0	2	2	0	0
Dry-season data set 10+ records and 50% or more detects	✓	✓	-	-	-	-	-
Lower Boardman Creek (SW 12)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Dissolved copper	Zinc	Dissolved zinc
Monitoring date range	2005–15	2005–15	2005–15	2012–15	2012–15	2012–15	2012–15
Number of observations	42	42	42	12	12	13	12
Wet-season detects	20	22	16	6	6	7	7
Wet-season non-detects	2	0	6	1	1	0	0
Wet-season data set 10+ records and 50% or more detects	✓	✓	✓	-	-	-	-
Dry-season detects	16	20	20	4	4	6	5
Dry-season non-detects	4	0	0	1	1	0	0
Dry-season data set 10+ records and 50% or more detects	✓	✓	✓	-	-	-	-

Table 1. Summary of Monitoring Sites and Data Review Statistics							
Linder Creek (SW 3)							
Statistic/parameter	TSS	*E. coli*	TP	Copper	Dissolved copper	Zinc	Dissolved zinc
Monitoring date range	2009–15	2009–15	2009–15	2012–15	2012–15	2012–15	2012–15
Number of observations	24	24	23	12	12	12	12
Wet-season detects	9	13	5	5	6	7	7
Wet-season non-detects	4	0	7	2	1	0	0
Wet-season data set 10+ records and 50% or more detects	-	✓	-	-	-	-	-
Dry-season detects	7	11	5	2	2	5	4
Dry-season non-detects	4	0	6	3	3	0	1
Dry-season 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 $\neq$ 0 (alternative)

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

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

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

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

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

Statistical Test Results

As described above, trends analyses were conducted on all wet-season and dry-season data sets that had at least 50 percent detected values and at least 10 observations. The 12 trends analyses completed were for data sets with 10 to 29 observations. Of the 12 trends analyses completed, 6 were conducted for wet-season data and 6 were conducted for dry-season 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														
Water body	River Forest Creek					Lower Boardman Creek					Linder Creek				
Site/Station ID	SW15					SW12					SW3				
2015 instream monitoring site	SE Fairoaks Blvd.					SE Walta Vista					E 99E and North of SE Park; outfall of 5' x 5' box culvert				
		Dry Season		Wet Season			Dry Season		Wet Season			Dry Season		Wet Season	
WQ parameter	Date range	N	Trend	N	Trend	Date range	N	Trend	N	Trend	Date range	N	Trend	N	Trend
TSS	2007-2015	16		17		2005-2015	20		22		2009-2015	11		13	
E. coli	2007-2015	16	⇧	17		2005-2015	20	↑	22		2009-2015	11		13	⇩
TP	2012-2015	5		7		2005-2015	20	⇩	22		2009-2015	11		12	
Total copper	2012-2015	5		8		2012-2015	5		7		2012-2015	5		7	
Copper (diss.)	2012-2015	5		7		2012-2015	5		7		2012-2015	5		7	
Total zinc	2012-2015	5		8		2012-2015	6		7		2012-2015	5		7	
Zinc (diss.)	2012-2015	5		7		2012-2015	5		7		2012-2015	5		7	

Summary/Conclusions

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

- Given a significance level of 5 percent, as recommended per the ACWA guidance, no improving water quality trends (i.e., decreasing pollutant concentrations) were observed and one deteriorating trend during the dry weather season was observed.
- Given a significance level of 10 percent, the number of improving water quality trends (i.e., decreasing pollutant concentrations) were the same for the dry weather and wet weather seasons with one improving trend for each.
- The majority of all of the trends analyses conducted (8 out of 12, or 75 percent) showed no trend given a significance level of 10 percent.
- The two deteriorating water quality trends occurred for *E coli.*
- The two improving water quality trends occurred; one for total phosphorus and one for *E coli*.

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

It should be noted that water quality data from grab samples represent conditions during a specific snapshot in time and the results can be influenced by many factors. Although there is evidence that stormwater management activities can have a measurable impact on reducing pollutants in stormwater, correlating data from instream and outfall water quality sampling with stormwater management activities is a challenging task because of the myriad of other influences on water quality. The results of the trends analyses presented here are not a definitive statement of the overall quality of the sampled streams, but rather one piece of information to be considered within the larger watershed context. Both the number of data points in a data set and the scatter of the data affect the results of the Mann-Kendall trends analysis. Data sets with more data may be more likely to exhibit a trend (if the data are not widely scattered) than data sets with fewer data points (McBride et al., 1993). In addition, a statistically significant result is not necessarily practically significant.

Other factors such as the magnitude and range of reported values compared to various water quality criteria can also be more practically significant, as well as longer-term indicators of watershed health such as benthic macroinvertebrate survey results. The results of the trends analysis are one piece of an overall evaluation of water quality.

References

Gibbons, R.D. 1994. Statistical Methods for Groundwater Monitoring. John Wiley & Sons, Inc., New York, N.Y., 286 pages.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company, New York, N.Y.

Hollander, M. and D.A. Wolfe. 1973. Nonparametric Statistical Methods. John Wiley and Sons, New York, N.Y.

McBride, G. et al. 1993. What Do Significance Tests Really Tell Us About the Environment? *Environmental Management.* 17:423–432.

McLeod, A.I. 2011. Kendall rank correlation and Mann-Kendall trend test. Package "Kendall" version 2.2.

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

U.S. EPA. 2013. ProUCL Statistical Support Software for Site Investigation and Evaluation. Office of Research and Development, United States Environmental Protection Agency, Washington, D.C. March 2013. Accessed October 2015: < http://www2.epa.gov/sites/production/files/2015-03/documents/proucl_one_page_fact_sheet.final_.pdf >

U.S. EPA. 2006. Data Quality Assessment: Statistical Methods for Practitioners EPA QA/G-9S. Office of Environmental Information, United States Environmental Protection Agency, Washington, D.C. February 2006. Document number EPA/240/B-06/003.

Wasteload Allocation Attainment Assessment

Wasteload Allocation Attainment Assessment

Prepared for

Oak Lodge Sanitary District

October 2015

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List of Abbreviations

ac	acre(s)
ACWA	(Oregon) Association of Clean Water Agencies
BMP	best management practice
DEQ	(Oregon) Department of Environmental Quality
District	Oak Lodge Sanitary District
EMC	event mean concentration
EPA	U.S. Environmental Protection Agency
ft	foot/feet
ft^2	square foot/feet
HSG	hydrologic soil group
LID	low-impact development
LS	lump sum
MEP	maximum extent practicable
MS4	municipal separate storm sewer system
MST	microbial source tracking
N/A	not applicable
NPDES	National Pollutant Discharge Elimination System
PLRE	pollutant load reduction evaluation
SCS	Soil Conservation Service
TMDL	total maximum daily load
WES	Clackamas County Water Environment Services
WLA	wasteload allocation
WLAAA	Wasteload Allocation Attainment Assessment

Section 1

Introduction and Background

This report presents the 2015 total maximum daily load (TMDL) wasteload allocation attainment assessment (WLAAA) for the Oak Lodge Sanitary District (District). As required by the District's National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Separate Storm Sewer System (MS4) permit, the WLAAA includes:

- An evaluation of best management practice (BMP) scenarios to determine what type of BMP and coverage level would be needed to achieve wasteload allocations (WLAs) established by applicable TMDLs
- A financial analysis of the cost to construct and maintain the hypothetical structural BMPs
- A description of the constraints and limitations related to implementing structural BMPs on the level required to achieve the TMDL WLAs

The WLAAA results show that the WLA may be hypothetically achievable through implementation of structural BMPs. Achievement of the WLAs would require widespread coverage of infiltration-based BMPs to manage runoff from all currently developed and developable areas of the District. Practical, physical, and financial constraints would limit the District's ability to implement structural BMPs necessary to achieve the WLAs.

In addition to structural BMPs, the District is currently implementing non-structural BMPs, such as source controls and programmatic activities that provide additional pollutant removal. These activities were not quantified through the modeling methods established for the WLAAA, though they are providing additional water quality benefit.

1.1 Permit Requirements

The District is a co-permittee on the Clackamas County NPDES MS4 permit 101348, issued on March 16, 2012. The requirements to conduct a WLAAA are detailed in Schedule D.3.b of the District's NPDES MS4 permit as follows:

> *(b) Wasteload Allocation Attainment Assessment: The co-permittee must complete an assessment of WLA attainment, including identifying information related to the type and extent of BMPs necessary to achieve pollutant load reductions associated with an established TMDL WLA and the financial costs and other resources that may be associated with the implementation, operation and maintenance of BMPs. The results of the assessment must be submitted to the Department by November 1, 2015.*

The U.S. Environmental Protection Agency (EPA) approved the Willamette Basin TMDL on September 29, 2006. The District's jurisdictional boundary is located entirely within the Lower Willamette Subbasin. Stormwater runoff from the District enters the MS4 and various tributaries, including Boardman and River Forest creeks, prior to discharge to the Lower Willamette River.

WLAs were developed originally as a means to regulate discharges from well-defined point sources (e.g., industries and wastewater treatment plants) but, with implementation of the NPDES MS4 permits, WLAs are now also used to regulate discharges from urban stormwater runoff covered by

NPDES MS4 permits. In the Lower Willamette Subbasin, a common WLA of 78 percent for bacteria[1] (*E. coli*) load reduction was established for both nonpoint source (agriculture) and point source areas, including urban areas covered by an NPDES MS4 permit.

1.2 Assessment Goals

The overall goal of the WLAAA is to estimate whether state-of-the-practice structural stormwater BMPs could be implemented to reduce TMDL pollutant discharges from the MS4 to levels required by the TMDL WLAs. The District implements structural BMPs (ponds, rain gardens, etc.), and non-structural BMPs (street sweeping, illicit discharge screening, public education, etc.) to address pollutants in stormwater. The pollutant load reduction evaluation (PLRE) looks only at the effects of structural BMPs that have documented quantifiable pollutant removal data in the literature. As such, the WLAAA evaluates whether WLAs could hypothetically be achieved through the construction of additional structural BMPs.

Specifically, this evaluation looks at various structural BMP scenarios to answer the following questions:

- Is achievement of the WLA for each TMDL watershed and TMDL parameter conceptually possible through implementation of current, state-of-the-practice stormwater structural BMPs?
- If achievement of WLAs is shown to be possible, what level/extent of BMP coverage is needed?
- If achievement of WLAs is shown to be possible, what are the financial requirements and financial implications of the required BMP coverage?
- If achievement of the WLA is shown to be possible, is implementation of the required BMP coverage feasible or practicable?
- If achievement of the WLA is shown to not be possible, what are potential reasons why?

1.3 Background

In accordance with the NPDES MS4 permit Schedule D.3.c, the District previously completed a PLRE to estimate current (2015) pollutant loads with and without BMP implementation. Pollutant loads were compared to applicable TMDL WLAs as well as established pollutant load reduction benchmarks. The PLRE is used to estimate the effectiveness of stormwater management facilities and show how BMPs are making progress toward achieving pollutant load reductions.

The PLRE was documented in a report titled *Oak Lodge Sanitary District TMDL Pollutant Load Reduction Evaluation* (BC, 2015b). The PLRE included an inventory of the District's contributing MS4 area, TMDL watersheds, land use, and BMP coverage. A spreadsheet loads model was used to calculate pollutant loads within the District's NPDES MS4 permit boundary, and to evaluate the pollutant removal from structural BMPs. Non-structural BMPs were evaluated qualitatively, but the effectiveness of these controls was not directly quantified or applied in the spreadsheet loads model. Therefore, the PLRE model results are assumed to be a conservative estimate (i.e., underestimate) of the pollutant load reduction currently achieved by the District's stormwater management program.

[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 District'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 District's NPDES MS4 permit area.

The PLRE was used as the basis for conducting this WLAAA. This assessment estimates the additional load reduction that would be required to achieve WLAs, and seeks to identify hypothetical scenarios in which the WLA could be achieved through implementation of structural BMPs. Figure 1-1 provides a conceptual schematic of the relationship between the PLRE, pollutant load reduction benchmarks, WLAs, and this WLAAA.

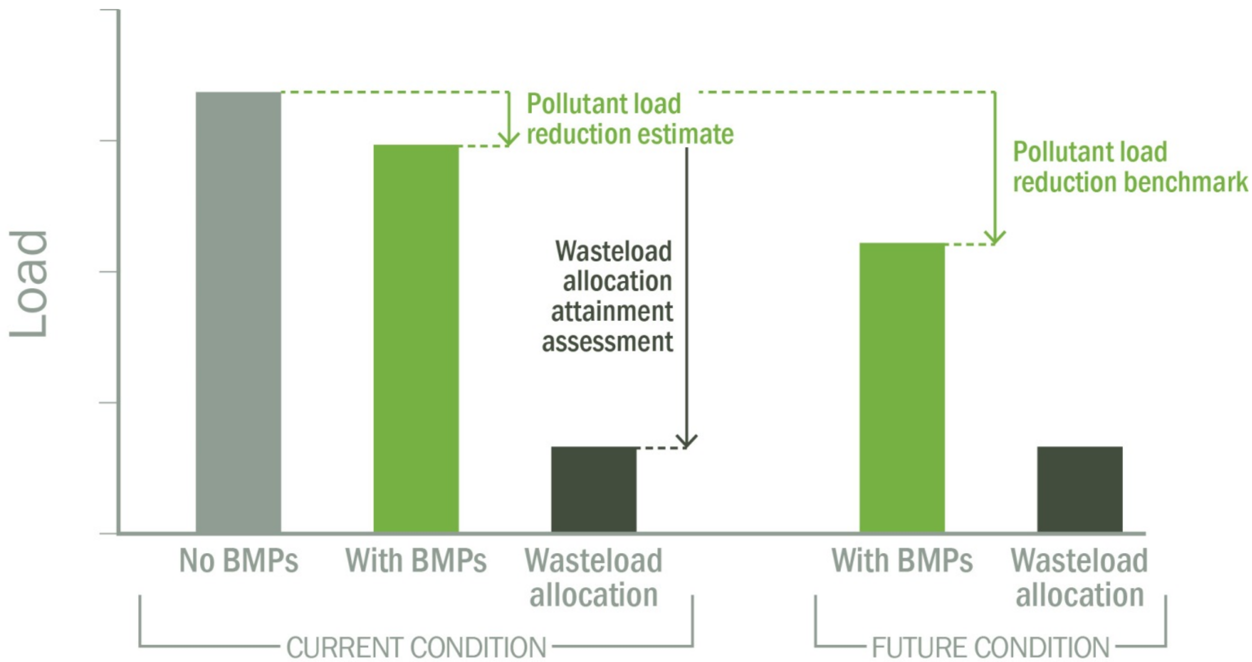

Figure 1-1. Conceptual pollutant load estimation

Section 2

Approach and Methods

In accordance with Schedule D.3.c of the District's NPDES MS4 permit, jurisdictions are required to conduct a WLAAA for all applicable TMDL parameters. The WLAAA uses the results from the 2015 PLRE as the baseline for evaluating additional BMP coverage scenarios, and comparing the resulting pollutant reductions to the 78 percent load reduction assigned through the WLA.

