SECTION 6 BENCHMARKS

6.1 INTRODUCTION

For receiving waters with an approved total maximum daily load (TMDL), the City of West Linn is required to establish new pollutant load reduction benchmarks and evaluate progress towards achieving previously developed benchmarks. With respect to previously developed benchmarks, the City submitted benchmarks to DEQ as part of their Interim Evaluation Report submittal in 2006. The permit requirements associated with benchmarks as provided in the City's MS4 NPDES Phase 1 permit, Schedule D(2)(d)(i) are as follows:

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.

In accordance with Schedule D(2)(d)(i)(2) of the permit, a benchmark is defined as follows:

(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.

In 2006, the City of West Linn was required to develop benchmarks for addressing the Tualatin River TMDL wasteload allocations (WLAs) as part of their Interim Evaluation Report submittal. Now, in conjunction with their permit renewal submittal, the permittee must evaluate progress towards achieving these developed benchmarks in accordance with the following requirement from Schedule B(2)(c):

(viii) If TMDL wasteload allocations were established at the time of permit issuance, (the permittee must provide) an evaluation of progress towards achieving applicable wasteload allocations to the maximum extent practicable. Progress will be measured through the TMDL performance measures and benchmarks established in accordance with Schedule D(2)(d).

Therefore, the City must compare projected, future condition (2008/9) benchmarks estimated previously as part of the Interim Evaluation Report submittal (2006) with current pollutant load reduction estimates for 2008 given actual land use and BMP coverage, and compare both pollutant load reduction estimates with the existing wasteload allocation for the Tualatin River TMDL parameters.

Also in 2006, a TMDL became effective for the Willamette River and associated tributaries. Because the Willamette River TMDL was not effective at the time of permit issuance (in 2004),

the City of West Linn was not required to generate TMDL benchmarks for the Interim Evaluation Report submittal. However, in accordance with Schedule D(2)(d):

(iii) if within three (3) years following permit issuance a TMDL is approved by the Environmental Protection Agency (EPA) and the TMDL has wasteload allocations assigned to stormwater within the geographic area covered by this permit, the co-permittee must, at the time of the next permit renewal application, complete a review and strategy development, and propose changes, if appropriate, to the SWMP to address urban stormwater discharges.

In conjunction with a letter of request issued by Greg Geist at DEQ (January 11, 2008), jurisdictions that discharge to the Willamette River or any tributaries referenced in the Willamette River TMDL should establish benchmarks as part of the permit renewal application.

This section of the permit renewal report provides the following:

- A summary of previously approved and more recently approved TMDLs that apply within the City of West Linn permit boundary (i.e., applicability of the benchmark requirement) – Section 6.2.
- The City of West Linn's general process for developing benchmarks – Section 6.3.
- The specific pollutant load modeling methods, assumptions, and rationale for the development of benchmarks – Section 6.4.
- Results of the benchmark process and relationship between the benchmarks and the TMDL WLAs- Section 6.5.
- References – Section 6.6

6.2 APPLICABILITY OF THE BENCHMARK REQUIREMENT

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 in the Willamette Valley (temperature). To translate the TMDL into guidelines for municipalities and industries, WLAs are developed, which allocate a proportion of the total maximum daily load to contributing sources (industries, future growth, municipalities, groundwater, CSOs, 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 covered by MS4 NPDES permits, which includes a wide variety of sources that are not well defined. This has resulted in inherent difficulties in applying WLAs to MS4 discharges.

<u>Previously Approved TMDLs</u>
As described above, the development of benchmarks for the Interim Evaluation Report (2006) was only required for areas where TMDL WLAs had been established and approved by EPA prior to the time of permit issuance in 2004. For the City of West Linn, the only applicable, previously approved TMDL was for the Tualatin River. The TMDL was established in 1998 and updated in 2001.

The WLAs 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 WLAs were 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 13% of the total city area and 0.13% of the total Tualatin Watershed Area. When the city area draining to the Tualatin River was delineated for the benchmark analysis, state roads were not included, as ODOT is classified separately with its own WLA in the TMDL.

Recently Approved TMDLs

The Willamette River TMDL was more recently approved by EPA and became effective in 2006. As this TMDL was not established at the time of permit issuance, benchmarks were not established for the Willamette River as part of the Interim Evaluation Report submittal. However, benchmarks have been requested by DEQ for the Willamette River (and referenced tributaries) as part of this permit renewal submittal.

The Willamette River TMDL was established for nine of the twelve subbasins within the entire Willamette Basin; the Tualatin Subbasin is not covered under this TMDL for bacteria and temperature since it already has a TMDL in place for those parameters, and the Molalla/ Pudding and Yamhill Subbasins are still under review by DEQ. The WLAs described in the Willamette River TMDL apply to all of the current Phase 1 MS4 NPDES permittees and co-permittees in the State of Oregon.

Basin-wide, the Willamette River TMDL is specific for mercury, bacteria, and temperature, although some tributaries have additional TMDL parameters. Temperature is not considered a stormwater pollutant in the Willamette River TMDL, and consequently is not addressed by the permittees' NPDES MS4 permits. Mercury is a phased TMDL with monitoring requirements expected for the first phase to support DEQ's development of wasteload allocations for the second phase. Thus, while mercury is considered to be associated with stormwater, permittees are not required to establish benchmarks for the pollutant at this time since waste load allocations have not yet been developed. Bacteria is the only basin-wide Willamette River TMDL parameter that requires new benchmarks to be established for the permit renewal.

The Willamette River watershed includes approximately 3,900 acres within the City of West Linn's current city limits. This area represents about 87% of the total city area. The portion of the City's permit area draining to the Willamette River and associated tributaries was used for the benchmarks analysis, but again, state roads were not included, as ODOT is classified separately in the TMDL.

Table 1 provides a summary of TMDL waterbodies applicable to the City of West Linn, classified by the date that their TMDL became effective and associated benchmark parameters.

TABLE 1: Summary of TMDL Waterbodies and Parameters

TMDLs established prior to the last permit issuance (2004)		
Waterbody	**Parameter(s)**	**Approval Date**
Tualatin River	o Total Phosphorus o Bacteria (E. Coli) o Dissolved Oxygen (with TSS as a surrogate for settleable volatile solids)	1998/ 2001
TMDLs established after the last permit issuance (2004)		
Willamette River	o Bacteria (E. Coli) Note: Mercury is also included in the TMDL, but no WLAs have been established yet. Therefore, benchmarks are not yet required.	2006

6.3 OVERALL PROCESS FOR DEVELOPING BENCHMARKS

Establishing benchmarks relies on the use of a pollutant loadings model to calculate estimates of 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 WLA identified in the TMDL can be used to estimate the effectiveness of the City's current stormwater management program or show progress in how the City's current stormwater management program is attempting to achieve WLAs. As described in Section 6.1, 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 1. The flowchart was developed as a template for jurisdictions including the City of West Linn to follow when looking at estimated pollutant loads with respect to the TMDL's WLA 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 the City of West Linn, the approach illustrated in Figure 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-loadings model to quantify the effectiveness of these BMPs. For the type of BMP described under category 2 above, the approach resulted in a recommendation that some type of monitoring plan or literature review be pursued to eventually obtain information. Until more comprehensive monitoring is completed for these BMPs, the approach treated them the same as the BMPs described under category 3. 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 removals 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.

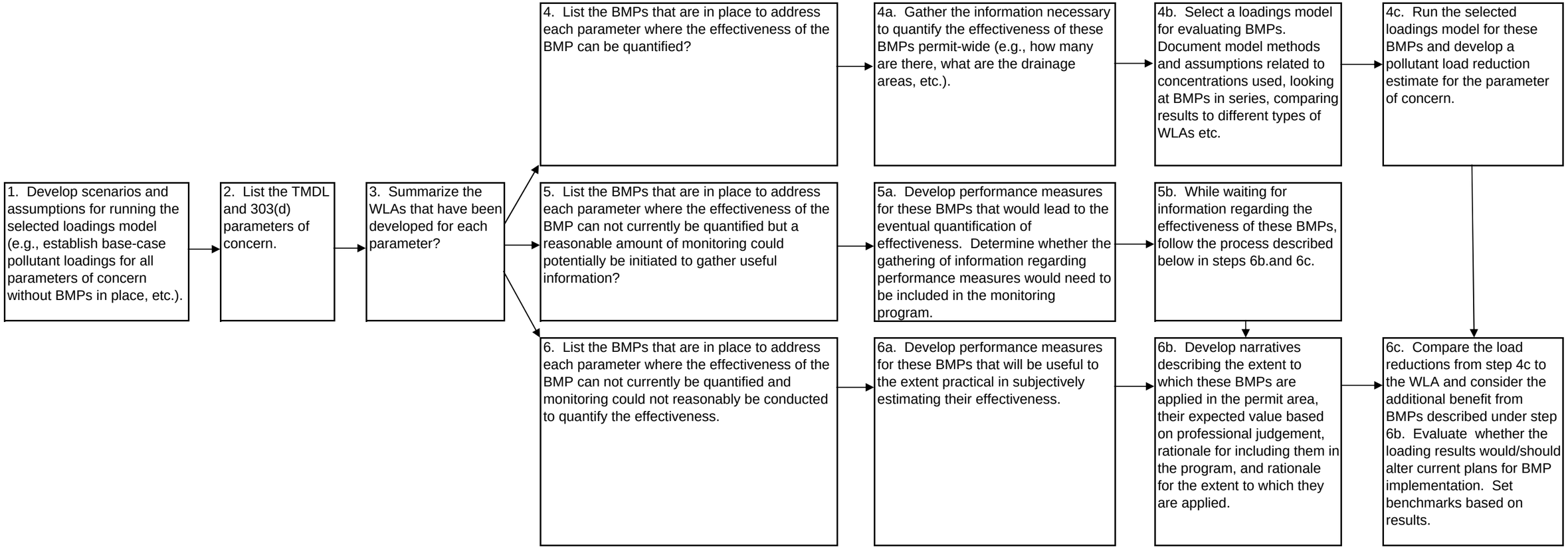
Rather than try to make best professional judgments regarding the quantitative effectiveness of BMPs in categories 2 and 3, the approach is to first compare pollutant loads generated after applying the structural BMPs in category 1 to the TMDL waste load allocations (WLAs). This will provide a relative 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 or have the potential to achieve the WLAs. That estimate may then be verified by future ambient water quality monitoring.

