City of West Linn

Interim Evaluation Report to Comply with MS4 NPDES Permit Requirements

May 1, 2006

Submitted By:
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SECTION 1 INTRODUCTION AND OVERVIEW

1.1 Permit Background

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

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

The permit period for the 1995 NPDES permit was five years during which time jurisdictions were responsible for implementation of their SWMPs. The permit required a renewal at the end of the five-year permit period. The renewal application was fairly simple and required jurisdictions to provide updated copies of their SWMPs and to describe the rationale for any changes to their programs. The City of West Linn's current SWMP is dated August 2000, coinciding with the permit renewal period.

During the permit renewal process, third-party environmental groups expressed significant concern that the permits should include numeric discharge limits at stormwater outfalls as opposed to a more general requirement to implement BMPs to the "maximum extent practicable". This concern was also linked to another Clean Water Act requirement related to the development of Total Maximum Daily Loads for creeks, rivers and streams that are currently in violation of water quality standards.

As a result of these third-party concerns, DEQ briefly convened an advisory group to help determine how to address water quality standards in the new permits. Concerns and issues related to the permits lasted over three years. In March 2004, the new NDPES permits were issued to the six larger Oregon jurisdictions, including Clackamas County and its co-permittees.

With respect to numerical water quality standards in the permit, DEQ attempted to balance the demands of the third-party groups with the needs of larger municipalities such as Clackamas County and the abilities of smaller co-permittees like the City of West Linn. For some jurisdictions including the City of West Linn that discharge to water bodies currently in violation of water quality standards, the 2004 permits have new requirements. Where TMDLs are established, jurisdictions must attempt to quantify the effectiveness of their SWMPs, set pollutant load reduction benchmarks for performance of SWMPs, check in on progress towards meeting those benchmarks, and apply an adaptive management process until benchmarks are achieved. Parts of the City of West Linn discharge to the Tualatin River, which has an established TMDL for bacteria, dissolved oxygen, and total phosphorus.

The new 2004 permits include some additional requirements that were not in the earlier permit including a requirement to conduct a SWMP evaluation, more specific monitoring requirements, additional annual reporting requirements, and preparation of a revised SWMP.

Third-party groups made a request for DEQ to reconsider the permit. DEQ agreed to reconsider the permit and as a result some additional changes were made. The changes include a request for more specific reporting of SWMP commitments, additional public involvement requirements, and a six-month extension for developing the revised SWMP. The City of West Linn must address these new permit requirements to comply with the current MS4 NDPES permit.

With respect to reporting requirements, the new permit requires the submission of an Interim Evaluation Report due May 1, 2006. The report is required to contain the following:

i) *An evaluation of, and proposed revisions to, the SWMP that address the requirements of Schedules D(2)(b) and B(1), including the rationale supporting the proposed revisions.*

See Section 2.0 that includes a summary of the program evaluation conducted on the City's previous SWMP and a revised SWMP.

ii) *A description of the current source identification components of the SWMP and the rationale regarding the adequacy of these components.*

See Section 6.0 that includes a section titled Source Identification Components of the SWMP.

iii) *For each of the listed non-storm water discharges [Schedule A(3)] expected to occur in a co-permittee's area, the co-permittee must identify the appropriate control measures and the rationale for the selection of these BMPs (or the rationale for why BMPs are deemed not necessary).*

See Section 7.0 that includes a section titled Evaluation of Non-Stormwater Discharges.

iv) *The required information regarding TMDL pollutants as described in Schedule D(2)(d)(v) and the corresponding proposed revisions to the SWMP, and/or the required information regarding 303(d) listed pollutants as described in Schedule D(2)(e) and the corresponding proposed revisions to the SWMP.*

See Sections 9.0 and 10.0 that includes a subsection titled 303(d) Evaluations and a second subsection titled Benchmark Development.

v) *An executive summary of the SWMP, not more than 15 pages in length, that describes the main elements of the SWMP.*

See Section 3.0 that includes an Executive Summary of the new and revised SWMP.

vi) *Maps providing updated information as described in 40 CFR Section 122.26(d)(1)(iii)(B), where applicable.*

See Section 11.0 that includes the relevant maps.

The purpose of this binder is to provide all of the documentation necessary to meet the Interim Evaluation Report requirements shown above. The section where each requirement is addressed is listed below each requirement. Also refer to the table of contents.

1.2 Description of the Permit Area

This section provides a description of the City's portion of the permit area, watershed boundaries within the permit area, and a summary of other co-permittees.

City of West Linn Permit Area

The City of West Linn covers approximately 7.0 square miles and is located within Clackamas County. The City is bounded to the north by the City of Lake Oswego, on the east by the Willamette River, and on the west by unincorporated Clackamas County. The City of West Linn is primarily a residential community with some commercial land use along the Highway 43 corridor.

The City is drained by a number of perennial streams that ultimately discharge into the Willamette or Tualatin Rivers. The city area has been divided into 15 major subbasins, each draining between 50 and 700 acres. Of the 5,059 acres of area included in the 15 major subbasins and drained through the City's storm sewer system, approximately 80%, or 3500 acres, drains to the Willamette River via Tanner Creek and other tributaries. The remaining 20% or 900 acres drains to the Tualatin via other small tributaries (Fritchie Creek, Stevens Creek). The Tualatin River currently has a TMDL in place for phosphorus, dissolved oxygen and bacteria, thus requiring establishment of benchmarks in this IER for the portion of the City draining to the Tualatin. The Willamette River is currently on the 303(d) list for a variety of parameters including mercury, bacteria, and various organics (DDE/DDT, dieldrin, aldrin, PCB), which require a 303(d) evaluation in this IER. Benchmarks will be required for the Willamette River for the next term of the permit.

Description of the Clackamas County Permit Area

The Clackamas County permit covers approximately 74 square miles. The City of West Linn is a co-permittee on the Clackamas County permit, along with a number of other smaller jurisdictions including the cities of Lake Oswego, Oregon City, Milwaukie, Gladstone, Wilsonville, Happy Valley, Johnson City, Rivergrove, and the Oak Lodge Sanitary District. Each co-permittee is a relatively small community, most having populations between 15,000 and 25,000 with some (Johnson City, River Grove) having populations significantly smaller.

1.3 Coordination with Clackamas County and Co-permittees

Summary of the City of West Linn's Stormwater Management Program

The City of West Linn's Public Works Department maintains responsibility for the development and implementation of the City's SWMP. There are, however, required components of the program where implementation and tracking occurs in other City Divisions, Departments, and groups. The Environmental Services Division of the Public Works Department is responsible for maintenance, inspections, and technical assistance related to the stormwater system and preservation of stormwater quality in the City. In addition the city's Planning and Engineering Department reviews development submittals to ensure stormwater provisions are addressed, as outlined in the City of West Linn's Development and Municipal Code and the City's Public Works and Design Standards.

Summary of City Coordination with Co-Permittees

As mentioned in Section 1.2, there are a number of co-permittees included on the Clackamas County MS4 NPDES permit. Most of these co-permittees are smaller cities with limited resources and funding. Per the permit itself, the co-permittees are responsible for meeting the same permit requirements as the Phase 1 jurisdictions, including significant monitoring efforts. However, with the limited resources, it is unlikely that even the most ambitious co-permittee will be able to match efforts of the larger Phase 1 jurisdictions. Therefore Clackamas County co-permittees have coordinated efforts (intergovernmental agreements, comprehensive programs) when possible to meet the new permit objectives. Clackamas County and its co-permittees have established regional objectives in order to coordinate and ensure consistency with regards to development standards, erosion control standards, design criteria for pollution control facilities, and monitoring efforts. The City of West Linn plans to continue this coordinated effort throughout the new permit period, particularly with respect to monitoring and data analysis activities (see Section 5.0 and Attachment A).

SECTION 2 SUMMARY OF PROPOSED CHANGES TO THE STORMWATER MANAGEMENT PLAN

The Department of Environmental Quality (DEQ) has written into the Clackamas and co-permittee's MS4 NPDES permit (#101348) a specific requirement for each municipality to verify that their Stormwater Management Plan (SWMP) from the Phase I permit is in conformance with the federal regulations (specifically CFR 40.122.26).

The City of West Linn must submit this comprehensive program analysis for their 2006 interim evaluation report per Schedule D(2)(b):

> *"…Each co-permittee must review Schedule D(2)(c) and, for each component, determine whether implementation of the components in the SWMP as submitted is sufficient to reduce the discharge of pollutants to the maximum extent practicable. Each co-permittee must submit to the Department details on how each of the components are, or will be, addressed and the rationale for the continued existing or revised level of implementation. (If certain components are not included in the plan, then the rationale for exclusion must also be submitted.) The level of implementation for each component must, when practicable, have measurable performance indicators to assist with the reporting on the status of implementation as part of the annual reports."*

As a result of the permit requirement provided above, West Linn reviewed their Stormwater Management Plan (SWMP) to evaluate how the plan is addressing relevant Federal and State regulations and programs including: CFR 40.122.26, new MS4 NPDES permit requirements, Total Maximum Daily Loads (TMDLs) and 303(d) Listed Impaired Water Bodies. The purpose of this section is to indicate how the City's SWMP was revised to better address the regulatory and program requirements.

From the program evaluation, the MS4 NPDES requirements are adequately being addressed by the activities that the City is currently conducting. Potential issues that were identified when conducting the program evaluation were minimal and largely related to clarification or verification of activities that are taking place and better documentation of commitments. Examples include the following:

- Verify and specify the responsible parties associated with specific tasks outlined under the BMPs. Responsibilities may have changed from the time the initial SWMP was issued.
- Verify the type, frequency, and coverage area of the operations and maintenance activities (catch basin cleaning, street sweeping, structural control inspections, etc).
- Describe the landscape and pest management activities conducted by the City, aside from public education activities, that are preventing pollutant discharges.
- When inspections are required (industrial requirements, illicit discharge requirements, erosion control), better document the procedures that are in place.

There are two types of BMPs in West Linn's program: BMPs for policy related activities (e.g., development of a stormwater master plan) and BMPs that are for on-going implementation activities. To better address both the planning and implementation aspects of the stormwater management program, the format of the existing Stormwater Management Plan was also adjusted to specifically state the distinct activities (BMPs) occurring under each regulatory requirement instead of focusing on each regulatory requirement and the variety of activities occurring that could potentially address that requirement. In addition, the “record-keeping” sub-sections for each BMP were redefined as “performance measures” in order to meet permit requirements and to track the tasks associated with each of the BMPs. Therefore, the reader will understand how each BMP is being implemented when reviewing the SWMP and annual reports. As a result of this overall program evaluation, minor adjustments were made to the BMPs. See Table 2-1 for a more detailed summary and rationale for those changes.

TABLE 2-1: SUMMARY AND RATIONALE OF SWMP CHANGES

	Modification Made to the BMP for the 2006 SWMP	Rationale for BMP Modification	New BMP Name in the 2006 SWMP
West Linn Structural and Source Control BMPs			
Stormwater Management Plan Table 4-1	1. Reformat existing BMPs, identify performance measures. 2. Verify specific maintenance frequencies for the stormwater conveyance system. 3. Update identification of public structural controls. 4. Update references to the implementation of municipal codes as related to stormwater treatment and design for new and redevelopment. 5. Combine reference to master planning and capital improvement projects into one BMP. 6. Revise BMP Section 4.1.6 to outline activities the City is currently conducting for pest management.	1. Minimized overlap between reported activities; allowed specific Stormwater Management activities to more closely align with regulatory requirements; and address new permit requirements regarding performance measures. 2. The NPDES permit requires specific maintenance frequencies to be established. Although established, the existing frequencies were not reflective of current activities. In addition, the City needed to establish a more specific procedure for ditch maintenance. 3. Additional structural controls, specifically those publicly maintained, needed to be identified to update the inventory. 4. The City has recently adopted the City of Portland's Stormwater Design Manual and updated the water quality portion of their development code to indicate a revised size of new development required to implement water quality. 5. Generally, CIP identification is the result of a master planning effort. Therefore, these activities were combined into one BMP, and the prioritization of CIPs once the Master Plan has been completed is discussed. 6. The existing BMP primarily discussed the public education measures being performed as part of West Linn's pest management program. In addition, the existing BMP referenced Clackamas County's Integrated Vegetation Management program as being adopted. The BMP was modified to reflect components of Clackamas County's program that is actually being implemented by the City.	• Conduct Stormwater Conveyance System Cleaning and Maintenance. • Conduct Catch basin Cleaning and Maintenance. • Conduct Structural Control Facility Cleaning and Maintenance. • Continue to Implement Municipal Development and Community Development Codes. • Conduct Master Planning for Stormwater Quality Improvement. • Conduct Street Area Repair. • Conduct Street Sweeping. • Continue to Implement a Pest Management Program.
West Linn Illicit Discharges Control BMPs			
Stormwater Management Plan Table 4-2	1. Reformat existing BMPs and identify performance measures.	1. Minimized overlap between reported activities; allowed specific Stormwater Management activities to more closely align with regulatory requirements; and address new permit requirements regarding performance measures.	• Continue to Implement the Illicit Discharges Elimination Program. • Continue to Implement the Spill Response Program. • Control Infiltration and Cross Connections to the Stormwater Conveyance System.

	Modification Made to the BMP for the 2006 SWMP	Rationale for BMP Modification	New BMP Name in the 2006 SWMP
West Linn Industrial Control BMPs			
Stormwater Management Plan Table 4-3	1. Reformat existing BMPs and identify performance measures. 2. Revise the industrial section of the SWMP to reflect the limited amount of industry within the City.	1. Minimized overlap between reported activities; allowed specific Stormwater Management activities to more closely align with regulatory requirements; and address new permit requirements regarding performance measures. 2. The City of West Linn only has one industrial facility and it operates under a 1200-Z industrial stormwater permit. This BMP was revised to reflect activities related to tracking of this one permitted facility, specifically obtaining and reviewing monitoring data submitted to DEQ.	• Review 1200-Z Permit Monitoring Data Submitted to DEQ
West Linn Construction Site BMPs			
Stormwater Management Plan Table 4-4	1. Reformat existing BMPs and identify performance measures. 2. Specify typical recommended structural and non-structural BMPs for use during construction.	1. Minimized overlap between reported activities; allowed specific Stormwater Management activities to more closely align with regulatory requirements; and address new permit requirements regarding performance measures. 2. The City of West Linn recommends the use of the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual* (revised Dec. 2000) in preparing the erosion control plans. This guidance document includes recommended non-structural and structural BMPs, which are now referenced in the SWMP.	• Continue to Implement the Erosion Control Manual. • Conduct Erosion Control Inspections.

	Modification Made to the BMP for the 2006 SWMP	Rationale for BMP Modification	New BMP Name in the 2006 SWMP
West Linn Public Education BMPs			
Stormwater Management Plan **Table 4-5**	1. Reformat existing BMPs, removing reference to public education and outreach activities from existing BMPs and outlining them under a separate BMP category. 2. Reformat existing BMPs, removing reference to training activities from existing BMPs, and outlining them under a separate category. 3. Identify performance measures. 4. Add a separate BMP regarding the City's Animal Waste Control Program. 5. Add a separate BMP to promote staff education related to environmentally friendly solutions.	1. Minimized overlap between reported educational and outreach activities by outlining them in a separate section and referencing which permit requirements a specific educational or training activity addressed. 2. For consistency with other education related BMPs, all training activities (related to spill response, pest management, and construction operations) were outlined in a separate section). 3. Addressed permit requirements regarding performance measures. 4. Called out a separate BMP regarding the City's Animal Waste Control Program to add a more recent activity that the City is conducting to address issues associated with domestic animal waste. 5. Called out a separate BMP regarding staff attendance at professional meetings, seminars and conferences that relate to stormwater management as this is essential to stay up to date with state-of-the-art practices and it is essential to the adaptive management process and success of the program.	• Provide Public Education and Outreach Materials Regarding Stormwater Management. • Ensure Staff Training for Pest Management. • Ensure Staff Training for Spill Response. • Continue to Implement a Pet Waste Program. • Provide Educational Information to Construction Site Operators. • Promote Staff Education Related to Environmentally Friendly Solutions. • Participate in Intergovernmental Coordination.

SECTION 3 EXECUTIVE SUMMARY OF THE STORMWATER MANAGEMENT PLAN (SWMP)

The City of West Linn covers approximately 7.0 square miles and is located within Clackamas County. The City is bounded to the north by the City of Lake Oswego, on the east by the Willamette River, and on the west by unincorporated Clackamas County. The City of West Linn is primarily a residential community with some commercial land use along the Highway 43 corridor.

The City is drained by a number of perennial streams that ultimately discharge into the Willamette or Tualatin Rivers. The city area has been divided into 15 major subbasins, each draining between 50 and 700 acres. Of the 5,059 acres of area included in the 15 major subbasins and drained through the City's storm sewer system, approximately 80%, or 3500 acres, drains to the Willamette River via Tanner Creek and other tributaries. The remaining 20% or 900 acres drains to the Tualatin via other small tributaries (Fritchie Creek, Stevens Creek). The Tualatin River currently has a TMDL in place for phosphorus, dissolved oxygen and bacteria, thus requiring establishment of benchmarks in this IER for the portion of the City draining to the Tualatin. The Willamette River is currently on the 303(d) list for a variety of parameters including mercury, bacteria, and various organics (DDE/DDT, dieldrin, aldrin, PCB), which require a 303(d) evaluation in this IER. Benchmarks will be required for the Willamette River for the next term of the permit.

Clackamas County covers approximately 74 square miles. The City of West Linn is a co-permittee on the Clackamas County permit, along with a number of other smaller jurisdictions including the cities of Lake Oswego, Oregon City, Milwaukie, Gladstone, Wilsonville, Happy Valley, Johnson City, Rivergrove, and the Oak Lodge Sanitary District. Each co-permittee is a relatively small community, most having populations between 15,000 and 25,000 with some (Johnson City, River Grove) having populations significantly smaller. Per the permit itself, the co-permittees are responsible for meeting the same permit requirements as the Phase 1 jurisdictions, including significant monitoring efforts. However, with the limited resources, it is unlikely that even the most ambitious co-permittee will be able to match efforts of the larger Phase 1 jurisdictions. Therefore Clackamas County co-permittees have coordinated efforts (intergovernmental agreements, comprehensive programs) when possible to meet the new permit objectives. Clackamas County and its co-permittees have established regional objectives in order to coordinate and ensure consistency with regards to development standards, erosion control standards, design criteria for pollution control facilities, and monitoring efforts. The City of West Linn plans to continue this coordinated effort throughout the new permit period, particularly with respect to monitoring and data analysis activities.

The City's stormwater management plan (SWMP) is made up of 21 BMPs grouped into five components as shown below. The City of West Linn's Public Works Department maintains responsibility for the development and implementation of the City's SWMP. There are, however, required components of the program where implementation and tracking occurs in other City Divisions, Departments, and groups. The Environmental Services Division of the Public Works Department is responsible for maintenance, inspections, and technical assistance related to the stormwater system and preservation of stormwater quality in the City. In addition the city's Planning and Engineering Department reviews development submittals to ensure stormwater provisions are addressed, as outlined in the City of West Linn's Development and Municipal Code and the City's Public Works and Design Standards.

Component #1 **Structural and Source Control BMPs to Reduce Pollutants from Commercial and Residential Areas**

- Conduct Stormwater Conveyance System Cleaning and Maintenance.
- Conduct Catch basin Cleaning and Maintenance.
- Conduct Structural Control Facility Cleaning and Maintenance.
- Continue to Implement Municipal Development and Community Development Codes.
- Conduct Master Planning for Stormwater Quality Improvement.
- Conduct Street Area Repair.
- Conduct Street Sweeping.
- Continue to Implement a Pest Management Program.

Component #2 **A Program to Detect and Remove Illicit Discharges and Improper Disposal** **Into the Storm Sewer System**

- Continue to Implement the Illicit Discharges Elimination Program.
- Continue to Implement the Spill Response Program.
- Control Infiltration and Cross Connections to the Stormwater Conveyance System.

Component #3 **A Program to Monitor and Control Pollutants Industrial Facilities**

- Review 1200-Z Permit Monitoring Data Submitted to DEQ.

Component #4 **A Program to Reduce Pollutants in Stormwater Discharges from Construction Sites**

- Continue to Implement the Erosion Control Manual.
- Conduct Erosion Control Inspections.

Component #5

- Provide Public Education and Outreach Materials Regarding Stormwater Management.
- Ensure Staff Training for Pest Management.
- Ensure Staff Training for Spill Response.
- Continue to Implement a Pet Waste Program.
- Provide Educational Information to Construction Site Operators.
- Promote Staff Education Related to Environmentally Friendly Solutions.
- Participate in Intergovernmental Coordination.

SECTION 4 CITY OF WEST LINN'S STORMWATER MANAGEMENT PLAN (2006)

4.1 SWMP Overview

As described in Section 2, one of the MS4 NPDES permit requirements is to conduct an evaluation of the previous SWMP, propose revisions to the plan, and provide the rationale for the revisions. This section contains the revised SWMP, incorporating the revisions as described in Table 2-1. Revisions to the SWMP are based on the results of the SWMP evaluation to make sure regulatory requirements are met. Specifically, existing BMPs were reviewed by those responsible for implementing the BMP, in order to propose changes to the BMP and enhance its effectiveness; BMP revisions were reviewed internally to ensure that commitments and activities are accurate and achievable; and a public review process was initiated to get feedback regarding priorities.

4.2 City of West Linn SWMP (2006)

The stormwater management plan is organized into the five major components listed below. The first four components match the four major components of the stormwater management plan that are outlined in the MS4 NPDES permit requirements (i.e., Schedule D(2)(c) i through iv). To simplify the SWMP, BMPs to address all of the public education requirements under the first four components of the plan have been grouped into a fifth component.

Component #1:	Structural and Source Control BMPs to Reduce Pollutants from Commercial and Residential Areas
Component #2:	A Program to Detect and Remove Illicit Discharges and Improper Disposal Into the Storm Sewer System
Component #3:	A Program to Monitor and Control Pollutants from Industrial Facilities
Component #4:	A Program to Reduce Pollutants in Stormwater Discharges from Construction Sites
Component #5:	Public Education, Coordination, and Public Involvement BMPs

Component #1
Structural and Source Control BMPs to Reduce Pollutants from Commercial and Residential Areas

NPDES permit requirements are listed below, followed by West Linn's relevant BMPs that address the permit requirement.

(1) Maintenance activities and a maintenance schedule for structural controls to reduce pollutants (including floatables) in discharges from municipal separate storm sewers.

BMP(s):

- Conduct Stormwater Conveyance System Cleaning and Maintenance.
- Conduct Catch basin Cleaning and Maintenance.
- Conduct Structural Control Facility Cleaning and Maintenance.