Two hypothetical BMP scenarios were included in this assessment, representing implementation of two different types of structural BMPs. Based on the high level of pollutant removal required to meet the WLA, the structural BMP scenarios were applied across all of the District's TMDL watershed drainage area to determine the maximum pollutant removal hypothetically achievable. Financial costs and constraints were calculated for the structural BMP scenario that was shown to meet the WLA.

2.1 Model Assumptions

The WLAAA is based on the modeling methods and assumptions developed for the 2015 PLRE. This includes model areas, land use coverage, rainfall depths, and current (2015) structural BMP coverages. Consistent land use event mean concentrations (EMCs), impervious percentages by land use, and BMP effectiveness information were also maintained from the PLRE. Structural BMPs were simulated based on the assumption that facilities are sized to treat 80 percent of the average annual runoff volume, consistent with current NPDES MS4 permit requirements.

As with the PLRE, pollutant loads and pollutant load removals were calculated as counts for *E. coli*. The TMDL pollutant loads were calculated as a range using an upper confidence limit and a lower confidence limit based on the widely variable nature of pollutant concentrations in stormwater runoff. However, the WLA is presented as a single value percent load reduction, so the WLAAA looks at only the geometric mean calculations to determine whether the bacteria WLA has been achieved.

2.2 2015 PLRE Results

The 2015 PLRE showed that the District is meeting interim benchmarks for pollutant removal during this permit term. However, significant additional pollutant removal would be needed to achieve the bacteria WLA outlined in the Willamette River TMDL.

Based on the 2015 PLRE, the modeled areas and current BMP coverage were calculated for the Lower Willamette TMDL watershed as shown in Table 2-1.

Table 2-1. Summary of 2015 PLRE Model Input Parameters											
TMDL watershed	Modeled area (ac)	BMP coverage area[a]	BMP coverage (ac)								
			Media filter	Dry, detention ponds	Wet, retention pond	Swale/ filter strip	Sedimentation manhole	Infiltration rain garden	Filtration planter/rain garden with underdrain	Drywell
Lower Willamette River	3,296.1	2.7%	1.4	33.4	9.4	0.7	2.7	26.5	0.0	14.0

a. *Calculated as the percent of the total model area.*

Current structural BMP coverage consists primarily of detention ponds and infiltration rain gardens. Detention ponds are designed to capture and slowly release flows to match a pre-development rate. Pollutants are removed through settling. Infiltration facilities use a combination of processes to remove pollutants, including filtering through vegetation and removal through infiltration.

In recent years, the District has seen more projects that use low-impact development (LID) or green infrastructure facility designs for stormwater management. Typical facilities include stormwater planters and rain gardens. Underlying soil conditions dictate whether the LID facilities should include an underdrain or function as fully infiltrating facilities. LID BMPs provide greater bacteria removal than traditional wet or dry ponds.

Table 2-2 shows the resulting pollutant load reductions, reflective of the existing BMP coverage documented in Table 2-1. The pollutant load reduction estimate is based on the difference between the pollutant load generated from 2015 land use coverage (referred to as the “no-BMP” load) and the 2015 load generated with existing structural BMPs applied (referred to as the “with-BMP” load).

Table 2-2. Oak Lodge Sanitary District Pollutant Load Reduction Benchmark Comparison			
TMDL watershed	Parameter (units)	WLA (% reduction)	2015 pollutant load reduction estimate (range)[a]
Lower Willamette River	Bacteria (counts)	78%	1.4%–1.9%

a. *Pollutant load reduction estimate is a range between the upper and lower confidence limits associated with the generated pollutant load.*

Pollutant load reduction is dependent on both the overall BMP coverage and the effectiveness of the BMP for the TMDL parameter of concern. For example, wet ponds and dry ponds are only marginally effective at removing bacteria compared to other structural facilities. Infiltrating BMPs are much more effective at addressing bacteria (and most other pollutants) because they effectively remove flow and the associated pollutant loads from the MS4.

2.3 BMP Implementation Scenarios

Hypothetical BMP implementation coverage scenarios were identified to estimate whether maximum coverage with structural BMPs would provide the pollutant removal needed to meet the WLA. A strategy meeting was conducted with District staff in October 2015 to evaluate potential BMP coverage scenarios and select two structural BMP types for evaluation. Multiple potential scenarios were considered, including variations on both BMP type and the area of the watershed to be covered by the selected BMP. All scenarios are hypothetical, as implementing structural BMPs is dependent on physical site conditions, land use policy, and financial costs.

The District elected to evaluate hypothetical scenarios that are consistent with the structural BMPs that are expected to be implemented in the District. As a service district, the vast majority of existing structural BMPs are constructed and maintained by private property owners. The District works to establish maintenance agreements with private owners and to conduct inspections of structural facilities. Past developments have constructed traditional stormwater management systems, such as detention ponds, but moving forward, the District intends to promote green infrastructure practices, as they are becoming standard in the region. In addition, the current MS4 permit conditions require the District to prioritize LID for new development and redevelopment.

In alignment with these objectives, the selected scenarios include green infrastructure facilities—assumed to be a combination of stormwater planters and rain gardens—in both filtration and infiltration configurations. Based on BMP effluent data, both filtration and infiltration LID facilities are highly effective at removing bacteria when compared to traditional structural facilities, such as wet ponds, dry ponds, or swales. The District currently discourages the use of proprietary treatment options, such as media filters, in the public right-of-way, so propriety treatment systems were not evaluated in this analysis.

Table 2-3 shows the BMP coverage scenarios evaluated for the WLAAA.

Table 2-3. BMP Coverage Scenarios

Scenario	BMP type	BMP coverage	Notes
1	Filtration planter/rain garden	100% coverage of all untreated areas	• Filtration planter rain gardens are consistent with green infrastructure objectives • Model assumptions include a 30% flow reduction to account for <u>some</u> infiltration • This scenario simulates District-wide BMP coverage and an emphasis on LID
2	Infiltration rain garden	100% coverage of all untreated areas	• Infiltration rain gardens are consistent with green infrastructure objectives • Infiltration systems are most effective at removing bacteria through flow reduction • Model assumptions include a 100% flow reduction for the water quality design storm • This scenario simulates District-wide BMP coverage and an emphasis on LID and infiltration • District soils would likely limit full implementation of this hypothetical scenario

For simplified modeling, all untreated areas were assumed to be routed to a new structural BMP. No analysis was included in the modeling to determine the suitability or practicality of connecting untreated areas to the stormwater system, or installing appropriately sized facilities. The only exception was that parks/open space areas not currently covered by a BMP were not assumed to be routed to a new structural BMP. Most of the untreated parks/open space areas in the District are protected natural areas, often adjacent to stream corridors, and are not expected to develop or redevelop into a high pollutant generating use.

The physical constraints of the hypothetical scenarios are evaluated in the WLAAA constraints discussion in Section 4.

The hypothetical BMP coverages were simulated using the spreadsheet model developed for the PLRE, and assume current (2015) land use and structural BMP implementation for each scenario in Table 2-3. The hypothetical BMP implementation coverages were applied District-wide to treat runoff generated from pollutant-generating surfaces.

Section 3

WLAAA Results and Cost Estimates

This section presents the results from the pollutant load modeling for the two structural BMP implementation scenarios. Only one of the hypothetical BMP coverage scenarios was estimated to achieve the bacteria WLA for the Lower Willamette River TMDL watershed.

The costs associated with constructing and maintaining the BMP scenario that achieves the WLA are presented in Section 3.2. The cost estimate shows that implementing structural BMPs to achieve the bacteria WLA would be well beyond what would be considered the maximum extent practicable (MEP) for the District's stormwater program.

3.1 WLAAA Results

Based on the existing BMP coverage across the District and the amount of existing parks and open space, the two scenarios simulate 98 percent total structural BMP coverage across the District. Table 3-1 shows the BMP coverage simulated in each scenario. In both scenarios, the total structural BMP coverage includes all of the urbanized drainage area, when accounting for both existing and added structural BMPs. The only watershed areas not receiving structural BMP treatment are those parks and open space areas that are assumed to be natural protected areas, not associated with high pollutant discharges.

Table 3-1. Hypothetical Structural BMP Implementation

Scenario	Modeled area (ac)	Current BMP coverage area	Current parks/open space area	Added structural BMP coverage area	Total structural BMP coverage area
Scenario 1: filtration LID[a]	3,296.1	2.7%	2.1%	95%	98%
Scenario 2: infiltration LID[b]	3,296.1	2.7%	2.1%	95%	98%

a. *Assumes that all untreated areas, excluding parks/open space, are treated by filtration planters or rain gardens.*

b. *Assumes that all untreated areas, excluding parks/open space, are treated by infiltration planters or rain gardens.*

Table 3-2 shows the pollutant load reduction estimate for each BMP implementation scenario. For simplicity and comparison, only the percent load reduction based on the geometric mean land use EMCs is shown, instead of a range as presented in Table 2-2.

Table 3-2. Oak Lodge Sanitary District WLAAA Results

TMDL watershed	Parameter (units)	WLA (% reduction)	Estimated load reduction	
			Scenario 1: filtration LID	Scenario 2: infiltration LID
Lower Willamette River	Bacteria (counts)	78%	76%	79%

The WLAAA shows that structural BMPs could hypothetically be effective treatment options to address bacteria loads in stormwater runoff when applied to treat runoff from a widespread area. Scenario 1 shows that filtration planters and rain gardens have the potential to provide significant bacteria removal over current load reductions. Based on land use EMCs and BMP effluent concentrations, the pollutant removal achieved with rain gardens and planters, even in lined or filtration configurations, ranges from 79 percent to 95 percent, depending on the land use type. Scenario 2 shows the additional bacteria removal possible through infiltration.

Structural water quality treatment BMPs are designed to treat 80 percent of the average annual runoff. As such, the pollutant load modeling assumes that 20 percent of runoff on a seasonal and annual basis will bypass the facility, resulting in 20 percent of the runoff and untreated pollutant load discharging to downstream water bodies, regardless of structural BMP coverage. This leads to challenges in meeting the 78 percent reduction WLA, based solely on modeling assumptions that reflect state of the practice design standards.

Scenario 2 shows potential achievement of the WLA for bacteria in the Lower Willamette River watershed. This scenario assumes implementation of infiltration rain gardens across all of the existing, untreated TMDL watershed area, including both currently developed areas and areas to be developed in the future. Scenario 2 and the associated hypothetical BMP coverage were used for the cost estimates described in Section 3.2.

3.2 Cost Estimation

Construction and maintenance costs were estimated for implementing the BMP type and coverage levels associated with Scenario 2, which assumes the installation of infiltration rain gardens to treat all currently untreated areas that are not associated with parks or open space. This is a hypothetical BMP implementation scenario. Constraints and limitations associated with this level of BMP implementation are discussed in Section 4.

3.2.1 Unit Costs

Unit cost estimates for construction, contingencies, and maintenance activities were compiled through a coordinated effort with other Phase I NPDES MS4 jurisdictions through the Oregon Association of Clean Water Agencies (ACWA). Unit costs based on recent bid tab information for projects within the cities of Portland, Gresham, Fairview, and Salem were compiled and compared. District staff reviewed results of the collective effort and selected appropriate unit costs for use in this analysis. As infiltration rain gardens were the selected structural BMP, unit cost information specific for infiltration rain gardens is presented.

Table 3-2 provides unit costs used in the calculation of the construction and maintenance costs. Unit costs do not reflect property acquisition.

Table 3-2. Preliminary Engineering Unit Cost			
Item	Unit	Unit cost ($)	Details
Water quality facility installation			
Infiltration stormwater planter or rain garden (unlined)[a]	ft^2	25	Includes walls, inlet and outlet, overflow, and plantings
12-inch storm drain pipe, 5- to 10-foot depth	ft	80	Includes excavation, backfill, and asphalt restoration
Markups			
Mobilization/demobilization	LS	10%	Average value, used for conceptual-level estimate, percentage of the facility subtotal
Erosion control	LS	2%	Average value, percentage of the facility subtotal
Traffic control	LS	2%	Average value, percentage of the facility subtotal
Contingency	LS	30%	Average value, percentage of the facility subtotal
Administration			
Engineering/permitting	LS	20%	Average value, percentage of the facility and markups total
Maintenance (annual)			
Rain garden maintenance	ft^2	$1.55	As reported by City of Portland, reflects direct costs (e.g., materials) and indirect costs (i.e., time for inspections, enforcement, etc.)

a. *Unit cost is estimated as an average cost for infiltration planters or rain gardens. Does not include additional infrastructure (manholes, catch basins, etc.) or connection to existing structures.*

It was assumed that piped connections will be required between individual rain garden facilities and the main storm lines. For purposes of this cost estimate, 50 feet of 12-inch-diameter storm pipe was included for every 2,000 square feet (ft^2) of infiltration rain garden. Construction markups were applied to the construction subtotal; the administration cost, which accounts for engineering and permitting, was applied as a percentage markup to the total construction cost.

3.2.2 Facility Sizing

In order to estimate construction and maintenance costs for BMP implementation associated with Scenario 2, an estimate was made of the total surface area of infiltration rain gardens needed to treat the corresponding drainage area. The rain garden surface area was calculated based on the total pollutant-generating area and the associated percent impervious area by land use.

Based on contributing impervious area, the WES BMP Sizing Tool was used to estimate the required size of infiltration rain gardens. Clackamas County Water Environment Services (WES) developed the WES BMP Sizing Tool in 2012, and updated it in 2015 to aid in sizing vegetated stormwater BMPs to meet water quality and/or flow control objectives. The sizing tool is based on a model that was calibrated to conditions reflective of the Johnson Creek TMDL watershed area, and can be used by developers and engineers across Clackamas County. Based on sizing factors in the WES BMP Sizing Tool, the surface area of an infiltration rain garden that will infiltrate 100 percent of the water quality design storm ranges from 4 percent to more than 20 percent of the contributing impervious area. Facility sizes vary based on the facility soil type and pre-developed ground cover conditions. For purposes of this hypothetical evaluation, a sizing factor of 10 percent was assumed across the District.

Using the 10 percent sizing factor, approximately 123 acres (ac) (or 5,353,300 ft^2) of infiltration rain garden would need to be installed to meet the bacteria WLA in the Lower Willamette River TMDL watershed. Table 3-3 shows the BMP coverage area, associated impervious area, and resulting facility sizes.

Table 3-3. WLAAA Treatment Area Summary

Land use classification	Impervious percent[a]	Hypothetical BMP implementation coverage for Scenario 4			
		Additional BMP coverage area (ac)	Impervious area requiring treatment (ac)	Estimated facility size (ac)	Estimated facility size (ft^2)
Industrial	87	37.4	32.5	3.3	141,700
Commercial	88	255.0	224.4	22.4	977,500
Parks/open space	48	0.0	0.0	0.0	0
Vacant	1	191.7	1.9	0.2	8,400
Single-family residential	30	2,322.3	696.7	69.7	3,034,800
Multi-family residential	82	333.4	273.4	27.3	1,190,900
Total		**3,139.8**	**1,228.9**	**122.9**	**5,353,300**

a. *Impervious percentage is based on District-wide calculations performed as the basis for the PLRE.*

3.2.3 Cost Estimate Results

Based on the required size of the infiltration rain gardens to be installed, the construction and maintenance cost estimates for the Lower Willamette River TMDL watershed are provided in Table 3-4. Subtotal and total costs were rounded to the nearest $1,000. All costs are present-day value and do not account for inflation. The total estimated construction and annual maintenance costs are indicated in bold.

