City of Portland

Annual CSO Performance Report FY-2013

Required by NPDES Permit #101505 for CBWTP & CSO Systems

September 2013

Environmental Services
City of Portland

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Executive Summary

The Annual CSO Performance Report for fiscal year 2013 provides a comprehensive review of Portland's completed CSO system that includes the collection system, CSO facilities and treatment systems at the Columbia Boulevard Wastewater Treatment Plant (CBWTP). The scope covered by this report is described in the July 2011 NPDES permit for CBWTP:

> *"At minimum the report must provide an update regarding activities performed during the year in implementing the Nine Minimum Controls, will identify any CSO outfall not meeting the CSO performance standards, include a summary of the CSO monitoring done and detail the CSO related bypass events in order to assess the CSO reductions observed and the wet weather treatment performance."* *Report Submittals, Item c. from 2011 CBWTP NPDES Permit, page 14.*

In addition to the NPDES Permit, the scope of this report is also informed by four other important regulatory and programmatic documents:

- The Mutual Agreement & Order (MAO), attached to the permit which prescribes CSO treatment improvements and specific information in preparation for the next permit renewal in 2016.
- No Feasible Alternative Analysis (NFAA, December 2009) which established the methods for analyzing secondary bypass events as well as the annual, monthly, and weekly peak flow treatment performance characteristics.
- Nine Minimum Controls (NMC) Report, December 2010 Update which provides the framework and key information for documenting how NMCs are being implemented by Portland in an on-going, continuous manner.
- Post-2011 CSO Facilities Plan (September 2010) which identifies the projects Portland is pursuing that will enable "further CSO reductions" to be achieved and ensure the level of CSO control for the Willamette River exceeds the 4-per-winter, 3-year summer standards.

CSO System Performance

Fiscal Year 2013 (FY2013) was close to an average year in which Portland received 41 inches of rainfall compared to the annual average of 37 inches. The CSO system successfully captured all storms except three that exceeded the 4-per-winter or 3-year summer standard. All active CSO outfalls were controlled to meet and exceed the permit requirements.

There were three storms large enough to exceed the capacity of the Willamette River CSO system:

- **November 19-20, 2012:** 176 MG discharged over a ten-hour period from the Willamette River CSO Tunnels. The storm matched the 5-year design criteria for multiple durations.
- **November 24, 2012:** Only 0.5 MG was discharged from the Ankeny Pump Station outfall when this 24-hour, 3-per-winter storm filled the tunnel but did not completely fill the shafts.

- **May 23, 2013:** 26 MG discharged for less than three hours to the Willamette River during a 3-year summer storm that lasted over 48-hours. The tunnels filled and overflowed to the eight Willamette CSO outfalls connected to the tunnel.

In FY2013, the CSO volume discharged was 203 MG, which represents 2.8% of the total 7.1 billion gallons of combined sewage generated in the combined sewer system. The CSO system captured and treated 97% of all the stormwater and sewage generated in the combined area.

CSO Treatment Performance

The performance standards for treating dry weather and wet weather (captured CSO) flows at CBWTP are identified in the NPDES permit Schedule A. The requirements are focused on maximum-monthly and peak-week effluent loads discharged from Outfalls 001 and 003, and the effluent loads from the two treatment trains – Dry Weather / Secondary system and the Wet Weather treatment train. Annual percent removals are also specified for the Wet Weather Treatment train.

During this fiscal year, the CBWTP system met the permit's water quality based effluent limits for BOD and TSS at the Outfall 001 and 003 discharge points into the Columbia River. This was a result of the Operations staff successfully increasing the flow rate and volume treated through the secondary treatment system which continually exceeded the 100 MGD minimum requirement established in the permit. The Max-Month and Peak-Week values from the CBWTP outfalls are summarized in Table ES-1.