(2) Planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers that receive discharges from areas of new development and significant redevelopment. Such a plan must address controls to reduce pollutants in discharges from municipal separate storm sewers after construction is completed. Controls to reduce pollutants in discharges from municipal separate storm sewers containing construction site runoff are addressed in paragraph Schedule D(2)(c)(iv).

BMP(s):

- Conduct Master Planning for Stormwater Quality Improvement.
- Continue to Implement Municipal Development and Community Development Codes.

(3) Practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems, including pollutants discharged as a result of deicing activities.

BMP(s):

- Conduct Street Area Repair.
- Conduct Street Sweeping.

(4) Procedures to assure that flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from storm water is feasible.

BMP(s):

See "Conduct Master Planning for Stormwater Quality Improvement" under requirement 2, component 1.

(5) A program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste. The description must identify priorities and procedures for inspections and establishing and implementing control measures for such discharges (this program can be coordinated with the program developed under Schedule D(2)(c)(iii)).

BMP(s):

- Not Applicable-The City does not own or operate any municipal landfills or other treatment storage or disposal facilities for municipal waste.

(6) A program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer that will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.

BMP(s):

- Continue to Implement a Pest Management Program.

(Note: See component #5 and Table 4-5 for other educational BMPs associated with this requirement).

See Table 4-1 for the City of West Linn's BMPs that address the requirements that are listed above.

TABLE 4-1 - Structural and Source Control BMPs to Reduce Pollutants from Commercial and Residential Areas

City of West Linn BMP Description	BMP Implementation	Performance Measures
NPDES Permit Requirement – *(1) Maintenance activities and a maintenance schedule for structural controls to reduce pollutants (including floatables) in discharges from municipal separate storm sewers.*		
Conduct Stormwater Conveyance System Cleaning and Maintenance	**BMP Owner:** City of West Linn Public Works Department, Environmental Services Division **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn annually inspects their entire stormwater conveyance system including: manholes, sewer pipes, culverts, and ditches. Problem areas identified upon initial inspection will be inspected after all major storm events and cleaned as needed. System components requiring repair or replacement will be maintained promptly.	(1) Track the length of conveyance system inspected. (2) Track the volume of debris removed during cleaning activities. (3) Track the number of "problem areas" and record results of those facilities inspections.
Conduct Catch basin Cleaning and Maintenance	**BMP Owner:** City of West Linn Public Works Department, Environmental Services Division **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn inspects and cleans catch basins at least once per year. Cleaning activities primarily occur during the dry weather season. A database tracking system is updated during each maintenance cycle to allow the City to better track catch basins requiring more frequent maintenance. Catch basins requiring repair or replacement will be maintained promptly.	(1) Track the number of catch basins inspected. (2) Track the volume of debris removed during cleaning activities.

City of West Linn BMP Description	BMP Implementation	Performance Measures
Conduct Structural Control Facility Cleaning and Maintenance	**BMP Owner:** City of West Linn Public Works Department, Environmental Services Division **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn owns and operates approximately 204 structural water quality facilities, although this number continually increases with implementation of capital improvement projects and new development standards. Such structural facilities currently include ponds, swales, detention tanks, and pollution control manholes. Structural control facilities are inspected annually and cleaned and maintained when inspections show it is needed.	(1) Track the number and frequency of structural facilities inspected and maintained. (2) Track the volume of debris removed during cleaning activities.
NPDES Permit Requirement – *(2) Planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers that receive discharges from areas of new development and significant redevelopment. Such a plan must address controls to reduce pollutants in discharges from municipal separate storm sewers after construction is completed. Controls to reduce pollutants in discharges from municipal separate storm sewers containing construction site runoff are addressed in paragraph Schedule D(2)(c)(iv).*		
Conduct Master Planning for Stormwater Quality Improvement	**BMP Owner:** City of West Linn Development Services **Permit Year:** Ongoing Implementation Activities: The City of West Linn will continue to conduct Master Planning efforts to update the current City drainage system and prioritize future capital improvement projects for flood control and water quality benefits. Prioritization is generally based on overall planning goals, cost, public safety, and environmental impact. As funding is available, the City implements the projects and continues to update the CIP inventory. The City will implement capital improvement projects (CIPs) as funding is available. The latest City of West Linn Stormwater Master Plan (2005) is currently in draft form.	(1) Track any updates or modifications to the current Stormwater Master Plan approved by the City. (2) Track the number of CIP projects implemented each year and discuss the added benefit (flood control, water quality, habitat restoration, etc) of each. (3) Map the location and drainage area of CIPs.

City of West Linn BMP Description	BMP Implementation	Performance Measures
Continue to Implement Municipal Development and Community Development Codes	**BMP Owner:** City of West Linn Development Services **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn continues to review new development submittals for conformance with the Municipal Code and Community Development Code, with regards to stormwater control. The Municipal and Community Development Codes serve to protect surface waters in the City by outlining overlay zones, stormwater control objectives, and erosion control measures. Overlay zones are generally buffer areas that exist to protect, conserve, and enhance streams, wetlands, riparian areas, and other surface waters. The plan review process identifies impacted overlay zones and addresses appropriate mitigation efforts or poses restrictions for these areas. Stormwater control requires new development to provide stormwater quality facilities to control phosphorus loading and reduce high velocity flows. Per the City's Development Code, stormwater quality needs to be addressed for new development that includes more than 500ft^2 of impervious surface. The City adopted the City of Portland's Stormwater Management Manual to provide guidance to developers.	(1) Track the number of development applications reviewed for compliance with the stormwater regulations. (2) Track any modifications to the list of currently approved structural control facilities. (3) Track private BMP implementation and their associated drainage areas.
NPDES Permit Requirement – *(3) Practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems, including pollutants discharged as a result of deicing activities.*		
Conduct Street Area Repair	**BMP Owner:** City of West Linn Public Works Department, Street Department **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn conducts road maintenance and repair activities continuously to prevent erosion and future pollution from occurring. Repair work is generally scheduled during the dry season when possible, to minimize polluted discharges from entering the stormwater conveyance system.	Track repair activities.

City of West Linn BMP Description	BMP Implementation	Performance Measures
Conduct Street Sweeping	**BMP Owner:** City of West Linn Public Works Department, Street Department **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn continues to conduct contracted street sweeping activities throughout the City. Each street in the City is swept approximately once every 60 days, and there are two additional target sweeps on select areas, one in the spring and one in the fall, for a total of eight sweeps per year. Regenerative air sweeping techniques are employed to minimize wash water from entering the stormwater conveyance system.	(1) Track the number of sweeps per year. (2) Track the number of miles swept per year. (3) Track the volume of debris removed.
NPDES Permit Requirement - *(4) Procedures to assure that flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from storm water is feasible.*		
See BMP "Conduct Master Planning for Stormwater Quality Improvement" under permit requirement (2) above for applicable BMP meeting this requirement.		
NPDES Permit Requirement - *(5) A program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste. The description must identify priorities and procedures for inspections and establishing and implementing control measures for such discharges (this program can be coordinated with the program developed under ScheduleD(2)(c)(iii)).*		
The City does not own or operate any municipal landfills or other treatment storage or disposal facilities for municipal waste.	**NA**	**NA**
NPDES Permit Requirement - *(6) A program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer that will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.*		

City of West Linn BMP Description	BMP Implementation	Performance Measures
Continue to Implement a Pest Management Program	**BMP Owner:** City of West Linn Public Works Department, Parks Department **Permit Year:** Ongoing **Implementation Activities:** As an informal guide, the City of West Linn refers to the *Clackamas County Integrated Vegetation Management program*, which defines appropriate application procedures and protocols along roadways, within City parks, and around water quality facilities for staff to adhere to during maintenance activities. Per the program, the following activities are typical: • Application of chemicals is eliminated where possible, • Regular removal of invasive plant species is conducted, • Native plants are used for revegetation projects, • Only spot spraying is conducted for blackberry removal. In addition, any work that is conducted within public right-of-ways requires certified, licensed applicators. Specific education measures and staff training is be discussed under Category 5: Public Education BMPs	(1) Track any updates or modifications to typical procedures and activities. (2) Track the volumes of herbicides and fertilizers applied by the City.

Component #2
A Program to Detect and Remove Illicit Discharges and Improper Disposal Into the Storm Sewer System

This component of the permit requires the following:

(1) A program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the municipal separate storm sewer system; this program description must address all types of illicit discharges, however the following category of non-storm water discharges or flows must be addressed where such discharges are identified by the municipality as sources of pollutants to waters of the United States: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration, uncontaminated pumped ground water, discharges from potable water sources, start up flushing of groundwater wells, aquifer storage and recovery (ASR) wells, potable groundwater monitoring wells, draining and flushing of municipal potable water storage reservoirs, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash waters, discharges of treated water from investigation, removal and remedial actions selected or approved by the Department pursuant to Oregon Revised Statute (ORS) Chapter 465, the state's environmental cleanup law; and discharges or flows from emergency fire fighting activities where discharges or flows from fire fighting are identified as not significant sources of pollutants to the waters of the state.

(2) Procedures to conduct on-going field screening activities during the life of the permit, including areas or locations that will be evaluated by such field screens;

(3) Procedures to be followed to investigate portions of the separate storm sewer system that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-storm water [such procedures may include: sampling procedures for constituents such as e. coli, surfactants (MBAS), residual chlorine, fluorides and potassium; testing with fluorometric dyes; or conducting in storm sewer inspections where safety and other considerations allow.] Such a description must include the location of storm sewers that have been identified for such evaluation.

Requirements 1, 2, and 3 are combined in Table 4-2.

BMP(s):

- Continue to Implement the illicit Discharge Elimination Program

(4) Procedures to prevent, contain, and respond to spills that may discharge into the municipal separate storm sewer.

BMP(s):

- Continue to Implement the Spill Response Program.

(5) A program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers.

BMP(s):

- Public Reporting occurs in conjunction with public education activities as described under Component #5, Table 4-5.

(6) Educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.

BMP(s):

- Public Education measures regarding proper material disposal occur in conjunction with public education activities as described under Component #5, Table 4-5.

(7) Controls to limit infiltration of seepage from municipal sanitary sewers to municipal separate storm sewer systems where necessary.

BMP(s):

- Control Infiltration and Cross Connections to the Stormwater Conveyance System.

See Table 4-2 for the City of West Linn's BMPs that address the requirements that are listed above.

TABLE 4-2 - BMPs to Detect and Remove Illicit Discharges and Improper Disposal Into the Storm Sewer System

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement - *(1) A program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the municipal separate storm sewer system; this program description must address all types of illicit discharges, however the following category of non-storm water discharges or flows must be addressed where such discharges are identified by the municipality as sources of pollutants to waters of the United States: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration, uncontaminated pumped ground water, discharges from potable water sources, start up flushing of groundwater wells, aquifer storage and recovery (ASR) wells, potable groundwater monitoring wells, draining and flushing of municipal potable water storage reservoirs, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash waters, discharges of treated water from investigation, removal and remedial actions selected or approved by the Department pursuant to Oregon Revised Statute (ORS) Chapter 465, the state's environmental cleanup law; and discharges or flows from emergency fire fighting activities where discharges or flows from fire fighting are identified as not significant sources of pollutants to the waters of the state.* **NPDES Permit Requirement** - *(2) Procedures to conduct on-going field screening activities during the life of the permit, including areas or locations that will be evaluated by such field screens;* **NPDES Permit Requirement** - *(3) Procedures to be followed to investigate portions of the separate storm sewer system that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-storm water [such procedures may include: sampling procedures for constituents such as e. coli, surfactants (MBAS), residual chlorine, fluorides and potassium; testing with fluorometric dyes; or conducting in storm sewer inspections where safety and other considerations allow.] Such a description must include the location of storm sewers that have been identified for such evaluation.*		

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
Continue to Implement the Illicit Discharges Elimination Program	**BMP Owner:** City of West Linn Department of Environmental Services **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn conducts illicit discharge inspections, monitoring, and investigations annually during dry-weather conditions (between July and September) at all major outfalls. The City prioritizes minor outfalls based on a watershed's surface water quality and inspects and investigates the higher priority minor outfalls as well. Trained personnel complete data inspection forms consistent with those shown in Part 1 of the City's original NPDES Permit Application while inspecting each of the outfalls and utilize a tracking database system to monitor the inspection results. Dry weather flows are inspected for a variety of visual characteristics, and sources of flows are characterized as either permissible (listed in Schedule A3 of the MS4 NPDES permit) or non-permissible. If non-permissable discharges are discovered, sampling, analysis, and investigation are conducted according to the following procedure: 1. A water sample is taken and analyzed for the suspected contaminant group. 2. Using a drainage map and other source identification data, an attempt is made to locate the potential sources upstream of the discharge location. 3. Investigate potential sources using one or more of the following techniques: onsite inspections, dye-testing, smoke testing, and/or TV inspection of lines. The Public Works director will be notified of all positive identifications of illicit connections and will take all necessary steps to eliminate them immediately (i.e., within one week).	(1) Track the number and location of outfalls inspected annually. (2) Summarize inspection results and indicate outfalls requiring monitoring (sampling) and/or investigations. (3) Indicate the outcome and resolution of any investigation activities conducted.

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement - *(4) Procedures to prevent, contain, and respond to spills that may discharge into the municipal separate storm sewer.*		
Continue to Implement the Spill Response Program	**BMP Owner:** City of West Linn through a contract with Tualatin Valley Fire and Rescue **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn Environmental Services initially responds to all calls reporting a spill within the City limits and then calls Tualatin Valley Fire and Rescue. If the spill is minor, Environmental Services will take care of it; if it is not minor, Tualatin Valley Fire and Rescue will take care of it. Procedures for spill response are outlined in the Fire Departments "Emergency Operations Plan" and coordination efforts by the Fire Department are as follows: 1. Contact the State Hazardous Materials Response Team (Tualatin Valley Fire and Rescue) 2. Contact the State and National Emergency Response System if the condition requires. 3. Contact the police department for traffic controls. 4. Contact the Public Works Department for storm system information and containment. Public Works staff will install catch basin covers and absorbent pads.	(1) Indicate the number of spills reported to the Fire Department. (2) Indicate sources, causes, and resulting water quality problems resulting from spill activities.
NPDES Permit Requirement - *(5) A program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers.*		
A Description of the City's Public Reporting Program is included in Component #5, Table 4-5.		
NPDES Permit Requirement - *(6) Educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.*		
A Description of the City's Public Informational Activities regarding management of hazardous materials is included in Component #5, Table 4-5.		
NPDES Permit Requirement - *(7) Controls to limit infiltration of seepage from municipal sanitary sewers to municipal separate storm sewer systems where necessary*		

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
Control Infiltration and Cross Connections to the Stormwater Conveyance System	**BMP Owner:** City of West Linn Environmental Services, Development Services, and Department of Engineering **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn implements an inflow and infiltration (I&I) abatement program for the sanitary sewer system. Sanitary lines are tested via smoke-testing, T.V. techniques, and flow metering for any cracking or breakage that would possibly result in infiltration from the sanitary to the storm system. The City's Development Services Department reviews new and re-development plans for possible cross-connections. The City's illicit discharge program also works to control and prevent any cross-connections during their outfall inspections and dry-weather field screening activities.	Indicate whether any cross-connections were discovered during the plan review process or during illicit discharge investigations, and describe follow-up activities.

Component #3
A Program to Monitor and Control Pollutants Industrial Facilities

This component of the permit requires an industrial monitoring program that does the following:

(1) Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges.

Not Applicable – there is only one industry located within West Linn's jurisdiction.

(2) Describe a monitoring program for storm water discharges associated with the industrial facilities identified in Schedule D(2)(c)(iii), to be implemented during the term of the permit, including, at a minimum, the submission of quantitative data on the pollutant parameters included in the Department's NPDES 1200-Z industrial general stormwater permit.

BMP(s):

- Review 1200-Z Permit Monitoring Data Submitted to DEQ

See Table 4-3 for the City of West Linn's BMPs that address the requirements that are listed above.

TABLE 4-3 - A Program to Monitor and Control Pollutants from Industrial Facilities

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement - *(1) Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges.* **NPDES Permit Requirement** - *(2) Describe a monitoring program for storm water discharges associated with the industrial facilities identified in Schedule D(2)(c)(iii), to be implemented during the term of the permit, including, at a minimum, the submission of quantitative data on the pollutant parameters included in the Department's NPDES 1200-Z industrial general stormwater permit.*		
Review 1200-Z Permit Monitoring Data Submitted to DEQ	**BMP Owner:** City of West Linn Engineering Department **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn has only one industrial facility within its jurisdiction and this facility has obtained a 1200-Z permit for its stormwater discharges. The City of West Linn requests, from DEQ, the monitoring and benchmark data collected by this 1200-Z permit holder for review. The City quantitatively assesses this information annually.	(1) Track the number of permitted and non-permitted industrial facilities within the City. (2) Track the status of reviewing the monitoring data submitted to DEQ by the one 1200-Z permittee that is located in West Linn.

Component #4
A Program to Reduce Pollutants in Stormwater Discharges from Construction Sites

This component of the permit requires the following:

(1) Procedures for site planning which incorporate consideration of potential water quality impacts.
(2) Requirements for nonstructural and structural best management practices.

BMP(s):
- Continue to Implement the Erosion Control Manual.

(3) Procedures for identifying priorities for inspecting sites and enforcing control measures that considers the nature of the construction activity, topography, and the characteristics of soils and receiving water quality.

BMP(s):
- Conduct Erosion Control Inspections.

(4) Appropriate educational and training measures for construction site operators.

BMP(s):
- Public education and training measures for construction site operators occur in conjunction with public education activities as described under Component #5, Table 4-5.

See Table 4-4 for the City of West Linn's BMPs that address the requirements that are listed above.

TABLE 4-4 - A Program to Reduce Pollutants in Stormwater Discharges from Construction Sites

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement – *(1) Procedures for site planning which incorporate consideration of potential water quality impacts.* **NPDES Permit Requirement** – *(2) Requirements for nonstructural and structural best management practices.*		
Continue to Implement the Erosion Control Manual.	**BMP Owner:** City of West Linn Engineering Department and Development Services **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn development standards require submission of an erosion control plan, consistent with requirements provided in the Municipal and Community Development Codes. The City recommends the use of the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual* (revised Dec. 2000) in preparing the erosion control plans. This guidance document recommends non-structural techniques for erosion control including: 1. Construction Phasing 2. Prompt Revegetation 3. Flagging areas not to be disturbed Suggestions for structural erosion control BMPs are also included in the guidance document and include: sediment fences, gravel entrances, ground cover, waddles, berms, etc. During the plan review process, new and redevelopment will be assessed for compliance with the erosion control guidance documents. Plans not in compliance will not be approved and will be required to implement appropriate erosion control techniques prior to approval.	(1) Report any updates or modifications to the Erosion Control Technical Guidance Handbook. (2) Record the number of erosion control plan reviews completed.

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement - *(3) Procedures for identifying priorities for inspecting sites and enforcing control measures that considers the nature of the construction activity, topography, and the characteristics of soils and receiving water quality*		
Conduct Erosion Control Inspections	**BMP Owner:** City of West Linn Engineering Department **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn development standards require erosion control to be in place prior to issuance of a construction and/or building permit. Construction site inspections are not prioritized as all sites greater than 500 ft2 of disturbance are required to have a plan, they are inspected, and they are required to pass inspections. For sites with an erosion control violation, 24 amount of time is typically given to initially correct the problem. If not immediately resolved, other penalties such as fines, stop work orders, and suspension/ withdrawal of development approvals may be imposed. Engineering or building inspections will also not be conducted while an erosion control violation exists. Before the final engineering or building inspection, all disturbed area must be permanently stabilized or revegetated.	(1) Report the number of erosion control inspections conducted each year. (2) Report the number of erosion control violations discovered during inspections, and describe the measures used to resolve the issue.
NPDES Permit Requirement - *(4) Appropriate educational and training measures for construction site operators.*		
A Description of the City's Educational Program for Construction Site Operators is included in Component #5, Table 4-5		

Component #5
Public Education, Coordination, and Public Involvement

Three of the four major components of the SWMP requirements include public education-related requirements as follows while public involvement measures are described under a separate SWMP requirement:

Educational Requirement from Component #1 –
(6) A program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer that will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.

BMP(s):
- Provide Public Education and Outreach Materials Regarding Stormwater Management.
- Ensure Staff Training for Pest Management.

Educational Requirement from Component #2 –
(5) A program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers.

(6) Educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.

BMP(s):
- Ensure Staff Training for Spill Response.
- Continue to Implement a Pet Waste Program.

Also see BMP listed above "Provide Public Education and Outreach Materials Regarding Stormwater Management".

Educational Requirement from Component #4 –
(4) Appropriate educational and training measures for construction site operators.

BMP(s):
- Provide Educational Information to Construction Site Operators.

Although not specifically outlined as a requirement in the permit, education of staff and coordination with other jurisdictions and involvement in stormwater related professional groups is necessary for continuing to ensure sound stormwater management related decisions and adaptive management. Therefore, two additional BMPs have been added to ensure this continued coordination.

BMP(s):
- Promote Staff Education Related to Environmentally Friendly Solutions.
- Participate in Intergovernmental Coordination.

See Table 4-5 for the City of West Linn's BMPs that address the requirements that are listed above.

TABLE 4-5 – Public Education, Coordination, and Public Involvement

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement, Component 1 - *(6) A program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer that will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.*		
Provide Public Education and Outreach Materials regarding Stormwater Management.	**BMP Owner:** City of West Linn Department of Public Works **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn continues to employ a public education program aimed at reducing the discharge of pollutants associated with a variety of activities including but not limited to: 1. The application of pesticides, herbicides and fertilizers by citizens. 2. Illicit discharges and dumping of waste materials into the storm drainage system. 3. Disposal of waste oil and toxic materials. The City utilizes newsletter publications, brochures, bill inserts, the City web page, and radio advertisements to promote public awareness of water quality issues related to the above-mentioned practices. Newsletter articles typically include information on recycling locations, local disposal programs, and other coordinated efforts with METRO. Other educational topics: naturescaping and alternative pesticide/fertilizer use. To aid in public education related to proper disposal of waste materials, the City of West Linn also conducts City-wide catch basin stenciling. The Public Works staff inspects the local catch basins, determines the level of effort needed, and coordinates with area volunteers to complete the stenciling. Stenciling is currently conducted on an as needed basis.	(1) Track the number, types, and topics of public educational materials dispersed to the public. (2) Indicate any large-scale public educational campaigns. (3) Track coordinated public outreach activities with local co-permittees. (4) Record the number of catch basins stenciled in a given year.