Table 3-4. Preliminary Engineering Cost Estimate				
Item	Unit	Unit cost ($)	Quantity	Itemized cost ($)
Water quality facility installation				
Infiltration planter/rain garden	ft^2	25	5,353,300	$133,832,500
12-inch storm drain pipe, 5- to 10-foot depth	ft	80	133,833	$10,706,600
			Facility construction subtotal	*$144,539,000*
Construction markups				
Mobilization/demobilization	LS	10%	N/A	$14,453,900
Erosion control	LS	2%	N/A	$2,890,780
Traffic control	LS	2%	N/A	$2,890,780
Contingency	LS	30%	N/A	$43,361,700
			Construction subtotal	*$208,136,000*
Administration (as a % of the construction subtotal)				
Engineering/permitting	LS	20%	N/A	$41,627,200
			Total estimated cost	**$249,763,000**
Maintenance (annual)				
Rain garden maintenance	ft^2	$1.55	5,353,300	**$8,298,000**

These cost estimates show that constructing the structural BMPs needed for the District to achieve the Lower Willamette River bacteria WLA would cost nearly $250 million. These costs do not account for property acquisition associated with structural BMP construction, which would be significant as the majority of these structural BMPs would be new facilities constructed in currently developed areas. Maintenance costs would exceed $8 million on an annual basis.

Section 4

Discussion and Conclusions

Results from the WLAAA indicate that the District could achieve the bacteria WLA under the most extensive hypothetical BMP coverage scenario. Achievement of the WLA for bacteria in the Lower Willamette River TMDL watershed assumes the hypothetical implementation of infiltration rain gardens across the watershed to treat all existing untreated areas that are currently developed or could be developed in the future.

The feasibility of implementing such a hypothetical BMP coverage is limited by practical, fiscal, and physical constraints as described in Section 4.1 below. In addition, Section 4.2 presents bacteria source data that show the challenges in managing bacteria through a municipal stormwater management system. Section 4.3 summarizes the District's current strategies toward ongoing pollutant removal in conjunction with conclusions drawn from this evaluation.

4.1 Constraints and Limitations

The hypothetical BMP implementation coverage associated with meeting the bacteria WLA would require installation of approximately 5,535,300 ft^2 of infiltration rain gardens within the District boundary. Together with existing facilities, the coverage would result in the collective treatment of 98 percent of the modeled area in the Lower Willamette River TMDL watershed.

The BMP coverage excludes parks and open space areas not currently draining to a structural BMP, but would include all other land uses.

Application of infiltration rain gardens to the extent required to meet the WLA would require overcoming some significant practical, fiscal, and physical constraints as described below.

4.1.1 Practicability Constraints

Across the District, infiltration rain gardens would need to treat both public and private property and, therefore, facilities would need to be installed on both public and private property. The District would need to rely on private owners to construct the necessary facilities or obtain rights to private property either through the purchase of the property or via easements.

In developed areas, this property acquisition would likely impact existing development, requiring removal of existing structures or existing infrastructure to provide space for infiltration facilities. Nearly 123 acres (or nearly 4 percent of the total basin area) would be required for the surface area of infiltration rain gardens. Additional property would be needed to provide grading to create the facility side slopes, maintenance access areas, and other infrastructure associated with constructing stormwater facilities.

The cost estimates in Section 3.2 do not reflect the cost of property acquisition or easements.

4.1.2 Fiscal Constraints

As documented in Section 3.2.3, installation of infiltration rain gardens at the scope and scale required to achieve the bacteria WLA would require an estimated construction cost of nearly $250 million, and an annual maintenance cost of over $8 million.

The District's total surface water program expenditure for the 2014/2015 fiscal year was $906,815. This included funding for the maintenance of existing stormwater infrastructure, structural stormwater management facilities, and staff and consultant time to implement the stormwater programs and policies. The District's 2014–15 Annual Report for the NPDES MS4 permit compliance reports that over 95 percent of expenditures were for operational expenses, which leaves very little money for capital project construction.

If all surface water program expenditures could be dedicated to installation of infiltration rain gardens in accordance with results of this analysis, it would take approximately 275 years to complete the scope and scale of infiltration rain garden installations needed to achieve the bacteria WLA. Even if infiltration rain gardens could be installed through private development funding, maintenance needs would not be met within the current budget allocation. Such a fiscal obligation is not feasible with the current funding levels and the District's definition of MEP.

4.1.3 Physical Site Constraints

Infiltration rain gardens were modeled to infiltrate 100 percent of the treated stormwater runoff (e.g., 80 percent of average annual runoff). Infiltration rain gardens were used in the WLAAA model scenario because they were the only structural BMP that could potentially achieve the bacteria WLA. However, application of infiltration rain gardens may be limited by the ability of native soils to support adequate infiltration.

Although the District prioritizes the use of green infrastructure and the construction of LID facilities, it is anticipated that many areas of the District will not support infiltration-based facilities. Areas with native soils having limited infiltration rates (e.g., less than 0.5 inch per hour), commonly associated with Soil Conservation Service (SCS) hydrologic soil groups (HSGs) C and D, often do not support the use of full infiltration-based stormwater management techniques. A recently completed hydromodification assessment conducted for the District included an evaluation of soils and HSGs across the District. While some areas in the District are classified as HSG A or B, these areas are generally isolated areas located directly adjacent to the Willamette River.

The majority of the watershed areas may not be suitable for the installation of infiltration rain gardens for treatment and disposal of all contributing stormwater runoff volume.

4.2 Limitations Related to Bacteria Load Reduction

Oregon's water quality standard for bacteria is based on an indicator bacteria, *E. coli,* which is found in the guts (and feces) of all warm-blooded animals. The bacteria water quality standard assumes that *E. coli* concentrations are generally correlated with human pathogens, and it is intended to ensure that water bodies are safe for swimming, wading, and other uses where skin contact or ingestion could occur.

Bacteria sources in the local, urban environment have been shown to have a very small human-derived component. The predominant sources of bacteria include wildlife (avian and rodent) that structural and non-structural BMPs are limited in treating or managing. This WLAAA shows that achievement of the entire bacteria WLA is possible only through widespread, structural BMP implementation that uses infiltration as a primary pollutant removal process.

Microbial source tracking (MST) techniques have been developed to identify the specific sources of fecal contamination and support development of control measures. Four regionally applicable MST studies have been referenced in Table 4-1.

As listed in Table 4-1, only a small percentage of the *E. coli* came from humans and human-related sources (e.g., pets and livestock). Most of the fecal contamination came from non-human sources such as birds and rodents, over which jurisdictions have little or no control, particularly in the realm of their stormwater programs. The District's TMDL WLA for bacteria requires 78 percent reduction in the total *E. coli* load. However, the regional MST data summarized in Table 4-1 suggest that human sources may account for only about 7 percent of the *E. coli* load, and anthropogenic sources (humans, pets, and farm animals) may account for only about 23 percent of the total *E. coli* load. Meeting the WLA for the total *E. coli* load may be infeasible through urban stormwater management facilities and programs, given the sources of the bacteria load.

Table 4-1. Typical Sources of Bacteria Identified in Four Pacific Northwest MST Studies

Study	State	Human	Avian	Canine/feline	Rodent	Farm/livestock	Wildlife	Unknown/other
Thurston County	Washington	7%	42%	7%	7%	7%	22%	8%
Tualatin River	Oregon	6%	51%	14%	16%	-	6%	9%
Olympic Peninsula	Washington	8%	39%	8%	-	10%	26%	8%
District of Puyallup	Washington	5%	41%	12%	28%	1%	8%	7%
Average of regions		7%	43%	10%	17%	6%	16%	8%

Note: Totals do not add to 100% because of the rounding of reported data values.

Source: BC, URS, 2005; CH2M Hill, 2003; Samadpour and Chechowitz, 1995; Woodruff et al., 2009.

4.3 Conclusions and Next Steps

Results from this WLAAA indicate that achievement of the WLA is not practical or feasible with current structural stormwater treatment BMPs given the District's practical and physical constraints and current fiscal abilities. While non-structural BMPs provide significant benefits, and they are not accounted for in this evaluation, it is not likely that they significantly address the gap needed to address the WLA.

However, the WLAAA shows that structural BMPs, such as rain gardens or stormwater planters, may be effective treatment options to address bacteria loads in stormwater runoff. Scenario 1 shows that filtration planters and rain gardens have the potential to provide significant bacteria removal over current load reductions. Scenario 2 shows the additional removal possible through infiltration. The District's *2014–2019 Surface Water Program Capital Improvement Plan* (District, 2014) prioritizes a number of large-scale projects to address water quality improvement in the District. Most of the identified projects are complex and will require multiple years to complete because of property acquisition, funding, and coordination among participating agencies. Many priority projects are part of the larger Boardman Creek Basin Initiative, which is a series of projects aimed at improving water quality, attenuating flows, and restoring riparian areas in the Boardman Creek Basin. These types of projects will continue to increase the coverage of structural BMP implementation across the District, while offsetting pollutant loads associated with stormwater runoff.

Even with increasing BMP coverage and application of more effective BMP treatment processes, the District recognizes that current TMDL language and TMDL development methods may simply result in unachievable pollutant load reductions for MS4s. It may be necessary to revisit the TMDL calculations and assumptions and/or the TMDL Water Quality Management Plans to establish more realistic WLAs focused on human sources of bacteria or address the attainability of beneficial uses. The TMDLs are often developed with limited information regarding pollutant sources, site-specific monitoring data, and pollutant removal capacity based on current technology. These assumptions based on limited data have clear implications for MS4 source areas that must continually evaluate pollutant load reduction and progress toward WLAs.

Section 5

References

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

Brown and Caldwell (BC). 2015a. *Hydromodification Assessment*, prepared for Oak Lodge Sanitary District, June.

BC. 2015b. *Pollutant Load Reduction Evaluation*, prepared for Oak Lodge Sanitary District, October.

BC, URS, 2005. Clarks Creek Watershed Pollution Reduction Project: Submittal Report, City of Puyallup, Washington.

CH2M Hill. 2003. Lower Boise River Coliform Bacteria DNA Testing: *Final Summary Report*.

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

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

Oak Lodge Sanitary District (District). 2014. *2014–2019 Surface Water Program Capital Improvement Plan. January.*

District. 2015. *2014-2015 Annual Report for NPDES MS4 Permit Compliance, Permit #108016*, October.

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

Samadpour M. and N. Chechowitz. 1995. Little Soos Creek microbial source tracking: a survey, University of Washington Department of Environmental Health, Seattle, Washington.

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

Woodruff D., Sather N., Cullinan V., Sargeant S. 2009. *Microbial Source Tracking in the Dungeness Watershed*, Washington, Battelle, Pacific Northwest Division.

U.S. Environmental Protection Agency (EPA). 2002. Wastewater Technology Fact Sheet.

Section 6

Limitations

This document was prepared solely for Oak Lodge Sanitary District (District) in accordance with professional standards at the time the services were performed and in accordance with the master services agreement between the District and Brown and Caldwell dated June 21, 2013. This document is governed by the specific scope of work authorized by the District; 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 District and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

303(d) Evaluation

6500 SW Macadam Avenue, Suite 200
Portland, OR 97239

T: 503.244.7005
F: 503.244.9095

Technical Memorandum

Prepared for: Oak Lodge Sanitary District

Project Title: Oak Lodge NPDES Permit Compliance Assistance

Project No.: 148271

Technical Memorandum

Subject: 303(d) Evaluation

Date: October 28, 2015

To: Jason Rice, Oak Lodge Sanitary District

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

Limitations:

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List of Abbreviations

µg	microgram(s)
ACWA	Association of Clean Water Agencies
ATSDR	Agency for Toxic Substances and Disease Registry
BMP	best management practice
CCDTD	Clackamas County Department of Transportation and Development
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
District	Oak Lodge Sanitary District
DEQ	(Oregon) Department of Environmental Quality
DHS	(Oregon) Department of Human Services
DO	dissolved oxygen
kg	kilogram(s)
L	liter(s)
LID	low-impact development
MEP	maximum extent practicable
mg	milligram(s)
MS4	municipal separate storm sewer system
Ng	nanograms
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rules
OC	organochlorine
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
RM	river mile
SOP	standard operating procedure
SWMP	Stormwater Management Plan
TM	technical memorandum
TMDL	total maximum daily load
TSS	total suspended solids
UIC	underground injection control
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

Section 1: Introduction

This technical memorandum (TM) provides an evaluation of 303(d)-listed pollutant parameters as they relate to discharges from the Oak Lodge Sanitary District (District) municipal separate storm sewer system (MS4), which is regulated under a National Pollutant Discharge Elimination System (NPDES) MS4 Permit.

This TM includes the following information:

- an evaluation of the likelihood that discharges from the regulated MS4 cause or contribute to water quality degradation as related to specific 303(d) parameters
- an assessment of the effectiveness of the District's existing stormwater program practices in addressing and reducing applicable 303(d)-listed parameters
- an identification of potential stormwater management program revisions that may be considered to address and reduce the 303(d) pollutants to the maximum extent practicable (MEP)

1.1 Summary of Permit Requirements

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

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

Receiving waters that are placed on the 303(d) list do not yet have an established total maximum daily load (TMDL), including load or wasteload allocations for the pollutant parameters. TMDLs established for specific pollutant parameters in the Willamette River and Clackamas River watersheds cover the drainage basins in the District. The District is addressing requirements for TMDL parameters through a separate quantitative evaluation of pollutant loads and pollutant load reduction, which is not included in this document.

The District is a co-permittee on Clackamas County's NPDES MS4 permit. Specific permit requirements for the 303(d) evaluation are listed in Schedule D.2 of the permit, as follows:

The co-permittee must:

i. *Review the applicable pollutants that are on the 2004/2006 303(d) list, or the most recent USEPA list if approved within three years of the issuance date of this permit, that are relevant to the co-permittee's MS4 discharges by November 1, 2015. Based on a review of the most current 303(d) list, evaluate whether there is a reasonable likelihood for stormwater from the MS4 to cause or contribute to water quality degradation of receiving waters.*

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

iii. *By November 1, 2015, submit a report summarizing the results of the review and evaluation, and that identifies any proposed modifications or updates to the SWMP that are necessary to reduce applicable 303(d) pollutants to the MEP.*

1.2 Summary of TM Organization

The purpose of this TM is to fulfill the NPDES permit requirements for a 303(d) evaluation as listed above.