Table ES-1: Outfall 001 & 003 Effluent Concentrations During Peak Mass-Loading Periods

Parameter	Permit Maximum Concentration (mg/l)	Average Actual Concentration (mg/)
Maximum 30-Day Performance		
BOD5	30	21
TSS	30	24
Peak 7-Day Performance		
BOD5	45	18
TSS	45	21

The Wet Weather Treatment Facility (WWTF) was upgraded with Chemically Enhanced Primary Treatment (CEPT) system in the fall 2012. This upgrade enabled the WWTF to achieve annual percent removals of 56% for bio-chemical oxygen demand (BOD) and 77% for total suspended solids (TSS). These values exceeded the permit required 50% BOD and 70% TSS removal rates.

Analysis of the CSO treatment data from FY2013 revealed that CBWTP received 7.1 billion gallons of captured CSO compared to the average year volume of 6.2 billion gallons. CBWTP Operators were able to treat 66% of this CSO volume through the Secondary system, with 34% treated in the WWTF. There were 22 events in which flows were "bypassed" to the wet weather system. The average bypass event lasted 30 hours and sent 110 million gallons through the WWTF and Outfalls 001 & 003. During these events, the average flow rate through the secondary system was 126 MGD, which is significantly higher than the 100 MGD required in the NPDES permit.

Nine Minimum Controls (NMC)

This FY2013 Annual CSO Performance Report continues to add to the information provided in the 2010 Nine Minimum Controls Update Report for those best management practices implemented on an on-going basis (compared to one-time capital investments). As envisioned in the permit, the annual CSO performance report provides the necessary documentation of the NMC implementation, thereby eliminating the need for large periodic NMC Update reports.

In examining the performance data for NMC #1, Operations & Maintenance, the priorities for the City's work using Asset Management principles are evident. These principles are being used to prioritize reducing system risks to public health and the environment. The result is a significant shift in capital and operating expenditures and budgets:

- Capital expenditures in Pipe Rehabilitation programs have doubled since 2008 to $33 million average per year. This trend continues into the next 10-year CIP, reflecting the City's focus on risk-based priorities for sewer capacity and condition.
- Expenditures for Sewer Capacity projects to relieve sewer backups by integrating grey and green infrastructure continue to be implemented. These projects are identified in the Post-2011 CSO Facilities Plan and help maintain Portland's high level of CSO control.
- Expenditures have also increased for collection system pipe cleaning and CCTV inspections. The inspection data has been critical for providing up-to-date information on the condition and remaining useful life of individual pipes, which has helped to shape the scope and scale of the Pipe Rehabilitation programs.
- Treatment & Pump Station capacity and maintenance work is at a peak level due to the improvements needed to support the CSO program, including increased capacity for hydraulic, solids and wet weather treatment needs.

The NMC requirements that are components of the System Operations, such as Maximizing Storage and Maximizing Flow to Treatment, are discussed together in this report in the context of the operating strategy for the entire system.

Water Quality Results

Section 8 of this report presents the results of the Willamette River and the Columbia River water quality monitoring programs. The data for the CSO pollutants of concern are shown in data plots with data from past years provided to give context. In both programs, long-term trends as well as data from the past year show no problems with meeting water quality standards and protecting beneficial uses.

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Section 1: Introduction

The purpose of the Combined Sewer Overflow (CSO) Control Program is to reduce the magnitude, frequency and duration of wet-weather-induced CSOs in accordance with the 1994 Amended Stipulation and Final Order (ASFO) issued by the State of Oregon, which amended the 1991 Stipulation and Final Order. The end goal of Portland's CSO Control Program is compliance with water quality standards, the Clean Water Act and the requirements of the ASFO.

The ASFO required Portland to implement a 20-year CSO Control Program as presented in its 1994 CSO Control Facilities Plan (called the Long-term Control Plan or LTCP in the CSO Policy). The LTCP identified how Portland would comply with specified CSO overflow limits into the Willamette River and the Columbia Slough, which are:

- CSO discharges to the Columbia Slough are eliminated except during storms that are larger than the 5-year winter[1] and the 10-year summer[2] design storms.
- CSO discharges to the Willamette River are eliminated except during storms that are larger than the 4-per-winter and the 3-year summer design storms.