<table>
<tr><th>City of West Linn BMP Descriptions</th><th>BMP Implementation</th><th>Performance Measures</th></tr>
<tr><td>Ensure Staff Training for Pest Management</td><td>BMP Owner: City of West Linn Department of Public Works
Permit Year: Ongoing
Implementation Activities: The City of West Linn informally follows the Clackamas County Integrated Vegetation Management program. In accordance with the program, crews from Public Works and the Parks Department are trained once every two years on proper application rates and techniques.</td><td>Track that training is accomplished every two years.</td></tr>
<tr><td colspan="3">NPDES Permit Requirement, Component 2 – (5) A program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers.
NPDES Permit Requirement, Component 2 – (6) Educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.</td></tr>
<tr><td>Ensure Staff Training in Spill Response</td><td>BMP Owner: City of West Linn through a contract with Tualatin Valley Fire and Rescue
Permit Year: Ongoing
Implementation Activities: The City of West Linn through a contract with Tualatin Valley Fire and Rescue provides Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) training to staff that initially respond to spills. Annual refresher courses are also provided to these staff members by an in-house crew chief.</td><td>Indicate the number of employees certified in OSHA HAZWOPER training. Indicate if any employees attended refresher courses in the given year.</td></tr>
<tr><td>Continue to Implement a Pet Waste Program</td><td>BMP Owner: City of West Linn Parks and Public Works
Permit Year: Ongoing
Implementation Activities: When stormwater facility inspections are conducted, staff looks for evidence of domestic animal waste. If problems are identified, signs are installed to educate citizens about the effects of animal waste on stormwater. Staff will also leave educational door hangers in the immediate area to make citizens aware of the problem. The Parks Department also installs signs to educate citizens about the effects of animal waste on stormwater at City Parks and they provide baggies and disposal areas for cleanup of domestic animal waste.</td><td>Report on activities conducted annually.</td></tr>
<tr><td colspan="3">Also refer to BMP “Provide Public Education and Outreach Materials regarding Stormwater Management” for educational activities addressing the above permit requirements.</td></tr>
</table>

City of West Linn BMP Descriptions	BMP Implementation	Performance Measures
NPDES Permit Requirement, Component 4 – *(4) Appropriate educational and training measures for construction site operators.*		
Provide Educational Information to Construction Site Operators	**BMP Owner:** City of West Linn Engineering Department **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn makes the *Clackamas County Erosion Prevention and Sediment Control Planning and Design Manual* available to engineers, contractors, and the general public. Educational brochures are attached to building and grading permits. As erosion control continues to be an ever-changing field, the City of West Linn also publicizes (via brochures, flyers, and pamphlets on the City hall bulletin board) a variety of educational opportunities pertaining to erosion prevention. Such opportunities include classes at the Urban Watershed Institute, classes at Portland Community College, and participation in regional erosion control awards.	Performance of the erosion control program is tracked via BMPs in Table 4-4.
Additional Coordination Efforts		
Promote Staff Education Related to Environmentally Friendly Solutions	**BMP Owner:** City of West Linn Environmental Program, Engineering Department **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn Environmental Program staff attend ACWA, APWA, NW Stream Restoration, regional erosion control awards committee, Tualatin Basin Policy Advisory Committee and other professional meetings, seminars and conferences, and maintain close connections with neighboring municipalities and professional organizations throughout the United States.	Track attendance at relevant conferences.
Participate in Intergovernmental Coordination	**BMP Owner:** City of West Linn Department of Public Works **Permit Year:** Ongoing **Implementation Activities:** The City of West Linn will continue to meet as necessary to coordinate with other Clackamas County co-permittees regarding regional water quality efforts. Areas for coordination include MS4 issues, education, public outreach and monitoring.	Indicate groups, committees, and organizations that the City is currently participating.

SECTION 5 CITY OF WEST LINN STORMWATER MONITORING PLAN

The monitoring requirements of the permit have been divided into two components: program monitoring and environmental monitoring. Program monitoring includes those activities as described in the Stormwater Management Plan that have specific indicator metrics (e.g., number of miles of streets swept, number of cross-connections found, tons of material removed from storm sewers, etc.). The program monitoring that will be conducted by the City of West Linn is provided in Tables 4-1 through 4-5 in the form of performance measures for each best management practice (BMP).

Environmental monitoring is another component of the overall monitoring program. Environmental monitoring includes sampling and testing of both instream waters and MS4 discharges. The City of West Linn is currently conducting the following monitoring activities as described in Table B-1 of the permit.

- MS4 Discharge Monitoring at a location Representative of a Tualatin Residential Drainage
  Frequency of Sampling - 2 times per year

- Ambient Instream Monitoring in Tanner Creek, an Un-named Creek near Johnson Road, and Trillium Creek
  Frequency of Sampling - 3 times per year

Conducting these activities fulfills the City's permit requirements for monitoring through Permit Year 2. Then, the permit requires that each co-permittee review and, if necessary, update its monitoring components to address the following objectives:

i) Determine the status of implementing the components of the SWMP;
ii) Evaluate the effectiveness of BMPs for specific source controls;
iii) Evaluate the source of specific pollutants;
iv) Assess the chemical, biological, and physical effects of MS4 runoff on receiving waters;
v) Characterize MS4 runoff discharges; and
vi) Evaluate long-term trends in receiving water quality associated with storm water discharges.

The updated monitoring component must also be designed to track the long-term progress of the SWMP towards achieving improvements in receiving water quality, including progress towards meeting pollutant load reduction benchmarks associated with TMDL parameters where applicable. The results of the monitoring component must be used to support the adaptive management process and lead to refinements of the SWMP.

The monitoring that is currently being conducted by West Linn will not, by itself, be sufficient to address each of the new permit monitoring objectives entirely. In addition, given the wide ranging variability of stormwater quality data, conducting monitoring that is sufficient to address any of these six objectives will require significant resources in order to obtain data that are statistically valid. This amount of monitoring would be beyond what is considered to be the maximum extent practicable for West Linn. DEQ itself acknowledged this issue and provided the following clause in the permit:

"If representative of the entire area subject to these permit requirements, the co-permittees may develop a cooperative MS4 discharge and in-stream monitoring strategy that assigns monitoring responsibilities to selected co-permittees."

Therefore, in order to maximize resources and to develop data that are more robust, statistically significant, and useful, six of the Clackamas County co-permittees have coordinated and developed a revised monitoring plan. Clackamas County Service District #1 is the co-permittee that has taken the lead on the development of this plan with participation from the cities of West Linn, Milwaukie, Oregon City, Gladstone, and Lake Oswego.

Development of the first phase of the plan involved a review of the monitoring that has been conducted to date by the Clackamas co-permittees, in accordance with their Table B-1 requirements. Existing efforts were reviewed comprehensively in light of addressing the six monitoring objectives listed above and answering questions that will support stormwater management decisions. As a result of this review, monitoring recommendations were made. The Phase I, comprehensive monitoring plan for Clackamas County and co-permittees has been included as Attachment A. Phase II of the plan will include information regarding implementation of the plan including sampling locations, sampling methods, and parameters for analysis. Phase II of the plan will be submitted with the 2006 West Linn annual compliance report.

SECTION 6 SOURCE IDENTIFICATION COMPONENTS OF THE CITY OF WEST LINN SWMP

Schedule B(2)(b)(i-vi) of the Clackamas County and co-permittee's MS4 NPDES permit outlines the requirements for the contents of the Interim Evaluation Report. Item (ii) requires the following:

(ii) A description of the current source identification components of the SWMP and the rationale regarding the adequacy of these components.

Preparation of this section is based on a conversation with DEQ where they explained that the intent of this specific requirement was to provide an update of the source identification requirements from the original Part 1 and Part 2 MS4 NPDES Permit Applications.

For the previously submitted Part 1 MS4 NPDES permit application the following information was required to be submitted with respect to the identification of sources:

A USGS 7.5 minute topographic map (or equivalent topographic map with a scale between 1:10,000 and 1:24,000 if cost effective) extending one mile beyond the service boundaries of the municipal storm sewer system covered by the permit application. The following information shall be provided:

1. *The location of known municipal storm sewer system outfalls discharging to waters of the United States;.*
2. *A description of the land use activities (undeveloped, residential, commercial, agricultural, and industrial uses) accompanied with estimates of population densities and projected growth for a 10-year period within the drainage area served by the separate storm sewer. For each land use type, an estimate of average runoff coefficient shall be provided.*
3. *The location and description of the activities of the facility of each currently operation or closed municipal landfill or other treatment, storage, or disposal (TSD) facility for municipal waste.*
4. *The location and permit number of any known discharge to the municipal storm sewer that has been issued a NPDES permit.*
5. *The location of major structural controls for storm sewer discharges (retention basins, detention basins, major infiltration devices, etc.).*
6. *The identification of publicly owned parks, recreational areas, and other open lands.*

The information for each of these items has been updated and is provided in the Mapping Section (Section 11.0) of this Interim Evaluation Report.

For the previously submitted Part 2 MS4 NPDES permit applications, an inventory was conducted of industrial discharges to the City of West Linn's stormwater system. In the Part 2 application, a total of one industry was identified. There are no updates or changes to this inventory.

SECTION 7 EVALUATION OF NON-STORMWATER DISCHARGES

With respect to non-stormwater discharges, West Linn's MS4 NPDES permit requires the following:

A(3) - Each co-permittee must effectively prohibit non-storm water discharges into the MS4 unless such discharges are otherwise permitted by an existing NPDES permit. Unless identified by any co-permittee, or the Department, the following non-storm water discharges need not be addressed by the co-permittee's illicit discharge program, provided appropriate BMPs, if needed, to minimize the impacts of such sources are developed under the SWMP: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated groundwater infiltration; uncontaminated pumped ground water; discharges from potable water sources; start up flushing of groundwater wells; aquifer storage and recovery (ASR) wells; potable groundwater monitoring wells; draining and flushing of municipal potable water storage reservoirs; foundation drains; air conditioning condensate; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; individual residential car washing; flows from riparian habitats and wetlands; dechlorinated swimming pool discharges; street wash waters; discharges of treated water from investigation, removal and remedial actions selected or approved by the Department pursuant to Oregon Revised Statute (ORS) Chapter 465, the state's environmental cleanup law; and discharges or flows from emergency fire fighting activities where discharges or flows from fire fighting are identified as not significant sources of pollutants to waters of the state.

With respect to reporting on compliance with the above requirement, the permit requires the following:

B(2)(b)(iii) - For each of the listed non-storm water discharges [Schedule A(3)] expected to occur in a copermittee's area, the co-permittee must identify the appropriate control measures and the rationale for the selection of these BMPs (or the rationale for why BMPs are deemed not necessary).

The City reviewed each of the above 24 categories of non-stormwater discharges. The reviews consisted of interviewing City staff with respect to activities conducted, obtaining additional information from other municipal stormwater management programs, and reviewing data collected from other municipal stormwater management programs. As a result, one of the following four statements was made regarding each category of stormwater discharges:

1. The City does not have this type of non-stormwater discharge.
2. The City does have this type of non-stormwater discharge. However, based on best professional judgment and/or regional monitoring results, the quality of such discharges is not expected to adversely impact receiving waters.
3. The City does have this type of non-stormwater discharge. However, the impact on receiving waters is not expected to be significant relative to other impacts that are being addressed by the City's SWMP and/or control of this discharge is not practicable.
4. The City has this type of non-stormwater discharge and has determined that the impact should be addressed. A BMP has been proposed in the revised SWMP.

The attached table provides a summary of the review that was conducted and associated results. It should be noted that some of the non-stormwater discharge categories were combined based on their similarities with respect to their potential impacts.

TABLE 7-1: Summary of Non-Stormwater Discharges

Category of Non-Stormwater Discharge	Statement 1 – 4 That Applies	Rationale for Selecting Statement 1 - 4	Relevant SWMP BMP that Addresses the Discharge (See the SWMP for details)
• Water line flushing. • Discharges from potable water sources. • Water from the draining and flushing of municipal potable water storage reservoirs.	2	These discharges have been grouped together as they all relate to the discharge of potable water. Depending on the magnitude of discharge, capacity of the receiving water body, and the travel distance between the source and water body, discharges from potable water sources could potentially impact streams due to elevated levels of chlorine. In the City of West Linn, super chlorinated water flushed from new water lines is discharged to the sanitary system. Hydrant and water line flushing from older water lines that is not discharged to the sanitary system occurs infrequently and if it does occur, is discharged to pervious surfaces, in conjunction with DEQs recommended guidelines.	
• Landscape irrigation. • Runoff from lawn watering.	4	These discharges have been grouped together as they both relate to the watering of yards and landscape areas. Generally, lawn watering and landscape irrigation activities may promote increased levels of fertilizer, pesticides, and herbicides into receiving waters. To address impacts related to these non-stormwater sources, the City of West Linn focuses on the use of public education as means to promote behavioral changes. When conducting landscape maintenance activities on public property, the City maintenance staff follows guidelines as defined by the *Clackamas County Integrated Vegetation Management Program*, which defined appropriate application procedures and protocols to limit the amount of chemicals potentially discharged to receiving waters.	See **Implement a Pest Management Program** under Component #1 and **Ensure Staff Training for Pest Management** and **Provide Public Education and Outreach Materials Regarding Stormwater Management** under Component #5 of the Stormwater Management Plan.
• Diverted stream flows	1	Historically, the City has not diverted stream flows unless authorized under a State permit to construct in a waterway.	N/A
• Rising ground waters. • Uncontaminated groundwater infiltration. • Uncontaminated pumped ground water.	2	These discharges have been grouped together as they relate to the direct discharge of groundwater into the stormwater conveyance system. These types of discharges are generally associated with surface water saturation and cannot typically be prevented. These discharges are not expected to adversely affect water quality. The City of West Linn implements a number of operation and maintenance BMPs to indirectly address impacts associated with additional flows in the stormwater conveyance system. Such BMPs minimize the amount of sediment and other pollutants that could potentially be discharged with increased flows due to rising groundwaters and groundwater infiltration.	See **Conduct Stormwater Conveyance System Cleaning and Maintenance** under Component #1 of the Stormwater Management Plan.
• Water from foundation drains. • Water from crawl spaces. • Water from footing drains.	3	These discharges have been grouped together as they relate to the discharges associated with eliminating accumulated groundwater or stormwater from building structures. Generally, not all structures discharge directly to the MS4 system; most drain to lawns or greenspaces when possible. Typically, stormwater entering these structures is filtered through soil and is not likely to be a significant source of pollutants. Risk of stormwater pollution associated with these discharges would primarily be due to a homeowner's landscape practices, spills, or illegal dumping. However, these impacts are not expected to be significant relative to other impacts being addressed by the City's SWMP. The City of West Linn implements a number of practices to indirectly address impacts associated with these type flows in the stormwater conveyance system. In addition, these non-stormwater discharges are addressed with the Uniform Building Code (see next column). Such practices (BMPs and code compliance) minimize the likelihood of additional pollutants discharges as a result of these possible, increased flows into the MS4.	See **Conduct Stormwater Conveyance System Cleaning and Maintenance** under Component #1 of the Stormwater Management Plan and **Provide Public Education and Outreach Materials Regarding Stormwater Management** under Component #5 of the Stormwater Management Plan. The City also requires complete compliance with the Uniform Building Code.

Category of Non-Stormwater Discharge	Statement 1 – 4 That Applies	Rationale for Selecting Statement 1 - 4	Relevant SWMP BMP that Addresses the Discharge (See the SWMP for details)
• Water from the start up flushing of groundwater wells. • Water from aquifer storage and recovery (ASR) wells. • Water from potable groundwater monitoring wells.	1	The City of West Linn does not own or operate any of these type wells thus not have any anticipated discharge associated with these type wells.	N/A
• Air conditioning condensate.	2	Due to regulated industry standards, there is not currently reason to suspect that condensate released from air conditioning systems contains contaminants and/or enters the storm system. The City of West Linn is not aware of any large-scale facilities that use wet cooling towers that may discharge blowdown water (recirculated water that has been chemically treated) to the stormwater system. Generally condensate from air conditioning systems used in the City consists only of H_2O and is typically discharged to landscaping or pervious surfaces. Although this discharge may occur, this discharge is not expected to adversely affect water quality. The City conducts illicit discharge investigations to control inappropriate discharges to the MS4 system.	See **Continue to Implement the Illicit Discharge Program** under Component #2 of the Stormwater Management Plan.
• Water from springs. • Flows from riparian habitats and wetlands.	2	Water from springs and/or riparian habitat may occasionally discharge into the City's MS4 system. However, these flows generally only occur following heavy rainfall periods when surface soils have become saturated. It is not clear whether such volume of discharge from these sources would potentially impact the City's MS4 system. In addition, riparian habitats and wetlands in particular generally serve a water quality and natural resources benefit by absorbing stormwater volumes, filtering sediment, and providing for uptake of nutrients. Although this discharge may occur, this discharge is not expected to adversely affect water quality. The City implements a number of practices to indirectly address additional flows in the MS4 system and limit possible contaminants that could discharge due to these flows.	See **Conduct Stormwater Conveyance System Cleaning and Maintenance; Conduct Catch basin Cleaning and Maintenance; and Conduct Street Sweeping** under Component #1 of the Stormwater Management Plan and **Provide Public Education and Outreach Materials Regarding Stormwater Management** under Component #5 of the Stormwater Management Plan
• Agricultural irrigation water.	3	The City does not have any agricultural irrigation operations.	N/A
• Water from individual residential car washing.	4	Runoff from individual car washing will likely contain surfactants, sediments, metals, oil and grease and other pollutants that could impact the City's MS4 system. Cumulative impacts from the City as a whole could potentially be significant. The City of Portland conducted monitoring of runoff quality from four charity car washes. They found elevated levels of suspended sediment and metals (chromium, copper, lead, nickel, and zinc) and at one site, found elevated levels of bacteria. To address impacts related to this non-stormwater discharge, the City of West Linn focuses on the use of public education as means to promote behavioral changes.	See **Provide Public Education and Outreach Materials Regarding Stormwater Management** under Component #5 of the Stormwater Management Plan
• Dechlorinated swimming pool water.	2	Water discharged directly from swimming pools is generally not suitable for direct discharge into the MS4 system due to the initial levels of chlorine and other chemicals. After dechlorination, however, the water is not expected to pose any significant water quality problems.	See **Conduct Stormwater Conveyance System Cleaning and Maintenance; Conduct Catch basin Cleaning and Maintenance; and Conduct**

Category of Non-Stormwater Discharge	Statement 1 – 4 That Applies	Rationale for Selecting Statement 1 - 4	Relevant SWMP BMP that Addresses the Discharge (See the SWMP for details)
		Although this discharge may occur, this discharge is not expected to adversely affect water quality. The City implements a number of practices to indirectly address additional flows in the MS4 system and limit possible contaminants that could discharge due to these flows.	**Street Sweeping** under Component #1 of the Stormwater Management Plan.
• Street wash waters.	1	The City of West Linn does not currently implement the practice of wetting streets prior sweeping or using water for the washing and cleaning of streets.	N/A
• Discharges of treated water from investigation, removal and remedial actions selected or approved by the Department pursuant to Oregon Revised Statute (ORS) Chapter 465, the state's environmental cleanup law.	1	The City of West Linn does not have any of these type discharges.	N/A
• Discharges or flows from emergency fire fighting activities where discharges or flows from fire fighting.	4	Large fires may generate runoff that flows to the MS4 system. However, not all fire fighting activities generate enough runoff to leave the site itself, due to the intensity of some fires and the use of chemical application for some fire fighting activities. If runoff does occur, there may be impacts to receiving water bodies, particularly if the volume of discharge is significant and the fire location is in close proximity to the receiving stream. Typically, the Fire Department's first responsibility is to protect the public. Generally, protective measures are taken after a fire is suppressed. If possible, absorbents and site sweeping are applied to minimize pollutant discharge into the storm system. There are not currently any BMPs in the City of West Linn's program to directly address increased runoff due to fire fighting activities, as fire fighting is a public safety measure. The City does implement a number of BMPs to indirectly address impacts related to increased flows in the MS4 system and possible contamination related to these increased flows.	See **Conduct Stormwater Conveyance System Cleaning and Maintenance** and **Conduct Street Sweeping** under Component #1 of the Stormwater Management Plan. See also **Provide Public Education and Outreach Materials Regarding Stormwater Management** under Component #5 of the Stormwater Management Plan.

SECTION 8 SUMMARY OF PUBLIC INVOLVEMENT PROCESS

Permit requirements outlined in Schedule D(2)(g)(i-iii) require each co-permittee to conduct a public involvement process for:

i) Interim Evaluation Report (IER) and MS4 permit renewal submittal; and
ii) On-Going Adaptive Management

To meet the first requirement, the City of West Linn conducted a public process to receive and to respond to public comment on the City's revised Stormwater Management Plan (SWMP). Specific details regarding the activities conducted are discussed in Section 8.1. To meet the second permit requirement, the City's stormwater management program must be continually evaluated and updated, meeting the adaptive management requirement of the permit. Adaptive management activities are discussed in more detail in Section 8.2.

8.1 Public Involvement Activities Related to the IER Submittal

The City of West Linn placed their Interim Evaluation Report on their website for the 30 day public comment period as required by the permit. The public comment period was also advertised in the City's local newspaper, the West Linn Tidings. The public comment period lasted from March 10, 2006 to April 10, 2006, and no comments on the IER were received.

8.2 Public Involvement Activities Related to On-going Adaptive Management

To allow for on-going adaptive management activities, the SWMP contains language to ensure that BMPs may be modified based on the results of inspections and changing priorities. With the pending approval of the Willamette River TMDL, the City will conduct adaptive management of their stormwater program to develop and address future benchmarks and may modify their stormwater program and SWMP accordingly. Substantive revisions to the City of West Linn's SWMP, not including the addition of BMPs or the modification of existing BMPs that does not change the substance of the BMPs, would require a public review process to meet the adaptive management requirement.

SECTION 9 303(D) EVALUATION FOR THE CITY OF WEST LINN

Aside from the TMDL currently established for the Tualatin River (see Section 10), there is one other receiving water body (the lower Willamette River) that is located within the City of West Linn's NPDES permit boundary and is listed as water quality impaired for bacteria, mercury, iron and manganese, PAHs, and a number of organochlorine compounds (collectively, 303(d) pollutants; DEQ, 2002). The City of West Linn's MS4 NPDES permit requires a review of their program with respect to these 303(d) constituents. Specifically, the requirements for this review consist of three parts:

ScheduleD(2)(e)

1) *Determine whether there is a reasonable likelihood for storm water from the MS4 to cause or contribute to water quality degradation of receiving waters through the discharge of pollutants on the 2002 303(d) list. Provide the rationale for the conclusion, including the results of an evaluation.*

2) *If the discharges from the MS4 is a contributor to specific listed pollutants, determine and describe the relationship between the 303(d) listed pollutant and the MS4 discharges.*

3) *Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants. If not, describe how the plan could be adapted to more appropriately address these pollutants. A summary of the rationale for this determination must also be included in the report.*

The sections below analyze each 303(d) parameter with respect to the above mentioned permit requirements. Analysis regarding the contribution of stormwater runoff via the MS4 system to the ambient pollutant concentrations and analysis regarding the effectiveness of stormwater BMPs in treating these 303(d) parameters is conducted using information from national databases, regional data, draft or existing TMDL documents and other local studies. BMPs specific to the City of West Linn's stormwater management program are evaluated with respect to their potential to reduce loads of each of the 303(d) pollutants.