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

- a summary of the relationship between regulated MS4 discharge and the listed parameter(s)
- an evaluation of the District's current best management practices (BMPs) to address the listed parameter(s)

Section 4 discusses potential Stormwater Management Plan (SWMP) adjustments for consideration in order to further address 303(d) parameters during the District's permit renewal effort in 2016.

1.3 Oak Lodge Sanitary District Stormwater Management Plan and Annual Report

The District's 2013 SWMP update outlines stormwater program activities with respect to NPDES MS4 permit compliance. The SWMP includes BMPs with measurable goals and tracking measures that the District currently implements, or plans to implement within the current permit cycle, to address water quality in MS4 discharges. BMPs are generally implemented across the whole permit area.

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

Since the development of the 2013 SWMP, the District has been continuously evaluating and adaptively managing its stormwater program based on new data, technology, and review of BMPs. In this way, the current SWMPs reflect the District's best professional judgment regarding resource allocation and optimization to reduce or eliminate the discharge of stormwater pollutants from the regulated MS4 to the MEP. The District also prepares an annual report for submittal to DEQ that outlines the District's progress toward complying with NPDES MS4 permit conditions and completing measureable goals.

The District's 2014-2015 Annual Report and associated BMPs are organized into seven major program components (plus one category of additional activities) that correspond to the District's NPDES MS4 permit. BMPs are listed in Table 1 below. Section 3 of this TM identifies the District's BMPs that are effective in addressing the 303(d)-listed pollutants. While the BMPs are not numbered in the SWMP or Annual Report documents, they have been numbered here to facilitate reference to individual BMPs in this document.

Table 1. Oak Lodge Sanitary District SWMP Summary		
Basic SWMP components*	BMPs	
1. Illicit Discharge Detection and Elimination	1-1	Enforcement Action Plan and Pollution Parameter Action Levels
	1-2	Conduct Annual Dry Weather Field Screening
	1-3	Implement the Spill Response Program
	1-3	Respond to Reports Involving Illicit Discharges
2. Industrial and Commercial Facilities	2-1	Screen Existing and New Industrial Facilities
	2-2	Address Other Industrial Facilities
3. Construction Site Runoff Control	3-1	Erosion Control Ordinances
4. Public Education and Outreach	4-1	Reduce Discharges of Pesticides, Herbicides and Fertilizers
	4-2	Privately Owned SWM Facility Education
	4-3	Erosion Control Contractor Training Opportunities
	4-4	Effectiveness Evaluation
	4-5	Employee Training
	4-6	Facilitate Public Reporting of Illicit Discharges
5. Public Involvement	5-1	Public Involvement and Participation
6. Post-Construction Site Runoff Control	6-1	Construction Site Runoff Control
7. Pollution Prevention for Municipal Operations	7-1	Street Sweeping
	7-2	Operations and Maintenance for Public Streets
	7-3	Control Infiltration and Cross Connections to the Stormwater Conveyance System
	7-4	Flood Management Projects and Water Quality
	7-5	Maintenance of Conveyance System Components and Structural Controls
	7-6	Catch Basin Cleaning and Maintenance
	7-7	Private Surface Water Facility Maintenance Program
8. Additional Activities	8-1	Hydromodification Assessment
	8-2	Retrofit Assessment

**BMPs have been numbered here to facilitate references to individual BMPs in this document.*

Section 2: Oak Lodge Sanitary District 303(d) Water Bodies and Parameters

Per the NPDES MS4 permit, the District must review the 2004/2006 303(d) list unless a more recent list has been approved by USEPA within 3 years of the issuance date of the permit. DEQ's 2010 303(d) list was submitted to USEPA in 2011 and finalized and approved by USEPA in December 2012. Therefore, the 2010 303(d) list is the effective 303(d) list for this evaluation. Applicable 303(d) parameters for the District pertain to receiving waters within the Willamette River watershed. The applicable 303(d) parameters are identified in Table 2.

Table 2. 2010 303(d) Parameters Applicable to Oak Lodge Sanitary District			
Water body	River mile	Season	Parameter
Lower Willamette Subbasin			
Willamette River	0–54.8	Summer	Chlorophyll a*
Willamette River	0–24.8	Year round	Aldrin
Willamette River	0–24.8	Year round	Biological criteria
Willamette River	0–24.8	Year round	Chlordane*
Willamette River	0–24.8	Year round	Cyanide*
Willamette River	0–24.8	Year round	DDT and DDT metabolite (DDE)
Willamette River	0–24.8	Year round	Dieldrin
Willamette River	0–24.8	Year round	Hexachlorobenzene*
Willamette River	0–24.8	Year round	Iron
Willamette River	0–24.8	Year round	Manganese
Willamette River	0–24.8	Year round	PCBs
Willamette River	0–24.8	Year round	Pentachlorophenol
Willamette River	0–24.8	Year round	Polynuclear aromatic hydrocarbons (PAH)

** Parameter added with the 2010 list.*

For the purpose of this evaluation, the evaluations of aldrin, chlordane, dichlorodiphenyltrichloroethane (DDT), DDT metabolite, dieldrin, and hexachlorobenzene have been combined in Section 3.3 under the discussion for organochlorine pesticides. Iron and manganese have also been grouped into a combined evaluation in Section 3.8.

Section 3: 303(d) Evaluation

This section provides an evaluation of the 303(d) parameters applicable to the District. The evaluation includes background and source information for each parameter and a description of the association between the parameter and MS4 discharges. In preparing the evaluation, the District's 2013 SWMP was reviewed. Table 3 summarizes the District's current BMPs and indicates how each BMP is anticipated to prevent the 303(d) parameter from discharging into receiving waters by (1) control of the ***source*** of a pollutant entering the regulated MS4, (2) control or limitation of the ***transport*** of a pollutant through the regulated MS4, or (3) general, assumed pollutant reduction through ***indirect*** means (e.g., education, behaviors, funding, etc.).

Table 3. Relationship between Current BMPs and 303(d) Pollutants

S *= control of the source of a pollutant entering the MS4* ***T*** *= control o f the transport mechanism of discharge* ***I*** *= indirect pollutant reduction benefits*

Component	BMP	Summary of activities	Biological criteria	Chlorophyll a	OC pesticides				PCBs	PAHs	Cyanide	Iron and manganese
					Aldrin/ Dieldrin	Chlordane	DDT and DDT metabolite	Hexachloro-benzene				
1. Illicit Discharge Detection and Elimination	1-1 Enforcement Action Plan and Pollution Parameter Action Levels	• Develop and implement SOPs to perform enforcement actions • Determine pollutant parameter action levels to identify illicit discharges • Document and implement Enforcement Plan	I	I	I	I	I	I	I	I	I	I
	1-2 Conduct Annual Dry Weather Field Screening	• Dry weather outfall inspections at least once a year • Update map of major outfalls on an annual basis • Update screening program as needed to comply with Permit • Track and document illicit discharge program activities	S	S	I	I	I	I	T	T		I
	1-3 Implement the Spill Response Program	• Coordinate emergency response with other local and regional agencies and departments • Implement the spill response program and associated protocols • Track spills and response actions	S	S	I	I	I	I	S	S	I	I
	1-4 Respond to Reports Involving Illicit Discharges	• Respond to reports involving alleged illicit discharges within two weeks • Evaluate illicit discharge allegations and assist in discharge control • Track illicit discharges (reported and controlled)	S	S	I	I	I	I	S	S	I	I
2. Industrial and Commercial Facilities	2-1 Screen Existing and New Industrial Facilities	• Review new industrial development applications once during the permit term to identify additional facilities needing to obtain 1200-Z permits • Track existing and new industrial facilities subject to 1200-Z permit	I	I	I	I	I	I	I	I	I	I
	2-2 Address Other Industrial Facilities	• Inspect identified high priority facilities • Track and document inspections including enforcement actions • Notify and work with industries to improve stormwater management as needed	I	S	I	I	I	I	S	S	I	S
3. Construction Site Runoff Control	3-1 Erosion Control Ordinances	• Update Oak Lodge Sanitary District Surface Water Management code and implement new code • Require submittal of erosion prevention and sediment control plans • Review and approve erosion prevention and sediment control plans • Maintain agreement with CCSD#1 to administer 1200-C permitting within the District • Track erosion control plan reviews and permits	S	S	S	S	S	S	S	S	S	S
4. Public Education and Outreach	4-1 Reduce Discharges of Pesticides, Herbicides and Fertilizers	• Promote educational information on City website, newsletter, and brochures • Prepare at least one public education bill insert per year • Participate with Regional Coalition of Clean Rivers and Streams • Education campaigns with schools and community environmental cleanup activities • Focus campaigns on natural alternatives, potential hazards to water quality and proper use • Track and document outreach, coordination and volunteer activities related to public education and outreach	I	I	I	I	I	I	I	I		I
	4-2 Privately Owned SWM Facility Education	• Implement Stormdrain Cleaning Assistance Program through mailers to private owners • Track efforts specific to privately owned facilities	I	I	I	I	I	I	I	I		I
	4-3 Erosion Control Contractor Training Opportunities	• Document and provide notice to construction site operators regarding erosion prevention and sediment control • Refer construction site operators to the Erosion Control Manual and WES for training and certification during plan review	I	I	I	I	I	I	I	I		I
	4-4 Effectiveness Evaluation	• Participate in the joint, coordinated effort to evaluate public education effectiveness										
	4-5 Employee Training	• Attend relevant stormwater management related training based on need and availability • Participate in advisory committee opportunities provided by local agency groups	I	I	I	I	I	I	I	I		I

Table 3. Relationship between Current BMPs and 303(d) Pollutants

S *= control of the source of a pollutant entering the MS4* ***T*** *= control o f the transport mechanism of discharge* ***I*** *= indirect pollutant reduction benefits*

Component	BMP	Summary of activities	Biological criteria	Chlorophyll a	OC pesticides				PCBs	PAHs	Cyanide	Iron and manganese
					Aldrin/ Dieldrin	Chlordane	DDT and DDT metabolite	Hexachloro-benzene				
	4-6 Facilitate Public Reporting of Illicit Discharges	• Create public access for public reporting of alleged illicit discharges through the District's webpage • Track and document illicit discharge reports, follow-up actions, and educational events and publications	I	I	I	I	I	I	I	I		I
5. Public Involvement	5-1 Public Involvement and Participation	• Provide opportunity for public to comment on SWMP update and pollutant load reduction benchmarks prior to submittal to DEQ • Provide public comment period for stormwater monitoring plan										
6. Post-Construction Site Runoff Control	6-1 Construction Site Runoff Control	• Require stormwater treatment through Oak Lodge Sanitary District Surface Water Management code • Review all applicable erosion and sediment control plans submitted as part of the building permit • Require submittal of a surface water management plan for post-construction pollutant and runoff measures • Track and document program activities	S	T	I	I	I	I	I	I		T
7. Pollution Prevention for Municipal Operations	7-1 Street Sweeping	• Maintain agreements CCDTD and City of Milwaukie to perform street sweeping within the District boundary	S	S	S	S	S	S	S	S	S	S
	7-2 Operations and Maintenance for Public Streets	• Maintain agreements CCDTD to perform street maintenance within the District boundary (includes ditch cleaning) • Remove illegal solid waste dumps as they are discovered • Collect sand applied for ice/snow events with 10 days of event	T	T	T	T	T	T	T	S/T		
	7-3 Control Infiltration and Cross Connections to the Stormwater Conveyance System	• Investigate damage, and repair sanitary lines • Review new development and redevelopment for potential cross-connections • Follow illicit discharge procedures (dry weather flow inspections) to remove cross-connections • Respond promptly to public reports of suspect discharge • Eliminate any identified sanitary discharges to the storm system	I	I					I	S	S	
	7-4 Flood Management Projects and Water Quality	• Ensure all planned stormwater CIPs include consideration of water quality • Track CIPs implemented per year relative to added water quality benefit • Examine existing system for feasible/beneficial water quality retrofit	S	S					I	I		I
	7-5 Maintenance of Conveyance System Components and Structural Controls	• Developing coordination and agreement with CCDTD inspection and maintenance of conveyance system and structural controls • Preform cleaning and repair storm pipe • Track and document District and CCDTD maintenance activities	T	T	T	T	T	T	T	T	T	T
	7-6 Catch Basin Cleaning and Maintenance	• Clean District operated/maintained catch basins on a 5-year rotational basis during dry weather • Schedule repair or replacement of catch basins based on inspection results	T	T	T	T	T	T	T	T	T	T
	7-7 Private Surface Water Facility Maintenance Program	• Maintain maintenance agreements with residential, private owners of stormwater quality and detention structures • Track structures inspected and cleaned	T	T	T	T	T	T	T	T	T	T
8. Additional Activities	8-1 Hydromodification Assessment	• Develop tool to assist design of stormwater facilities to reduce target pollutants and stream degradation impacts	I	I								
	8-2 Stormwater Retrofit Strategy	• Develop a stormwater retrofit strategy for developed areas	I	I	I	I	I	I	I	I		I

3.1 Biological Criteria

Oregon's narrative water quality standard related to biological criteria is simply stated in Oregon Administrative Rules (OAR) 340-041-0011 as follows: "Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities." Currently, there are no numeric criteria for biocriteria. Instead, the *Methodology for Oregon's 2010 Water Quality Report and List of Water Quality Limited Waters* (DEQ, May 2011) includes a narrative assessment protocol. The protocol is based on USEPA guidance that biological community assessments are an indicator of aquatic life beneficial-use support. The protocol uses numeric benchmarks to evaluate biological communities (macroinvertebrates), but does not relate those benchmarks to specific pollutants.

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

3.1.1 Relationship between MS4 Discharges and Biological Criteria

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

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

3.1.2 Current BMPs to Address Biological Criteria

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

As shown in Table 3, nearly all of the District's stormwater BMPs may be seen as a way to address biological criteria. BMPs that specifically address the physical structure of surface water systems include design standards and development review to require water quality treatment and flow control in private and public projects (BMP 6-1), maintenance activities to remove trash and sediment from the collection and conveyance systems and stormwater facilities (BMPs 4-2, 7-2, and 7-5 through 7-7), street sweeping (BMP 7-1), and spill and illicit discharge complaint investigations (BMPs 1-3 and 1-4) to keep direct pollutants and trash out of the MS4. Construction site erosion control standards, project reviews, and site inspections and enforcement (BMP 3-1) also help to reduce large sediment discharges to the MS4 and downstream areas.

3.2 Chlorophyll a

Chlorophyll a is a measure of the portion of algae pigments in the water body that are active and photosynthesizing. Therefore, Chlorophyll a is not a pollutant in itself, but an indicator of aquatic weeds and algae in the water body. Oregon's water quality standard for Chlorophyll a is 0.015 milligrams per liter (mg/L). Several water quality samples in the Willamette River have exceeded this standard by small amounts.