This process outlined in Figure 1 was applied to each applicable TMDL parameter within the West Linn MS4 permit area. Assumptions made in developing loading estimates and estimating the effectiveness of BMPs is documented in Sections 6.4 and 6.5.

6.4 MODELING METHODS AND ASSUMPTIONS

To conduct the pollutant loadings analysis, the City of West Linn opted to use a spreadsheet model that utilizes the EPA simple method for pollutant loads generation for each of their TMDL waterbodies. 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 and future condition pollutant loads, assuming 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 judgment are made in the results and discussion sections of this memo (Section 6.5). This section will describe the assumptions and methods associated with developing the model. The subsections below include information regarding the following: modeled areas, model scenarios, model assumptions related to land use and BMP effectiveness, and methods for comparing model results to waste load allocations.

Figure 1: Proposed Process for Developing MS4 NPDES Stormwater Benchmarks



6.4.1 Modeled Areas

The City of West Linn defines their permit area as the area within their city limits, as they only provide stormwater services within the City limits. When areas within the UGB are annexed into the city, the City's permit area expands and stormwater services are provided to these newly annexed areas.

The Tualatin River watershed currently encompasses about 13% of the total city area. The City of West Linn used GIS to define the portion of their permit area that drains to the Tualatin River for current conditions (2008) and for future conditions (2013), assuming projected annexations over the next five years that would result in expansion of the City limits. As mentioned previously, area within the city limits that is the responsibility of another permittee (i.e., state roadways) was omitted from the modeled area.

The Willamette River watershed as a whole encompasses about 87% of the total city drainage area. The TMDL provides individual WLAs for various tributaries and subbasins; therefore the City used GIS to define the portion of their permit area that discharges to each of the tributaries or subbasins of the Willamette River that are specifically referenced in the TMDL for current (2008) and future conditions (2013). Again, the future condition permit area accounts for projected annexations over the next five years that would result in expansion of the City limits.

Current and future condition drainage areas for each watershed are provided in Tables 2 and 3.

6.4.2 Model Scenarios

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

<u>Current Condition Scenarios:</u>
The current condition (2008) model scenarios use the current City limits and current condition land use information, further described in Section 6.4.3, to calculate a pollutant load for each parameter that a WLA is established. Structural BMP systems were considered in this scenario. Existing structural BMP drainage areas were delineated for use in the model. Structural BMP systems modeled included both public and private facilities. Although some rough estimates are available for some non-structural BMP categories, specifically street sweeping, sweeping was already being conducted when the land use concentration 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 explicitly 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. An initial load scenario (no BMPs) and a treatment load scenario (with structural BMPs) were simulated based on the characteristics summarized in Table 2 and Table 3 for current conditions.

As a TMDL for the Tualatin River was established at the time of permit issuance, the City of West Linn must compare the benchmarks previously submitted with their Interim Evaluation Report submittal with the new, current condition benchmarks, to assess anticipated progress towards meeting the wasteload allocation. Although benchmarks previously submitted were calculated for 2009, they will be compared to the current, actual 2008 benchmarks.

Future Condition Scenarios

The future conditions model scenarios assume annexations and associated incremental expansion of the City limits and development of current vacant parcels through the year 2013. The future conditions model assumes land use information used in the current conditions model is still accurate for currently developed parcels. To approximate future development conditions, areas anticipated for annexation in the next five years were included in the City's permit area; a zoning designation was provided for the annexed areas if available, otherwise they were categorized as vacant; and existing vacant parcels that were anticipated for development in the next five years were assigned land use and imperviousness based on zoning. Future development conditions are associated with the year 2013 because the end of the next permit term is expected to be 2014, and the evaluation is due prior to the end of the permit term.

All current condition structural BMPs were assumed to still be working and in place for this scenario. No additional capital improvement projects for water quality are currently anticipated for construction for future conditions. As it is unknown at this time which stormwater treatment (structural BMP) option that new developments will include to comply with development standards, treatment of all previously vacant areas and newly annexed and developed areas is assumed equal to that of a detention pond. 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 Tables 2 and Table 3 for future conditions.

Model Simulations

As discussed above, initial load simulations (no BMPs) and treatment load simulations (with structural BMPs) were conducted given the land use and BMP coverage summarized in Tables 2 and 3.

In order to compare modeled load results with the wasteload allocation (WLA) defined in the TMDL documents, the spreadsheet model was run for specific storm events (precipitation volumes). For the Tualatin River TMDL and associated benchmark calculations, a summer and winter design storm event and seasonal rainfall events were identified in the TMDL and used in the calculations. 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". The storm events (precipitation volumes) to be used in the simulation were specified for each parameter. Loads (reported as pounds or counts) were generated for each parameter based on the specified design storms used in the TMDL for the specified parameters. Depending on the parameter, the WLA was defined as either a specific concentration or as a percent reduction in load for a specified season. WLAs in the TMDL are defined specifically for each reach or tributary of the Tualatin River and for each permittee.

TABLE 2: Summary of Model Input Parameters (Land Use) by Watershed

	Total Modeled Area (acres) (Excludes ODOT ROW)	**Land Use Breakdown (acres)**						
		Residential	Commercial	Agricultural	Open Space	Vacant	Multi-family Residential	Industrial
Tualatin River Watershed								
Current Condition	601.8	423.9	6.6	0	54.4	73.6	43.4	0
Future Condition	609.9	445.4	6.9	0	54.4	60.2	43.4	0
Lower Willamette River Watershed								
Current Condition	2577.9	1777.8	79.4	0	456.7	184.6	43.9	35.6
Future Condition	2581.8	1787.8	79.4	0	456.7	175.8	46.5	35.6
Middle Willamette Watershed								
Current Condition	1327.2	820.6	110.4	0	56.6	121.3	82.1	136.1
Future Condition	1345.9	837.3	110.4	0	56.6	123.3	82.1	136.1

TABLE 3: Summary of Model Input Parameters (BMP Coverage)

	Total Modeled Area (Excludes ODOT ROW)	**Structural BMP Coverage Area (acres by land use)**							**Total BMP Coverage**
		Residential	Commercial	Agricultural	Open Space	Vacant	Multi-family Residential	Industrial	Percentage of total area covered by structural BMPs
Tualatin River Watershed									
Current Condition	601.8	212.70	3.35	0	42.94	55.94	36.70	0	58.4%
Future Condition	609.9	234.18	3.35	0	42.94	41.48	36.70	0	58.8%
Lower Willamette River Watershed									
Current Condition	2577.9	344.71	25.86	0	78.72	31.91	0	0	18.7%
Future Condition	2581.8	354.69	25.86	0	78.72	31.91	2.58	0	19.1%
Middle Willamette Watershed									
Current Condition	1327.2	526.40	102.73	0	37.64	86.18	80.87	14.53	63.9%
Future Condition	1345.9	543.13	102.73	0	37.64	86.18	80.87	14.53	64.3%

For the Willamette River TMDL, WLAs are either defined for year round, for the summer season, and/or for fall, winter, and spring season. However, unlike the Tualatin River TMDL, the Willamette River TMDL does not specify the volume of the summer or winter design storm events or seasonal rainfall event. Therefore, rainfall used in the pollutant loads model was determined for the City individually. WLAs are provided in the TMDL that are unique to each reach of the Willamette River (e.g., upper Willamette, middle Willamette, or lower Willamette), but may also be further distinguished by subbasin and by tributary. In the case of the Middle Willamette, varying WLAs are provided depending on whether the discharge is directly to the Willamette River or through a tributary to the Willamette River. As a result, permittees whose permit area overlaps multiple subbasins or watersheds may be subject to different WLAs and have to establish separate benchmarks for each watershed that has its own WLA. WLAs for bacteria are represented in terms of a percent reduction.

6.4.3 Model Assumptions and Input Data

A number of assumptions were made with regard to the acquisition, processing, and utilization of land use concentration and BMP effluent concentration data in order to generate pollutant loads. Assumptions were also made with respect to associated input parameters as related to land use categories, BMP categories, and modeling methods. These assumptions are described below.

<u>Land Use and BMP Effluent Concentration Data</u>
Numerous jurisdictions, including the City of West Linn, are covered under the six Oregon Phase I NPDES MS4 permits. Since the 2004 permit became effective, 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 and has continued from 2004 to present day. One item that ACWA has coordinated on is the determination of appropriate, typical land use runoff concentrations and BMP effluent concentrations for use in loads modeling.

Tables of land use and BMP effluent concentrations were originally developed in 2005 for benchmarks due as part of the Interim Evaluation Report submittal. The concentrations in these tables were developed using data obtained by local jurisdictions in addition to published, statistically verified national data. Data were combined, statistically validated, and provided in terms of means and median values.