The following text addresses the 303(d) evaluation requirement for the following 303(d) parameters:

- Bacteria
- Mercury
- Iron and Manganese
- PAH's
- PCBs, DDT, DDE, aldrin, dieldrin

9.1 <u>Bacteria</u>

Water quality standards for bacteria are designed with the intent of protecting human health by limiting the amount of pathogens in the water. With secondary water treatment, the primary beneficial use protected by water quality standards is recreational contact with water. Both *Fecal coliform* (pre-1996) and *Escherichia coli* (*E. coli*) have been used as indicators of harmful pathogens in receiving waters. The Oregon Department of Environmental Quality's (DEQ's) current water quality standard is for *E. coli* in freshwater where water contact recreation is the most sensitive beneficial use. The *E. coli* standard is less than 406 *E. coli* organisms (most probable number – MPN) per 100 milliliters (mL) in any single sample; and a 30-day log mean of 126 E. coli organisms per 100 mL, based on a minimum of five samples. These standards were established for ambient or receiving water concentrations, not for in-pipe concentrations of stormwater prior to mixing at the discharge point.

Part 1: Likelihood of water quality degradation related to stormwater.

<u>Analysis</u>

Recent TMDL documents state that bacteria concentrations exceeding water quality criteria are ubiquitous in urban streams in the lower Willamette River Valley (DEQ 2004a, c). This is consistent with nationwide findings of elevated bacteria concentrations in receiving waters of urban areas. Bacteria analyses performed for TMDLs are a result of sampling receiving water bodies rather than MS4 systems. However, elevated bacteria levels have been found to be associated with specifically with the MS4 systems, and national and local data sources support this observation. At a national level, Pitt et al. (2004) evaluated data from MS4s across the nation. This data evaluation was restricted to samples from storm sewer pipes or outfalls only (rather than receiving waters), so it is truly representative of the contribution of the permitted MS4 systems. Results are summarized in Table 9-1. An assessment was also completed specific to the Pacific Northwest (EPA Rain Region 7) Region, and bacteria concentration values summarized for all land uses ranged from 10 to approximately 50,000 mpn/100mL, with a median value of approximately 2,000 mpn/100mL.[1]

TABLE 9-1: Summary of Fecal Coliform Concentrations in U.S Urban Stormwater Systems

Land Use	Median (MPN/100 mL)	Number of Observations	% Above Detection	Coefficient of Variation
Overall	5,091	1,704	91%	4.6
Residential	8,345	446	88.3%	5.0
Mixed Residential	11,000	313	94.9%	3.3
Commercial	4,300	233	88.0%	2.8
Mixed Commercial	4,980	109	94.5%	3.3
Industrial	2,500	297	87.9%	5.6
Mixed Industrial	3,033	115	95.7%	2.5
Freeways	1,700	49	100.0%	2.0
Mixed Freeways	730	16	81.3%	2.0
Open Space	7,200	23	91.3%	1.1
Mixed Open Space	2,600	95	97.9%	2.3

Source: Pitt et al., 2004

[1] Bacteria concentrations are variously reported as "colonies," "colony-forming units (cfu)", or "most probably number (mpn)" per 100mL of water, depending on the test used.

A regional data compilation and summary of land-use based stormwater sampling of MS4 systems in Oregon (not receiving waters) indicated median bacteria concentrations in storm drain systems of up to 1,300 *E. coli* colonies per 100 mL, and 1,600 *Fecal coliform* colonies per 100 mL (WCC, 1997). These values are presented in Table 9-2. In addition, sampling of bacteria in MS4 systems from the City of Portland and Clean Water Services since MS4 permits were issued in 1995 continues to suggest that urban stormwater exceeds the ambient bacteria standard by a wide margin.

TABLE 9-2: Median Bacteria Concentrations in Oregon Urban Stormwater Systems

Land Use	Fecal coliform (MPN/100 mL)	E. Coli (MPN/100 mL)
Residential	1,600	600
Multi-Family Residential	1,600	600
Commercial	1,600	1,300
Industrial	885	610
Public Open Space	1,090	1,000
Vacant	1,090	1,000
Rural	1,090	1,000

Source: WCC, 1997 and Raj Kapur, Clean Water Services, pers. comm., 2005

Recent sampling of Fanno Creek, a tributary to the Tualatin River in the Portland metropolitan area, by the U.S. Geological Survey (USGS 2000, 2002) indicates a link between bacteria and runoff conditions, and suggests impacts of failing septic systems on the bacterial load specifically for Fanno Creek. The USGS sampling occurred within the receiving water body rather than the storm drainage system. The USGS performed spatially detailed sampling during low flow conditions in the summer of 1996, and storm sampling at three locations during three storms between June 1998-December 1999. The median *E. coli* concentration in Fanno Creek during low flow conditions was 520 CFU/100mL, with 70% of the samples exceeding the single-sample ambient standard; the median *E. coli* concentration in nearby but less developed Bronson Creek during the same period was 180 CFU/100mL, with 33% exceeding the single-sample ambient standard (USGS, 2000). Bacteria concentrations were found to be much higher during conditions of storm runoff. During the three storm events, the median *E. coli* concentration in Fanno Creek was 1,800 CFU/100mL and 96% of these samples exceeded the single-sample ambient standard.

DEQ has also evaluated the relationship between bacteria and wet weather in the course of developing TMDLs for the Columbia Slough and the Johnson Creek basins, both of which are located in the Portland metropolitan area. In each case, data supports a correlation between wet weather conditions and exceedance of the bacteria standard.

Conclusion

Based on this analysis, it is clear that urban stormwater can contribute to elevated levels of bacteria in local receiving water bodies.

__Part 2: What is the relationship between the 303(d) listed pollutant and the MS4 discharges?__

<u>Analysis</u>

As described above, MS4 discharges can contribute to elevated bacteria levels in receiving waters. Unfortunately, the relative contribution of bacteria from different sources is difficult to determine.

The intent of the water quality standard for bacteria is to limit the potential discharge of pathogenic (particularly human) bacteria. Bacteria from humans are thought to enter MS4 systems from a number of sources including:

- Failing septic systems or leaky sewer systems and associated infiltration and inflow to the MS4 system;
- Combined sewer overflows and sanitary sewer upsets;
- Illegal dumping (e.g., from mobile sanitary services) and illicit connections to the storm drain instead of the sanitary sewer service.

It is important to note however that bacteria in receiving waters have also been associated with domestic animals (including feral populations), and wildlife (such as avian species and rodents). Multiple studies over the past decade have revealed that only a small percentage of bacteria in ambient waters are actually associated with human sources. Four microbial source tracking (MST) studies using ribosomal tracking of coliform bacteria illustrate this point well as follows:

1. <u>Blaine, WA:</u> The City needed to evaluate contamination sources to shellfish beds (HEC, 1999). In Cain Creek, an urban stream, no human sources of bacteria were found. Instead, half of the matched bacterial strains were attributed to dogs and cats (evenly divided), and the remaining half of the matched strains were attributed to ducks/geese and gulls (in a 2:1 ratio). Results from Portal Drain, a storm sewer outfall, were nearly identical. Bacterial concentrations were noticeably higher during a wet period on the flood tide, suggesting that there may be some transport from bacterial sources in the bay upstream with the tides. HEC noted, however, that these samples were collected later in the spring than other samples, so the warmer weather and difference in wildlife activity may have also influenced the total concentration of bacteria. In a stream draining an unsewered area with some agricultural land use, 8% of the identified bacteria strains were of human origin.

2. <u>Boise, ID</u>: A study in support of implementation of the Boise River TMDL included two sites that are stormwater outfalls, as well as several sites in receiving waters (CH2MHill, 2003). At one of these sites, where the stormwater was combined with irrigation return flow, sources of 72% of the bacterial strains were identified: dog was the dominant source (30%), humans were next at 21%, 12% was avian (mixed, including ducks/geese), 5% cat, 3% rodent, and 1% duck-goose-rabbit. At the second site, which had a combination of residential and recreational land uses, sources of 83% of the bacterial strains were identified. In this case, 29% of the bacteria were associated with avian sources, 29% with dog, 10% with human, 8% with cat, 3% rodent, and approximately 1% each of opossum-rabbit and duck-goose-squirrel-cat.

3. Puyallup, WA: In a study of receiving waters in urban areas of Puyallup, Washington, geese were shown to be the dominant bacterial source at 41% of the total bacterial strains (Milne et al., 2004). This is important because the study area contains the Western Washington Fairgrounds, considered to be a potentially significant bacterial source. The next largest bacterial source was rabbit-rodent (28%), followed by: canine (11%), unknown (9%), human (5%), raccoon (3%), deer-elk (2%), and < 1% each of feline, bovine, or horse. During high rainfall events, human sources were not distinguishable.

4. Tualatin Basin, OR: In a yet to be published study conducted by Clean Water Services in 2005, avian species with about 50% of the total bacteria strains were predominant, followed by rodents, and domestic animals. None of the stormwater samples analyzed showed any human sources of bacteria.

5. Seattle, WA: A study in Pipers Creek, an urban stream in northwestern Seattle, contained a primary wastewater treatment plant in the middle of this watershed. While the wastewater treatment plant discharged to Puget Sound through a deep-water outfall, concerns were raised about leaks in this conveyance system. A MST study using a ribosomal tracking method found that 30 percent of the samples contained bacteria matching a cat source strain, 7 percent were from dogs, and 3 percent were from ducks. Fifty-seven percent of the bacteria could not be definitively identified (HEC, 1993). HEC concluded that the relatively high percentage of cat source was attributed to the success of Seattle's scoop laws for dogs. The cat source of bacteria was presumably a combination of domestic cats and feral cats.

Seasonal variations in bacterial concentrations independent of suspended sediment concentrations were observed by USGS (2002). In a relatively minor storm in June at Fanno Creek, bacteria numbers were substantially higher than during winter storms, and higher than the concentrations typical of MS4 systems. This may be due to a number of processes including: dilution by larger volume of winter storms, suspension of bed sediments containing bacterial colonies that developed *in situ* in streambed sediments during warm weather, runoff from a more concentrated reservoir of bacteria present in upland soils during warm weather (Hunter and others, 1999 as cited in USGS, 2002), or due to a greater buildup of bacteria on impervious surfaces due to a longer antecedent dry period than is typical of winter storms. Understanding this seasonal variation and determining whether it occurs at other sites could bring about useful management insights specifically targeted at reducing bacteria levels.

Conclusion

Regionally available bacteria source tracking studies have shown that bacterial sources in urban environments are not predominantly human. The more predominant sources of bacteria include wildlife and/or domestic pets (e.g., canine/feline).

Part 3. Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants.

Analysis

This section describes the effectiveness of structural stormwater BMPs for which information was available relative to bacterial removal based on either local data or data from the ASCE

International BMP Database (ASCE, 2005). Based on a review of both national and local data on BMP effectiveness, a number of observations were made:

1. Reducing overall stormwater volumes through infiltration (i.e., low impact development techniques) can help to reduce bacteria loads to surface waters by reducing the volume of stormwater entering a stream and hence suspended bacteria loads. Soil is an excellent filtration medium for bacteria, as demonstrated by numerous studies that have been conducted to develop design standards for septic systems.

2. Although there are significant limits with respect to bacteria removal through the use of structural BMPs, there are some factors that promote increases in bacteria die-off that have implications for BMP effectiveness. These include:

   - Sunlight - Maximum die-off requires clear water, however, the turbidity and organic matter found in urban runoff can greatly interfere with the sunlight effect (Bank and Schemhel, 1990, in CWP, 1999). Substantial treatment would be needed to remove suspended solids before UV light could be effective. In addition, exposing water bodies to increased UV light results in warming, which is contrary to the goal of water quality standards for temperature.

   - Chemical/Ultraviolet Disinfection - Although effective for treatment of drinking water and wastewater, chlorine dosing of stormwater is difficult due to the variable flows and turbidity levels. Therefore, it has only been used for this purpose in rare cases. In addition there are stringent water quality standards with respect to the discharge of chlorine. Exposure to ultraviolet disinfection would be even more problematic due to the concentrations of suspended sediment typical of stormwater.

   - Growth Inhibitors - cooler temperatures, low nutrient levels, low carbon supplies, low pH levels and moisture loss are all factors that inhibit the growth of bacteria.

3. There are upper limits on what stormwater treatment systems that rely on sedimentation can achieve with respect to bacteria removal (ASCE, 2005).[2] Even an advanced secondary wastewater treatment plant that filters its effluent still discharges fecal coliform at the 10^3 to 10^5 levels before final disinfection. That being said, the most common removal mechanisms and their estimated effectiveness are as follows:

   - Sedimentation - One study indicated that 15 to 30 percent of fecal coliform cells present in stormwater are adsorbed to larger suspended particles, most of which are greater than 30 microns in diameter (Schillinger and Gannon 1982, in CWP 1999). The bacteria that do adsorb to these larger particles can settle rapidly out of the water column. Of the bacteria that do not attach or absorb to larger particles, the remainder either attach to smaller particles less than 30 microns in diameter or do not attach at all. Specifically, fifty percent of fecal coliform bacteria were found unattached. These bacteria have slower settling velocities and may remain in suspension for days or weeks. A subsequent study found that approximately 90 percent of bacteria (both attached and unattached) are

[2] It is important to note that only the data reported in the National BMP Database that was collected as Event Mean Concentrations (EMCs) was examined for this summary. Data reported in the National BMP Database that was collected as grab samples was not examined.

expected to settle out from a typical stormwater pond in about two days under ideal conditions (Auer and Niehaus 1993, in CWP 1999).

- Sand Filtration - Most field studies of sand filters show removal of 50 to 65 percent of bacteria.

- Soil Filtration - Similar to sand filtration although more effective since the higher organic matter and clay content of most soils increases potential bacteria adsorption (Robertson and Edberg, 1997, in CWP, 1999).

4. Structural BMP-specific study results conducted nationally and locally suggest that there are limited practicable options for bacterial removal from stormwater. Results below cite results from specific BMP evaluations using local data where available, supplemented with national data as necessary. Effluent data from the BMPs that were studied were so variable with respect to bacteria that it can't be determined whether one is more effective than another or whether any of them are very effective at all:

    - Detention Ponds – Gresham monitors the Mt. Hood Community College and Kelly Creek detention ponds. Outflow concentrations of *E. coli* in 2003-2004 averaged approximately 100 CFU/100mL, down from outflow concentrations measured in 2001-2002 that ranged from 220-440 CFU/100mL (Gresham 2004). At both ponds, outflow values were less than inflow values, indicating that the ponds are responsible for some load reductions. *E. coli* data collected as part of ongoing BMP effectiveness evaluations by Clean Water Services showed ranges from 600 MPN/100 mL to 250,000 MPN/100 mL in effluent samples, with a median value of 2,550 MPN/100mL (Kapur 2005).[3] Data indicate that effluent bacteria levels were actually higher than influent levels in many of the samples.

    - Retention Ponds - Outflow concentrations of *E. coli* from the Water Garden wet (retention) pond at the City of Portland's Water Pollution Control Laboratory average 1209 CFU/100mL (BES 2001).

    - Sand Filters - The City of Portland currently monitors a sand filter (the Parkrose sand filter) that has effluent concentrations that are consistently below the 406 CFU/100 mL standard.

    - Swales - Outflow concentrations of fecal coliform averaged 2,506 colonies/100 mL based on 3 events (CWP, 1999). Average *E. Coli* concentrations in effluent from Portland swales ranged from 5,500 to 12,000 colonies/100 mL. The range of effluent concentrations in the swale sampled by CWS was even greater (15-70,000 MPN/100mL). As a group, the grass swales were found to have no ability to reduce fecal coliform levels, with zero or negative changes in concentrations reported in four out of five studies. Pet droppings, wildlife use, in-situ growth of the bacterial colonies, and short travel times within the swale were all cited as reasons for the poor performance of swales.

    - Grass Filter Strips - Studies suggest only a modest capability to remove fecal coliforms from runoff.

[3] As a means of qualifying these results, Jan Miller (personal communication 5/3/05) notes that the detention pond, while designed to be dry, has a spring source and so remains damp and vegetated year-round with wetlands species.

- Vortechnics Settling Chamber - Samples collected from 1997-2004 by CWS revealed often higher bacteria levels in effluent samples than influent samples[4]. Concentrations ranged from 7 MPN/100 mL to 28,300 MPN/100 mL.

5. Very little monitoring has been conducted to determine if source controls and other non-structural BMPs (ex: public education) can actually reduce watershed bacteria levels. There are four primary types of source control used to control bacteria: pet management, wildlife management, illicit connection control, and converting septic-systems to sanitary system hook-ups. A study on controlling pet waste in the Chesapeake Bay showed that approximately 41% of dog walkers do not pick up the waste. Eighty percent of that 41% indicated that several factors (i.e., complaints, simpler collection methods, more convenient disposal methods and/or fines) would still not induce them to change their behavior. This indicates that source control programs will need to be very creative to alter these deeply rooted attitudes. A recent survey by CWS ratepayers favored fines (presumably associated with an ordinance) and, secondarily, disposable scoops or bags and disposal locations in places popular with dogs as inducements for compliance (CWS, 2002). The Pipers Creek study cited above provides some support for the recommendations of CWS. The effectiveness of illicit connection control is evaluated qualitatively below. Hook-ups of failing septic systems can be very effective for localized problems, as suggested in data from Fanno Creek.

   Although broadly recognized as effective and necessary, few successful studies exist that quantitatively show the effectiveness of public education and information efforts to change behaviors related to stormwater quality. Based on a meta-analysis of numerous surveys concerning environmental knowledge, attitudes and behavior, Doug McKenzie-Mohr (Univ. of Toronto) found that human behavior is more influenced by convenience and perceptions of what others will think than by what people believe to be correct. Although Gresham has targeted campaigns to encourage proper disposal of pet waste through education accompanied by provision of conveniently located waste receptacles, it has been difficult to translate use of the receptacles to a quantity of bacteria that has been prevented from entering stormwater.

Based on the overall review of BMP effectiveness, there appears to be three important data gaps that should be noted:

1. Studies did not discuss/evaluate whether maintenance practices such as street sweeping and catch basin cleaning are effective at reducing levels of bacteria in runoff. To the extent that these practices remove sediment-bound bacteria before they reach receiving waters, they should be further evaluated with respect to effectiveness.

2. Studies did not discuss the potential effectiveness of successful source control or public education programs (e.g., it is difficult to quantify the effect that 50,000 distributed landscaping brochures have on bacteria loads in urban areas). In particular, the effectiveness of garbage disposal for rodent control, wildlife control (e.g., “Don’t feed the wildlife” signs), and pet waste disposal campaigns have not been quantified.

[4] The Vortechnics chamber is difficult to sample and oversized relative to receiving flow volume.

3. Studies did not evaluate the potential effectiveness of low impact development (LID) techniques aimed at reducing flow volumes.

<u>Conclusion</u>

As stated earlier studies have shown that only small percentages of bacteria loads in stormwater are from human sources. Larger proportions of bacteria are from pets and wildlife. Most structural and non-structural stormwater BMPs have not been shown to be very effective at reducing bacteria loads and in some cases even increase loads. The exception would be for BMPs that reduce runoff volumes including low impact development practices and infiltration.

Based on the overall analysis of bacteria as discussed above, the City of West Linn's Stormwater Management Plan (SWMP) focuses on the following sources to reduce the discharge of bacteria to the maximum extent practical:

- <u>Human Sources</u> - Even with the small proportion of the bacteria load that is associated with human sources, this source is the target of the water quality standard and should be eliminated to the extent possible. This would include fixing or eliminating failing septic systems and searching for and eliminating illicit discharges.
- <u>Domestic and Feral Animal Sources</u> - Reducing sources of bacteria associated with pet waste should focus on educating pet owners regarding proper pet waste management. Other activities that could assist in behavior modification include providing free bags for waste pickup at convenient locations and/or assessing fines for those caught not picking up the waste. To address feral animal sources issues such as proper management of food wastes, etc. should be considered so as to reduce areas that attract nuisance rodents, etc.
- <u>Wildlife Sources</u> - As there are natural sources of bacteria it is assumed that the intent of the water quality standard was not to eliminate these sources. However, enhancement of riparian areas could potentially provide for slowing of flows and hence enhancing infiltration and filtration.

Based on this conclusion, the City of West Linn's SWMP should be effective at reducing bacteria to the MEP because it already includes the following BMPs to address all three of these potential bacteria sources. For a detailed description of these BMPs, see Section 4.0 – Stormwater Management Plan.

- **Continue to Implement the Illicit Discharges Elimination Program**
- **Control Infiltration and Cross Connections to the City's Stormwater Conveyance System**
- **Provide Public Education and Outreach Materials Regarding Stormwater Management**
- **Conduct Master Planning for Stormwater Quality Improvement**
- **Continue to Implement a Pet Waste Program**

It should be noted that these BMPs are not likely to reduce bacteria levels to the extent that they will meet water quality standards since a large portion of the bacteria load is likely due to feral and wild animal sources which will not be eliminated.

9.2 Mercury

Mercury in the aquatic food chain is now recognized as a widely distributed problem throughout North America (Brumbaugh et al. 2001). In the Willamette basin, mercury is on the 303(d) list due to fish advisories for the mainstem of the Willamette River and headwater tributary, the Coast Fork Willamette.

Water quality standards for mercury are designed to protect human health by limiting the amount of mercury that can bioaccumulate in the food chain of the Willamette River and tributaries, eventually lodging in human-consumable fish in the form of methylmercury, which is highly toxic. Existing Oregon water quality standards are 144 ng/L, 146 ng/L, and 2000 ng/L for water and fish ingestion, fish ingestion, and drinking water respectively. However, recent food web modeling (DEQ, 2004d) suggests that these criteria are not low enough to achieve fish tissue concentrations of 0.3 mg/kg: DEQ estimates that the water column “guidance value” for total mercury should be 0.92 ng/L. Ambient water column concentrations in the Willamette River currently average 1.3 ng/L.[5]

Part 1: Likelihood of water quality degradation related to stormwater.