With the completion of Portland's CSO Control Program in 2011, and the expiration of the ASFO (January 30, 2013), the CSO control requirements were incorporated into the Columbia Boulevard Wastewater Treatment Plant (CBWTP) discharge permit. The National Pollutant Discharge Elimination System (NPDES) permit requires BES to submit annual CSO reports to the Oregon Department of Environmental Quality (DEQ) that document the performance of the overall CSO system. The Annual CSO Performance report covers CSO capture, conveyance, overflow characteristics, treatment efficiencies and on-going implementation of the Nine Minimum Controls (NMC) including Post-Construction Monitoring.

1.1 Purpose

This report is intended to meet the CSO-related reporting requirements in the CBWTP NPDES permit. The report documents the performance of the CSO capture, conveyance and treatment systems over the past fiscal year (July 1, 2012 through June 30, 2013), as well as the activities performed by the City of Portland to improve on the already high level of CSO control. The report also examines the major storm events that caused CSO to be discharged, and examines the wet weather treatment performance at CBWTP. In addition, the report documents the ongoing implementation of Portland's robust Nine Minimum Control (NMCs) program. This program

[1] Winter is defined as November 1 through April 30.
[2] Summer is defined as May 1through October 31.

consists of appropriate, and cost-effective best management practices that make up the EPA-specified NMCs, which have been integrated into the City's CSO Control Program.

1.2 Regulatory & CSO Program Background for Report

This Annual CSO Performance Report provides a summary of important performance measures derived from five major regulatory and CSO program documents:

- 2011 CBWTP NPDES Permit
- 2011 CBWTP Mutual Agreement & Order (MAO) that is coupled with the permit
- No Feasible Alternative Analysis (NFAA) Report dated December 2009
- Nine Mininum Controls Report dated December 2010
- Post-2011 CSO Facilities Plan dated September 2010

These regulatory and programmatic documents are also derivatives of the long-term CSO control process Portland has followed over the past 20+ years.

2011 CBWTP NPDES Permit

The Columbia Boulevard NPDES Permit (effective July 1, 2011) is the primary regulatory document that prescribes most of the Annual CSO Performance report content. Permit requirements include:

- Long-term CSO Control Program Performance (provided in Section 2 of this report)
- Wet Weather CSO Treatment Performance (Section 2.5)
- Nine Minimum Controls (Sections 3 through 8)
- Post-Construction Monitoring Plan (Sections 2 and 8)

2010 Nine Mininum Controls (NMC) Report

With full implementation of the CSO Control Program at the end of 2011, Portland effectively entered Phase III of EPA's NMC Program. In this phase the NMCs will continue to be implemented and adjusted to complement and enhance the control provided by the grey and green infrastructure developed as part of the CSO Control Program.

This annual report (Sections 3 through 8) provides summary charts, tables and graphs for each of the NMCs to provide ongoing documentation of the implementation of these NMCs. Similarly, the annual pretreatment report required by the permit and submitted separately, contains information about the status and performance of the pollution prevention program. Consequently, this Annual CSO Report does not include information about the City's pretreatment and pollution prevention programs.

Section 2: CSO System Performance for Fiscal Year 2013

The CSO System consists of the combined sewer collection system, the CSO collection, storage & pumping system and the CBWTP treatment systems. This section reports on the performance of the overall CSO system.

2.1 Expected Control Levels for Portland's CSO Outfalls

The specific level of CSO control and the control methods for each permitted outfall are summarized in Table 2-1. The BES Control Standard reflects the CSO control level Portland expects to achieve, which can equal or exceed the level required in the NPDES Permit.