For the benchmark updates and the calculation of new benchmarks, both prepared for this 2008 Permit Renewal Submittal, the original values for land use concentrations developed in 2005 were revisited. For land use concentration data, adjustments to the original data set included: 1) the inclusion of an additional open space land use category (Balch Creek) in order to ensure all analytes under the open space land use category had a sufficient number of data points; 2) revisions to the statistical method of dealing with non-detects; and 3) the accounting for all outliers in the statistical calculations. As was done in 2005, the data were “bootstrapped”, a 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). The model uses the mean (or median in the case of the Tualatin River Phosphorus TMDL), the upper 95% confidence interval and the lower 95% confidence interval to produce a range of associated pollutant loading. Revised mean and median land use concentrations and the associated upper and lower confidence intervals are provided in Table 4.

Also for preparation of this 2008 Permit Renewal, the original BMP effluent values from 2005 were revisited. The original BMP effluent values from 2005 were based on the national data set of BMP effluent concentrations compiled by GeoSyntec Consultants (see ACWA Rangers 2005). In 2008, the national data were reviewed for inconsistencies and questionable values (e.g., data points where the dissolved concentration was greater than the total concentration; data points where the BMP effluent concentration was greater than local land use EMCs). Local data were compiled and compared to the questionable data values from the national data set. If the local data set contained sufficient data points and appeared to better represent local conditions, best professional judgment was used to adjust the questionable BMP effluent concentrations. The mean and median BMP effluent concentration values are provided in Table 5.

Pollutants of Concern

Per the Tualatin River TMDL, parameters requiring load calculations are total phosphorus, bacteria (E. Coli), and dissolved oxygen. As the Tualatin TMDL uses median concentrations in the calculation of the total phosphorus WLA, median land use and BMP effluent concentrations were used in the analysis. Otherwise, all other WLAs were reported in means or in counts (in the case of bacteria), so means or counts associated with the land use and BMP effluent values were used in the pollutant loadings model. Land use and BMP effluent concentration information is not readily available for dissolved oxygen. However, the TMDL presents the wasteload allocation for dissolved oxygen in terms of a percent reduction in settleable volatile solids. Due to the lack of data on settleable volatile solids, total suspended solids (TSS) were recognized as a surrogate parameter. Total phosphorus, bacteria, and TSS were modeled for the City and compared with the WLA as reported in Section 6.5.2.

Per the Willamette River TMDL, the applicable parameter requiring load calculations as part of the Permit Renewal Submittal are bacteria (E. Coli). The bacteria WLAs are presented as a percent reduction in bacteria load. Bacteria was modeled for the City and compared to the WLA as reported in Section 6.5.3.

Land Use Categories

Existing zoning information was combined with GIS layers representing parks, open space, and vacant properties to create existing land use coverage. The future land use coverage was created from the existing land use coverage, with the exception that previously vacant areas that are expected to develop by 2013 were assigned future condition land use based on their zoning classification and annexed properties (or anticipated annexations) were also included.

Zoning categories were processed and consolidated 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 6 summarizes the modeled land use categories.

TABLE 4: Land Use Concentration Values used in Benchmarking

Land Use Concentration Information
Mean values are actual per ACWA
Data Range (+/- 95%) provided by City of Portland
Based on modified ACWA Data Set (2008)

Key:
EMC value used in the model
Range value as used in the model

			Bootstrapped MEAN			Bootstrapped MEDIAN		
Parameter	**Land Use**	**Count**	**95% L-CI**	**Mean**	**95% U-CI**	**95% L-CI**	**Geomean**	**95% U-CI**
TSS	C [1]	72	64	82	103			
mg/L	I	48	117	184	284			
	OP [2]	10	16	31	50			
	R [3]	65	44	66	99			
	T	23	124	169	227			
Pb,T	C [1]	25	37.8	54.0	72.7			
µg/L	I	22	32.7	48.3	67.0			
	OP [2]	9	0.6	0.8	1.1			
	R [3]	28	11.0	17.7	27.6			
	T	22	37.1	63.1	98.8			
Pb,d	C [1]	9	3.2	5.0	7.4			
µg/L	I	13	1.52	2.58	3.77			
	OP [2]	4	0.1	0.118	0.128			
	R [3]	5	1.23	1.8	2.53			
	T	15	1.26	3.59	7.71			
Zn,T	C [1]	28	130	170	217			
µg/L	I	24	283	674	1353			
	OP [2]	9	6.3	7.8	9.5			
	R [3]	39	77	104	134			
	T	22	146	203	265			
Zn,d	C [1]	11	50	95	113			
µg/L	I	20	165	216	270			
(2005 ACW	OP [2]	8	7.8	15.2	26.3			
	R [3]	18	43	60	80			
	T	23	51	76	123			
Cu, T	C [1]	26	20.8	28.6	38.2			
µg/L	I	26	33.8	45.5	58			
	OP [2]	10	2	2.5	3			
	R [3]	33	10.5	13.4	17.1			
	T	23	25.4	34.6	45.7			
Cu, d	C [1]	11	4.0	8.6	17.4			
µg/L	I	20	6.1	8.7	12.0			
(2005 ACW	OP [2]	8	3.0	4.0	4.9			
	R [3]	12	4.8	7.2	9.4			
	T	22	5.9	8.6	13.2			
BOD	C [1]	22	8.5	11.9	16.6			
mg/L	I	23	26.1	39.6	56.1			
	OP [2]	3	2.4	3.3	4.2			
	R [3]	28	5.9	8.1	10.8			
	T	19	10	17.9	29.1			
COD	C [1]	26	51.8	65.1	81.5			
mg/L	I	25	76.8	102.6	134.1			
	OP [2]	9	11.1	19.6	27.6			
	R [3]	36	37.4	50.9	66			
	T	11	40.6	100	185			
TP	C [1]	26	0.28	0.38	0.50	0.23	0.28	0.31
mg/L	I	25	0.40	0.51	0.64	0.36	0.47	0.65
	OP [2]	8	0.095	0.12	0.15	0.079	0.086	0.089
	R [3]	36	0.23	0.34	0.48	0.16	0.21	0.23
	T	21	0.29	0.37	0.46	0.24	0.31	0.41
Fecal Colifo	C [1]	52	707	1540	2974			
CFU/100 ml	I	58	190	541	1240			
(geomean)	OP [2]	9	96	117	141			
	R [3]	65	1197	2045	3273			
	T	29	847	1860	3657			
E. coli	C [1]	52	573	1247	2409			
CFU/100 ml	I	58	154	438	1004			
(geomean)	OP [2]	9	57	87	124			
FC (E. coli =	R [3]	65	970	1656	2651			
and rounded	T	29	686	1507	2962			
Mercury	C [1]							
No data avai	I							
	OP [2]							
	R [3]							
	T							

Notes

1 Land use EMCs for Commercial are equal to Agriculture
2 Land use EMCs for Open Space are equal to Vacant
3 Land use EMCs for Residential are equal to Multi family Residential

TABLE 5: BMP Effluent Concentration Values used in the Benchmark Model

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/ Raingardens
TSS	mg/L	57	13	33	16	23	7	50	1000	1000	1000
TP	mg/L	0.13	0.12	0.29	0.14	0.24	0.08	0.14	1000	1000	1000
E. coli	CFU/100 mL	3550	98	2950	430	2950	430	3550	1000	1000	1000
Cu, d	µg/L	6.9	3.1	12	2.9	5.1	7.1	4.9	1000	1000	1000
Cu, T	µg/L	12	5.3	20	7.1	11.9	3	11.5	1000	1000	1000
Pb,d	µg/L	1.1	0.13	1.5	0.1	0.42	0.1	0.16	1000	1000	1000
Pb,T	µg/L	5.7	3	18	1.88	7.43	1	7.3	1000	1000	1000
Zn,d	µg/L	25	6.4	44	8.7	19	11	32	1000	1000	1000
Zn,T	µg/L	70	14	83	31.7	47	17	74	1000	1000	1000
Flow Reduction	% as decimal	0	0	0.23	0.05	0.29	0	0	0.6	0.77	0.99999
BOD	mg/L	6	2.5	6	6	5	6	6	1000	1000	1000
Mercury	mg/L	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

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/ Raingardens
TSS	mg/L	115.00	43.00	43.00	29.0	24.00	25.00	67.00	1000	1000	1000
TP	mg/L	0.22	0.15	0.35	0.2	0.21	0.16	0.22	1000	1000	1000
E. coli	CFU/100 mL	5587	79.00	1922	499	1922	499	5587	1000	1000	1000
Cu, d	µg/L	14.00	3.70	14.00	3.2	5.90	3.2	6.20	1000	1000	1000
Cu, T	µg/L	15.00	5.70	22.50	7.7	12.50	7.6	14.7	1000	1000	1000
Pb,d	µg/L	2.10	0.13	2.40	0.1	0.50	0.13	0.26	1000	1000	1000
Pb,T	µg/L	14.00	7.60	32.00	2.5	7.80	3.30	9.10	1000	1000	1000
Zn,d	µg/L	35.00	8.30	59.00	30.0	20.60	14.00	38	1000	1000	1000
Zn,T	µg/L	103.00	15.00	123.00	74.0	55.00	32.00	92	1000	1000	1000
Flow Reduction	decimal %	0.00	0.00	0.23	0.1	0.29	0.00	0	0.60	0.77	1.00
BOD	mg/L	6.0	3.4	6.1	6.1	5.4	6.1	6.0	1000	1000	1000
Mercury	mg/L	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

NOTES

Values in **RED** are from the ACWA Ranger Memo (2005)

Values in **GREEN** are values from City of Portland (2008) reanalysis of BMP effectiveness

1 Dry pond BOD numbers based on wet pond BOD numbers
2 Dry pond Ecoli numbers based on wet pond Ecoli numbers
3 Wetland BOD numbers based on wet pond BOD numbers
4 Wetland Ecoli numbers based on wet pond Ecoli numbers
5 Sediment manhole BOD numbers based on hydrodynamic devices

Values in **Purple** are City of Portland values for BMPs/ parameters where there was a large discrepancy between the City values and Ranger values.