Analysis

Recent TMDL documents state that ambient mercury concentrations in the Willamette River result in excessive levels in fish tissue (DEQ, 2004a). Sources of mercury in the environment are identified in the TMDL as:

- Air deposition of ionic mercury (Hg^{2+}) from local and far-field sources, at a rate approximately 10 $\mu g/m^2$-yr (DEQ, 2004b). Far-field sources include coal combustion in Asia. Near-field sources could include everything from Mt. St. Helens to broken fluorescent light bulbs and incinerators/crematoria (Krabbenhoft, personal communication, 4/18/05).
- Mine wastes from cinnabar (HgS) mining and milling, and amalgam-based gold milling activities in the Cascades. These wastes include mercury-enriched soils, waste or ore rock, and water discharges from mine openings (adits).
- Soil erosion, where soil mercury concentrations in the Willamette River valley floodplain are typically 0.09 mg/kg at the surface (i.e., A-horizon), and 0.05-0.06 mg/kg in the subsurface (i.e., B-horizon) outside of mining districts (Khandoker, 1997).
- Limited point sources, including industrial and municipal wastewater discharges. Mercury in municipal wastewater discharges can be traced to a large number of small sources—diet (e.g., swordfish or tuna), personal care products, pharmaceuticals, waste

[5] A critique of DEQ’s analysis was filed as part of ACWA comments on the draft TMDL in January, 2005. This critique, prepared by URS and Entrix on behalf of ACWA, finds major flaws in DEQ’s link between methylmercury concentrations in fish tissue and total water column concentration of mercury, with particular emphasis on the poor relationship between water column methlymercury and total mercury. For purposes of this memo, however, these flaws will not be considered.

amalgam from dentists, broken thermometers—in addition to industrial sources covered by pretreatment requirements. Most of this influent mercury is removed during wastewater treatment (Downing, 2005). In preliminary results from the San Jose/Santa Clara Water Pollution Control Plant, influent mercury concentrations of 193.7 ng/L (1.3 ng/L methylmercury) were reduced to 2 ng/L total mercury (THg) and 0.03 ng/L methylmercury following treatment by tertiary filters.

- River sediments reflecting total mercury derived from all of these sources. A compilation of Willamette Basin data from the 1990s by the USGS indicates that streambed sediment averages 0.29 mg/kg, but ranges from 0.01 to 2.5 mg/kg (Rice, 1999). This average value is confirmed by DEQ (2004a) for the Willamette River mainstem.

Stormwater runoff is the primary pathway by which aerially deposited mercury in the urban environment reaches aquatic systems. Brumbaugh et al. (2001) notes that urban streams that have no other specific point sources typically have elevated levels of total and methyl mercury in streambed sediments. Little is known about mercury concentrations in most tributary streams of the lower Willamette River valley (DEQ 2004a, b). Sampling by the USGS (2004) in metro-Portland area creeks (Johnson, Fanno, and Beaverton Creeks) indicates that these urban creeks have both slightly higher concentrations of water column mercury and a slightly higher percentage of methylmercury than comparable creeks in the forested basins of East Fork Dairy Creek, and Lookout Creek. Dissolved mercury averaged 0.77 ng/L in urban streams (9% methylmercury), and 0.62 ng/L in forest streams (6.5% methylmercury). This pattern has been partially corroborated in one of the few studies to address mercury partitioning in stormwater, undertaken in the Sacramento, California area. In the Sacramento-area study, urban and non-urban streams had comparable water column total mercury concentrations, but methylmercury concentrations were higher in the urban streams (Archibald and Walberg 2004).

A recent evaluation of data from MS4s across the nation revealed that relatively poor data are available for mercury in stormwater (Pitt et al. 2004; Pitt 2005). This data evaluation was restricted to samples from storm sewer pipes or outfalls only (rather than receiving waters), so it is truly representative of the contribution of the permitted MS4 systems. Of 3765 samples compiled in this effort, fewer than 1/3 were analyzed for mercury. In the subset of samples analyzed for mercury, mercury was undetected at analytical detection levels of 100-300 ng/L in most samples (i.e., close to Oregon water quality standards but well above target water column concentrations from the draft Willamette River TMDL). In the 103 samples in which mercury was detected (as total mercury), concentrations ranged from 30 to 9,200 ng/L, with the mean and median concentrations equal to 370 and 200 ng/L, respectively. No data were presented that could illuminate the partitioning of mercury between the total, dissolved, or methylmercury fractions. Looking at Oregon results from the compilation of samples from MS4 systems by Pitt (2005), mercury concentrations ranged from non-detects at 200-500 ng/L, to detected values of 200-700 ng/L. The Oregon results exhibit a similar proportion of sampled/detected values as the national data compilation.

Conclusion

Based on this analysis, it appears very little is known regarding the connection of urban stormwater runoff to instream mercury concentrations. However, urban stormwater is suspected of providing a pathway for aerial sources of mercury to be discharged to receiving waters.

Part 2: What is the relationship between the 303(d) listed pollutant and the MS4 discharges?

Analysis

Stormwater conveyance, whether in a piped system or surface conveyances (e.g., ditches and channelized streams) is designed to get stormwater quickly off impervious surfaces in the urban environment. Therefore, urban runoff has relatively little contact time with soil and other environments where mercury can be bound up as less-reactive compounds prior to reaching receiving waters. This is important because "young" mercury seems to be more bioavailable than "old" mercury (Krabbenhoft, personal communication, 2005). In other words, this young mercury is more rapidly methylated and incorporated into the aquatic food chain. From the data summarized above, it does appear that MS4 systems may provide an important pathway source of mercury.

Three example calculations are illustrative of the relative contribution of different mercury sources in the urban environment:

1. Air deposition:
   - Assume that the average mercury load to urban environments from air deposition is diluted by the average annual rainfall for the Portland metropolitan area.
   - Annual mercury load from air deposition is calculated in the draft Willamette TMDL as 10 $\mu g/m^2$ (DEQ, 2004a);
   - Average annual rainfall is 41.22 inches, or 1.05 m (National Climate Data Center means for 1971-2000 at Oregon City, Hillsboro, Troutdale, Portland, and Beaverton averaged);
   - Urban runoff from impervious surfaces is approximately 95% of incident precipitation (1.05 m rainfall * 95% = 1meter runoff);
   - Assume that there is no re-volatilization or other mercury losses.
   - Average concentration of mercury in runoff from urban impervious surfaces in the metropolitan area is 10 $\mu g/m^3$, or 10 ng/L. This is approximately one order of magnitude higher than the target water column concentration (i.e., 0.92 ng/L) necessary to achieve required fish tissue concentrations.
2. Sediment resuspension:
   - Mercury concentrations in streambed sediments of the Willamette River average approximately 0.3 mg/kg (DEQ, 2004b).
   - Typical suspended sediment concentrations in Willamette River streams are 10 mg/L in moderate streamflows (DEQ, 2004b).
   - The contribution to the water column mercury concentration from suspended sediment, assuming that it is derived from re-suspended bed sediment, would be 3 ng/L, or approximately 3 times the target water column mercury concentrations.
3. Soil erosion:
   - Mercury concentrations in surface soil in the Willamette valley are approximately 0.09 mg/kg.
   - Typical suspended sediment concentrations in Willamette River streams are 10 mg/L in low and moderate streamflows (DEQ, 2004a). Wet weather conditions generally increase

instream concentrations; data from the City of Portland indicates that instream TSS concentrations range from 30-60 mg/L during wet weather conditions (Wildensee, 2005).

- The contribution to the water column mercury from suspended sediment if soil erosion contributes the only source of sediment would be 0.9 ng/L during dry conditions and about 3 to 6 ng/L during wet conditions, or up to six times the target water column mercury concentration.

Conclusion

Data discussed in Part 1 and 2 of the mercury analysis indicates that urban stormwater systems in Oregon provide efficient transport pathways for mercury to reach receiving waters. Elevated urban peak flows can promote resuspension of mercury-enriched streambed sediments, effectively moving the problem "downstream." Soil erosion can also contribute to elevated mercury loading in the urban environment, although erosion is estimated to be an even more substantial issue in agricultural or forest harvest settings (DEQ, 2004b).

Part 3. Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants.

Analysis

The goal of stormwater BMPs should be to reduce the load of both mercury and methylmercury to receiving waters. This is done by reducing the mercury load in absolute terms and reducing methylation in the environment. Mercury binds strongly to sulfur-containing organic ligands such as weathered plant material, so that mercury that reaches biologically active soils tends to be well sequestered (i.e., less bioavailable for methylation). Therefore, sediment-trapping BMPs can be expected to be effective at trapping mercury and reducing methylmercury loads. If, as has been hypothesized, "young" mercury is more bioavailable than "old" mercury, the potential for enhanced methylation in stormwater BMPs must also be addressed, in addition to the reduction of total mercury. Krabbenhoft (2005) notes that delivery of methylmercury to aquatic systems requires—in addition to mercury—sulfur, carbon, the anaerobic conditions that favor sulfate-reducing mercury, and a method to periodically flush methylmercury from where it is being formed. Methylmercury can also be reduced to elemental mercury by photo-degradation.

Structural BMP effectiveness data for mercury are essentially non-existent: only 5 sites included in the ASCE International BMP database have mercury data, and for most of those observations, mercury was not detected (ASCE, 2005). The City of Austin sampled residual sediments in inlet filters for mercury at 3 sites between 1994 and 1996. Detection limits were variable, ranging from 0.14 to 0.20 mg/kg (i.e., above the mercury concentration in typical Willamette Valley soils). Mercury was detected in 3 of 16 samples at concentrations ranging from 0.18 to 0.66 mg/kg. One wet retention basin in Michigan was sampled for mercury, with 8 inlet and 6 outlet samples. Inlet concentrations averaged 0.29 μg/L, and outlet concentrations averaged 0.22 μg/L. However, this study is somewhat dated (from the early 1990's) and mercury data gathered in the Midwest may not be the most representative of conditions in the Pacific Northwest, due to the large number of mining and coal-burning facilities and activities. More recent, local sampling and analysis by the City of Portland found that mercury concentrations in stormwater are typically <0.01 μg/L or <0.005 μg/L (Wildensee, personal communication). Most outlet concentrations for the Parkrose sand filter were below method detection limits at <0.01 μg/L; a

50% reduction between inflow and outflow was observed for those samples with mercury detected in both the inflow and outflow.

Because data are severely limited, the effectiveness of stormwater BMPs currently cannot be quantitatively assessed with any degree of certainty. Stormwater BMP effectiveness should be tested using well controlled and documented evaluation protocols. Furthermore, target effluent concentrations should be at or below ambient concentrations that are already quite low. For this reason, none of these structural BMPs may result in sufficiently low effluent concentrations to meet the water quality target in the draft Willamette River TMDL.

Evaluating BMP effectiveness is also more involved than simply analyzing patterns of inflow and outflow concentration differences. Particularly because the goal is to remove very small quantities of mercury from the aquatic environment, a more holistic (i.e., life cycle) view of mercury removal is required. All material removed from these BMPs should be disposed of properly. Incineration during disposal or recycling, for instance, can re-vaporize the mercury that was previously trapped, resulting in a local airborne source. In general, mercury should be sequestered in upland soil or subsurface environments.

In the absence of data, structural stormwater BMPs that would conceptually be most effective at reducing mercury loads would include the following characteristics:

- They would promote the sort of retention times necessary for the dissolved mercury fraction to be adsorbed to particulates.
- They would trap sediment (particularly fine sediment) for alternative disposal.
- They would promote reduction in flow volumes such that mercury would be incorporated into the soil matrix.
- They would provide aerobic conditions that limit methylation.
- They would not result in the remobilization of particulate, dissolved, or methylmercury.

In addition, non-structural BMPs to be implemented within the municipal NPDES-permitted community should focus on source reduction efforts by dentists (i.e., amalgam collection, mandatory in San Francisco proper), households, and other commercial interests. This latter category included collection and proper recycling or disposal of mercury switches in automobiles, impact lights (e.g., tennis shoes and toys), fluorescent lights (containing mercury vapor), and pharmaceuticals. From a stormwater perspective, BMPs that focus on reducing mercury vapor emissions are also important because they reduce a local source of mercury in air deposition. In addition, BMPs that focus on sediment control (ex: erosion control, operation and maintenance activities) will also be beneficial at reducing mercury by reducing the potential for methylation to occur.

Conclusion

Effectiveness of stormwater BMPs in reducing mercury loads has not yet been determined quantitatively. Therefore, West Linn is currently revising their monitoring analyses to include mercury so that more local knowledge can be gained regarding the levels and sources of mercury in stormwater. The results of this monitoring, as well as evaluations of non-structural BMPs, will be used to re-evaluate the SWMP with respect to mercury for the next permit term. BMPs that the City of West Linn currently implements that can be effective at reducing mercury loads include the following.

- **Conduct Stormwater Conveyance System Cleaning and Maintenance**
- **Conduct Catch basin Cleaning and Maintenance**
- **Conduct Street Sweeping**
- **Continue to Implement the Erosion Control Manual**
- **Conduct Erosion Control Inspections**
- **Provide Educational Information to Construction Site Operators**
- **Provide Public Education and Outreach Materials Regarding Stormwater Management**

A more detailed description of the above BMPs can be found in Section 4.0 – Stormwater Management Plan.

9.3 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% iron (i.e., 50,000 mg/kg) and 1,000 mg/kg manganese (Shacklette and Boerngen, 1984); these concentrations are high compared to national averages due to 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 %; 7% 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[6], although there may be some anthropogenic contribution as well.

Part 1: Likelihood of water quality degradation related to stormwater.

Analysis

Water quality standards for these chemicals are designed to protect aquatic life as well as human health due to water and fish ingestion. Ambient Oregon chronic freshwater criteria for iron are 1.0 mg/L. The criteria for the protection of human health based on water and fish ingestions are 0.3 and 0.05mg/L for iron and manganese, respectively. The lower Willamette River is on the 303(d) list for both these constituents (DEQ, 2002).

Both instream iron and manganese concentrations, from which the Willamette River 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

[6] 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).

exceedence of the iron criterion, assuming that the iron content in 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. Iron and manganese concentrations in stormwater have typically not been evaluated by municipalities in the Willamette Valley. However, total suspended solids have been measured in stormwater as a function of land use (WCC, 1997). Average concentrations of total suspended sediment (TSS) range from 53 mg/L in open space settings to 169 mg/L for transportation land uses[7], suggesting that ambient water quality criteria for iron and manganese are often likely to be exceeded in stormwater.

Conclusion

Stormwater runoff likely contributes to exceedances of water quality criteria for iron and manganese in the Willamette River during periods heavy rainfall, causing elevated suspended sediment concentrations due to transport of eroded soil or resuspension of streambed sediments.

Part 2: What is the relationship between the 303(d) listed pollutant and the MS4 discharges?

Analysis

Given the lack of measured iron and manganese concentrations in urban stormwater in the Portland metropolitan area, the relationship between MS4 discharges and these listed pollutants cannot be quantified locally. However, qualitative relationships are possible based on gross observations of urban runoff processes. Stormwater conveyance, whether in a piped system or surface conveyances (e.g., ditches and channelized streams) is designed to get stormwater quickly off impervious surfaces 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 and manganese concentrations in the water column by quickly elevating streamflow volumes in receiving waters, resulting in either resuspension of streambed sediments or accelerated erosion of streambanks.

Conclusion

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

Part 3. Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants.

Analysis

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. A modest amount of structural BMP effectiveness data are available with respect to iron from the International BMP database (ASCE, 2005), and BMP effectiveness data

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

for the Portland metropolitan area have been summarized based on prior monitoring under various MS4 programs. Based on available information, structural stormwater BMPs that would conceptually be most effective at reducing iron and manganese loads would include the following characteristics:

- They collect and/or trap sediment (particularly fine sediment) that is not easily remobilized.
- They promote reduction in flow volumes such that sediment transport capacity of the conveyance system or receiving waters is appropriately reduced.

<u>Conclusion</u>

BMPs that include infiltration and which reduce stormwater volumes discharged to surface water bodies, are the preferred BMP 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 biofilters/swales are all effective structural BMPs for treating TSS-rich stormwater because they both retain sediment and provide some amount of flow modification. Detention ponds provide the best flow attenuation of the structural BMPs but may be prone to sediment resuspension. Properly deployed and maintained erosion and sediment control BMPs (and training/education that improves their effectiveness) are necessary during construction activities. Maintenance activities that include the collection of sediments are also effective (i.e., street sweeping and catch basin cleaning).

The City of West Linn's stormwater management plan is already focused on sediment reduction to the maximum extent practicable through the use of BMPs (structural and nonstructural) described below. BMPs that the City of West Linn currently implements that can be effective at reducing iron and manganese loads include the following:

- **Conduct Stormwater Conveyance System Cleaning and Maintenance**
- **Conduct Catch basin Cleaning and Maintenance**
- **Conduct Street Sweeping**
- **Continue to Implement the Erosion Control Manual**
- **Conduct Erosion Control Inspections**
- **Provide Educational Information to Construction Site Operators**
- **Provide Public Education and Outreach Materials Regarding Stormwater Management**

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 due to naturally elevated levels in local soils.

The 303(d) listing of iron and manganese in the Tualatin River did not result in a TMDL because DEQ concluded that these analytes are naturally occurring and not due to anthropogenic impacts (DEQ, 2001). Based on similar geology in the Lower Willamette Basin, it is likely that a TMDL will not be established for the Willamette River.

9.4 PAHs

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals that are both naturally occurring and anthropogenically derived. These ringed hydrocarbons are found both within and as combustion products of organic material, including petroleum hydrocarbons. They are persistent in the environment, hydrophobic (i.e., partition out of water to sediment), and carcinogenic to wildlife and humans. Hydrophobicity increases with the molecular weight of the PAH, while acute toxicity is greater with the lower molecular weight PAHs (LPAHs; Nagpal, 1993; Smith et al, 2000). Several high molecular weight PAHs (HPAHs) are carcinogenic. They are transported by air and deposited as wet or dry deposition on land, resulting in worldwide occurrence at trace levels. As with many toxics, they have been intensively studied in the Great Lakes region. Concentrations of PAHs in air increase in proximity to urban areas. Many regional water quality investigations by the U.S. Geological Survey have found them widespread in streambed sediments.

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 that can eventually lodge in human-consumable fish. In addition, these chemicals have toxic effects on wildlife. The Oregon standard for protection of human health for total PAHs is 2.8 ng/L. No freshwater standard exists.

Part 1: Likelihood of water quality degradation related to stormwater.

Analysis

The lower Willamette River is on the 303(d) list for PAHs, based on estimated 35-day average aqueous concentrations during low flows of 52.9 ng/L at RM 6 on the Willamette River (DEQ, 2002). Concentrations observed during 1998 high flow conditions were estimated to be about half these values (McCarthy and Gale, 1999). In the Portland metropolitan area, these compounds are found in streambed sediments. The USGS found PAHs in mid-channel Willamette River sediments at a concentration of 809 μg/kg in 1997 (measured as the sum of 15 PAH compounds; McCarthy and Gale, 1999); Portland harbor contains PAH hot spots associated with industrial sources with PAH concentrations several orders of magnitude greater.

Smith et al. (2000) report differences in PAH loading in urban runoff as a function of hydrocarbon residue, with loadings from a gas station site substantially higher than loadings from high traffic volume parking lots, which are greater in turn than the loadings from freeway onramp sites, which are greater in turn than loadings from low traffic volume parking lots. Sampling of stormwater runoff by the City of Portland (described in detail below) found PAH concentrations that exceed water quality standards by nearly 2 to 5 orders of magnitude, depending on land use.

Conclusion

Stormwater runoff is the primary pathway by which PAHs in the urban environment reach aquatic systems, and PAHs have been detected in urban stormwater in the Portland area. Storm runoff also transports eroded soil containing PAHs to the aquatic environment, and some of this runoff occurs via MS4 systems. Because water quality degradation occurs with very low concentrations of these PAH chemicals, stormwater can easily contribute to water quality degradation in the Willamette River.

Part 2: What is the relationship between the 303(d) listed pollutant and the MS4 discharges?

Analysis

Stormwater conveyance, whether in a piped system or surface conveyances (e.g., ditches and channelized streams) is designed to get stormwater quickly off impervious surfaces in the urban environment. Therefore, urban runoff has relatively little contact time with soil and other environments where PAHs can be chemically bound prior to reaching receiving waters. The City of Portland sampled stormwater for PAHs as a function of land use in preparation for application of their initial NPDES MS4 permit. Total PAH concentrations ranged from 105 ng/L in runoff from open space, through 1,929 ng/L at residential stations, to 6,925 ng/L at commercial sites, 10,058 ng/L on a traffic corridor, and 34,539 ng/L at stations representing industrial land uses (WCC, 1993). HPAHs were 72% of the total PAH concentration at the open space sites, 54% of the total at the residential sites, 40-41% of the total at the traffic, commercial, and mixed use sites, and 8% of the total at the industrial sites.

Conclusion

These data indicate that urban stormwater systems in Oregon provide efficient transport pathways for PAHs to reach receiving waters via MS4 systems. The limited sampling by the City of Portland also demonstrates that urban background concentrations of PAHs in runoff (i.e., from open space) exceed water quality standards – either because natural PAHs would result in exceedances, or because airfall deposition contributes broadly to PAH loadings. The data also indicates the importance of stormwater treatment for high traffic and industrial areas to remove PAHs. Treatment of stormwater from areas directly exposed to hydrocarbons and hydrocarbon combustion products is more important than reduction of soil erosion for reducing PAH concentrations in urban runoff.

Part 3. Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants.

Analysis

Structural BMP effectiveness data for PAHs is extremely limited: only 3 sites included in the International BMP database appear to have been sampled for PAHs in inflow and outflow; a few additional sites analyzed retained sediment for PAHs (ASCE, 2005). Recent sampling of treated municipal stormwater prior to injection into the subsurface via dry wells or other underground injection control devices detected no benzo(a)pyrene (a PAH) above the detection limit of 100 ng/L (GeoSyntec, 2004). Because the BMP effectiveness data are severely limited, the effectiveness of stormwater BMPs to reduce PAH concentrations cannot now be quantitatively assessed. Furthermore, if the goal of structural BMPs is to achieve effluent concentrations that are at or below ambient concentrations, which are already quite low (i.e. in the 1×10^{-6} mg/L range), it may not prove to be entirely cost effective or feasible to monitor for this parameter.

In the absence of data, stormwater BMPs that would conceptually be most effective at reducing PAH loads would include the following characteristics:

- They trap sediment (particularly fine sediment) and floating hydrocarbons and ensure that they are not easily remobilized.
- They promote reduction in flow volumes such that PAHs would be incorporated into the soil matrix.
- They promote degradation or sequestration in the soil matrix.