Table 2-1: CSO Outfall Control

Basin	CSO Outfall	Method of CSO Control	BES Control Standard[1]
Willamette River CSO Outfalls - Minimum Control Level			
Sheridan	7B	West Side CSO Facilities	4-per-Winter Storm and 3-Year Summer Storm
CBD/Ankeny	9	West Side CSO Facilities	
Nicolai	15	West Side CSO Facilities	
NW 110th	24	Cornerstone & Pump Station Improvements	
Taggart	30	Cornerstone & East Side CSO Facilities	
Alder	36	Cornerstone & East Side CSO Facilities	
Wheeler	43	Cornerstone & East Side CSO Facilities	
Beech-Essex	46	Cornerstone & East Side CSO Facilities	
Riverside	47	West Side CSO Facilities	
St. Johns B	52 & 53	Cornerstone & System Improvements	
Willamette River CSO Outfalls - Highest Control Level			
Balch	17	West Side CSO Facilities, Balch Consolidation Conduit	5-Year Winter Storm and 10-Year Summer Storm
California	1	Sewer Separation, Downspout Disconnection; SWPI	
Carolina	3	Southwest Parallel Interceptor (SWPI)	
Sellwood	26A	Partial Separation, System Improvements	
Sellwood - Lents	27	System Improvements, Storage & Pumping	
Columbia Slough CSO Outfalls - Highest Control Level			
St. Johns A	54	Expanded Separation and Downspout Disconnection	5-Year Winter Storm and 10-Year Summer Storm
Oswego	55	Sumps, Expanded Separation, and Downspout Disconnection	
Oregonian	56	Sumps, Expanded Separation, and Downspout Disconnection	
Fiske A	57	Cornerstone Projects & Columbia Slough CSO Facilities	
Chautauqua	58	Cornerstone Projects & Columbia Slough CSO Facilities	

Basin	CSO Outfall	Method of CSO Control	BES Control Standard[1]
Bayard	59	Cornerstone Projects & Columbia Slough CSO Facilities	
Kenton	60	Cornerstone Projects & Columbia Slough CSO Facilities	
Albina	62/62A	Cornerstone Projects & Columbia Slough CSO Facilities	
NE 13th	65	Cornerstone Projects & Columbia Slough CSO Facilities	

Note #1: The NPDES permit does not require floatables control devices on outfalls that are controlled to the 5-Year Winter Storm and 10-Year Summer Storm levels.

2.2 Rainfall Patterns for the Past Fiscal Year

FY2013 was a little above average in rainfall with 40 inches measured at the CBWTP gauge compared to the average 37 inches per year. During this period, five winter storms exceeded the 4-per-winter design storms, and one summer storm exceeded the 3-year summer storm depths. Three of the events were large enough to generate CSO discharges:

1. November 19-21, 2012 – Winter CSO Event
2. November 24, 2012 – Winter CSO Event
3. December 3-4, 2012 – No Overflows
4. December 15-17, 2012 – No Overflows
5. December 19-20, 2012 – No Overflows
6. May 23, 2013 – Summer CSO Event

2.2.1 Winter Storm Review

The five winter storms that exceeded the 4-per-winter ASFO design depths are shown graphically in Figure 2-1 below. This graph is a "Depth-Duration" chart that displays the maximum depth of rainfall that occurred for storm durations from 1-hour to 48-hours. The events that caused CSO to occur are shown with red-tinted lines, and the storms that had no CSO are shown with green-tinted lines. These events are compared to the two ASFO Winter Design Storms (4-per-winter and 5-year winter[3]) shown with blue-tinted lines. (The May 2013 summer storm is included in Figure 2-1 for comparison purposes only.)

The rainfall depth values used to create the chart are presented in Table 2-2. This table shows the specific storm frequency depths that provide the basis for estimating the return frequency and durations of actual storms (such as a 5-year, 48-hour Winter Storm). In examining the data and number of storms, it would appear that the rainfall depth criteria for the 4-per-winter design storm indeed represent depths that occur or are exceeded about 4 times per winter.

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[3] 5-Year Winter Storm is included on the charts for the Willamette CSO System because it is a control standard in the permit for outfalls that are not required to have floatables control devices installed.