Values in **Blue** are for Mercury, where no data is available yet (placeholder).

Values in **Orange** are where no data is available yet (placeholder).

Impervious Values

Effective impervious percentages for select land use categories were taken from the final West Linn Master Plan (2006). The EPA formula (1) was used to translate between percent impervious and a runoff coefficient, for use in the spreadsheet model. Table 6 shows the associated impervious values used for select land use types.

(1) Runoff Coefficient = 0.05 * 0.009 (% Impervious)

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

Modeled Zoning or Land Use Classification	Modeled Impervious Percentage
AGR [(3, 4)]	2%
RES	21%
MRES [(4)]	35%
COM	85%
VAC [(4)]	0%
IND	85%
OSP	0%

Note 1 = Key for land use abbreviations:

Land Use Category	Referenced Abbreviation
RES	Residential (Single Family)
COM	Commercial
MRES	Multi-family Residential
OSP	Open Space
AGR	Agricultural
IND	Industrial
VAC	Vacant

Note 2 = Impervious values for the various land use categories were taken from the Final West Linn Master Plan (2006)

Note 3 = Agricultural was not a land use category included in the Draft West Linn Master Plan (2005). The effective impervious percentage for agricultural land use was determined to be similar to that of Rural (RUR) land use in the Final West Linn Master Plan (2006).

Note 4 = The land use concentration data shown in Table 4 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 of West Linn categorized and classified their structural BMPs in accordance with categories where 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 7 summarizes the actual structural BMP categories and the modeled BMP category, if BMP effectiveness information was not available for the actual BMP category. As mentioned previously, non-structural BMPs were not included in the model simulations.

TABLE 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 or Wet Retention Basin (2)
Swales	Swales- Vegetated Filter Strips
Wetlands	Wetlands
Pollution Control Manholes	Sedimentation Manholes
Raingardens	Raingardens

Note 1 = The BMP effluent concentration data shown in Table 5 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 5 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

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. Other situations could include treatment trains where two or more relatively efficient BMPs are treating the same area. For purposes of the benchmark analysis, typically the furthest downstream BMP system was selected as the representative BMP for drainage areas where more than one BMP is applied. The BMP drainage area was delineated by City staff as only that of the furthest downstream BMP. This method does not give credit for additional load removal likely achieved with BMPs in series. Therefore the results are expected to be conservative for load reduction estimates.

In addition, BMPs are not capable of treating all runoff that may enter a facility in any given year. Generally, BMPs are designed to treat a proportion of the total annual rainfall/ runoff that occurs. For example, a typical water quality design storm in the Portland metropolitan area is the 6-month/ 24 hour design storm (67-72% of the 2-year/ 24 hour design storm), which is generally deemed to account for treatment of 80% of the average annual rainfall. As design standards vary amongst jurisdictions, BMPs included in the model were assumed to capture and treat 80% of the average annual rainfall and bypass additional flow. Therefore, for seasonal or annual rainfall, BMP bypass was accounted for in the loadings model. For design storms less than the typical 6-month/ 24 hour storm event, BMPs were included in the model as fully functional.

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

Tualatin River

The Tualatin River TMDL reports wasteload allocations as either a concentration, a load generated for a certain time period, or as a percent reduction achieved. 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 and the wasteload allocation (as a concentration) specific for the City of West Linn as provided in the TMDL. 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) = WLA (mg/L) * Seasonal Discharge Volume (ft^3) *$6.24x10^{-5}$

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

The allocation as identified in the TMDL for the City of West Linn is 0.14 mg/L for total phosphorus 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 seasonal rainfall volume.

A current condition and a future condition model were generated for the City of West Linn, using land use and BMP characteristics described in Tables 2 through 7. The spreadsheet model calculates a pre-BMP pollutant load for each parameter. Then, using the BMP drainage areas, the type of BMP facilities, 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 (2008) and future condition (2013) both with and without BMPs, based on the design storm specified for each parameter. Per the discussion of "benchmarking" in Section 6.5.4, a pre-BMP and post-BMP load was calculated for the mean (or median), upper confidence limit, and lower confidence limit land use concentration, in order to provide a range of loading for each parameter. 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. In addition, as benchmarks representing conditions in 2009 had previously been calculated for the Interim Evaluation Report submittal, those predicted loads (with and without BMPs) are also shown on the graphs. The difference between the predicted loads with no BMPs in 2013 and the predicted loads with BMPs in 2013 indicates the amount of load reduction anticipated with the currently implemented stormwater program (structural BMPs only) and is representative of the City's benchmarks.

Willamette River

The Willamette River TMDL reports wasteload allocations as a percent reduction achieved. As mentioned previously, for the City of West Linn, bacteria was the only parameter 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, the model results were graphed as a total load for the designated storm event (rainfall volume) and the WLA was graphed as the associated load necessary to yield the percent reduction required.

As the City of West Linn is located between the Lower Willamette and Middle Willamette watersheds, the City is subject to various WLAs as specified in the TMDL. For the Lower Willamette watershed, the WLA identified in the TMDL (Chapters 2 and 5) is a 78% reduction in E. Coli year-round. The Middle Willamette River watershed, however, has separate WLAs based on whether the area directly discharges to the Willamette River or discharges first to a tributary and then to the Willamette River. For areas that discharge directly to the Willamette River, the WLA identified in the TMDL (Chapter 2) is a 75% reduction in E. Coli year-round. For areas that discharge to a tributary (unspecified) prior to discharge in the Willamette River, the WLA identified in the TMDL (Chapter 7) is a 75% reduction in E. Coli during the fall, winter, and spring and an 88% reduction in E. Coli during the summer. Annual rainfall used for the City of West Linn benchmarks is 47.5 inches per year, with a summer seasonal rainfall of 6.82 inches (consistent with the Tualatin River TMDL) and fall-winter-spring seasonal rainfall of 40.68 inches.

A current condition and a future condition model were generated for West Linn, using land use and BMP characteristics described in Tables 2 through 7. The spreadsheet model calculates a pre-BMP pollutant load for each parameter. Then, using the BMP drainage areas, the type of BMP facilities, and the relative breakdown of land use inside the BMP drainage areas, the model calculates a post-BMP pollutant load for each parameter.

For each parameter, loads (as pounds) were calculated for current condition (2008) and future condition (2013) both with and without BMPs, based on the City specific rainfall volume (whether annual or seasonal). Loads were individually calculated for the upper confidence limit, the mean, and the lower confidence limit, in order to yield a range in the resulting loads. The WLA 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 predicted load with no BMPs in 2013 and the predicted load with BMPs in 2013 indicates the amount of load reduction anticipated with the currently implemented stormwater program (structural BMPs only) and is representative of the City's benchmarks.

6.5 MODEL RESULTS AND RATIONALE FOR THE DEVELOPMENT OF BENCHMARKS

Figures 2 through 9 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 are estimated or anticipated 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.

6.5.1 Model Load Results Summary

The pollutant load model results are summarized by TMDL waterbody (and associated tributary or subbasin if necessary) and by parameter.

In summary for the Tualatin River, a comparison is provided to show the difference between predicted loadings representing 2009 conditions from the IER submittal (previously predicted loads) with the current, calculated pollutant load estimates representing 2008 conditions (current loads). Based on the model results, it appears that the City may currently be meeting or close to meeting their wasteload allocation for bacteria and dissolved oxygen but may not be meeting it for 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 could potentially be meeting their WLA for each parameter, especially when considering that the effectiveness of non-structural BMPs was not included in the model. These results are consistent with the previously predicted loading results from the IER submittal.

In summary for the Willamette River, the City does not appear to be meeting their WLAs for bacteria as specified in the TMDL. However, the model results are conservative in that the model doesn't account for non-structural BMP implementation. With the consideration of non-structural BMP implementation, specifically pet waste programs and public education, the City is likely closer to meeting the WLA than the model results indicate.

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

6.5.2 Model Load Results for the Tualatin River

Benchmarks for the Tualatin River were previously submitted as part of the IER submittal in 2006. Therefore, the City must compare those previously predicted loadings representing 2009 conditions from the IER submittal (previously predicted loads) with the current, calculated pollutant load estimates representing 2008 conditions (current loads). Unfortunately, some assumptions originally made for the IER submittal are not consistent with current conditions and some modeling methods and data input parameters have changed as a result of adaptive management. Therefore, the loads are not directly comparable. One difference in modeling

methods is that the current loads were modeled based on the actual bootstrapped UCL and LCL for land use whereas the UCL and LCL for the previously predicted loads were not included in the model but applied based on an estimated range from the bootstrapped values. This results in a refined range around the current loads as compared to the previously predicted loads. The current loads are also based on a slightly different total modeled area and associated land uses than the IER submittal. Specifically, the previously predicted loads assumed full build out conditions in 2025 and an extrapolation was used to predict the 2009 load. This was an estimate and therefore not completely representative of the actual conditions now. The current loads were based on revised/ updated land use concentration and BMP effluent values (discussed in Section 6.4.3), and those revisions significantly influenced the loading estimate, especially for bacteria.

The following subsections provide more specifics for each modeled parameter.

Total Phosphorus

The following graph (Figure 2) contains the total phosphorus load comparison plot for the City of West Linn. The dark purple color represents the loading previously predicted for 2009, calculated for the Interim Evaluation Report (IER) Submittal in 2006 (previously predicted load). The light purple represents the current estimated load in 2008, calculated for this permit renewal submittal (current load). The total phosphorus WLA is based on a concentration; therefore, the load is dependent on the runoff volume generated. For 2013, the WLA was recalculated to be based on the current predicted volume of runoff generated.