Conclusion

With the lack of quantitative structural BMP effluent data, the goal of stormwater BMPs should be to reduce the load of PAHs to receiving waters by controlling hydrocarbons and, to a lesser extent, soil and sediment. The City of West Linn's SWMP includes BMPs for sediment reduction (catch basin cleaning, structural BMP maintenance) and roadway maintenance activities (street sweeping). The following BMPs are in place to address PAH loading:

- **Continue to Implement the Illicit Discharges Elimination Program**
- **Continue to Implement the Spill Response Program**
- **Conduct Stormwater Conveyance System Cleaning and Maintenance**
- **Conduct Catch basin Cleaning and Maintenance**
- **Conduct Street Sweeping**
- **Continue to Implement the Erosion Control Manual**
- **Conduct Erosion Control Inspections**
- **Ensure Staff Training for Spill Response**
- **Provide Educational Information to Construction Site Operators**
- **Provide Public Education and Outreach Materials Regarding Stormwater Management**

9.5 PCBs, DDT, DDE, Aldrin, Dieldrin

PCBs and organochlorine (OC) pesticides in the aquatic food chain are now recognized as a widely distributed problem throughout North America in much the same manner as mercury (USGS, 1999). In the City of West Linn, polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane/dichlorodiphenyldichloroethylene (DDT/DDE), aldrin, and dieldrin are on the 303(d) list for the lower Willamette River (DEQ, 2002)[8]. Concentrations of these compounds are found in excess of ambient water quality standards, and are the sources of fish consumption advisories. All of these organochlorine (OC) compounds have anthropogenic sources:

- 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 U.S. in 1977 due to deleterious effects on wildlife and human health. PCB-containing equipment was aggressively

[8] The lower Willamette River is also listed for pentachlorophenol (PCP). However, this listing is associated with creosote-contaminated sediments in the vicinity of the McCormick and Baxter wood-treating site rather than with any conditions arising from activities within the City of West Linn. For this reason, the contribution of the MS4 system to PCP loading in the lower Willamette is not evaluated.

retrofitted throughout the 1980s and 1990s to remove PCBs, so little equipment containing PCBs remains in use in the U.S. (ATSDR, 2005).

- DDT was widely used as an insecticide, particularly for agricultural application to control mosquito outbreaks. DDE is also a contaminant, generated during the manufacturing of DDT and found in the environment as one of the breakdown products of DDT. DDT was banned in 1972 after it was found to significantly impair eggshell development in birds exposed to DDT through the food chain (ATSDR, 2004b).
- Aldrin and dieldrin are pesticides that were commonly used for agricultural purposes (corn, root crops) from the 1950s to 1970s. They were banned in 1974 except for use in termite control; all uses were banned in 1987. Both are neurotoxins. Aldrin breaks down quickly to dieldrin (ATSDR, 2004a).

These OC compounds 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. Where studied intensively in the Great Lakes region, these compounds are found to be transported in air, and deposited as air deposition, with an environmental half life of approximately 6 years (e.g., Hillery et al., 1997). National water quality investigations by the US Geological Survey have found them widespread in streambed sediments (USGS, 1999). Because of the common properties of these compounds, their relationship to urban stormwater in the Portland metropolitan area will be evaluated as a group.

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 that can eventually lodge in human-consumable fish. In addition, these chemicals have toxic effects on wildlife. Oregon DEQ (ODEQ) has recently revised water quality standards for toxic compounds that are pending EPA approval. All standards are set at levels that can be exceeded with trace amounts of these OC compounds present in the water column. Ambient water quality criteria that are protective of aquatic life are:

- PCB: 2,000 and 14 ng/L (acute and chronic criteria, respectively)
- DDT: 1,100 and 1 ng/L (acute and chronic criteria, respectively)
- Dieldrin: 2,500 and 1.9 ng/L (acute and chronic criteria, respectively)
- Aldrin: 3,000 ng/L (acute criterion)

The most restrictive of the water quality standards—for consumption of fish and water, with a cancer risk of 1 per million exposed individuals are:

- PCB: 0.079 ng/L
- DDT: 0.024 ng/L
- Aldrin: 0.074 ng/L
- Dieldrin: 0.071 ng/L.

Part 1: Likelihood of water quality degradation related to stormwater.

<u>Analysis</u>

Recent TMDL documents state that ambient aqueous concentrations of DDT and dieldrin in Johnson Creek exceed fresh water chronic water quality standards of 1 ng/L and 1.9 ng/L, respectively (DEQ, 2004). Repeated sampling of Johnson Creek (and its Kelly Creek tributary and two associated storm drains) by the USGS, ODEQ, and the City of Portland have found these OC compounds at trace amounts (ng/L levels, frequently exceeding chronic criteria) in the water column (McCarthy and Gale; 1999 Tanner and Lee, 2004). Aldrin and PCBs were rarely detected in the sampling results presented in these reports (although the detection limit used in the Tanner and Lee study exceeded the chronic criteria by an order of magnitude). Dieldrin was commonly found in Johnson and Kelly Creeks and the Willamette River but not in the storm drain samples. The DDT species was the dominant species (50-70%) of the total DDT (sum of DDX species) (Tanner and Lee, 2004). DDT concentrations from Johnson Creek measured in 2002 were approximately an order of magnitude lower than those measured in 1989-90 (Tanner and Lee, 2004). Tanner and Lee found positive correlations between DDT concentrations and both turbidity and suspended sediment: a TSS concentration of 8 mg/L at Palmblad Road in upper Johnson Creek, and 15-18 mg/L at lower-basin sites would be sufficient to result in exceedances of the chronic water quality standard.

Sources of these compounds in the environment are identified in the TMDL as primarily related to streambed sediments, which themselves have an upland (soil) source. DDT concentrations in sediments in Johnson Creek range from 11 to 510 μg/kg, with the highest concentrations found in agricultural areas upstream of the Gresham City limits. Dieldrin was also found to exceed preliminary effects concentrations (i.e., a common screening level at which toxic effects are found) only at an upstream site (Pugh, 2005). PCB concentrations in Johnson Creek exceed the screening level value of 7 μg/kg locally in the upper basin and regularly below river mile 3, with a maximum concentration in recent sampling of 406 μg/kg. PCBs in Willamette River sediments were measured in 1997 at 15 μg/kg (McCarthy and Gale, 1999) upstream of Portland Harbor.

The USGS reports that nationally concentrations of dieldrin are typically highest in urban areas, presumably as a result of their use to control termites (USGS, 1999). This points to the potential for exceedances of dieldrin concentrations to result from urban stormwater discharges. Soil represents a major environmental reservoir of DDT and PCBs; therefore, reduction in DDT and PCB loads are related to reducing soil erosion.

<u>Conclusion</u>

Stormwater runoff is the primary pathway by which aerially deposited toxics in the urban environment reaches aquatic systems. Storm runoff also transports eroded soil to the aquatic environment, and some of this runoff occurs via MS4 systems. Finally, water quality degradation occurs at very low concentrations of these OC chemicals. Based on this analysis, it is possible that OC-enriched sediment resuspended in urban stormwater can contribute to water quality degradation in the Willamette River and tributaries for PCBs, DDT, aldrin, and dieldrin.

Part 2: What is the relationship between the 303(d) listed pollutant and the MS4 discharges?

Analysis

Stormwater conveyance, whether in a piped system or surface conveyances (e.g., ditches and channelized streams) is designed to get stormwater quickly off impervious surfaces in the urban environment. Therefore, urban runoff has relatively little contact time with soil and other environments where OC can be chemically bound up prior to reaching receiving waters. From the data summarized above, it does appear that MS4 systems may be minor sources of these organochlorine compounds, particularly PCBs due to their use in industrial (i.e., urban) settings. However, the only detected concentrations of these OC compounds in an MS4 system were DDT from land use-based sampling in Portland in 1991-1993 (WCC, 1993) (residential concentrations up to 0.13 μg/L DDT+DDE, industrial concentrations up to 0.315 μg/L DDT+DDE), and from Johnson Creek in 2002 (0.018 μg/L DDT+DDE in a Portland storm drain at SE 45^{th}) (Tanner and Lee, 2004).

Conclusion

Data discussed in Part 1 and 2 indicates that while urban stormwater systems in Oregon provide efficient transport pathways for OC compounds to reach receiving waters, they have been detected in only limited quantities in the MS4 system. Elevated urban peak flows can promote resuspension of OC-enriched streambed sediments, effectively moving the problem "downstream." Soil erosion can also contribute to elevated OC loading in the urban environment, although erosion control is a more substantial issue in agricultural or forest harvest settings (DEQ, 2004b).

Part 3. Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants.

Analysis

The goal of stormwater BMPs should be to reduce the load of OC compounds and other hydrophobic toxic compounds discharging to receiving waters. Therefore, sediment-trapping BMPs are expected to be effective at trapping these compounds as well as BMPs that reduce runoff volumes in a manner that limits peak flows causing instream erosion.

BMP effectiveness data for OC compounds are essentially non-existent: only one site included in the International BMP database appears to have been sampled for OC compounds for inflow and outflow, and for those observations, OC compounds were either not detected or detected at low concentrations in both effluent and influent (results summarized below; ASCE, 2005). Because data are severely limited, the effectiveness of stormwater BMPs cannot currently be quantitatively assessed. Stormwater BMP effectiveness should be tested using well controlled and documented evaluation protocols. Furthermore, target effluent concentrations should be at or below ambient concentrations that are already quite low. For this reason, none of these BMPs may result in sufficiently low effluent concentrations necessary to achieve human health-based water quality criteria. Based on available information, stormwater BMPs that would conceptually be most effective at reducing OC compounds would include the following characteristics:

- They trap sediment (particularly fine sediment) and ensure that they are not easily re-mobilized.
- They promote reduction in flow volumes such that OC compounds would be incorporated into the soil matrix.
- They promote reduction in flow volumes such that instream sediments are not unnecessarily resuspended beyond natural conditions.

Conclusion

Effectiveness of stormwater BMPs to address OC compounds cannot be determined quantitatively at this time. However, based on available information, BMPs that focus on preventing soil erosion and treating stormwater containing eroded soils are expected to be most effective at reducing these OC compounds in stormwater. City of West Linn BMPs that would be expected to be beneficial at reducing the discharge of OC compounds are as follows:

- **Continue to Implement the Illicit Discharges Elimination Program**
- **Continue to Implement the Spill Response Program**
- **Conduct Stormwater Conveyance System Cleaning and Maintenance**
- **Conduct Catch basin Cleaning and Maintenance**
- **Conduct Street Sweeping**
- **Continue to Implement the Erosion Control Manual**
- **Conduct Erosion Control Inspections**
- **Ensure Staff Training for Spill Response**
- **Provide Educational Information to Construction Site Operators**
- **Provide Public Education and Outreach Materials Regarding Stormwater Management**

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SECTION 10 BENCHMARKS

10.1 Introduction

The City of West Linn's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Sewer Storm System (MS4) permit issued in July 2005, requires Clackamas County and its co-permittees (including the City of West Linn) to implement various categories of stormwater quality best management practices (BMPs) in order to reduce pollutants in runoff to the "maximum extent practicable" (MEP). In addition, if a total maximum daily load (TMDL) has been established, Clackamas County and its co-permittees are required to establish benchmarks for the applicable TMDL parameters. For the 2004 – 2009 permit term, West Linn is required to evaluate their progress towards meeting the benchmarks. If the benchmarks are not achieved, the permit requires an adaptive management approach that will allow the permittees to propose and implement changes to their program in a continual effort towards meeting the benchmarks. Specific requirements from the City's NPDES MS4 permit are as follows:

Schedule D2(d)
i) Progress towards reducing TMDL pollutant loads must be evaluated by the co-permittee through the use of performance measures and pollutant load reduction benchmarks developed and listed in the SWMP.

(2) A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a [Waste Load Allocation] WLA is established at the time of permit issuance. A benchmark is used to measure the overall effectiveness of the storm water management plan in making progress toward the wasteload allocation (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal that is subject to the maximum extent practicable standard. The co-permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale.

This section of the interim evaluation report provides the following:

- Areas where TMDLs apply within the City's permit boundary (i.e., applicability of the benchmark requirement) – Section 10.2.
- The City's overall process towards the development of benchmarks – Section 10.3.
- A summary of the City's participation in a statewide process to coordinate on issues related to the development of benchmarks – Section 10.4.
- The specific pollutant load modeling methods, assumptions, and rationale for the development of benchmarks – Section 10.5.
- Results of the benchmark process and relationship between the benchmarks and the TMDL waste load allocations- Section 10.6.
- References – Section 10.7

This section is organized according to the section numbers listed for each bullet above.

10.2 Applicability of the Benchmark Requirement

Existing TMDLs

As described above, the development of benchmarks is only required for areas where TMDL waste load allocations have been established and approved by EPA prior to the time of NPDES MS4 permit issuance. Within the West Linn permit area, a TMDL was established in 1998 and updated in 2001 for the Tualatin River.

TMDLs are generally developed as a way to project the maximum pollutant load capacity of a waterbody so as not to exceed water quality standards. They may be developed for pollutants with direct links to stormwater runoff (aka: metals, nutrients) and also for pollutants for which loads of concern are not typically associated with urban stormwater runoff (temperature). To translate the TMDL into guidelines for municipalities and industries, wasteload allocations (WLAs) are developed, which allocate a proportion of the total maximum daily load to contributing sources (industries, future growth, municipalities, groundwater, CSO, wastewater treatment plants, etc). WLAs were originally developed as a means to regulate discharges from well-defined point sources (industries and wastewater treatment plants), but with the implementation of MS4 NPDES permits, WLAs are now used to regulate discharges from urban stormwater runoff, which includes a wide variety of sources that are not well defined. This has resulted in inherent difficulties in applying WLAs to MS4 discharges.

Table 10-1 is provided to show a summary of the relevant TMDL affecting the City of West Linn that was established at the time of permit issuance (March 2004). The table includes the TMDL water body, the parameters for which a TMDL was established, a summary of the existing water quality standards for each listed parameter, and the waste load allocation for each listed parameter. It also summarizes the current Willamette River 303(d) parameters, for which the City of West Linn will need to establish benchmarks in the future.

The wasteload allocations described in the Tualatin River TMDL also apply to the City of Lake Oswego, another co-permittee on the Clackamas County permit, and Clackamas County itself, in addition to a number of other jurisdictions outside the Clackamas County permit area (City of Portland, Multnomah County, Oregon Department of Transportation (ODOT), Clean Water Services). The parameters for which relevant waste load allocations (WLAs) have been established for the Tualatin River watershed are:

- Bacteria
- Dissolved Oxygen
- Total Phosphorus

The Tualatin River watershed includes approximately 600 acres within the City of West Linn's current city limits. This area represents about 11% of the total city area and 0.13% of the total Tualatin Watershed Area. When the city area draining to the Tualatin River was determined for the benchmarks analysis, state roads were not included, as ODOT is classified separately in the TMDL.

TABLE 10-1 - Tualatin and Willamette River TMDL and 303(d) Summary

City of West Linn - TMDL

Waterbody	Sub-basin	Constituent	Water Quality Standard	Design Storms/Flows used for Analysis	Load allocation (LA)	Comments
Tualatin River	**Middle Willamette**	Bacteria	A 30-day log mean of 126 E.Coli/100 mL and no single sample shall exceed 406 E.Coli/ 100mL.	Winter design storm (November 1 - April 31) = 1.96"/96 hour event Summer design storm (May 1 - October 31) = 0.11"/24 hour	Concentration (measured as an EMC): Summer: During runoff events = Median 12000 E coli/100mL; all other times = Median 406 E coli/100mL Winter: During runoff events = Median 5000 E coli/100mL; all other times = Median 406 E coli/100mL Load specific for West Linn (using design storms as specified): Summer: 2.48E+13 E Coli counts/day Winter: 4.57E+13 E Coli counts/day	Load allocations were developed to meet the water quality standards.
		Dissolved Oxygen	The lower Tualitin River is considered cool water habitat for steelhead salmonid spawning (Dec 15 through May 31). Minimum of 11.0 mg/L for salmon spawning habitats during periods of spawning. Absolute minimum of 6.5 mg/L for cool water habitats supporting aquatic life. Settleable volatile solids and ammonia load allocations translate into meeting the 6.5 mg/L DO standard (see load allocation column).	N/A	Settleable Volatile Solids (applicable May 1 to October 31) = 20% reduction in settleable volatile solids in stormwater runoff. There is no ammonia WLA identified for the City of West Linn or the lower Tualatin River in the TMDL.	Due to the lack of data on settleable volatile solids, use of TSS as a surrogate (1:1) may be implemented.
		Total Phosphorus	Background concentration is used as the water quality standard. The Tualatin mainstem background total phosphorus concentration at RM 5.5 (furthest downstream RM indicated) is 0.10 mg/L.	Summer design storm (May 1 - October 31) = 0.11"/24 hour	Concentration: Summer allocation for sources to the mainstem Tualatin below Dairy Creek = 0.14 mg/L (summer median concentration May 1 - October 31) Load specific for West Linn (pounds per TMDL season): Summer = 26.4 pounds	Allocations are updates to the initial Tualatin River TMDL completed in 1991, which addressed chlorophyll a and pH violations. Total phosphorus is a key nutritional load supporting excessive algal growth, thus leading to increased pH and low dissolved oxygen concentrations.

City of West Linn - 303(d)

Waterbody	Sub-basin	Constituent	Time Frame	Parameter Listing Year
Willamette River	Lower Willamette	Dieldrin	Year Around	2002
		DDT	Year Around	2002
		DDE	Year Around	2002
		Biological Criteria	Not reported	1998
		Aldrin	Year Around	2002
		PCB	Year Around	2002
		Iron	Year Around	2002
		Mercury	Year Around	1998
		Fecal Coliform	Winter, Spring, Fall	1998
		PAH	Year Around	2002
		Manganese	Year Around	2002

Pending TMDLs

A draft TMDL currently exists for the Willamette River (mercury, bacteria, and temperature), thus benchmarks will need to be established for mercury and bacteria during the next permit cycle (2009). Temperature is not considered to be a stormwater related pollutant; therefore it is not a parameter addressed by the NPDES permit and does not require a benchmark to be established.

However, the current permit requires an evaluation of stormwater with respect to the parameters that are included on the State's 2002 303(d) list for the water bodies within the permit boundary. This evaluation includes parameters outlined in the pending Willamette River TMDL and includes iron, manganese, various organic compounds, bacteria, mercury, and PAHs. That evaluation is provided in Section 9.0 of this interim evaluation report.

10.3 Overall Process for Developing Benchmarks

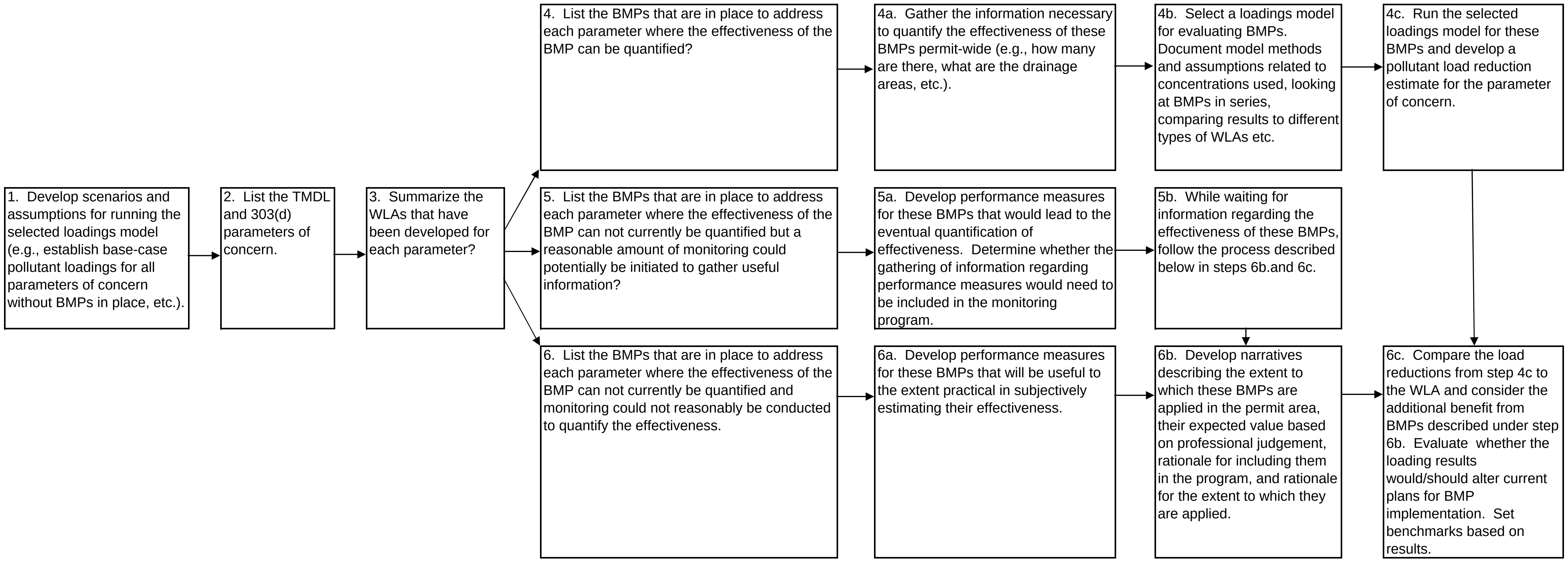
Establishing benchmarks relies on the use of a pollutant loadings model to calculate pollutant loads for select parameters, select scenarios, and under select development conditions. Once loads are generated, both with and without best management practice (BMP) implementation, a comparison between the loads and the wasteload allocation (WLA) identified in the TMDL can be used to estimate the effectiveness of the City's current stormwater management program. As described in Section 10.1, a benchmark is defined as a pollutant load reduction estimate. Therefore, the differences between loads without BMPs and reduced loads associated with BMPs define the City's benchmarks.

A general process was developed to assist in the benchmark development effort, and the resulting benchmark process flowchart is shown in Figure 10-1. The flowchart was developed as a template for jurisdictions (the City of West Linn) to follow when looking at estimated pollutant loads with respect to the TMDL's wasteload allocation and was followed for each TMDL parameter. As shown on the flow chart, there are three categories of BMPs that were considered in the evaluation:

1) Structural BMP systems or practices where pollutant removals can be reported quantitatively and are based on the results of scientific research (i.e., effluent concentrations).
2) Structural and/or source control BMP applications or practices administered where pollutant removals could potentially be reported in objective, quantitative terms but the research has not yet been conducted and information is not yet available.
3) Non-structural/source control BMP applications where pollutant removals are not likely to be reported in objective, quantitative terms.