Aquatic weeds and algae are natural components of aquatic ecosystems. In large quantities they can produce dense mats that can impede activities like swimming and fishing, and may cause odor problems and oxygen depletion. When algae die, they decompose in a process that removes oxygen from the water. Fish and other aquatic organisms cannot survive in water with low dissolved oxygen (DO) levels. Animal waste and nutrients (e.g., fertilizers containing nitrogen and phosphorus) feed aquatic plants and organisms, which in turn require more oxygen for respiration and deplete oxygen when decomposing. Elevated temperatures may also result in an increase in biologic activity (plant growth, respiration, and decomposition), which depletes oxygen from the system. In Oregon, water quality standards for DO have been established to ensure that water bodies provide critical habitat for salmonids and other aquatic species, particularly for spawning, rearing, and migration activities. There is concern that high levels of Chlorophyll a may lead to depletion of DO levels below critical levels, though this has not yet been found to be the case in the Willamette River.

In addition, large quantities of algae (called "blooms") can pose a significant potential threat to human and ecological health. Harmful algae blooms are often composed of microorganisms known as cyanobacteria, which have the potential to produce toxins that can cause adverse health effects on humans and animals through the contamination of waterways used for recreational purposes and as drinking water supplies. (USEPA, 2014).

The USEPA added Chlorophyll a to the 2010 303(d) list for the Willamette River from river mile (RM) 0 to 54.8 based on several samples exceeding the 0.015 mg/L water quality standard.

3.2.1 Relationship between MS4 Discharges and Chlorophyll a

Increased levels of Chlorophyll a are indicators of higher algae production, which is generally caused by excess nutrients in water bodies. A direct relationship exists between the amount of phosphorus in a water body and the amount of algae growing in that water body. As phosphorus levels increase, the amount of algae increases. Stormwater runoff entering the MS4 can be a contributor of nutrients into receiving waters. Potential nutrient sources in stormwater runoff include animal waste, illicit discharges and dumping, and cross-connections between the sewer and stormwater systems. In addition, landscaping waste such as leaves, grass, and other plant materials may be treated with fertilizers that are then transported through the MS4 and discharged into receiving waters.

3.2.2 Current BMPs to Address Chlorophyll a

As shown in Table 3, the District's SWMP includes several BMPs that address sources of nutrients to receiving waters. The illicit discharge detection and elimination program aims to reduce non-stormwater discharges to the MS4. Activities include dry weather screening of outfalls to identify illicit connections and illicit discharges (BMP 1-2) and pollution complaint investigations (BMP 1-4). The industrial and commercial facilities program includes procedures to identify businesses that are storing chemicals (including fertilizers) and to inspect pollution prevention activities at high-priority sites (BMPs 2-1 and 2-2). The District's public education and outreach activities are aimed at household waste, pesticides, herbicides, and fertilizers (BMP 4-1).

Other pollution prevention activities include street sweeping (BMP 7-1) and maintenance of stormwater facilities and the stormwater conveyance system (BMPs 4-2, 7-2 and 7-5 through 7-7) to remove nutrients from the MS4 before they are discharged to downstream water bodies.

3.3 Organochlorine Pesticides

Organochlorine (OC) pesticides cover a large category of pesticides that are persistent in the environment. OC pesticides in the aquatic food chain are now recognized as a widespread problem in streambed sediments (USGS, 1999). The 303(d) list for the Lower Willamette River (between RM 0 and 24.8) includes aldrin, chlordane, DDT, and DDT metabolite (dichlorodiphenyldichloroethylene [DDE]), dieldrin, and hexachlorobenzene.

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

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

DDT was widely used as an insecticide, particularly for agricultural application to control mosquito outbreaks. DDT was banned in 1972 after it was found to significantly impair eggshell development in birds exposed to DDT through the food chain (ATSDR). DDT metabolite, also referred to as DDE, is formed during the breakdown of DDT. DDT metabolite is particularly dangerous because it is fat-soluble like other OC compounds and is rarely excreted from the body. Concentrations of DDT metabolite tend to bioaccumulate and increase throughout life.

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

Hexachlorobenzene is a fungicide formerly used as a seed treatment, especially on wheat to control fungal disease. It has been banned in the United States since 1966 and globally since 2004 under the 2001 Stockholm Convention on Persistent Organic Pollutants. USEPA added hexachlorobenzene to the 2010 303(d) list for the Willamette River based on 32 exceedances from samples collected at the Portland Harbor cleanup site.

3.3.1 Relationship between MS4 Discharges and OC Pesticides

The OC pesticides on the 303(d) list are no longer manufactured or approved for use in the United States. Therefore, urban stormwater runoff is not a potential source for new contributions of these pollutants. However, these OC pesticides continue to be of concern as a result of past uses, as they are persistent in the environment and hydrophobic (binding tightly to soil particles). Therefore, legacy sources of the pollutants may be contained in sediments and transported in urban runoff.

Soil erosion can also contribute to elevated OC pesticide loading in the urban environment, which is a potential problem for MS4s with a strong historical or upstream agricultural influence. New development activity and stormwater runoff over exposed soils that were previously used for agricultural purposes could potentially result in the collection and conveyance of these compounds in the MS4.

3.3.2 Current BMPs to Address OC Pesticides

The District does not have control over the availability, sale, or use of products containing OC pesticides. The District does not currently use any of the listed pesticides, nor are they available for public use. The District's public education program focuses specifically on reducing pollutants associated with the application of pesticides, herbicides, and fertilizers (BMP 4-1).

If legacy pollutants bound to sediment are introduced into the MS4, the District's stormwater maintenance activities (BMP 7-2 and 7-5 through 7-7) are focused on the removal of trash, debris, and sediment, providing opportunities to remove soil-bound insecticides from catch basins, conveyance systems, and stormwater management facilities. Private facility maintenance education (BMP 4-2) also promotes proper removal of sediment and debris form private stormwater facilities. Street sweeping (BMP 7-1) removes sediments before they enter the collection system.

Additionally, implementation of erosion and sediment control requirements (BMP 3-1) and construction site review activities (BMP 6-1) help to prevent the transport of sediment and associated legacy pollutants into the MS4 during ground-disturbing activities associated with new development and redevelopment.

3.4 PCBs

Polychlorinated biphenyls (PCBs) are a family of chemicals with widespread industrial uses—for example, as insulators in electrical equipment, as hydraulic fluids, and as a component of carbonless copy paper—until their manufacture was banned in the United States in 1977 because of their deleterious effects on wildlife and human health. PCB-containing equipment was aggressively retrofitted throughout the 1980s and 1990s to remove PCBs, so little equipment containing PCBs remains in use in the United States (ATSDR, 2014). However, PCBs may still be present in building materials, particularly in older institutional and industrial buildings.

PCBs share many common properties with OC pesticides: they are highly persistent, they bioaccumulate in the food chain, and they are highly hydrophobic (i.e., partition out of water to sediment). Water quality standards are designed to protect human health by limiting the amount present in the food chain of the Willamette River and tributaries.

3.4.1 Relationship between MS4 Discharges and PCBs

Sources of PCBs in the environment are related primarily to streambed sediments, which themselves have an upland (soil) source. PCBs in Willamette River sediments were measured in 1997 at 15 micrograms per kilogram (µg/kg) (McCarthy and Gale, 1999) upstream of Portland Harbor. Stormwater runoff is the primary pathway by which aerially deposited toxics in the urban environment reach aquatic systems. Stormwater conveyance, whether in a piped or open-channel system, has traditionally been designed to drain stormwater quickly off impervious surfaces into downstream water bodies in the urban environment.

MS4 systems may be sources of PCBs when older buildings are demolished for redevelopment activities. In addition, elevated urban peak flows can promote re-suspension of PCB-enriched streambed sediments, potentially contributing to water quality degradation in downstream water bodies.

3.4.2 Current BMPs to Address PCBs

The goal of stormwater BMPs should be to reduce the load of PCBs discharging to receiving waters. Sediment-trapping BMPs are expected to be effective at trapping these compounds, as well as BMPs that prevent soil erosion and reduce runoff volumes to limit peak flows that cause instream erosion. As shown in Table 3, the District's primary BMPs that focus on sediment removal are street sweeping (BMP 7-1) and stormwater system maintenance (BMPs 7-2 and 7-5 through 7-7).

Implementation of stormwater detention and water quality requirements (BMP 6-1) and erosion and sediment control requirements (BMP 3-1) will also help to prevent the transport of sediment and associated legacy pollutants into the MS4 during ground-disturbing activities associated with new development and redevelopment. In addition, the District's program to evaluate industrial operations (BMPs 2-1 and 2-2) should help to locate and prevent potential pollutant discharges.

3.5 Pentachlorophenol

Pentachlorophenol (PCP) is a pesticide and disinfectant that has many uses, primarily as a wood preservative. The Willamette River listing for PCP is based on samples taken at the McCormick & Baxter Superfund site on the east bank of the Willamette River in Portland, Oregon. The site is a former wood-treating facility, and the Superfund site includes 43 acres of land and 23 acres of contaminated river sediments.

A 2013 DEQ memorandum indicates that the Willamette River from RM 0 to 24.8 for PCP will be delisted from the 2012 303(d) list. The 2012 303(d) list under review with USEPA moves the listing to "Category 4B: Water quality limited, other control measures." The 2012 303(d) list explains that the remedial actions and pollution controls at the McCormick & Baxter Superfund site will result in attainment of Oregon's narrative and numeric water quality standards in the site's vicinity by containing, controlling, and preventing future releases of contaminants into the sediments and water and protecting beneficial uses. In addition, results of monitoring show that contaminant concentrations in crayfish have declined. Based on the monitoring report, the Oregon Department of Human Services (DHS) removed the fish consumption health advisory on February 25, 2010.

Further evaluation of PCP and the relationship to MS4 discharges and BMPs has not been included in this memorandum.

3.6 PAHs

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

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

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

As with other toxics, the water quality criterion for PAHs is designed to protect human health by limiting the amount present in the food chain of the Willamette River and tributaries that can eventually lodge in human-consumable fish. The Oregon standard for protection of human health is 2.8 nanograms/liter (ng/L) for the total concentration of 16 PAH compounds. The Lower Willamette River is on the 303(d) list for PAHs based on an estimated 35-day average concentration during low flows of 52.9 ng/L.

3.6.1 Relationship between MS4 Discharges and PAHs

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

These results show that the MS4 system has the potential to transport PAHs that have been collected in stormwater runoff from the urban environment. While most PAHs may enter the MS4 as part of stormwater runoff, stormwater programs should pay particular attention to acute contributions to the MS4 from spills and other direct non-stormwater discharges to the conveyance system.

3.6.2 Current BMPs to Address PAHs

As shown in Table 3, the District’s SWMP includes several spill prevention and response BMPs that may provide protection against the transport of a concentrated discharge of fuel, oil, or other substances containing PAHs to the MS4 and downstream surface waters. Primarily, the illicit discharge investigation program (BMPs 1-1 through 1-4) and the industrial stormwater discharge program (BMPs 2-1 and 2-2) work to prevent spills, identify chemical storage sites, and identify high-risk areas to prevent spills to the MS4. In addition, BMP 4-1 provides education to residents about proper waste disposal.

The District’s street sweeping activities (BMP 7-1) also work to remove accumulated pollutants before they can reach the MS4 and maintenance activities facilitate the removal of floating oils and sediments from roads, catch basins, manholes, drainage ditches, and stormwater management facilities (BMPs 4-2, 7-2 and 7-5 through 7-7).

3.7 Cyanide

Cyanide is a naturally occurring compound, produced by certain bacteria, fungi, and algae, and is found in a number of plants. Cyanides are found in substantial amounts in certain seeds and fruit stones, such as apricots, apples, and peaches. High levels of exposure can lead to cyanide poisoning, though the most common source of cyanide exposure for the general population is through tobacco smoke.

Cyanide enters air, water, and soil from both natural processes and industrial activities. Cyanide and hydrogen cyanide are used in electroplating, metallurgy, organic chemicals production, photographic developing, manufacture of plastics, fumigation of ships, and some mining processes. Cyanide in the environment is not likely to cause adverse health effects in humans. Most cyanide in surface water will form hydrogen cyanide and evaporate; cyanide in water does not bioaccumulate; cyanide is not classified as a human carcinogen (ATSDR).

3.7.1 Relationship between MS4 Discharges and Cyanide

USEPA added cyanide to the 2010 303(d) list for the Willamette River based on 75 exceedances from samples collected at the Portland Harbor cleanup site. Portland Harbor is the source of significant environmental cleanup efforts to address legacy pollutants from past industrial activities and it is located approximately 12 miles downstream of the District.

In 2009, the Oregon Association of Clean Water Agencies (ACWA) published a study characterizing the nature of stormwater across Oregon, based on sampling data collected by municipal agencies. The data consisted of more than 25,000 samples with 45 analytes collected between 1990 and 2008. The data set used for the study included 85 stormwater samples that had been tested for cyanide. None of the stormwater samples had cyanide at levels that exceeded current regulatory limits. Therefore, it is assumed that municipal stormwater discharges from the District's MS4 area are unlikely to be a source of cyanide to the Willamette River.

3.7.2 Current BMPs to Address Cyanide

Municipal stormwater is not considered to be a source of cyanide. Cyanides are fairly mobile in soil and can be removed by several processes. BMPs that are effective at preventing cyanide from entering the stormwater system are those that focus on removing cross-connections that could be sources of non-stormwater discharges. These BMPs include illicit discharge detection and elimination (BMPs 1-1 through 1-4) as well as screening of industrial facilities (BMP 2-1 and 2-2). BMPs that remove total suspended solids (TSS) could also be effective at removing cyanide compounds. These include ditch cleaning (BMP 7-2) and pipe, catch basin and detention system cleaning (BMP 7-5 through 7-7).

3.8 Iron and Manganese

Iron and manganese are fundamental components of soils and the rocks from which soils are derived. Typical concentrations of iron and manganese in surficial geological materials of the Willamette River valley are 5 percent (i.e., 50,000 mg/kg) iron and 0.1 percent (i.e., 1,000 mg/kg) manganese (Shacklette and Boerngen, 1984). These concentrations are high compared to national averages because of the prevalence of volcanic or volcanic-derived geological materials. Soil concentrations of these elements vary by soil horizon (i.e., they are typically concentrated in subsoils) and are relatively higher where soils are derived from basalts (e.g., the Columbia River basalts, Troutdale gravels, etc.). Iron concentrations in streambed sediments of the lower and middle Willamette River (below Salem) range from 3.5 to 8.5 percent; 7 percent iron is a typical value for the lower Willamette River (Rice, 1999). These sediment concentrations most likely reflect the influence of iron- (and manganese-) enriched bedrock[1], although there may be some anthropogenic contribution as well.

The instream iron and manganese concentrations on which the Willamette River 303(d) listings are based are measured as the total recoverable metal fraction. Therefore, some of the resulting exceedances of water quality criteria could be related to elevated suspended sediment concentrations. Total suspended sediment concentrations as low as 5 mg/L could result in an exceedance of the iron criterion, assuming that the iron content of suspended sediment is equivalent to the iron content of streambed sediments. Similarly, the manganese criterion would be exceeded when total suspended sediment concentrations exceed 50 mg/L. Average TSS concentrations in stormwater runoff range from 53 mg/L in open-space settings to 169 mg/L for transportation land uses[2] (WCC, 1997), suggesting that the ambient water quality criterion for iron is often likely to be exceeded in stormwater.