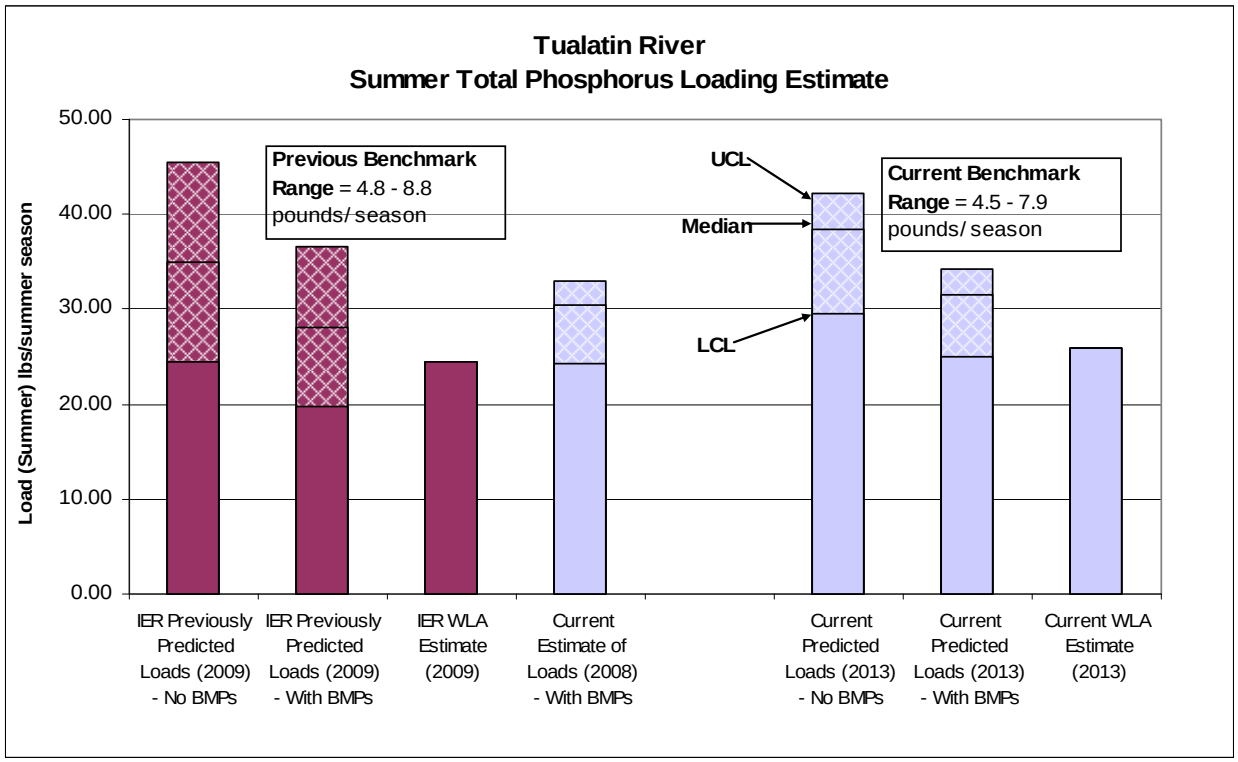
In comparing the previously predicted loads and the current loads, it appears that the current estimate of the 2008 load with BMPs is reasonably consistent with the IER predicted load for 2009 with BMPs. As described above, the range associated with the current loads estimate is more refined than with the previously predicted loads, but remains within the previously predicted loading range. The current median value is slightly higher than the predicted value, likely due to the fact that current, actual land use was used in the simulation as opposed to previously predicted land use and development conditions. Based on the variability of the data, the current pollutant load represented by the low value of the range (LCL) is just about equal to the WLA. Therefore, for this parameter it may be reasonable to assume that implementation of non-structural BMPs could potentially be reducing the current median total phosphorus load to where it is meeting the WLA.

For the future condition (2013), the City shows a predicted, median load reduction of approximately 6.9 lbs. due to existing BMPs and planned implementation of structural BMPs associated with anticipated redevelopment. As shown for the current condition, the pollutant load represented by the low value of the range (LCL) 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 total phosphorus load to where it could be meeting the WLA during this permit period.

As the benchmark is defined as a pollutant load reduction, the low value of the total phosphorus benchmark range is 4.5 lbs./season, and the upper value of the total phosphorus benchmark range is 7.9 lbs./season (see Table 8 at the end of Section 6.5.4 for a summary of all the benchmarks). The low value of the range was calculated by taking the difference between the 2013 LCL with

no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Comparison of available instream monitoring data for a Tualatin River tributary with the WLA (0.14 mg/L), it appears that the benchmark results are consistent with the instream monitoring results, as the City occasionally exceeds the instream WLA but a majority of the time meets the WLA.

Figure 2: Total Phosphorus Loading



UCL = Upper Confidence Interval
LCL = Lower Confidence Interval

Bacteria

The following graphs (Figures 3 and 4) contain the summer and winter bacteria load comparison plots for the City. The dark purple color represents the loading previously predicted for 2009, calculated for the Interim Evaluation Report (IER) Submittal in 2006 (previously predicted load). The light purple represents the current estimated load in 2008, calculated for this permit renewal submittal (current load). Like total phosphorus, the bacteria WLAs for summer and winter storm event is based on a concentration; therefore, the load is dependent on the runoff volume generated. For 2013, the WLAs were recalculated to be based on the current predicted volume of runoff generated.

In comparing the previously predicted loads and the current loads, it appears that the current estimate of 2008 loads with BMPs for the summer storm event is reasonably consistent with the IER previously predicted load for 2009 with BMPs for the summer storm event. As described above, the range associated with the current loads estimate is more refined than with the previously predicted loads, but remains within the previously predicted loading range. For the

winter storm event, it appears that the current load estimate is slightly greater than the previously predicted load estimate. This is likely a result of a larger storm volume and the differences between the current land use breakdown and previously predicted land use breakdown. Even with the variability of the data, the current pollutant load is less than the WLA. Therefore, for this parameter it may be reasonable to assume that the City is currently meeting their WLA, especially given that non-structural controls have not been included in the model.

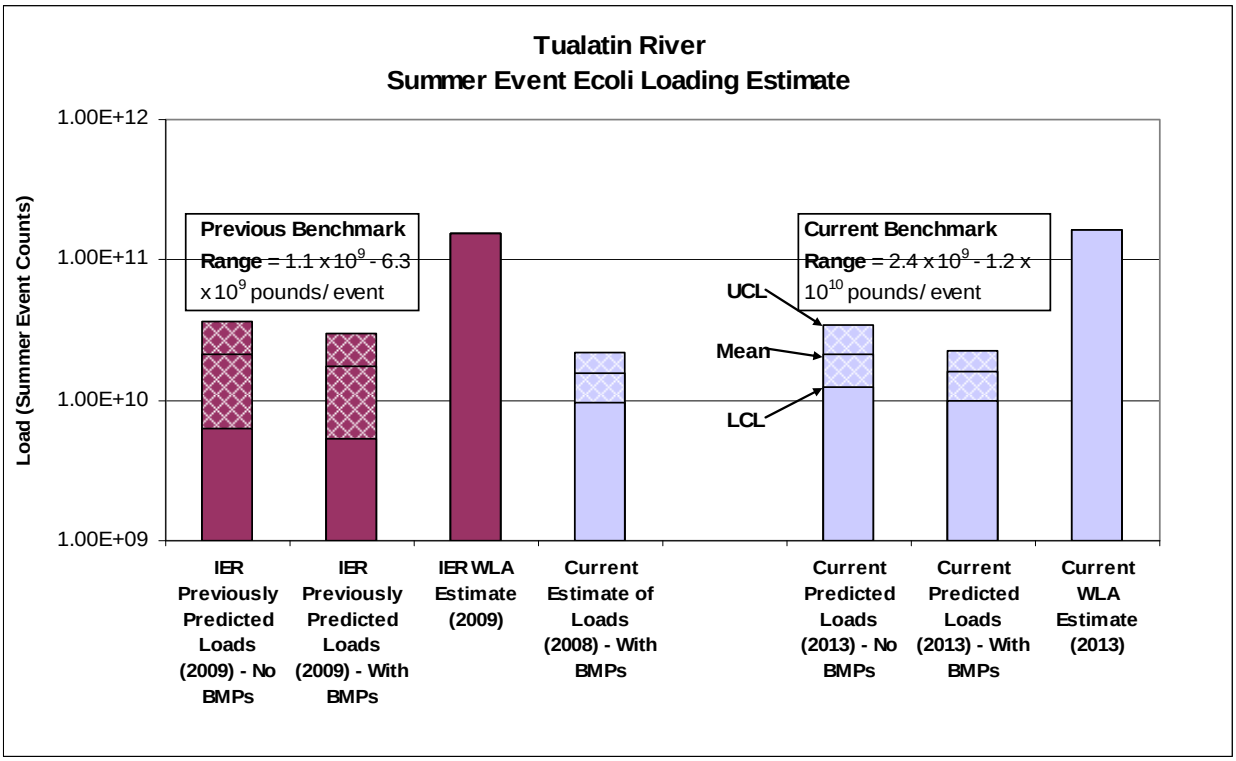
In the future condition (2013), the City shows a mean load decrease of approximately 5×10^9 counts when compared to conditions estimated without BMPs during the summer design storm. The City shows a load decrease of approximately 9.3×10^{10} counts when compared to conditions without BMPs during the 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 than actual removal of bacteria itself.