Figure 2-1: FY2013 Winter (and one Summer) Storms Compared to ASFO Design Storms

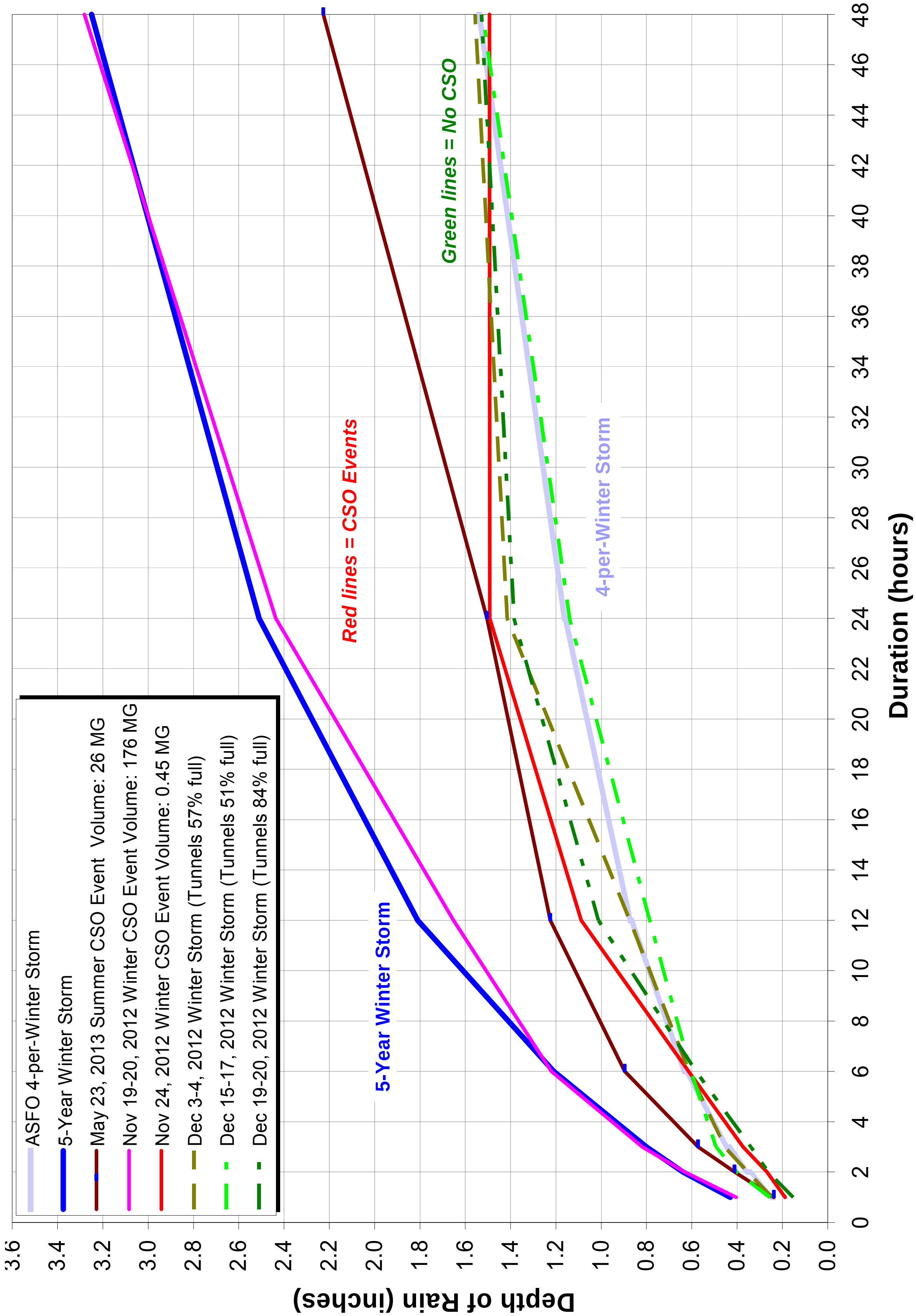


Table 2-2: FY2013 Winter Storms Compared to ASFO Design Storms

Comparison of Willamette CSO Winter Storm Events							
Duration (hours)	**1**	**3**	**6**	**12**	**24**	**48**	
Willamette River Winter Design Storms (inches)							
4-per-Winter Design Storm	0.24	0.44	0.65	0.89	1.19	1.53	
3-per-Winter Storm	0.27	0.49	0.72	1.01	1.35	1.74	
2-per-Winter Storm	0.30	0.55	0.81	1.17	1.59	2.07	
1-per-Winter Storm	0.35	0.65	0.97	1.43	1.93	2.55	
5-year Winter Design Storm	0.43	0.8	1.21	1.81	2.51	3.26	
Historical Storms - Average Rainfall over Willamette CSO Basin (inches)							**Approximate Return Frequency & Duration**
November 19-20, 2012 ***CSO Event***	0.40	0.82	1.22	1.65	2.44	3.28	5-year, 48-hour Winter Storm
November 24, 2012 ***CSO Event***	0.19	0.37	0.61	1.09	1.49	1.49	3-per Winter, 24-hour Storm
December 3-4, 2012	0.25	0.45	0.61	0.87	1.42	1.56	3-per Winter, 24-hour Storm
December 15-17, 2012	0.26	0.49	0.60	0.79	1.14	1.52	4-per Winter, 24-hour Storm
December 19-20, 2012	0.15	0.34	0.58	1.01	1.39	1.53	3-per Winter, 12-hour Storm