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

[2] Median concentrations of TSS range from 16 mg/L in open-space areas to 120 mg/L in transportation corridors.

The numeric human-health water quality criteria for both iron and manganese[3] were withdrawn from Oregon's 2011 water quality standards. The withdrawal of numeric criteria was based on iron and manganese being naturally occurring earth elements. In addition, the previous numeric criteria for iron and manganese were based on USEPA's recommendations for taste and laundry staining effects, not on human-health effects. USEPA issued a letter of approval for withdrawal of the standards on June 9, 2011, and Oregon's revised water quality standards for human-health criteria were approved in 2011.

Despite the change in the water quality standard, the Willamette River is still listed on the current 303(d) list for iron and manganese because the 2010 303(d) list was developed prior to the approval of the revised water quality standards. Now that the numeric criteria for iron and manganese have been withdrawn, it is anticipated that these two pollutants will be delisted in future publications of the 303(d) list.

3.8.1 Relationship between MS4 Discharges and Iron and Manganese

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

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

3.8.2 Current BMPs to Address Iron and Manganese

The goal of stormwater BMPs designed to address iron and manganese should be to reduce the suspended sediment load in receiving waters and to moderate the effects of increased urban runoff volumes. Structural stormwater BMPs that would conceptually be most effective at reducing iron loads would be those that collect and/or trap sediment and those that reduce flow volumes so that sediment transport capacity of the conveyance system is reduced.

Surface infiltration through green infrastructure facilities such as infiltrating rain gardens and stormwater planters, as well as subsurface infiltration via underground injection control (UIC) systems, are the preferred BMPs for treatment of iron- and manganese-rich stormwater, assuming that concentrations of other stormwater pollutants are acceptable for discharge to groundwater. Wetlands, wet ponds, sand filters, and swales are all effective structural BMPs for treating TSS-rich stormwater because they retain sediment and provide some amount of flow attenuation. Detention ponds provide the best flow attenuation of the typical structural BMPs but may be prone to sediment re-suspension. Proper use and maintenance of erosion- and sediment-control BMPs are necessary during construction activities to reduce sediment entering the stormwater system. Maintenance activities that include the collection of sediments (e.g., street sweeping and catch basin cleaning) should also be effective at reducing the transport of sediment from the regulated MS4 into downstream water bodies.

As shown in Table 3, the District's SWMP already focuses on sediment reduction to the MEP through the use of structural stormwater controls (BMP 6-1). The erosion control program (BMP 3-1) includes design guid-

[3] Oregon water quality standards still include a saltwater criterion for total manganese. The saltwater criterion does not apply to the water bodies applicable to the District.

ance, permitting requirements, and construction site inspections and enforcement to reduce sediment introduced into the MS4. Street sweeping (BMP 7-1) includes collection of sanding materials, reducing sediment loads in the MS4. Finally, structural facility maintenance (BMPs 4-2, 7-2 and 7-5 through 7-7) addresses sediment removal from structural water quality facilities and catch basins.

It should be noted that while stormwater BMPs can reduce the loads of iron and manganese (measured either directly or using TSS as a surrogate), they may not be sufficient to allow effluent to consistently meet ambient water quality concentrations because of naturally elevated levels in local soils.

Section 4: Summary and Conclusions

The District is using reasonable and available controls to reduce the discharge of pollutants to the MEP through the implementation of current BMPs. Potential BMP modifications that may be made to further address pollutants of concern are listed below by pollutant.

It is important to note that proposed SWMP updates and adjustments to BMPs will be prepared in conjunction with the District's NPDES MS4 permit renewal application, due in September 2016. At that time, and based on feedback from DEQ regarding anticipated NPDES MS4 permit language changes, the SWMP will be updated to improve functionality, implementation, organization, and revised commitments as appropriate. SWMP modifications will include consideration of the recommendations from this 303(d) evaluation, the results of the MEP evaluation (due in 2016), and a review of District organization and resources.

4.1 Potential BMP Modifications to Address Biological Criteria

The District's SWMP has controls in place to address biological criteria to the MEP. Biological criteria are an indicator of cumulative water and habitat quality. DEQ's biocriteria TMDL for the Umpqua Basin states that "… implementing the Waste Load Allocations and Load Allocations for other water quality-limiting parameters, as well as making improvements in habitat and flow conditions, should recover biological communities to expected compositions." In addition to addressing waste load allocations through the MS4 permit, the District has a TMDL implementation plan to work toward reaching the load allocations for TMDL parameters.

The District has recently completed a hydromodification assessment to evaluate whether current controls, design standards, and proposed projects address hydromodification issues in local streams. Implementing the recommendations from the hydromodification assessment, including prioritizing capital projects and updating stormwater design standards, should further address biological criteria as well as other listed pollutants. No additional changes to the SWMP are proposed at this time to specifically address biological criteria.

4.2 Potential BMP Modifications to Address Chlorophyll a

Chlorophyll a is an indicator of the presence of algae in the water body. Algae production increases with an increase in nutrients and temperature. The District's SWMP has controls in place to reduce discharges of nutrients to the MEP. Public education programs are focused on the importance of pet waste pickup and environmentally friendly landscaping and yard maintenance practices. The District contracts out landscaping activities, so the public education program could be enhanced to increase outreach to these landscaping contractors regarding property use of fertilizers and proper storage and disposal of such materials.

4.3 Potential BMP Modifications to Address OC Pesticides

The District's SWMP has controls in place to reduce sediment discharges of OC pesticides, including aldrin, chlordane, DDT/DDE, dieldrin, and hexachlorobenzene, to the MEP. No new sources of these specific OC pesticides are being introduced into the environment. In most cases, the primary factor in reducing OC pesticides is time. For example, the Molalla-Pudding Subbasin TMDL for pesticides (DEQ, 2008) states that "DEQ expects that significant [TSS] reductions … and ongoing decay of dieldrin over time should result in the achievement of both aquatic health chronic toxicity and human health based criteria for dieldrin." Therefore, no modifications to the SWMPs are listed for consideration to specifically address OC pesticides.

4.4 Potential BMP Modifications to Address PCBs

The District's SWMP has sufficient controls in place to reduce sediment discharges and TSS (and hence PCBs bound to TSS) to the MEP. Addressing PCBs is a matter of managing sediments as well as historical sources. The District's illicit discharge program includes investigation of water quality complaints. This program could be expanded to include identification and reporting of illegal dump sites, which could be a potential source of older products that could contain PCBs.

The District may also consider enhancing the stormwater program to address proper disposal of building materials during redevelopment. The enhancements could include changes to the focus of public outreach materials and/or revisions to stormwater design standards to include guidelines on proper materials disposal.

4.5 Potential BMP Modifications to Address Pentachlorophenol

Remediation activities at the McCormick & Baxter Superfund site downstream of the District in Portland are expected to result in the attainment of water quality standards for PCP. Therefore, no modifications are recommended to the District's SWMP or BMP elements to address PCP.

4.6 Potential BMP Modifications to Address PAHs

The District's SWMP has BMPs in place to identify and respond to water quality complaints. While PAHs are a common component in stormwater runoff, the District's stormwater program should pay particular attention to acute contributions to the MS4 from spills and other direct non-stormwater discharges. The District already has standard operating procedures (SOPs) for spill response and containment, including training for all District staff on spill reporting. The SWMP also has maintenance practices to remove potential pollutants from roadways and the MS4. These maintenance practices should include SOPs for waste disposal and vehicle maintenance to prevent the introduction of PAHs into the stormwater system during District maintenance activities.

4.7 Potential BMP Modifications to Address Cyanide

The District's SWMP has controls in place to reduce illicit discharges and cross-connections from industrial sources to the MEP. In addition, municipal stormwater runoff from the District is not a likely contributor to cyanide levels in the Willamette River. Therefore, no modifications are recommended to the SWMP and BMP elements to address cyanide.

4.8 Potential BMP Modifications to Address Iron and Manganese

The District's SWMP has controls in place to reduce sediment discharges and TSS to the MEP. In addition, numeric criteria for iron and manganese have been withdrawn from Oregon's water quality standards. Therefore, no modifications are recommended to the SWMP and BMP elements to address these two pollutants.

References

Agency for Toxic Substances and Disease Registry (ATSDR), ATSDR Toxic Substances Portal, http://www.atsdr.cdc.gov/substances/index.asp, accessed September 2014 and August 2015.

CCDTD, NPDES MS4 Discharge Permit Annual Report for July 1, 2014-June 30, 2015, June 2015.

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

DEQ, Methodology for Oregon's 2010 Water Quality Report and List of Water Quality Limited Waters, May 2011.

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

DEQ, Memorandum from Karla Urbanowicz, WQ Assessment Program Coordinator to 2012 Integrated Report File regarding Category 4B Demonstration Addressing Pentachlorophenol in Willamette River Sediments, dated October 21, 2013.

DEQ, Oregon's 2010 Integrated Report – Assessment Database and 303(d) List, http://www.deq.state.or.us/wq/assessment/rpt2010/search.asp, accessed March 2014.

DEQ, Oregon's 2012 Integrated Report – Assessment Database and 303(d) List, http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp#db, accessed September 2015.

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

DEQ, *Water Quality Standards Review and Recommendations: Iron and Manganese*, November 16, 2010.

EXTONET, Extension Toxicology Network, http://pmep.cce.cornell.edu/profiles/extoxnet/haloxyfop-methylparathion/heptachlor-ext.html, September 2014, Pesticide Information Project of Cooperative Extension Offices of Cornell University, Michigan State University, Oregon State University, and University of California at Davis.

Glenn, III, D., D. Liu, and J. Sansalone (2002). Influence of Chemistry, Hydrology and Suspended Solids on Partitioning of Heavy Metals to Particles – Considerations for In-Situ Control of Urban Stormwater Quality. In Global Solutions for Urban Drainage, Proc. Ninth International Conference on Urban Drainage (9ICUD).

Oregon Association of Clean Water Agencies, "Compilation and Evaluation of Existing Stormwater Quality Data from Oregon," Kennedy/Jenks Consultants, December 16, 2009.

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

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

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

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

Oak Lodge Sanitary District, 2014-2015 MS4 Annual Report for NPDES MS4 Permit Compliance, Permit #108016, October 2015.

Oak Lodge Sanitary District, *Stormwater Management Plan*, MS4 Permit 108016, May 2013.

Shacklette, H.T. and Boerngen, J.G. 1984. Elemental concentrations in soils and other surficial materials of the conterminous United States. *U.S. Geological Survey Professional Paper* 1270.

State of Oregon, Oregon Administrative Rules 340-041.

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

USGS. 1999. The quality of our nations' waters: nutrients and pesticides. USGS Circular 1225. US Geological Survey, Reston, Va.

USEPA, Dissolved Oxygen and Biochemical Oxygen Demand, http://water.epa.gov/type/rsl/monitoring/vms52.cfm, accessed September 2014.

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

USEPA Region 10. Office of Water and Watersheds. EPA Approval of Oregon's Withdrawal of Numeric Human Health Criteria for Iron and Manganese (OAR 340-041-0033(2), Table 20) and Revisions to the Associated Footnote to Table 20. June 9, 2011.

WCC, 1993. *Final Data Report*, Data for Storms Monitored between May 1991 and January 1993. Prepared for Portland Bureau of Environmental Services. Woodward-Clyde Consultants. June 1993.

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

14. Public Notice of 2014-2015 Annual Report

OLSD solicited public comment on this annual report in the following manner:

- Public Notice and Solicitation of Comments on the OLSD Website: 3 weeks in October 2015
- October OLSD Board Meeting: Planning and Engineering Staff Report mentions availability of report on website for public review and comment.
- North Clackamas Urban Watersheds Council: OLSD's monthly report mentions availability of report on website for Public Review and Comment.
- The 2014 Annual Report and the 2015 Draft Report were posted on OLSD Website.

Appendix A

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Illicit Discharge Detection and Elimination **Enforcement Response Plan and Pollution Parameter Action Levels**	**4.a.i – iii**	**BMP Description:** In cases where an illicit discharge has resulted in a discharge that OLSD suspects resulted in a violation of state water quality standards, water quality samples may be collected at the suspected discharge point, as well as upstream and downstream of the discharge point. This is done in an effort to prove the impact on water quality that the illicit discharge has had. The samples will be tested at the laboratory based on field observations of the discharge in an effort to identify any pollutants present in the discharge. Staff will also investigate the source of the discharge by looking in the surface water system upstream of the discharge point; samples may be taken at locations suspected of originating the illicit discharge. In cases of an oily discharge, OLSD will notify DEQ through the OERS (Oregon Emergency Response System), which is in place to address oil spills into waterways and ditches. If the DEQ and/or EPA become involved, OLSD will provide a support role to these agencies. When the source of the illicit discharge is identified, OLSD will determine whether this discharge violated the District's Surface Water Management Code, and if so, fines may be levied against the offending party, including all cleanup costs, investigative and sampling costs, and OLSD staff costs, including legal fees. OLSD will rely on State of Oregon water quality standards to determine a pollutant level that violates water quality as a trigger to initiate full enforcement action.	(1) Documentation of Enforcement Plan (2) Response Procedures (3) Pollutant Parameter Action Levels	1. Illicit discharges are managed through the Districts documented Illicit Discharge Program. 2. OLSD maintains an SOP (Standard Operation Procedure) for staff to perform enforcement actions with illicit discharges. 3. OLSD has determined pollutant parameter action levels to match Oregon State water quality standards.
	4.a.iv	**BMP Description:** The purpose of dry-weather outfall inspections is to detect an illicit discharge at the outfall or confirm that they are not present. If flow is detected during dry weather, District staff track it upstream through the storm sewer system to the source, and then address, or if necessary, control the discharge. Illicit discharges are detected during dry-weather inspections through the use of hand-held water quality measuring equipment and through visual inspections by the inspector. When a visual inspection or a pollutant level measured at an outfall indicates that an illicit discharge may be present, an upstream investigation through the storm sewer system is performed. When the discharge's source is located, District staff work with the property owner and/or business owner to evaluate, and if necessary, control the discharge.	(1) Number of outfalls inspected during dry-weather. (2) Number and type of illicit discharges that were encountered and controlled. **(3) Status of updating procedures to address new** permit requirements Measurable Goals: • Inspect major or priority outfalls for the presence of illicit discharges at least once per year. • Update maps of major outfalls on an annual basis. • Update dry weather field screening program to address new permit requirements by November 1, 2012	1. All four Dry Weather Outfalls were inspected during the dry season of 2015 for the 2014/2015 Permit year. 2. No illicit discharges were noted from the outfall inspections. 3. No new requirements where established for the 2014/2015 OLSD Storm water Monitoring Plan.