The plots indicate that the City is expected to continue to meet both the summer and winter WLA, although there is not a substantial decrease in loads due to implementation of structural BMPs. 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 2.4×10^9 colonies/event in the summer and 4.3×10^{10} in the winter. The upper values of the E. Coli benchmark range are 1.2×10^{10} colonies/event in the summer and 2.1×10^{11} in the winter (see Table 8 at the end of Section 6.6.3 for a summary of all the benchmarks). The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Comparison of instream monitoring data for a tributary to the Tualatin River with the E. Coli concentrations used to develop the TMDL WLA indicate that the City would meet the WLA, consistent with the results of the benchmarking exercise. E. Coli concentrations from the instream monitoring data generally do not exceed either the summer or winter concentrations referenced in the TMDL.

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 over which the City has no control (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, the City of West Linn's bacteria benchmark for the Lower Tualatin River will be focused on

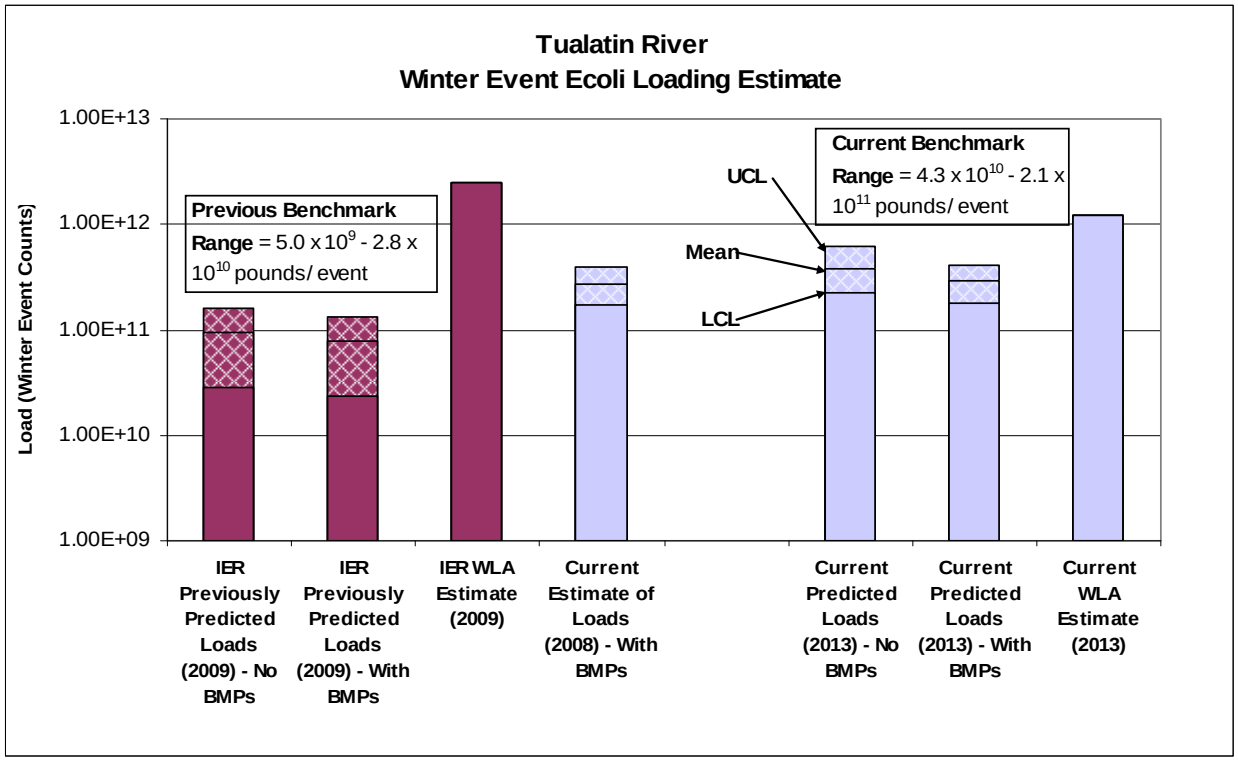
continued activities to reduce human and pet sources of bacteria and less focused on loads, especially given that the WLAs are being achieved.

Figure 3: Bacteria Loading (Summer Storm Event)



UCL = Upper Confidence Interval
LCL = Lower Confidence Interval

Figure 4: Bacteria Loading (Winter Storm Event)



UCL = Upper Confidence Interval
LCL = Lower Confidence Interval

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 (Figure 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%. The IER WLA (2009) was calculated based on a 20% load reduction from the IER predicted load with no BMPs (2009). Because the current, predicted load with no BMPs (2013) differs from the IER predicted load with no BMPs, the WLA was recalculated for 2013 using the current, predicted loads (2013) with no BMPs.

The dark purple color represents the loading previously predicted for 2009, calculated for the Interim Evaluation Report (IER) Submittal in 2006 (previously predicted load). The light purple represents the current estimated load in 2008, calculated for this permit renewal submittal (current load). It should be noted that the IER submittal used median values and a summer event to calculate TSS loads. In order to compare the previously predicted loads with the (mean) current loads, the original IER model was revisited and TSS recalculated using mean values as opposed to medians and using a summer seasonal rainfall instead of a summer event. The recalculated, mean TSS values are shown in Figure 5.

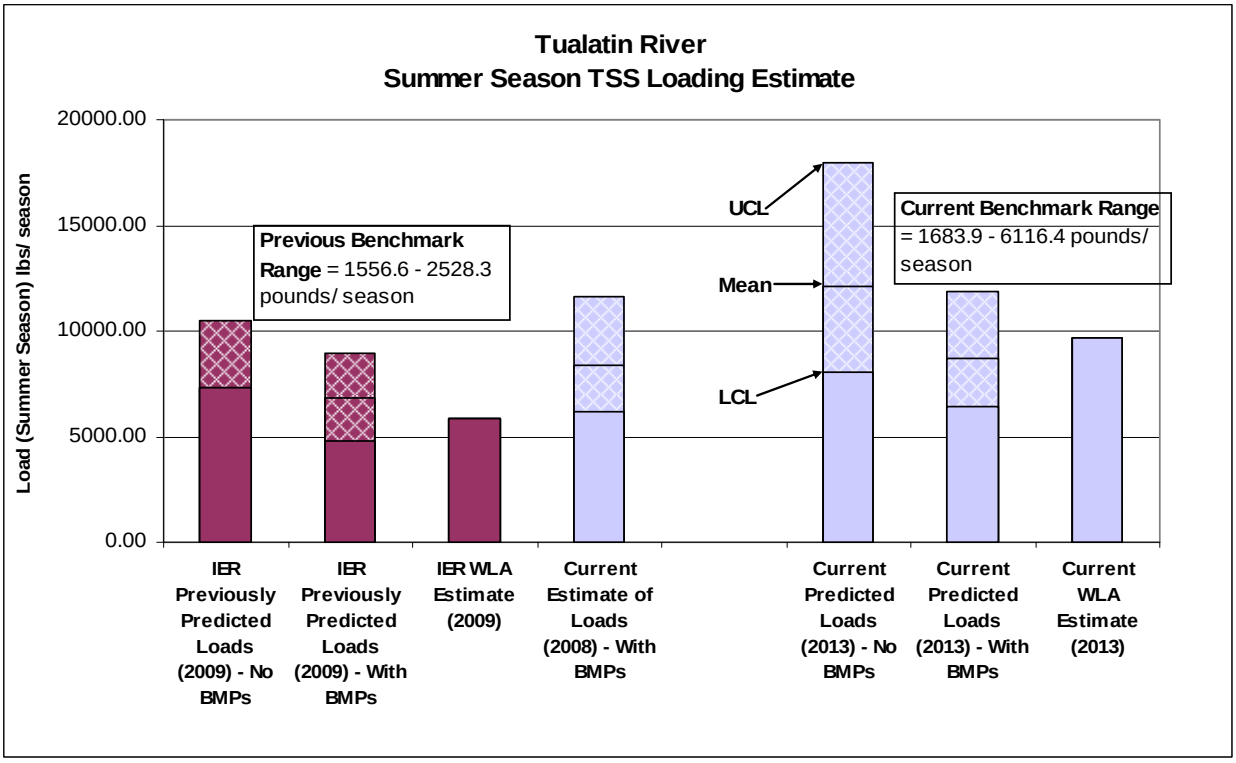
In comparing the previously predicted loads and the current loads, it appears that the current estimate of 2008 loads with BMPs for the summer storm event is reasonably consistent with the IER predicted load for 2009 with BMPs for the summer storm event, although the current load

estimate is slightly greater than the predicted load estimate. This is likely a result of the differences between the current land use breakdown and previously predicted land use breakdown. Even with the variability of the data, the LCL of the current TSS load is close to the predicted WLA. Therefore, for this parameter it may be reasonable to assume that the City is currently meeting their WLA, given that this estimate does not even include the effectiveness of non-structural controls.

During future conditions (2013), the City shows a mean reduction of approximately 3,421 pounds during the summer season (6.82" of rainfall total) due to implementation of structural BMPs. This reduction is expected to allow the City to meet their WLA. For this parameter it may also be reasonable to assume that accounting for implementation of non-structural BMPs could potentially further reduce the overall mean 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 1683.9 lbs./season and the upper value of the TSS benchmark range is 6116.4 lbs./season (see Table 8 at the end of Section 6.5.4 for a summary of all the benchmarks). The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. As the WLA was calculated as a percent reduction in load instead of being a concentration, no comparison was made between available instream monitoring data and the WLA.

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



UCL = Upper Confidence Interval
LCL = Lower Confidence Interval

6.5.3 Model Load Results for the Willamette River

As described previously, new benchmarks were calculated for the Willamette River as part of this permit renewal submittal. Bacteria (E. Coli) is the only parameter currently requiring benchmarks. Per the Willamette River TMDL, different reaches of the Willamette River have different WLAs. Therefore, the following subsections are categorized based on reach instead of parameter.