Once a comprehensive BMP inventory was obtained for West Linn, the approach illustrated in Figure 10-1 split into three directions depending on the three BMP types described above. For the type of BMPs described under category 1) above, the approach relied on the use of a pollutant-loading model to quantify the effectiveness of these BMPs. For the type of BMP described under category 2) above, the approach recommended that some type of monitoring plan be developed and assessed as to the effectiveness of these BMPs, to eventually obtain

Figure 10-1
Proposed Process for Developing MS4 NPDES Stormwater Benchmarks



information or at least to track literature to the extent possible. Until more comprehensive monitoring is completed for these BMPs, the approach treated them the same as the BMPs described under category 3) above. For BMPs described under category 3) above, the approach relied on the development of narratives describing the extent to which these BMPs are applied. This three-tiered approach is considered conservative, as it does not estimate pollutant load removal achieved by category 2 and 3 type BMPs. However, it is acknowledged that these BMPs maintain some inherent benefit, although not currently documented or tested.

Rather than try to make best professional judgments regarding the quantitative effectiveness of BMPs in categories 2) and 3), the approach is to first compare pollutant loads generated after applying the structural BMPs in category 1) to the TMDL waste load allocations (WLAs). This will provide a relative picture as to how close or how far off the permittees are with regards to meeting the WLAs with structural BMPs alone. If the structural BMP program is very close to meeting WLAs, a general statement based on best professional judgment was made as to whether or not the non-structural or non-quantifiable BMPs would be expected to be sufficient to achieve the WLAs. That estimate may then be verified by future ambient water quality monitoring.

This process outlined in Figure 10-1 was applied to each Tualatin River TMDL parameter for the Tualatin River watershed area within the West Linn MS4 permit area. Assumptions made in developing loading estimates and estimating the effectiveness of BMPs is documented in Sections 10.4 and 10.5 below.

10.4 Statewide Process Related to the Development of Benchmarks

As numerous jurisdictions are covered by the six Oregon Phase I NPDES MS4 permit requirements, some of these jurisdictions decided to coordinate efforts in order to share ideas and information, maximize the effectiveness of investments in research, and to maintain consistency with respect to interpretation and implementation of the permit requirements. The statewide coordination process was facilitated through the Oregon Association of Clean Water Agencies (ACWA) Stormwater Committee. Specifically, ACWA decided to coordinate on the following three items:

1) Model Development - Development of modeling methods and a modeling tool to be used to estimate pollutant loadings and evaluate the effectiveness of municipal stormwater management programs in reducing pollutant loads.

2) BMP Database - Development of a database to summarize what is currently known regarding the effectiveness of BMPs.

3) Typical Concentrations - Development of tables that include typical land use runoff concentrations and typical effluent concentrations from BMPs. The concentrations in these tables would be used as input data for the pollutant-loading model. The tables were developed using data obtained by local jurisdictions in addition to published, statistically verified national data. Data was combined, statistically validated, and provided in terms of means and median values.

The City of West Linn is a member of ACWA and therefore was able to use the results of the ACWA study to assist in their own efforts. The City opted to use a different model than the one developed by ACWA, but did utilize a similar modeling approach and the tabular data summarizing typical land use runoff concentrations and BMP effluent concentrations for use in their modeling. The concentration data used by the City is provided in Tables 10-2 and 10-3. The Tualatin River TMDL was based on median data values for total phosphorus and dissolved oxygen, and the mean data values for bacteria calculations. The tables include the mean and median values for reference. When the median data was used in the TMDL, median land use concentration and BMP effluent data was used in the model; if mean data was used in the TMDL, mean land use concentration and BMP effluent data was used in the model. It should be noted that there were some gaps in the available data. In some cases information regarding specific parameters was not provided in the literature. In other cases, for specific BMPs, effectiveness data were either not provided at all, or the data were not robust or sufficient for computing medians or means. Methods for dealing with these data gaps are discussed in the following sections.

With the amount of variability in the data used in the modeling, the City of West Linn chose to apply a range to the resulting loads generated from the model and report their benchmarks as this resulting range. The City of Portland conducted a statistical analysis of the ACWA land use data to assess the use of upper and lower 95% confidence intervals in establishing ranges around the means and medians. Using the raw data resulted in some negative numbers for ranges.

Therefore, the City of Portland chose to use a “bootstrapping” statistical method to estimate land use concentration ranges. In essence, this method normalizes the data, resulting in more reasonable upper and lower confidence intervals (i.e., non-negative numbers). However, in using this method, the means and medians were also slightly adjusted and differ from the data produced by ACWA. The City of West Linn chose to use the data from ACWA. To estimate ranges, the ranges from the City of Portland data were converted to percentages above and below the mean or median and averaged for each parameter. The relative range was then applied to the pollutant loads generated from the model based on the ACWA data.

10.5 Modeling Methods and Assumptions

As described in Section 10.4, the City of West Linn did not elect to use the pollutant loads model (PLOAD) developed during the ACWA study. Instead the City opted to use a spreadsheet model that utilizes EPA simple method for pollutant load generation, consistent with the approach used in ACWA’s model. A spreadsheet model was generated using EPA’s equations, such that once demographic information is entered into the spreadsheet, loads are automatically calculated. The model was used to estimate current pollutant loads, assuming no structural BMPs in place and with structural BMPs in place, and future pollutant loads (2025) assuming development and UGB expansion, with no structural BMPs in place and with structural BMPs in place. Quantitative data is not currently available to assess the effectiveness of non-structural BMPs. Therefore, estimates of the relative effectiveness of non-structural BMPs based on best professional judgement are made in the results and discussion sections of this memo (Section 10.6). This section will describe the assumptions and methods associated with developing the model. The subsections below include information regarding the following: modeled areas,

TABLE 10-2: Summary of ACWA Land Use Concentration Statistics

Parameter	Land Use	Count	Arithmetic Mean	Arithmetic Std. Dev	Median	Geomean	MLE-Mean	RATIO Mean / Median
TSS	C	72	80	81	55	53	83	1.52
mg/L	I	52	136	179	91	77	147	1.62
	OP	10	53	70	16	25	58	3.61
	R	65	60	96	38	36	59	1.56
	T	23	169	128	120	132	169	1.41
Pb,Total	C	25	35	57	17	19	32.0	1.88
µg/L	I	22	48.0	43.9	30.0	32.3	50.7	1.69
	OP	9	2.6	1.2	3.0	2.2	2.8	0.95
	R	28	10.3	6.1	9.5	8.2	11.2	1.17
	T	22	62.8	77.5	40.0	42.6	60.2	1.50
Pb,Dissolved	C	9	4.0	5.4	2.0	2.4	3.9	1.94
µg/L	I	13	3.3	3.0	2.0	2.3	3.3	1.66
	OP	4	1.8	1.0	1.5	1.6	1.8	1.21
	R	5	4.0	2.9	3.0	3.1	4.4	1.47
	T	15	5.0	10.7	1.2	2.0	3.9	3.27
Zn,Total	C	28	154	187	90	106	143	1.58
µg/L	I	25	651	1568	282	286	536	1.90
	OP	9	25	33	12	13	30	2.49
	R	39	105	82	80	80	108	1.35
	T	22	235	162	185	193	236	1.28
Zn,Dissolved	C	18	114	227	50	57	95	1.89
µg/L	I	21	554	1550	220	202	420	1.91
	OP	8	15.3	15.4	7.5	10.9	15.2	2.03
	R	18	60	42	50	50	60	1.20
	T	23	81	95	56	59	76	1.36
Cu, Total	C	26	17.1	14.3	12.5	13.3	16.9	1.35
µg/L	I	26	45.4	33.9	31.0	35.3	45.7	1.47
	OP	10	4.2	1.9	4.0	3.8	4.3	1.06
	R	33	14.2	9.4	10.0	11.8	14.3	1.43
	T	23	34.6	26.3	26.0	27.7	34.8	1.34
Cu, Dissolved	C	10	9.3	12.6	4.0	5.8	8.6	2.15
µg/L	I	20	8.7	6.9	7.0	7.0	8.7	1.24
	OP	8	3.9	1.4	4.0	3.7	4.0	1.01
	R	12	7.1	4.3	5.5	6.0	7.2	1.30
	T	22	9.0	9.0	6.0	6.7	8.6	1.43
BOD	C	22	10.0	10.1	6.7	7.4	9.5	1.43
mg/L	I	23	39.7	38.6	24.0	24.8	42.6	1.77
	OP	3	4.7	1.5	5.0	4.5	4.8	0.96
	R	28	8.8	8.7	5.0	6.1	8.7	1.73
	T	19	16.4	19.7	10.0	10.6	16.2	1.62
COD	C	26	63.5	63.8	46.5	46.6	63.0	1.36
mg/L	I	25	102.7	74.6	81.0	79.6	105.7	1.31
	OP	9	22.0	10.8	24.0	19.1	23.2	0.97
	R	36	55.2	57.9	32.4	38.0	54.0	1.67
	T	11	99.1	130.2	47.0	59.0	94.5	2.01
TP	C	26	0.41	0.71	0.23	0.22	0.368	1.57
mg/L	I	25	0.606	0.317	0.550	0.516	0.637	1.16
	OP	8	0.175	0.051	0.170	0.168	0.176	1.04
	R	36	0.339	0.452	0.200	0.206	0.319	1.59
	T	21	0.373	0.198	0.310	0.328	0.376	1.21
E. coli	C	52	31659	137481	1900	1800		
CFU/100 mL	I	58	73561	492788	795	700		
converted from	OP	9	8632	23391	1090	900		
FC (E. coli = FC*0.81)	R	65	14081	38603	1800	1700		
	T	29	11148	30010	1600	1400		

NOTES

Shaded values are the means used in the pollutant load model

Land Use abbreviations:
- C Commercial
- I Industrial
- OP Open Space
- R Residential
- T Transportation

TABLE 10-3
Summary of ACWA
BMP Effluent Concentration Data

MEDIANS*

Parameter	Units	Centrifugal Separator Hydrodynamic devices	Filters (Leaf/Sand/Other)	Ponds, Dry Vegetated Detention Pond	Ponds - Wet Retention Basin	Swales - Vegetated Filter Strips	Wetlands - Constructed Surface Flow	Sed MH	Green Roofs (4" substrate)	Porous Pavement	Soakage Trenches
TSS	mg/L	57	13	33	16	23	7	50			
TP	mg/L	0.13	0.115	0.29	0.14	0.24	0.077				
E. coli	CFU/100 mL		98								
Cu, d	µg/L	6.9	6.6	12	2.9	5.1					
Cu, T	µg/L	12	9.3	20	7.1	11.9	3				
Pb,d	µg/L	1.1	0.13	1.5	0.1	0.415	0.72				
Pb,T	µg/L	5.7	3	18	1.88	7.43	1				
Zn,d	µg/L	25	27	44	17.6	19	11				
Zn,T	µg/L	70	44	83	31.7	47	17				
Flow Reduction	%	0	0	23	5	29	0	0	60	77	100

MEANS

Parameter	Units	Centrifugal Separator Hydrodynamic devices	Filters (Leaf/Sand/Other)	Ponds, Dry Vegetated Detention Pond	Ponds - Wet Retention Basin	Swales - Vegetated Filter Strips	Wetlands - Constructed Surface Flow	Sed MH	Green Roofs (4" substrate)	Porous Pavement	Soakage Trenches
TSS	mg/L	151	43	43	29	32	25	**67**			
TP	mg/L	0.22	0.29	0.35	0.16	0.42	0.16				
E. coli	CFU/100 mL	**3634**	**79**		321	**1820**					
Cu, d	µg/L	14	11	14	**3.2**	**5.9**	**6.4**	**6.3**			
Cu, T	µg/L	15	18	28	**7.7**	**12.5**	**4.1**	**14.8**			
Pb,d	µg/L	2.1	**0.13**	2.4	**0.13**	**0.50**	2.5	**0.26**			
Pb,T	µg/L	14	7.6	32	**2.47**	**7.8**	3.3	**9.3**			
Zn,d	µg/L	35	73	59	**30.0**	**20.6**	14	**38.4**			
Zn,T	µg/L	103	143	123	**74**	**55**	32	**93**			
Flow Reduction	%	0	0	23	5	29	0	0	60	77	100

NOTES

Values in **Bold** are calculated from City of Portland BMPs

Conversion factor from Fecal coliform to E. coli = 0.81

* Median values were used for the City of West Linn, due to the TMDL being in terms of medians.

model scenarios, model assumptions related to land use and BMP effectiveness, and methods for comparing model results to waste load allocations.

10.5.1 Modeled Areas

As mentioned above, the Tualatin River is the only surface water body with a TMDL in place within the West Linn NPDES permit boundary. The Tualatin River watershed currently encompasses about 11% of the total city area. The City of West Linn used their GIS to estimate total areas draining to the Tualatin River for current conditions and for future conditions, assuming expansion of the City's UGB. The total West Linn-Tualatin drainage area for current conditions is estimated to be 595 acres and for future conditions is estimated to be 639 acres. As mentioned previously, the Tualatin River watershed area within the city limits that is the responsibility of another permittee (i.e., state roadways) was omitted from the modeled area.

10.5.2 Model Scenarios

In order to estimate loadings based on current and future development and BMP application, it is necessary to model various scenarios to depict how pollutant load generation and wasteload allocation comparisons will change with time. Assumptions and details related to each proposed scenario are described below.

Current Scenario:
The current condition (2005) model scenario uses current condition land use information and land use runoff concentrations estimated by ACWA. Structural BMP systems were considered in this scenario. Structural BMP drainage areas were delineated and the respective treatment areas were estimated for use in the model. Structural BMP systems modeled included both public and private facilities. Although some effectiveness information is available for street sweeping activities (a non-structural BMP), sweeping was already being conducted when the ACWA land use data was collected. Therefore, street sweeping should only be included in the model if the frequencies of sweeping have increased since that time. Street sweeping frequencies have not changed within the City of West Linn; thus, street sweeping was not considered in the model scenario. As mentioned earlier, quantitative effectiveness information does not currently exist for other non-structural BMPs; therefore, other non-structural BMPs were not considered in the model simulation either. An initial load scenario (no BMPs) and a treatment load scenario (with structural BMPs) were simulated based on the characteristics summarized in Table 10-4 and Table 10-5 for current conditions.

Future Scenario
The future condition model scenario assumes full growth of the city to the UGB and full development of vacant parcels in the year 2025. The future conditions model assumes land use information used in the current condition model is still accurate for previously developed parcels. To approximate future development conditions, all vacant parcels from the existing condition land use file were assumed developed and assigned land use and imperviousness based on zoning and representing full build-out conditions. Theoretically, future development conditions would be specifically associated with the year 2009 because that is the end of the permit term. However, due to the level of uncertainty that would be associated with random selection of

which parcels would be developed by 2009, loads were projected for the year 2025. The graphs depicting the benchmarks (section 10.6) were plotted to show the resulting load in 2009. These values were obtained by assuming a linear trend in loading from 2005 to 2025 and interpolating a resulting 2009 load.

Land use runoff concentration values estimated by ACWA were used in this scenario. All current condition structural BMPs were assumed to still be working and in place for this scenario. No capital improvement projects for water quality are currently anticipated for construction. As it is unknown at this time which stormwater treatment (BMP) option new developments will select to comply with development standards, treatment of all previously vacant areas is assumed equal to that of detention ponds. Thus new development standards requiring water quality treatment were incorporated into this scenario. An initial load scenario (no BMPs) and a treatment load scenario (with structural BMPs) were simulated based on the characteristics summarized in Table 10-4 and Table 10-5 for future conditions.

Model Simulations

As mentioned earlier, initial load simulations (no BMPs) and treatment load simulations (with structural BMPs) were conducted given the characteristics summarized in Table 10-4 and 10-5.

In order to compare modeled load results with the wasteload allocation (WLA) defined in the Tualatin River TMDL document, the spreadsheet model was run for specific storm events. The Tualatin River TMDL includes both a summer and winter design storm and seasonal rainfall events. The summer design storm is 0.11”/24 hours, the winter storm event is 1.96”/96 hours, and the summer seasonal rainfall is 6.82”. Loads (reported as pounds) were generated for each parameter based on the specified design storm used in TMDL for that particular parameter.

TABLE 10-4: Summary of Model Input Parameters (Land Use)

	Total Modeled Area (Excludes I-205 corridor)	Land Use Breakdown (acres and % of total area)					
		Residential	Commercial	Agricultural	Open Space	Vacant	Multi-family Residential
City of West Linn Current Condition	595.2 acres	387.9 (65.17%)	4.9 (0.82%)	1.7 (0.29%)	61.6 (10.35%)	92.7 (15.57%)	46.4 (7.80%)
City of West Linn Future Condition	638.9 acres	523.3 (81.91%)	4.9 (0.77%)	1.7 (0.27%)	61.6 (9.64%)	1.0 (0.16%)	46.4 (7.26%)

TABLE 10-5: Summary of Model Input Parameters (BMP Coverage)

	Total Modeled Area (Excludes I-205 corridor)	Structural BMP Coverage Area (acres by land use)						Total BMP Coverage
		Residential	Commercial	Agricultural	Open Space	Vacant	Multi-family Residential	Percentage of total area covered by structural BMPs
City of West Linn Current Condition BMP Coverage	595.2 acres	151.4	1.7	1.7	49.0	66.9	38.6	52%
City of West Linn Future Condition BMP Coverage	638.9 acres	279.0	1.7	1.7	49.1	1.0	38.6	58%

10.5.3 Model Assumptions and Input Data

A number of assumptions were made with regard to the processing and utilization of supplied land use and BMP effluent information in order to generate pollutant loads. The acquisition and analysis of available concentration data was described previously in Section 10.4.

Pollutants of Concern

Per the Tualatin River TMDL, parameters requiring load calculations are total phosphorus, bacteria, and dissolved oxygen. Event mean or median concentrations (EMCs) and effluent concentration information was available for total phosphorus and bacteria, and these parameters were modeled and compared with the WLA as reported in Section 10.6. EMC and effluent concentration information is not readily available for dissolved oxygen. However, the TMDL presents the wasteload allocation for dissolved oxygen in terms of a % reduction in settleable volatile solids. Due to the lack of data on settleable volatile solids, total suspended solids (TSS) is recognized as a surrogate parameter.

Land Use Categories

Land use information was processed internally to group information into only those land use categories for which concentration and impervious information either specifically existed or could be approximated using another representative land use category. Table 10-6 summarizes the modeled land use categories.

Impervious Values

Effective impervious percentages for select land use categories were taken from the draft West Linn Master Plan (2005). The EPA formula (1) was used to translate between percent impervious and a runoff coefficient, for use in the spreadsheet model. Table 10-6 shows the associated impervious values used for select land use types.

(1) $$\text{Runoff Coefficient} = 0.05 * 0.009\ (\%\ \text{Impervious})$$

TABLE 10-6: Land Use Categories and Impervious Values used in the City of West Linn's Pollutant Loads Model [1]

West Linn Modeled Land Use Category	Percentage Effective Impervious Area [2]
AGR [3, 4]	2%
RES	21%
MRES [4]	35%
COM	85%
VAC [4]	0%
OSP	0%

Note 1 = Key of land use abbreviations:

Land Use Category	Referenced Abbreviation
RES	Residential (Single Family)
COM	Commercial
MRES	Multi-family Residential

OSP	Open Space
AGR	Agricultural
VAC	Vacant
RUR	Rural

Note 2 = Impervious values for the various land use categories were taken from the Draft West Linn Master Plan (2005)

Note 3 = Agricultural was not a land use category included in the Draft West Linn Master Plan (2005). Effective impervious for agricultural land use was determined to be similar to that of Rural (RUR) land use.

Note 4 = The land use concentration data shown in Table 10-2 does not include all of the West Linn land use categories. Therefore, some West Linn land use categories were modeled using concentration data from a comparable land use category. This occurred for the West Linn MRES category (modeled using RES concentration data); AGR category (modeled using COM concentration data); and VAC category (modeled using OSP concentration data).

BMP Categories

Because the ACWA study resulted in limited effectiveness information for certain structural BMP types, the City's BMPs were categorized and classified much like the land use data so that effectiveness information either specifically existed or could be approximated using another representative BMP category for all modeled BMPs. Once the BMP categories were defined, city staff estimated the respective BMP drainage areas. Table 10-7 summarizes the modeled structural BMP categories, including the source of BMP effectiveness information if data for such BMP category was not readily available or included in the literature. As mentioned previously, non-structural BMPs were not included in the model simulations.

TABLE 10-7: Structural BMP Categories used in the City of West Linn's Pollutant Loads Model

West Linn Actual Structural BMP Category	West Linn Modeled BMP Category [1]
Pond	Either Dry Vegetated Detention Pond, Wet Retention Basin [2]
Swales	Swales- Vegetated Filter Strips
Wetlands	Wetlands
Pollution Control Manholes	Sedimentation Manholes

Note 1 = The BMP effluent concentration data shown in Table 10-3 does not include the all of the West Linn BMP categories. Therefore, some of West Linn's actual BMP categories were modeled using concentration data from a comparable BMP category. This column identifies the BMP category from Table 10-3 that was used to represent each of West Linn's actual BMP categories.

Note 2 = Pond BMPs had to be further classified according to whether they had a sump (retention/wet pond) or completely drained (detention/dry pond).

Modeling BMPs in Series

Throughout the City of West Linn, there are a number of BMPs that work together in series to achieve pollutant removal. Generally these applications consist of a sedimentation type device (pollution control manhole) upstream of a more regional type pond or wetland facility. For modeling purposes, the furthest downstream BMP system was selected as the representative BMP for drainage areas where more than one BMP is applied. The BMP effluent concentration of the furthest downstream BMP is applied to the entire drainage area to represent treatment of the upstream contributing area. This methodology is consistent with that used by other local jurisdictions. This method does not give credit for additional load removal likely achieved with BMPs in series, which results in conservative load reduction estimates.

10.5.4 Comparison of Model Results to Waste Load Allocations (WLAs)

The Tualatin River TMDL reports wasteload allocations as either a concentration, a load generated for a certain time period, or as a % reduction achieved. The TMDL also outlines specific winter (1.96"/96 hours) and summer (0.11"/24 hours) storm events and seasonal rainfall (6.82"/summer season) events to use when calculating the pollutant loads. As mentioned previously, total phosphorus, bacteria, and TSS (as a surrogate for settleable volatile solids and representative of dissolved oxygen loading) were the parameters modeled and compared to the wasteload allocations. The spreadsheet model is capable of reporting pollutant loads in terms of a concentration (based on the runoff generated for the particular storm event), a load generated (for the specific storm event), or a percent reduction achieved when comparing loads generated both with and without BMP implementation. For consistency with other local jurisdictions, WLAs (as loads) were calculated for total phosphorus and bacteria based on the runoff generated from the appropriate design storm event, the WLA as a concentration specific for the City of West Linn, and the appropriate conversion factors. Equations used for the calculations were provided in the TMDL and are shown below as equations 2 (total phosphorus) and 3 (bacteria).