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Illicit Discharge Detection and Elimination **Implement the Spill Response Program**	**4.a.v**	**BMP Description:** The District's Spill Response Program prevents, contains, and responds to spills of dangerous, hazardous and other materials. The District's Spill Response Program ensures that the actual or possible release of dangerous/hazardous materials to the MS4 is properly addressed. Except for minor incidents, The District's Spill Response Program personnel always coordinate closely with other agencies and departments, including Clackamas County Fire District No. 1 (and for certain incidents involving hazardous materials, the Gresham HazMat Team), DEQ, Oregon State Police, Clackamas County's Road Department (DTD), and Oregon's Department of Transportation.	(1) Number of reported spills to the MS4 system. (2) Number and type of response to the reported spills. Measurable Goals: • Implement the spill response program and associated protocols.	1. During the reporting period 2014/2015 the District received and investigated 11 storm water complaints of potential spills. 2. Nine of the complaints resulted in no problem found. Two of the complaints were spills; One was satisfied by informal response between the owner and District. The second is an ongoing illicit discharge that is being monitored by OLSD, DEQ and EPA cleanup site.
Respond to reports involving illicit discharges	**4.a.V – 4.a.xii**	**BMP Description:** Reports are often received from Oregon's DEQ, Oregon's ODOT, Water Districts, Fire Districts, cities, citizens, district employees and others which allege that an illicit discharge has occurred or is occurring. When reports are received which allege that an illicit discharge has occurred or is occurring, OLSD will attempt to confirm the allegation in a timely manner. If it can be confirmed that an illicit discharge has occurred or is occurring, District staff will cooperate with the property owner and/or business owner to evaluate, and if necessary, control the discharge. Control options that may be applied or recommended by the District include, but are not limited to: • The removal of certain pollutants from the wastewater prior to discharge to the storm sewer system (i.e. cease usage of soap when washing). • Issuance of the proper discharge permit from DEQ. A discharge that has been authorized and controlled by a DEQ water quality permit is not an illicit discharge. • Application of the wastewater to dry land with no discharge to surface waters or storm sewers. This option is inappropriate for certain types of wastewaters, discharge rates, and soil types and may require the issuance of a WPCF permit from DEQ. • Wastewater reuse without any discharge. • Hauling the wastewater off-site for proper disposal. • With the necessary permits, discharge the wastewater to OLSD's sanitary sewer system.	(1) Number of alleged illicit discharges and non-stormwater discharges which were reported each year (2) Number of illicit discharges that were controlled. Measurable Goals: • Respond to reports involving alleged illicit discharges within two weeks.	OLSD received 11 possible Illicit discharge complaints during the reporting year 2014/2015. 2 were found to be Illicit discharges. • One was stored oil leaking from a site. Cleanup by the property owners was done eliminating the illicit discharge source and cleanup was done. • This was an EPA/DEQ funded cleanup site. Federal funds were used to cleanup this site.
Screen Existing and New Industrial Facilities	**4.b.i – 4.b.iii**	**BMP Description:** Once during the permit term, OLSD will review new industrial development applications to determine whether any existing or new facilities would be subject to an industrial stormwater NPDES permit. This determination will occur based on a review of the 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.	**Track the number of existing or new industrial facilities subject to a stormwater industrial NPDES permit during the permit term.** Measurable Goals: • Review new industrial development applications once during the permit term to identify additional facilities needing to obtain 1200-Z permits.	The District has two 1200Z Industrial users within its boundaries . One is no longer in production but still holds an open 1200Z permit status with DEQ. The other is the Districts own 1200Z industrial permit. No new Industrial users were opened in 2014/2015. The District continually reviews all new industrial facilities through its development review process.

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Address Other Industrial Facilities	**4.b.i - iii**	**BMP Description:** The facilities that are addressed by the District for this BMP are those that are not required to obtain a 1200Z permit, and/or are anticipated to contribute a substantial load of pollutants to the MS4. Facilities will primarily be inspected on a complaint-driven basis, but it is possible that some inspections will be conducted by the District during source tracking activities if the District's storm event monitoring work or routine monitoring work shows that excessive levels of one or more pollutants are present. All facilities that are the subject of a complaint will be inspected in a timely manner by District staff. The implementation of control measures for stormwater discharges from these facilities will be deemed necessary by the District if the presence of excess levels of stormwater pollution can be confirmed by the District. For instances where the presence of excess levels of pollution in stormwater has been confirmed by the District, and in the event that the discharger's initial attempts to improve stormwater quality do not produce the required improvement, then District personnel will continue to provide guidance and technical assistance until the facility's stormwater quality improves. The presence of excess levels of pollution in stormwater can generally be confirmed by two general methods: visual and analytical. Analytical methodologies include hand-held meters, and those performed by an environmental laboratory. The District will use visual or analytical methods at the District's discretion. Industrial users permitted under the pretreatment program 40CFR403 have an annual facility inspection which includes a review of storm water facilities.	1. The number of inspections performed, and where applicable, monitoring data collected. 2. The number of letters, enforcement actions, or other contacts made. 3. Number of pretreatment inspections performed Measurable Goals: • Notify and work with industries to improve stormwater management if an inspection is conducted that indicates improvement is needed.	2014/2015 OLSD with cooperation and funding from the EPA/DEQ was able to enforce a commercial business site to comply with Federal /State and Local pollutant limits. This commercial site was discharging heavy oils into a drainage basin. The EPA/DEQ were able to DNA the oils to this specific commercial business. Coast Guard funding was used to clean/repair/ and install a storm water asset on site. Dollar numbers for the entire project was close to $1,000,000.
Construction Site Runoff Control **Erosion Control Ordinances**	**4.c.i – 4.c.vi**	**BMP Description:** *OLSD Surface Water Management Code* The District updated the Surface Water Management Code in 2011-2012 to match updated requirements through the MS4 permit. The code addresses regulatory and review requirements related to erosion control, tree removal, undisturbed buffers, and flow control and treatment requirements. These regulations require submittal of an erosion prevention and sediment control plan containing methods and/or interim facilities to be constructed or used concurrently with land development. Plan submittals are required to provide details of erosion control measures, schedules for construction, and a maintenance schedule for erosion control activities. OLSD has an agreement with CCSD#1 for administration of the 1200-C permitting program for the areas inside OLSD.	(1) Implement Code Measurable Goals: • Update SWMC and implement new code	Completed; Code update adopted in July 2012. OLSD is implementing the 2012 SWM code.

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Public Education and Outreach **Topic: Reduce Discharges of Pesticides, Herbicides and Fertilizers**	4.d.iii	BMP Description: OLSD administers a public education program which provides information that attempts to motivate workers and residents to reduce stormwater pollution that is caused by the application of pesticides, herbicides, and fertilizers in the District. Educational information is shared with the public through the use of: • Articles in newsletters • District's ' website. • Through local public involvement campaigns. A recent example of a relevant public involvement campaign is one that has been launched annually over the past several years throughout the Portland Metro area by many municipal partners, including the Districts. This group is called the Regional Coalition for Clean Rivers and Streams. • Brochures Common topics that are addressed by this program include: • Less harmful alternatives to the use of pesticides, herbicides, and fertilizers are provided. For example, use of ladybugs to eat insect pests is encouraged as an alternative to pesticide application. • Information about the potential hazards to water quality, public health, and aquatic life associated with the misuse of pesticides, herbicides, and fertilizers in the District. • Users are reminded that pesticide and herbicide products need to be used in a manner consistent with the product's label.	(1) Track programs messages delivered, type of communication piece, and where appropriate, the number of people affected Measurable Goals: • Continue to maintain relevant public education materials on the district's website. • Prepare a minimum of one relevant article per year for inclusion with customer billing statements.	The following outreach efforts occurred last year: Bimonthly Newsletters with surface water education topics in each and Annual Report with District facts and School Outreach: Administered WHEP with our high school partner, Rex Putnam. Conducted seven group plant tours for 3rd- 12th grade students. Macroinvertebrates workshop for high school students. Native planting and watershed observations for 6-12th grade students. Rex Putnam Green Team annual report and Board presentation. Planting at William J. Wild Park with Cub Scouts and community members. Partner with Schoolyard Farms to teach about runoff risks within gardens. Events: OLSD hosted or participated four events (SOLV*E* Green Team Student Summit, Get Wet in your Watershed Teacher Workshop, CWET Celebrating Water Event, and Children's Clean Water Festival) Brochure: *"Dump Smart:"* Proper Disposal for Paint, Power Washing, and Carpet Cleaning; Plant workflow diagram for students, Participation in the Regional Coalition for Clean Rivers and Streams, Clackamas County Water Education Team, Watershed Health Education Programs, Participation in Boardman Rinearson Wetlands cleanups and plantings with SOLV*E*. Website: Streamlined access to information for property owners, tenants, and educators on maintenance, conservation and other general issues.
Education and Outreach **Privately Owned SWM Facility Education**	4.d.iv	**BMP Description:** Privately owned SWM facilities require periodic inspection and maintenance to keep them working correctly. This effort focuses on outreach and education to those private landowners who own these types of facilities	(1) Number and Type of Education and Outreach efforts specific to privately owned facility inspection and maintenance.	Participation in SCAP (Stormdrain Cleaning Assistance Program) with mailers sent to 200+ property owners who has/may have private storm drains on their property.

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Education and Outreach **Erosion Control Contractor Training Opportunities**	4.d.v	**BMP Description:** Provide notice to construction site operators concerning where education and training to meet erosion prevention and sediment control requirements can be obtained.	(2) Describe efforts to provide this notice	OLSD Plan Review Staff refers contractors to the WES Erosion Control manual and to WES for information on training and certification opportunities.
Education and Outreach **Effectiveness Evaluation**	4.d.vi	**BMP Description:** Over the permit term, OLSD will provide information related to an effectiveness evaluation. This may be conducted in coordination with other local Phase 1 jurisdictions. The effectiveness evaluation information will focus on assessing changes in targeted behaviors and will allow for additional information that can be used in adaptive management of the OLSD education and outreach strategy.	(3) Report on activities annually. Measurable Goals: • Provide/compile information regarding a public education effectiveness evaluation over the permit term.	During the 2013-2014 permit year, OLSD participated in a regional study about the effectiveness of various stormwater-related public outreach efforts within Oregon. The report was commissioned through Oregon Association of Clean Water Agencies. See Appendix B for a copy of the study.
Education and Outreach **Employee Training**	4.d.vii	**BMP Description:** A variety of training is provided to staff associated with surface water management. Training and advisory committee opportunities are made available through local agencies and groups involved with a broad range of water quality issues including stormwater (e.g., Oregon Association of Clean Water Agencies conferences). Such training is provided based on need and availability.	Track the number of employees receiving training in stormwater management annually**.** Measurable Goals: • Attend relevant stormwater management related training based on need and availability.	A monthly newsletter for OLSD employees is included with paychecks. During 2014-2015, MS4 related information was included in 6 of the 6 newsletters. Specific Trainings: Certification for Stormwater Inspector put on by NPDES January 30, 2015. Certification good for 5 years. Water Environmental Services Short School. 4 days.
Public Education and Outreach **Topic: Facilitate Public Reporting of Illicit Discharges**	4.d.viii	**BMP Description:** The District implements a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges and other types of improper disposal of materials into the MS4. After District staff have received a report which relates to one of these discharges, they investigate and, if appropriate, apply control measures. See BMP #3.	(1) Number illicit discharges reported. (2) Number of illicit discharges requiring action. (3) Number of educational events educating public about illicit discharges and procedures to report. (4) Number of publications educating public about illicit discharges and procedures to report. Measurable Goals: • Create a page for public complaints on the District's website and track number of complaints for reporting.	Potential illicit discharges reported: 9 Actions taken: 9 Educational Events: 2 Educational Publications: 4

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Public Involvement and Participation	4.e	**BMP Description:** Schedule A.4.e of the District's MS4 NPDES permit requires OLSD to provide opportunity for public participation in the development, implementation, and modification of the Stormwater Management Plan (SWMP). Prior to submittal of various milestone reports, OLSD will provide the public with an opportunity to comment for a period of 2 weeks prior to submittal dates. Comments on the documents will be collected and considered. Additionally, OLSD has many opportunities for members of the community to participate in various sub committees that provide oversight and guidance to OLSD management related to MS4 implementation.	Measurable Goals: • Provide for public participation with the SWMP and pollutant load reduction benchmarks prior to the permit renewal application deadline. • Provide for public participation with the monitoring plan due to the Department by September 1, 2012	Monitoring Plan Public Noticed: completed, notice in newspapers was completed SWM Annual Report Public Notice: completed, notice in newspapers was completed SWM Annual Report and Permit on website: completed, documents uploaded for public to access Boardman Watershed Community Committee: 1 community meeting occurred, with community participating in development of a capital project design to support Boardman Watershed Initiative Website contains a variety MS4 related material, opportunity for public to comment.
Construction Site Runoff Control	**4.f.i - 4.f.iv**	**BMP Description:** *OLSD Development Review* The District reviews all development plans for new construction or redevelopment projects in the District's service area through the building permit process. All reviews are conducted in accordance with the OLSD Surface Water Management Code (SWMC). These regulations require submittal of a surface water management plan that addresses post-construction pollutant and runoff control measures. The OLSD SWMC was updated during this reporting year, and new, more stringent requirements for surface water management have been adopted.	(2) Annual number of permitted, active construction projects (i.e., those projects disturbing 800 s.f. or more). (3) Annual number of site plan reviews and approved plans. Measurable Goals: • Review all applicable erosion and sediment control plans submitted as part of the building permit	Number of development permits issued: 8 Acreage of development activity: 20 Acres Number of erosion control permits issued: 68 Number of erosion control inspections completed: 258 Number of enforcements (violations that needed enforcement action): 6 Identify any new industrial businesses in OLSD: 2 Variance Requests: 1 Appeals: 0 Estimate of total new and replaced impervious surface area related to development projects: 1.8 acre

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
Pollution Prevention for Municipal Operations **Street Sweeping**	**4.g**	**BMP Description:** Major arterial curbed streets within the DTD service area (which includes OLSD) are swept on a regular basis by DTD. The frequency varies depending on a variety of factors (for example, traffic volumes). For information on their street sweeping activities, refer to the DTD MS4 NPDES SWMP.	(1) Number of miles that were swept OLSD (2) Mass or volume of material removed during sweeping For DTD roads, see tracking measures in the DTD MS4 NPDES SWMP.	Street Sweeping within OLSD Boundary: (1) 663 Shoulder Miles (2) 465 CY debris removed The district has entered into an agreement with the City of Milwaukie to have its WRF impervious surface's swept once a month. This BMP is a result of the Districts 1200Z Permit.
Operations & Maintenance for Public Streets	**4.g**	**BMP Description:** Operations and maintenance of public streets within the DTD service area (which includes OLSD) is the responsibility of DTD. For information on their activities, refer to the DTD MS4 NPDES SWMP.	Measurable Goals: • DTD Roads: See DTD's MS4 NPDES SWMP. • Remove illegal solid waste dumps as they are discovered. • Collect sand applied for ice/snow events within 10 days of the end of the event.	See DTD's MS4 NPDES SWMP.
Control Infiltration and Cross Connections to the District's Stormwater System	**4.g**	**BMP Description:** The District prevents exfiltration of flows from municipal sanitary through the presence of a rigorous maintenance program involving routine cleaning and inspection of lines to ensure that there are very few leaks. Lines are inspected with a television camera on a periodic basis. Tree roots, which could cause leakage, are removed whenever identified. The District prohibits cross-connections in new/redevelopments through the development and building permit review and issuance process. This system, which features plan review in the office and field inspections by certified plumbing inspectors, ensures that fixtures that need to be plumbed into OLSD's sanitary sewer system or a private septic system are actually plumbed into those systems, preventing hundreds of illicit discharges per year. The District is able to identify and control the exfiltration of flows from municipal sanitary sewers when it occurs by: • Performing dry-weather inspections at all major or priority outfalls on an annual basis to detect non-stormwater flows, and • Receiving and promptly responding to reports from citizens of unusual colors, odors and solids.	(1) Number of cross-connections/ sanitary discharges identified. Measurable Goals: Eliminate any identified sanitary discharges to the storm system.	During this permit year, OLSD identified 0 cross connections through routine inspections.
Flood Management Projects and Water Quality	**4.g**	**BMP Description:** There are two Components to this BMP. The first is to ensure that water quality is assessed and addressed when developing capital improvement projects (CIPs) for flooding. The second is to examine the existing system to determine whether water quality retrofits would be beneficial and feasible. <u>CIPs:</u> The District develops 5 and 10 year Capital Improvement Plans to identify major projects necessary to address water quality concerns. One of the main goals and outcomes of the CIP is to prioritize what stormwater management actions and activities should be conducted in	(1) Number of retrofits constructed that address water quality treatment. (2) Number of flood management projects implemented or constructed and the percentage of those projects that include water quality Components. Measurable Goals:	(1) During this permit year, OLSD participated in a stormwater retrofit project at an elementary school. Concrete was replaced with a rain garden. Additionally, several parking lots have been identified to pursue retrofit projects, but no landowners have agreed to allow OLSD to install the retrofit BMP's. Ownership of the system continues to be a challenge for OLSD to build retrofit projects.