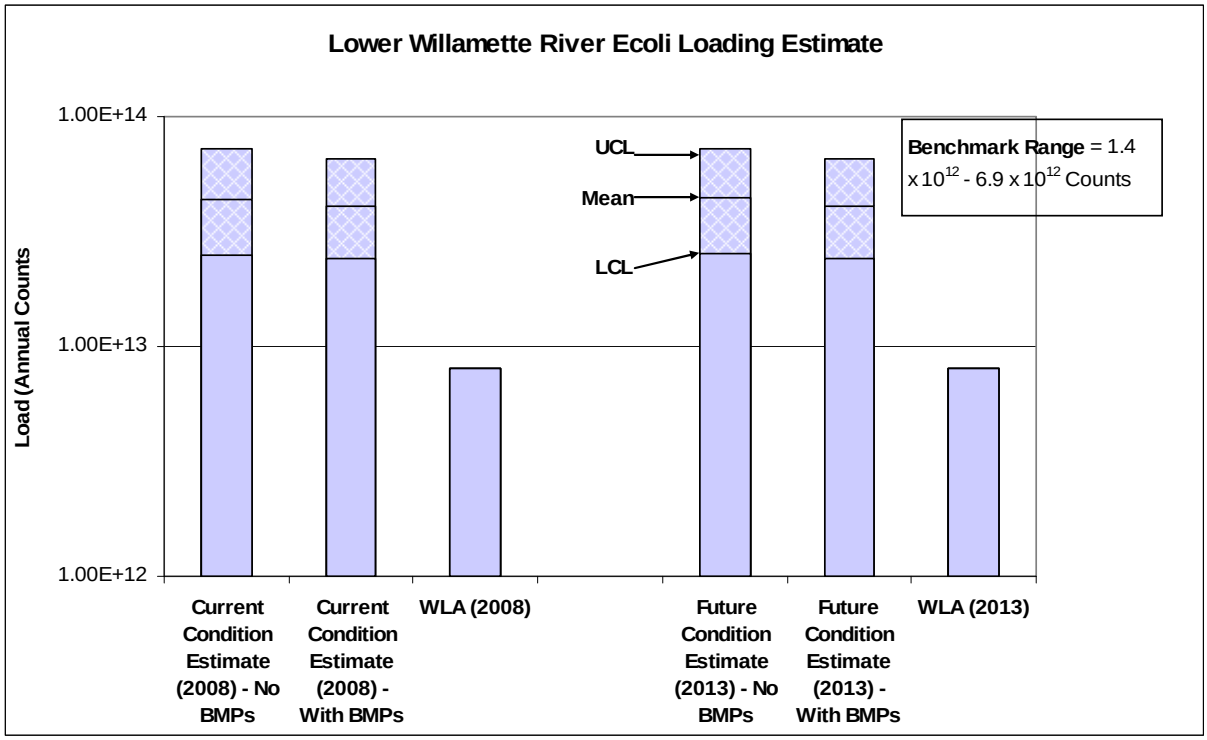
<u>Lower Willamette River</u>
The following graph (Figure 6) contains the annual bacteria load comparison plots for the Lower Willamette River watershed. The WLA for discharge to the Lower Willamette River is a 78% reduction in loading from the no-BMP load. Because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future condition individually.

In the future condition (2013), the City shows a mean load decrease of approximately 3.5×10^{12} counts when compared to conditions estimated without BMPs in the Lower Willamette watershed. Given that structural BMPs generally show limited effectiveness for bacteria removal (whether fecal coliform or E. Coli), there does not appear to be a substantial decrease in loads due to implementation of structural BMPs. 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 is not expected to meet the WLA in the Lower Willamette watershed. The low value of the E. Coli benchmark range is 1.4×10^{12} counts annually. The upper value of the E. Coli benchmark range is 6.9×10^{12} counts annually (see Table 8 at the end of Section 6.5.4 for a summary of all the benchmarks). The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Comparison of instream monitoring results for two Willamette River tributaries with the maximum instantaneous instream E. Coli concentration used to develop the WLA (406 MPN/ 100 mL) indicates that the benchmark calculations are consistent with current conditions, as monitored instream concentrations occasionally exceed 406 MPN/ 100mL.

Again, it should be noted that bacterial sources in urban environments have a very small human-derived component. 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, the City of West Linn's bacteria benchmark for the Lower Willamette River will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 6: Lower Willamette Annual E. Coli Loading



UCL = Upper Confidence Interval
LCL = Lower Confidence Interval

Middle Willamette River

The following graphs (Figures 7, 8, and 9) contain the annual or seasonal bacteria load comparison plots for the Middle Willamette River watershed. The Middle Willamette watershed has separate WLAs based on whether the discharge is direct to the Willamette River or to a tributary prior to discharge in the Willamette River. If the discharge is to a tributary prior to discharge in the Willamette River, the TMDL specifies a summer seasonal and a fall, winter, spring seasonal WLA. The WLA for discharge to the Middle Willamette River directly is a 75% reduction in loading. The WLA for discharge to a tributary prior to discharge in the Middle Willamette River is a 75% reduction in loading for the fall, winter, and spring seasonal rainfall and an 88% reduction in loading for the summer season. Like for the Lower Willamette River, because the current (2008) and future (2013) no BMP loads differ, the WLA was calculated for the current and future condition individually.

In the future condition (2013), the City shows a mean load decrease of approximately 1.4 x 10^{11} counts when compared to conditions estimated without BMPs in areas discharging to the Middle Willamette directly watershed. The City shows a mean load decrease of approximately 8.8 x 10^{11} for the summer season and 5.3 x 10^{12} for the winter season in areas discharging to tributaries prior to discharge in the Willamette River. Given that structural BMPs generally show limited effectiveness for bacteria removal (whether fecal coliform or E. Coli), there does not appear to not be a substantial decrease in loads due to implementation of structural BMPs. 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 may not be meeting the WLA in the Middle Willamette watershed. Specific benchmarks in accordance with the discharge locations are provided in Table 8 at the end of Section 6.5.4 and shown in Figures 7, 8, and 9. The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs. Comparison of instream monitoring results for two Willamette River tributaries with the maximum instantaneous instream E. Coli concentration used to develop the WLA (406 MPN/ 100 mL) indicates that the benchmark calculations are consistent with current conditions, as monitored instream concentrations generally exceed 406 MPN/ 100mL.

Again, it should be noted that bacterial sources in urban environments have a very small human-derived component and the more predominant sources of bacteria include wildlife (avian and rodent) and/or domestic pets. 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 for the other bacteria benchmark calculations, the City of West Linn's bacteria benchmark for the Middle Willamette River will be focused on continued activities to reduce human and pet sources of bacteria and less focused on loads.