(2) WLA (lb/season) = Allocation (mg/L) * Seasonal Discharge Volume (ft^3) *6.24×10^{-5}

(3) WLA (Counts/day) = Allocation (Counts/100mL) * Daily Discharge Volume *283 (100mL/ft^3)

The allocation as identified in the TMDL for total phosphorus is 0.14 mg/L and for bacteria is 5000 Counts/100mL (winter) and 12000 Counts/100mL (summer). For dissolved oxygen, since the WLA is reported as a concentration reduction (20%) for settable volatile solids (using total suspended solids as a surrogate), the WLA was calculated as the load resulting from a 20% reduction in the current condition TSS load using the summer design storm event.

A current condition and a future condition model were generated for West Linn, using land use and BMP characteristics described in Table 10-4 and Table 10-5 and mean or median land use and BMP effluent concentration information. The spreadsheet model calculates a pre-BMP pollutant load for each parameter. Then, using the BMP drainage areas, the type of BMP facility, and the relative breakdown of land use inside the BMP drainage area, the model calculates a post-BMP pollutant load for each parameter.

For each parameter, loads (as pounds) were calculated for current condition (2005) and future condition (2025) both with and without BMPs, based on the design storm specified for each parameter. Loads representing 2009 were interpolated from the current and future condition results. As the current permit term only extends until 2009, the plots (benchmarks) only show the projected future condition loads in 2009. The concentration ranges, as described in Section 10.4, were applied to the modeled loads (with and without BMPs). The wasteload allocation as described in the TMDL was plotted on the same graph in order to directly compare the estimated load being generated and the wasteload permitted. The difference between the projected loads with no BMPs and the projected loads with BMPs indicates the amount of load reduction achieved with the currently implemented stormwater program and is representative of the City's benchmarks.

10.6 Model Results and Rationale for the Development of Benchmarks

Figures 10-2, 10-3, 10-4, and 10-5 include the pollutant loading plots resulting from the model assumptions and simulations, as described in previous sections for the City of West Linn.

Prior to summarizing results, it should be emphasized that the results portray the incremental improvements that can be achieved with the implementation of structural BMPs. The City implements a significant number of non-structural BMPs that are not reflected in the results, including public education, illicit discharges elimination, spill prevention, catchbasin cleaning, erosion control, etc.

10.6.1 Model Load Results Summary

The future condition (2009) model results with structural BMPs indicate that the City of West Linn is meeting their wasteload allocation for bacteria and dissolved oxygen but not total phosphorus, when comparing the mean or median model results (with BMPs) to the WLA. However, when comparing the relative range of projected loading with the WLA, it appears the City is meeting their WLA for each parameter.

Specific results for each of the parameters are provided in the following text followed by a description of how benchmarks are defined.

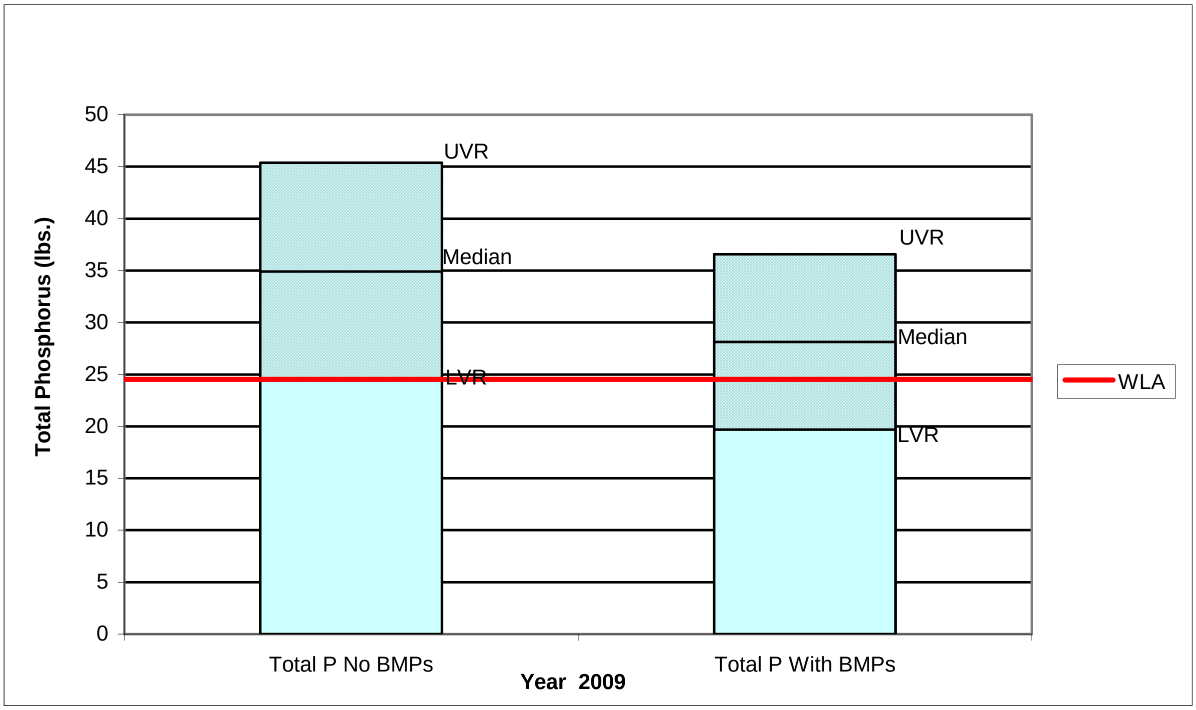
10.6.2 Model Load Results (by parameter)

Total Phosphorus

The following graph (Figure 10-2) contains the total phosphorus load comparison plot for the City of West Linn. In the future condition (2009), the City shows a load reduction of approximately 6 lbs. or 17% due to existing BMPs and planned implementation of structural BMPs associated with anticipated redevelopment. Based on the variability of the data, the pollutant load represented by the low value of the range (LVR) is either just about equal to or lower than the WLA. Therefore, for this parameter it may be reasonable to assume that implementation of non-structural BMPs could potentially reduce the overall median TP load close to the WLA during this permit period.

As the benchmark is defined as a pollutant load reduction, the low value of the TP benchmark range is 4.7 lbs./season, and the upper value of the TP benchmark range is 8.8 lbs./season (see Table 10-8 at the end of Section 10.6.3 for a summary of all the benchmarks).

Figure 10-2: Total Phosphorus Loading



UVR = Upper Value of the Range
LVR = Lower Value of the Range

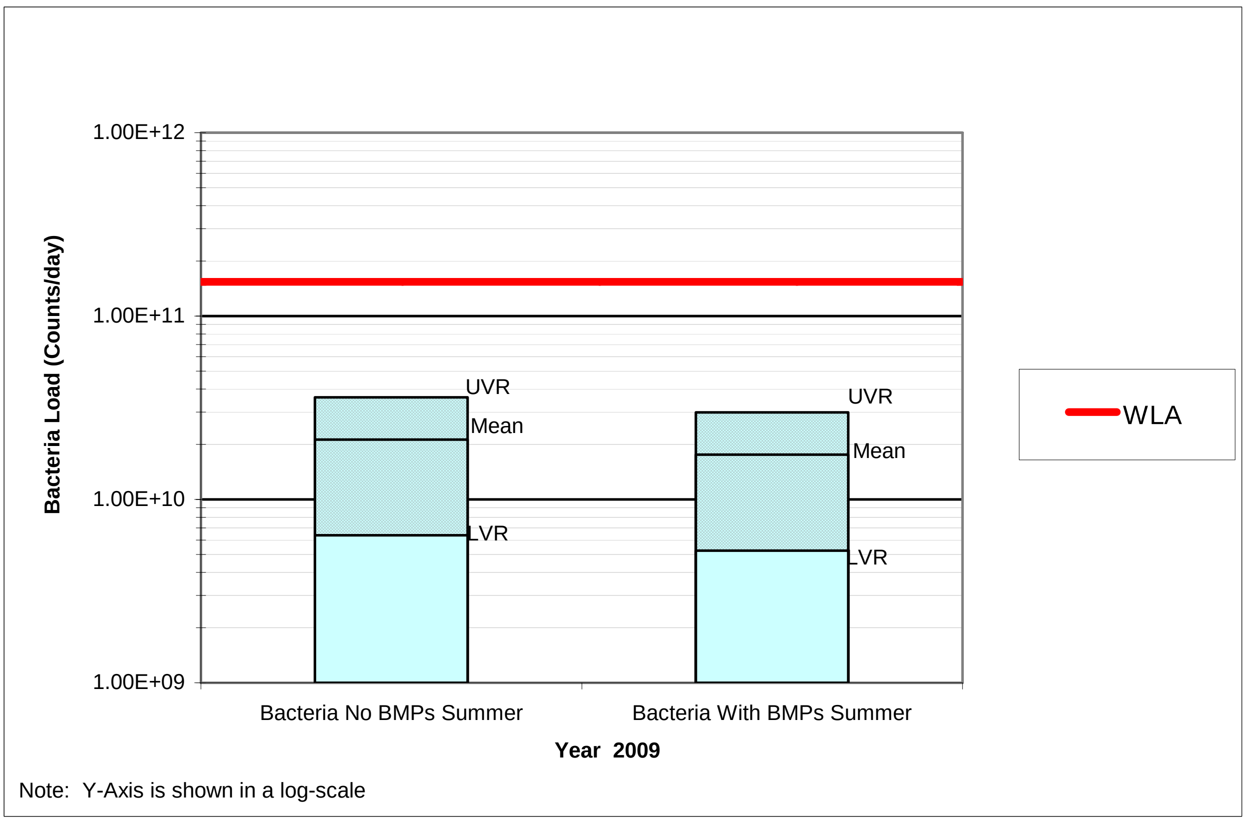
Bacteria

The following graphs (Figures 10-3 and 10-4) contain the summer and winter bacteria load comparison plots for the City. In the future condition (2009), the City shows a load decrease of approximately 4 x 10^9 counts when compared to conditions estimated without BMPs during the summer design storm. The City shows a load decrease of approximately 1.7 x 10^{10} counts when compared to conditions without BMPs during the daily winter design storm. Structural BMPs generally show limited effectiveness for bacteria removal (whether fecal coliform or E.Coli). In some cases, structural BMPs have even been shown to increase bacteria loads if they result in increased habitat for wildlife. Generally, bacteria reduction is due to flow reduction that the structural BMP achieves rather then actual removal of bacteria itself.

The plots indicate that the City will meet both the summer and winter WLA. Although there is not a substantial decrease in loads due to implementation of structural BMPs, for the reasons described above. The anticipated load reduction within the upper and lower value of the range represents the City's benchmark. The low values of the E.coli benchmark range are 1.1 x 10^9 colonies/day in the summer and 5.0 x 10^9 in the winter. The upper values of the E.coli benchmark range are 6.3 x 10^9 colonies/day in the summer and 2.8 x 10^{10} in the winter (see Table 10-8 at the end of Section 10.6.3 for a summary of all the benchmarks).

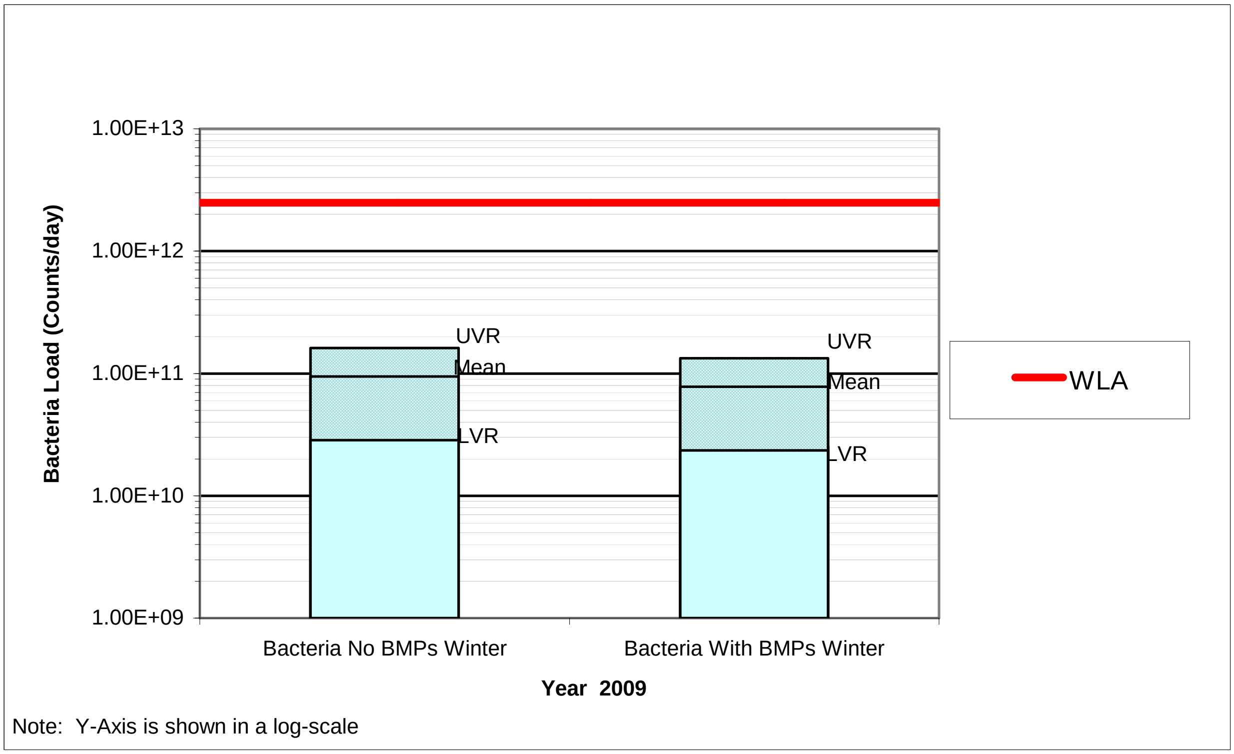
Observations: Potential human sources of bacteria include infiltration from the sanitary system, illicit connections, illegal dumping, and faulty septic systems. However, regionally available bacteria source tracking studies have shown that bacterial sources in urban environments have a very small human-derived component. Human sources have typically been shown to represent between 0% and 8% of the total bacteria count. In a recent local study in Washington County, human sources in the streams represented an average of about 6% of the bacteria and in the storm pipes human sources represented 0% of the bacteria counts. The more predominant sources of bacteria include wildlife (avian and rodent) and/or domestic pets. Non-structural controls to address human sources of bacteria loading are important, even though human sources are not predominant but such controls are unlikely to achieve significant reductions in bacteria loads. It is difficult to develop a benchmark for this parameter because the WLA includes all sources of E.coli including those that the City would not be responsible for reducing (i.e., the goal would not be to reduce wildlife such as avians). As locally and regionally available bacteria source tracking studies have shown that bacterial sources in urban environments are not predominantly human (see the 303(d) evaluation in this Interim Evaluation Report), the City of West Linn's bacteria benchmark for the Lower Tualatin River will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads, especially since the WLAs are being achieved.

Figure 10-3: Bacteria Loading (Summer Storm Event)



UVR = Upper Value of the Range
LVR = Lower Value of the Range

Figure 10-4: Bacteria Loading (Winter Storm Event)



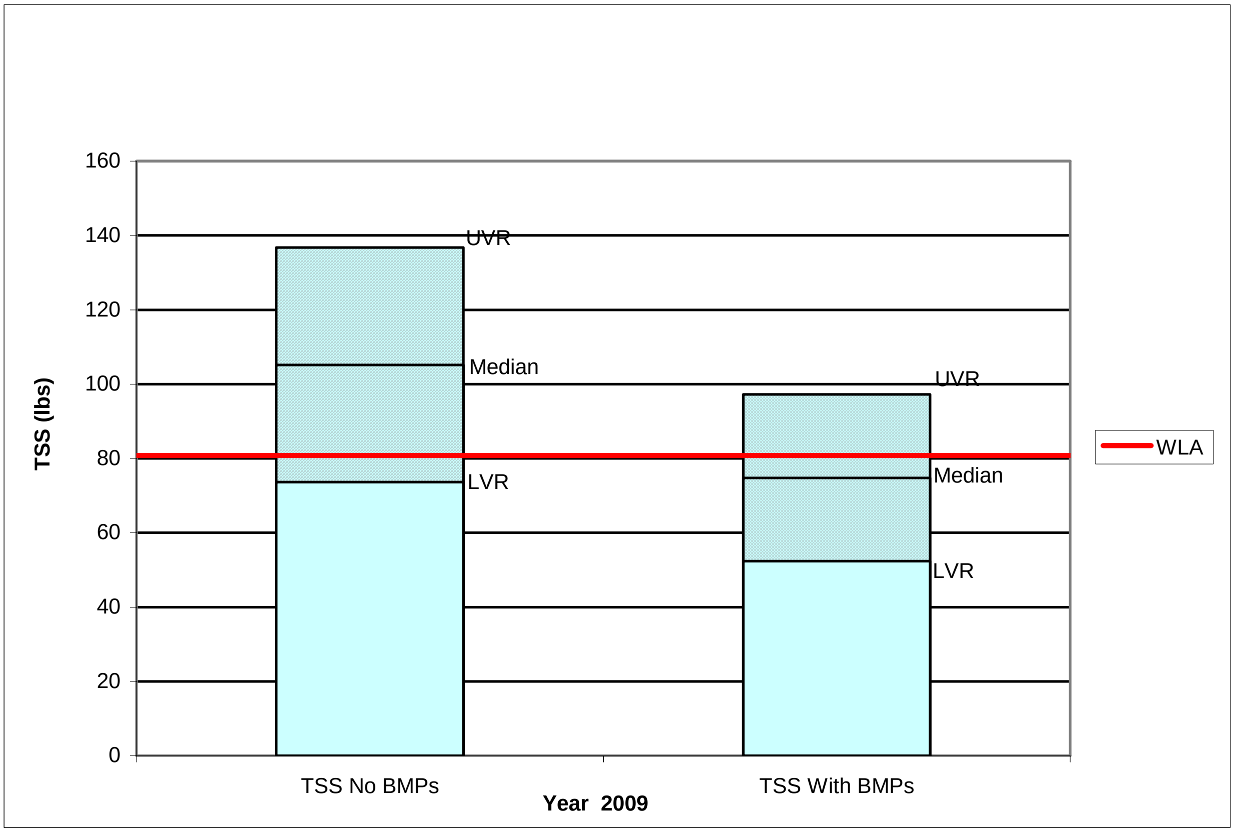
UVR = Upper Value of the Range
LVR = Lower Value of the Range

Dissolved Oxygen

As mentioned previously, the dissolved oxygen WLA is presented as a general percent reduction observed for settleable volatile solids. With limited data available for settleable volatile solids, TSS is the approved surrogate at a 1:1 ratio. The following graph (Figure10-5) shows the TSS pollutant load estimates for the City, assuming the total settleable volatile solids WLA is synonymous with a surrogate TSS load reduction of 20% from current condition, no BMP loads. During future conditions (2009), the City shows a reduction of approximately 30 pounds (or 29%) during a typical summer storm event (0.11"/24 hours) due to implementation of structural BMPs. This reduction allows the City to meet their WLA based on the median loading data. For this parameter it may also be reasonable to assume that accounting for implementation of non-structural BMPs could potentially further reduce the overall median TSS load, as suspended sediment is addressed through a number of non-structural BMPs including catchbasin cleaning and erosion control.

The low value of the TSS benchmark is 21.3 lbs./day (assuming a summer design storm event), and the upper value of the TSS benchmark range is 39.5 lbs./day, also assuming a summer design storm event (see Table 10-8 at the end of Section 10.6.3 for a summary of all the benchmarks).

Figure 10-5: Dissolved Oxygen Loading (based on a summer design storm event)



<u>UVR = Upper Value of the Range</u>
<u>LVR = Lower Value of the Range</u>

10.6.3 Benchmark Development

The City of West Linn's MS4 NPDES permit defines a benchmark as follows:

A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established at the time of permit issuance. …

Figures 10.2, 10.3, 10.4, and 10.5 show the City of West Linn's future (2009) pollutant loadings, assuming no controls, and future (2009) pollutant loadings with structural controls. The WLAs were calculated as a load, either based on an equation included in the TMDL for the parameter (Equations 2 and 3) or on a required percentage reduction in current condition, pre-BMP loading. Modeled load results (2009) and the associated loading range based on the variability in data were plotted in comparison to the WLAs. Pollutant load reduction associated with non-structural controls is not included on the graphs.

Current projections indicate that the City is meeting their WLAs for bacteria and dissolved oxygen, although an argument may be made that if non-structural BMPs were included in the loadings model, the City may also meet their WLA for total phosphorus, as the projected total phosphorus loading is close to the WLA. The WLA is considered an ultimate discharge goal.

For the City of West Linn, the pollutant reductions shown are representative of the implementation of development standards and public structural BMPs. In all, future condition structural BMPs cover about 58% of the total West Linn area draining to the Tualatin. The range around the difference between the 2009 no-BMP loads and the 2009 with-BMP loads are the City's benchmarks for the 2004 – 2009 permit cycle. A summary of the benchmarks is provided in Table 10-8. The benchmarks are expected to be conservative (i.e., greater reductions are probably achieved) for several reasons including the following:

1) It is expected that further load reductions would be achieved through the application of the many non-structural controls that the City is implementing, and
2) Whenever an assumption is made in the methods for developing benchmarks, the most conservative assumption was chosen.
3) Structural BMPs operating in series were given the effectiveness of only the most downstream BMP.

The City chose a conservative approach to avoid overestimating the effectiveness of the program. It is anticipated that future monitoring and literature review results will be used to further refine the estimates over time.

The benchmarks reflect the maximum extent practicable standard, as the City is currently able to foresee; however, with adaptive management efforts, the load reductions may increase in the future as more information and/or new, more cost effective technologies become available.

Table 10-8: City of West Linn Benchmarks

Tualatin River TMDL Parameter or Surrogate	Lower Value of the Range	Upper Value of the Range
Total Phosphorus (lbs)	4.7	8.8
E. Coli (Winter) (Counts)	5.0E+09	2.8E+10
E. Coli (Summer) (Counts)	1.1E+09	6.3E+09
Total Suspended Solids (lbs)	21.3	39.5

10.7 References

ASCE/EPA (American Society of Civil Engineers Urban Water Resources Research Council and United States Environmental Protection Agency) 2003, International Stormwater Best Management Practices Database (www.bmpdatabase.org/).

Environmental Protection Agency; *Guidance Manual for the Preparation of Part 2 of the NPDES Permit Application for Discharge from Municipal Separate Storm Sewer Systems*, 1992.

Federal Highway Administration (FHWA); *Pollutant Loadings and Impacts from Highway Stormwater Runoff – Volume III Analytical Investigation and Research Report,* April, 1990.

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Liebe M.;*Generalized Documentation of the BES Simplified Watershed Yield Model (SWYM) – alias BES GRID Model*

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SECTION 11 MAPS