OLSD 2014-2015 Summary of BMP Implementation

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
		specific sub-basin areas, such as where to assist the operations and maintenance program in targeting specific activities in various locales. Another main goal of the CIP is to build projects to protect, restore, and enhance the health and function of a watershed.	Ensure all planned stormwater CIPs include consideration of water quality.	(2) OLSD currently has two capital improvement projects in pre-design. Both projects focus on water quality improvement as well as water volume management.
Maintenance of Conveyance System Components and Structural Controls	**4.g**	**BMP Description:** The District maintains conveyance and treatment components of the storm water system that are located outside the right-of-way of publicly owned roads in maintenance agreement subdivisions or that are owned by the District. The conveyance components include, but are not limited to, culverts, storm sewer lines (8" or greater in diameter) and inlets. The stormwater treatment components of the system include, but are not limited to, vegetated aboveground stormwater detention facilities, sedimentation manholes, and various types of underground proprietary pollution control systems. Maintenance records are kept by both DTD and the District. The District and DTD are working on the development of an intergovernmental agreement to clarify and coordinate maintenance activities.	(1) Miles of ditches and storm lines maintained (2) Number and type of components inspected and/or cleaned, and (3) Mass or volume of material removed during cleaning	(1) <u>Ditch Cleaning: 704' – By Clackamas DTD</u> (2) <u>Storm Pipe Cleaned: 666' by OLSD</u> (3) <u>Mass Removed: 2.25 tons of material (stormline cleaning)</u> <u>Mass Removed: 18 tons of material (Ditch Cleaning)</u>
Catchbasin Cleaning and Maintenance	**4.g**	**BMP Description:** OLSD cleans all District owned or District operated/maintained catch basins once every five years. Catch basin cleaning activities primarily occur during the dry weather season, but during the fall, certain catch basins may be cleaned more frequently if needed. Utility crews utilize a database to document inspection and maintenance activities for the annual reports. Repair or replacement of public catch basins is scheduled following inspection.	(1) Track the number of District owned or District operated/maintained catch basins cleaned per year. (2) Track the mass or volume of debris removed during cleaning activities. Measurable Goals: • Clean OLSD District operated/maintained public catch basins on a 5-year rotational basis. Schedule repair or replacement of catch basins based on inspection results.	During this reporting period, OLSD and Clackamas Co. developed a new approach to storm system inspection and maintenance (see updated SWMP). Zone 2 results were as follows: (1) Catchbasin Inspections: 436 (2) Catchbasins Cleaned: OLSD: 226 CCDTD: 4 (3) Mass of Debris Removed: 46.8 by OLSD + 1.56 by CCDTD
Private Surface Water Facility Maintenance Program	**4.g**	**BMP Description:** This BMP includes maintenance agreements for stormwater quality and detention structures in residential areas. There are very few of these facilities in OLSD. This infrastructure varies from subdivision to subdivision, but may include any of the following: catch basins, below-ground stormwater detention tanks, above-ground storm water detention and/or water quality ponds, below-ground vortex separators, and swales.	(1) Number of structures inspected and cleaned.	15 Private Facility inspections were done as part of the Districts Zone 4 inspection/cleaning program. The Facilities that meet the criteria for cleaning will be cleaned.
Hydromodification Assessment	5.a – 5.d	**BMP Description:** OLSD anticipates partnering with adjacent co-permittees (CCSD#1, Clackamas County DTD) to develop a simplified tool for development engineers to easily size LID BMPs to address the duration of elevated flow levels in addition to addressing flow volumes and peaks. Use of the tool in designing LID BMPS is expected to ultimately address the long-term impacts of increased runoff from development. To address flow durations, a long-term continuous simulation of hydrology is required. As a result, designing and sizing BMPs becomes more	(1) Net impervious area treated by LID. (2) Number of applications submitted using tool. (3) Customer Feedback/ Community Relations. Measurable Goals:	See Hydromodification Assessment submitted to DEQ on June 29, 2015.

Best Management Practice	*MS4 Permit Schedule A Requirement*	*BMP Description*	*Performance Measure*	*Annual Report 2014-2015*
		complicated than traditional design practices focused on a single design event. In order to make the BMP design process easier for the development community, neighboring states have developed a sizing tool. Currently, there are no BMP design/sizing tools to address the impacts of Hydromodification that are applicable to local conditions such as rainfall patterns and critical channel forming flows. This tool will provide a simple, consistent and defensible methodology for designing/sizing LID throughout Clackamas County and the region to address Hydromodification impacts.	The primary goal is to develop, by June 30, 2013, a tool to assist development engineers with the design/sizing of stormwater management facilities in order to reduce target pollutants and stream degradation impacts (i.e., Hydromodification) associated with the development of impervious surfaces.	
Stormwater Retrofit Strategy	6.a – 6.c	**BMP Description:** Develop a stormwater quality retrofit strategy that applies to developed areas identified as impacting water quality.	(5) Submit plan to DEQ by July 1, 2015.	See Stormwater Retrofit Strategy and Plan submitted to DEQ on June 29, 2015.

Appendix B

OLSD 2014-2015 Water Quality Sampling Data Results: Storm Sampling and Quarterly Stream Sampling

SW 8 – SE Naef Rd / SE Blanton St – South Boardman Creek, 60' north of intersection

MS4 Sample Type: WET WEATHER, 3 events per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphate (mg/L)	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	Hardness (mg/L)	Calcium (µg/L)	Magnesium (µg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)	Ortho-Phosphorous (mg/L)	Ammonia Nitrogen (mg/L)
10/22/2014	13	2.84	N/A	7.23	21.9	1410	N/A	40	N/A	ND	0.15	N/A	NONE	ND	9.83	46.2	0.404	18.6	5.28	1.32	0.00603	0.00143	0.0801	0.00371	0.000267	0.0555	0.09	0.023
Due to lack of storm events within work hours and hours of operation of the lab, a sample could not taken. A rain gauge data log is on file with the District.																												
5/12/2015	85	2.1	N/A	7.39	24.3	1410	N/A	85	N/A	ND	0.11	N/A	NONE	ND	10.21	82.2	0.573	31.1	8.35	2.49	0.00567	ND	0.0598	0.0047	0.00289	0.0513	0.061	0.043

SW 5 – 15100 SE Woodland Way – River Forest Creek – 48" CMP outfall on west side of road

MS4 Samlpe Type: WET WEATHER, 3 events per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphate (mg/L)	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	Hardness (mg/L)	Calcium (µg/L)	Magnesium (µg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)	Ortho-Phosphorous (mg/L)	Ammonia Nitrogen (mg/L)
10/22/2014	30	5.16	N/A	6.94	21.5	>2420	N/A	16	N/A	ND	0.138	N/A	NONE	NO	9.81	24.2	ND<0.250	9.45	2.86	0.56	0.0088	0.00438	0.0919	0.00401	0.000522	0.0599	0.052	0.104
Due to lack of storm events within work hours and hours of operation of the lab, a sample could not taken. A rain gauge data log is on file with the District.																												
5/12/2015	5	2.82	N/A	6.85	24.4	1730	N/A	37	N/A	ND	ND	N/A	NONE	NO	10.12	34.4	0.458	12.5	3.68	0.814	0.00968	0.00247	0.148	0.00818	0.000633	0.138	ND	0.149

SW 2 – SE Courtney Ave / SE Rupert Dr – MH on SW corner

MS4 Sample Type: WET WEATHER, 3 events per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphate (mg/L)	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	Hardness (mg/L)	Calcium (µg/L)	Magnesium (µg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)	Ortho-Phosphorous (mg/L)	Ammonia Nitrogen (mg/L)
10/22/2014	21	6.63	N/A	6.99	22.4	>2420	N/A	34	N/A	ND	0.144	N/A	NONE	NO	9.47	36.5	0.292	13.4	3.89	0.894	0.00656	0.0029	0.0397	0.0036	0.000367	0.0251	0.069	0.071
Due to lack of storm events within work hours and hours of operation of the lab, a sample could not taken. A rain gauge data log is on file with the District.																												
5/12/2015	5	3.1	N/A	7.01	25.2	2420	N/A	71	N/A	ND	ND <0.100	N/A	NONE	NO	9.51	34.4	1.04	29.1	8.03	2.19	0.00848	0.00106	0.0377	0.00447	0.0003	0.035	0.047	0.058

SW 15 – 15000 SE Fairoaks Ave – River Forest Creek – River Forest Lake influent

MS4 SAMPLE TYPE: Instream Sample, 4 times per year

	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphate (mg/L)	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	Hardness (mg/L)	Calcium (µg/L)	Magnesium (µg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)	Ortho-Phosphorous (mg/L)	Ammonia Nitrogen (mg/L)
9/9/2014	17	ND	N/A	7.65	16.8	770	N/A	145	N/A	ND	ND	N/A	NO	NO	5.57	220	0.346	90.7	23.5	7.76	0.00177	0.00117	0.0388	ND	ND	0.0142	0.109	0.038
12/18/2015	ND	ND	N/A	7.63	9.3	81.6	N/A	122	N/A	ND	ND	N/A	NO	NO	10.62	172.7	1.42	65.5	16.9	5.65	ND	0.000211	0.0172	0.00104	ND	0.0159	0.036	ND
2/5/2015	15	ND	N/A	7.56	10	770	N/A	73	N/A	ND	NO	N/A	NO	NO	10.7	105	0.989	44.8	11.4	3.95	0.00291	0.00137	0.0211	0.00148	ND	0.0145	0.03	ND
4/15/2015	ND	ND	N/A	7.44	23.7	261	N/A	128	N/A	ND	NO	N/A	NO	NO	11.31	166.6	1.13	67.2	16.6	6.22	0.00138	ND	0.0248	0.00128	ND	0.0224	0.036	ND

SW 12 – 3131 SE Walta Vista Ct – Lower Boardman Creek – 48" CMP outfall

MS4 SAMPLE TYPE: Instream Sample, 4 times per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphate (mg/L)	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	Hardness (mg/L)	Calcium (µg/L)	Magnesium (µg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)	Ortho-Phosphorous (mg/L)	Ammonia Nitrogen (mg/L)
9/9/2014	ND	ND	N/A	7.77	16.9	228	N/A	182	N/A	ND	0.142	N/A	NO	NO	7.71	261	0.318	90.3	22.5	8.27	0.00114	0.000223	0.00762	ND	ND	0.00671	0.076	0.035
12/18/2014	ND	ND	N/A	7.12	9.6	90.9	N/A	156	N/A	ND	ND <0.100	N/A	NO	NO	9.39	196.8	0.901	78.1	20	6.85	ND	0.000333	0.032	0.00113	ND	0.0289	0.043	0.064
2/5/2015	15	ND	N/A	7.51	10.2	236	NA	93	N/A	ND	0.144	N/A	NO	NO	9.83	122	0.883	46.1	12	3.92	0.0108	0.00163	0.0574	0.00342	ND	0.0351	0.031	ND
4/15/2015	9	ND	N/A	7.21	23.8	114	N/A	126	N/A	ND	0.13	N/A	NO	NO	9.6	167.2	0.809	68.2	17	6.27	0.00177	ND	0.0277	0.0138	ND	0.0225	0.043	0.035

SW 3 – Courtney Springs Creek on east side of SE McLoughlin Blvd, 350' north of SE Park Ave – outfall of 5' x 5' concrete box culvert

MS4 SAMPLE TYPE: Instream Sample, 4 times per year

DATE	TSS (mg/L)	BOD (mg/L)	Fecal coliform (MPN)	pH	Temp (celsius)	E. Coli (col/100)	CL2 (mg/L)	TDS (MGL)	COD (mg/L)	O&G (mg/L)	Tot Phosphate (mg/L)	TKN (mg/L)	FLOATING SOLIDS	O&G SHEEN	Luminescent DO (mg/L)	Conductivity (µS/cm)	Nitrate (mg/L)	Hardness (mg/L)	Calcium (µg/L)	Magnesium (µg/L)	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)	Ortho-Phosphorous (mg/L)	Ammonia Nitrogen (mg/L)
9/9/2014	ND	ND	N/A	8.18	17.8	14.8	N/A	162	N/A	ND	ND	N/A	NO	NO	9.36	243	0.563	90.2	24.4	7.08	0.001	0.000278	0.00512	ND	ND	ND	0.048	0.025
12/18/2014	ND	ND	N/A	8.15	11.5	57.3	N/A	159	N/A	ND	ND	N/A	NO	NO	10.48	190	2.08	74.8	20	6.03	ND	0.000322	0.011	0.0127	ND	0.0124	0.03	0.026
2/5/2015	ND	ND	N/A	8.3	10.8	240	N/A	90	N/A	ND	ND	N/A	NO	NO	10.8	117.7	1.25	46.6	12.4	3.78	0.00263	0.000933	0.0203	0.0017	0.000211	0.016	0.023	ND
4/15/2015	5	ND	N/A	7.44	24	133	NA	140	N/A	ND	ND	N/A	NO	NO	10.5	182.7	1.65	74	19.2	6.33	0.00217	0.00101	0.0153	0.00151	ND	0.0123	0.031	0.027

ND = non detect
NO = None Observed