Figure 7: Middle Willamette (Direct to River) Annual E. Coli Loading

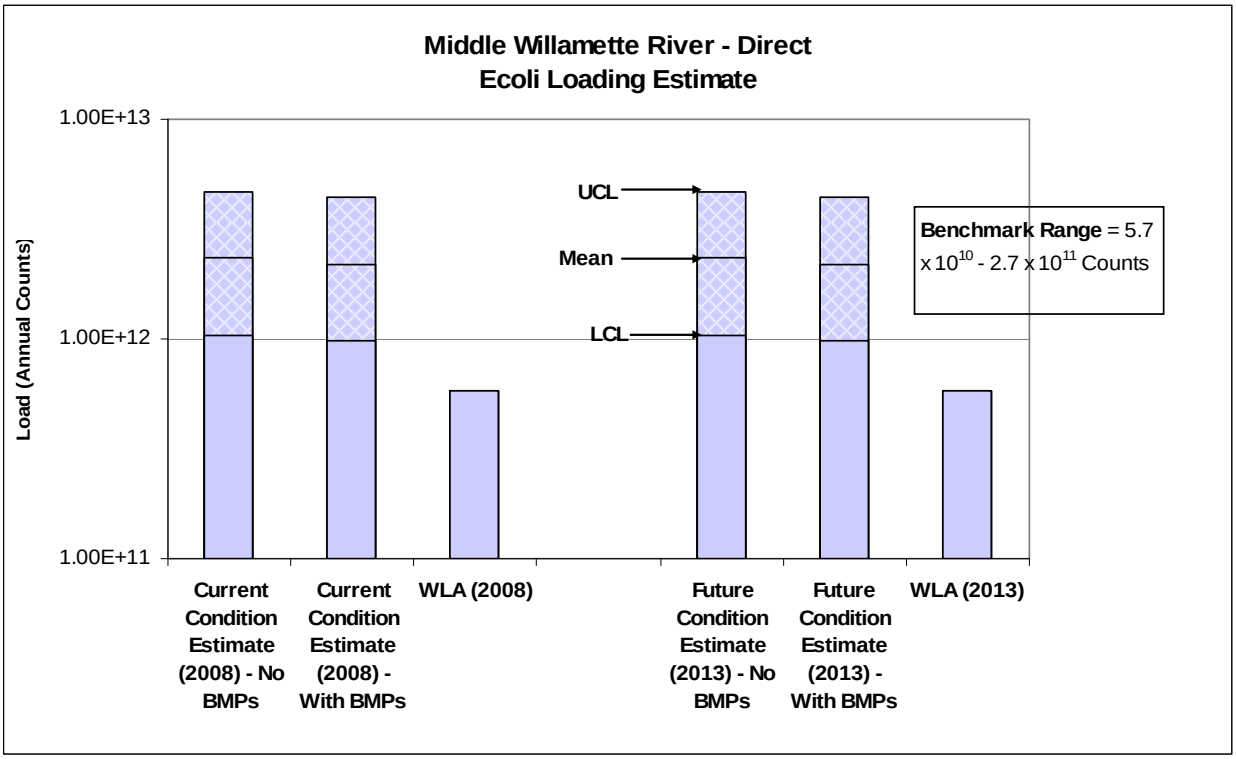


Figure 8: Middle Willamette (Tributary) Summer Season E. Coli Loading

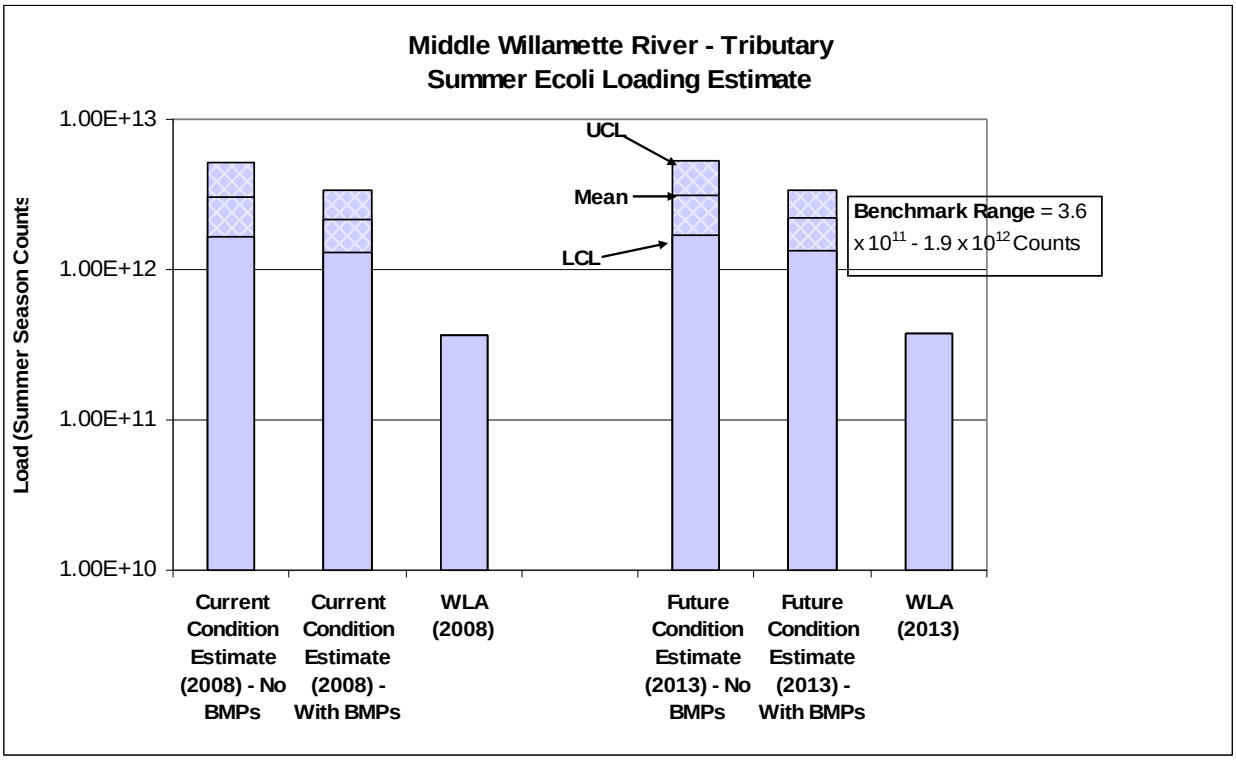
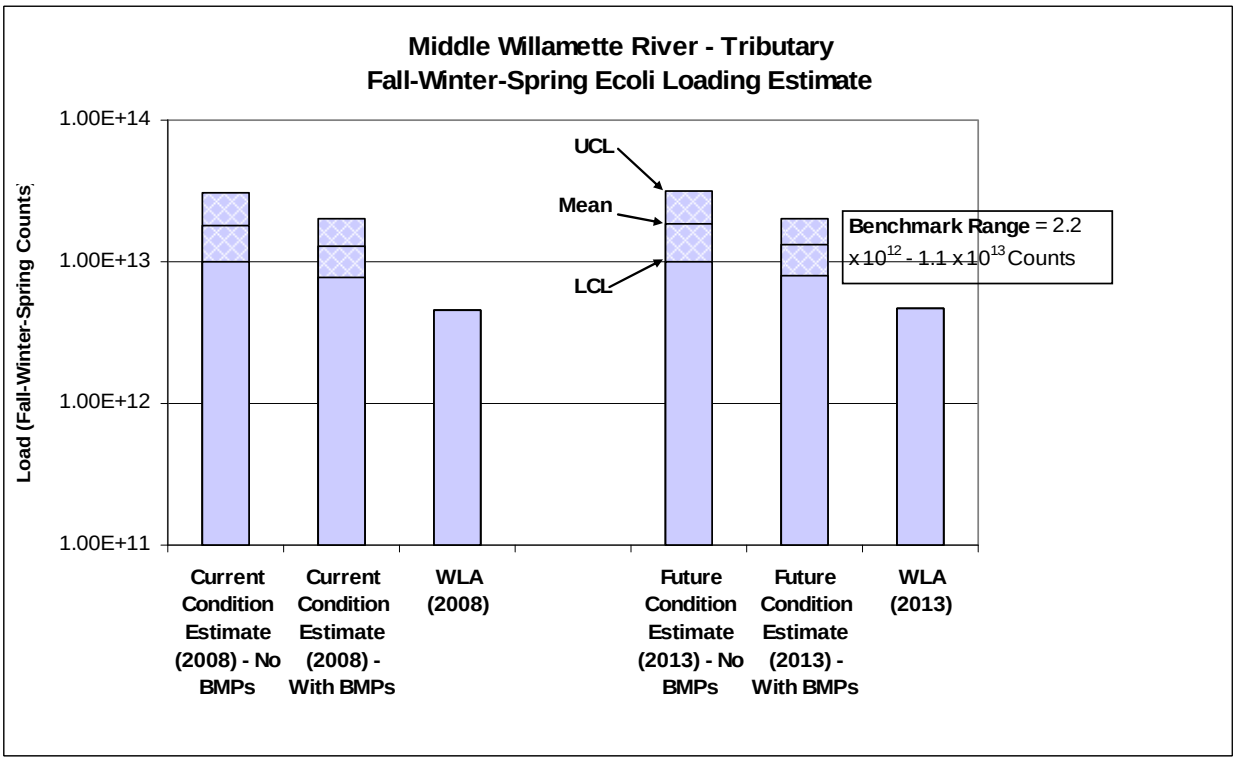


Figure 9: Middle Willamette (Tributary) Fall-Winter-Spring Season E. Coli Loading



UCL = Upper Confidence Interval
LCL = Lower Confidence Interval

6.5.4 Benchmarks

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 2 through 9 show the City of West Linn's current pollutant loads compared with the projected pollutant loads for the Tualatin River watershed and their current and future (2013) pollutant loadings for the Willamette River watershed. Loadings are shown for conditions assuming no structural controls and for conditions 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 as a percent reduction as defined in the TMDL. Modeled load results and the associated loading range based on the variability in data were plotted in comparison to the WLAs. Pollutant load reduction estimates associated with non-structural controls are not included on the graphs.

Current projections indicate that the City is currently expected to be meeting or close to meeting their WLAs for bacteria and dissolved oxygen in the Tualatin River watershed, although an argument may be made that if non-structural BMPs were included in the loadings model, the estimate would also show the City as likely to be meeting their WLA for total phosphorus, as the projected total phosphorus loading is close to the WLA.

Based on the loads model results, the City may not currently be meeting their WLAs for bacteria in the Willamette River watershed. This can be attributed to a number of reasons including the fact that structural BMPs are not generally effective for bacteria and the WLA described in the Willamette River TMDL is strictly a percent reduction over existing (no BMP) conditions. As a result, the WLA does not allow cities to take credit for preservation of parks and open space as a means to control pollutant discharge. The TMDL (and associated WLA) requires a flat reduction in bacteria based on an undefined point in time. The percent load reduction requirement (upwards of 75%) is difficult to meet given the limited BMP effectiveness data available and the fact that the bacteria sources are generally those that can not be managed by the City (see discussions above).

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, 19% of the total City area draining to the Lower Willamette, and 64% of the total City area draining to the Middle Willamette. The range around the difference between the 2013 no-BMP loads and the 2013 with-BMP loads are the City's benchmarks for the 2009 – 2014 permit cycle. A summary of the benchmarks is provided in Table 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;
2) Whenever an assumption is made in the methods for developing benchmarks, the most conservative assumption was chosen; and
3) Structural BMPs operating in series were given the effectiveness of only the most downstream BMP. BMPs operating in series are likely to be increasingly effective.

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 8: City of West Linn Benchmarks

	Lower Value of the Range	Upper Value of the Range
Tualatin River TMDL		
Total Phosphorus (lbs)	4.5	7.9
E. Coli (Winter) (Counts)	4.3×10^{10}	2.1×10^{11}
E. Coli (Summer) (Counts)	2.4×10^{9}	1.2×10^{10}
Total Suspended Solids (lbs)	1683.9	6116.4
Lower Willamette River TMDL		
E. Coli (Annual) (Counts)	1.4×10^{12}	6.9×10^{12}
Middle Willamette TMDL (via Tributary)		
E. Coli (Winter) (Counts)	2.2×10^{12}	1.1×10^{13}
E. Coli (Summer) (Counts)	3.6×10^{11}	1.9×10^{12}
Middle Willamette TMDL (Direct to River)		
E. Coli (Annual) (Counts)	5.7×10^{10}	2.7×10^{11}

Note: The low value of the range was calculated by taking the difference between the 2013 LCL with no BMPs and the 2013 LCL with BMPs. The upper value of the range was calculated by taking the difference between the 2013 UCL with no BMPs and the 2013 UCL with BMPs.

6.6 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.

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