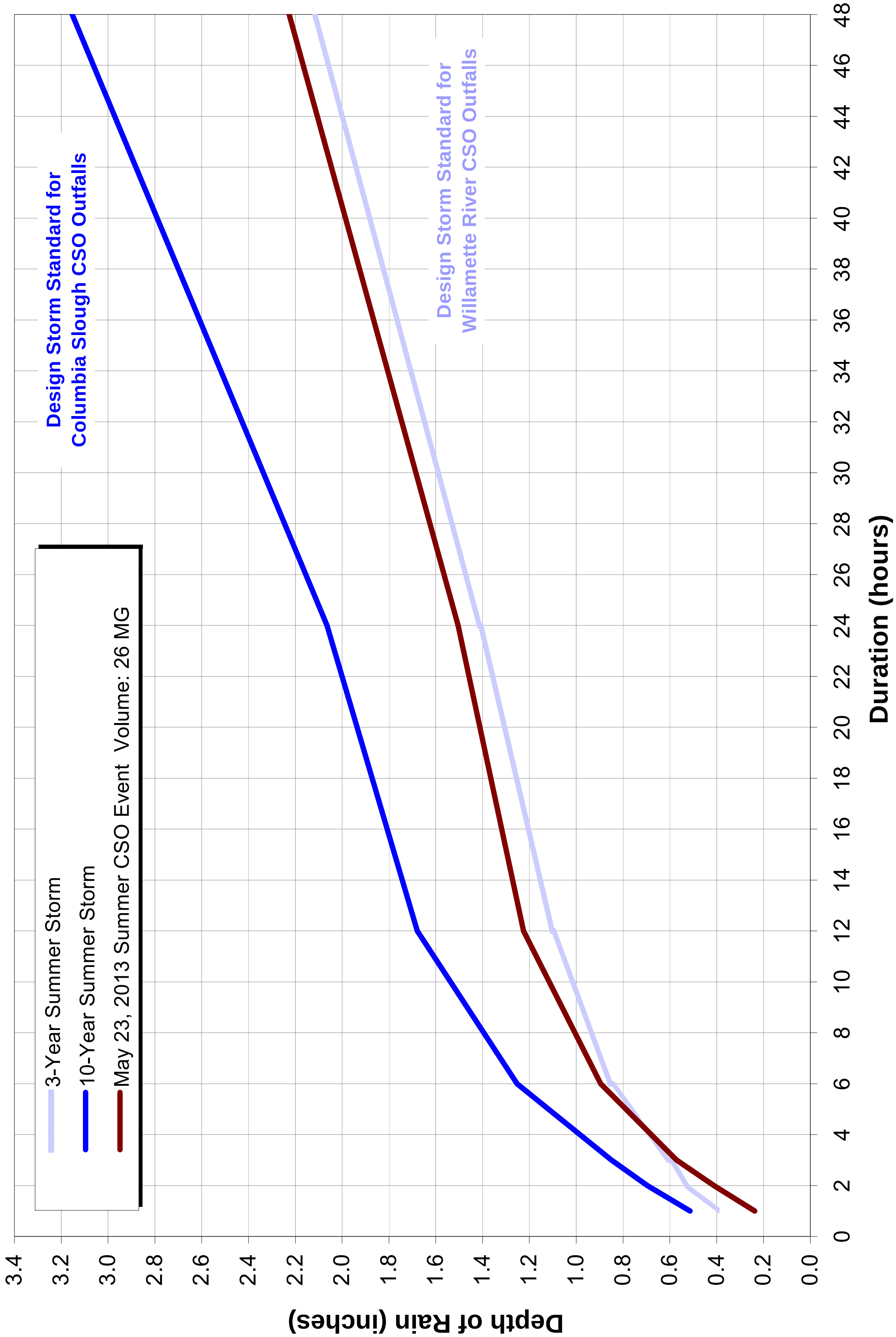
2.2.2 Summer Storm Review

The May 23, 2013, storm exceeded the standard 3-year summer storm depths by about 10% for durations of 6 to 24 hours. A comparison of the measured rainfall versus the standard summer design storm criteria is shown graphically in Figure 2-2 below, as well as in Table 2-3 below. As can be seen from the data, the May 23, 2013, rainfall exceeded the 3-year summer storm by about a tenth of an inch for the 12-hour to 48-hour durations.

Table 2-3: May 23, 2013, Storm Rainfall Depths vs. Design Storms

Comparison of Summer Storm Events in Willamette CSO Area							
Duration (hours)	**1**	**3**	**6**	**12**	**24**	**48**	
Willamette River Summer Design Storms (inches)							
3-year Summer Storm	0.40	0.60	0.85	1.10	1.41	2.12	
10-year Summer Storm	0.51	0.85	1.25	1.68	2.06	3.15	
Historical Storms - Average Rainfall over Willamette CSO Basin (inches)							**Approximate Return Frequency & Duration**
May 23, 2013 ***CSO Event***	0.24	0.57	0.90	1.22	1.50	2.23	> 3-year, 12-hour Summer Storm

Figure 2-2: May 23, 2013 Rainfall Compared to ASFO Summer Storms



2.3 CSO Discharges into the Willamette River and Columbia Slough

In fiscal year 2013 there were no CSO discharges into the Columbia Slough. There were three storms large enough to exceed the capacity of the Willamette River CSO system:

- **November 19-20, 2012:** 176 MG discharged over a ten-hour period from the Willamette River CSO Tunnels. The storm matched the 5-year design criteria for durations of one hour to 48 hours.
- **November 24, 2012:** Only 0.5 MG was discharged from the Ankeny Pump Station outfall when this 24-hour, 3-per-winter storm which filled the tunnel but did not fill all of the shafts completely except at Ankeny.
- **May 23, 2013:** 26 MG discharged for less than three hours to the Willamette River during a 3-year summer storm that lasted over 48-hours. The tunnels filled and overflowed to the eight Willamette CSO outfalls connected to the tunnel.

In FY2013, 203 MG of CSO was discharged from the completed CSO system. This volume represents 2.8% of the total 7.1 billion gallons of stormwater and CSO collected by the combined system in FY2013. This means the CSO system captured and treated 97% of all the stormwater and sewage generated in the combined area.

A summary of the CSO discharges since December 1, 2011, is provided below in Table 2-3. Five CSO events have occurred since the East Side CSO system was brought online, which marked the completion of the Willamette CSO system.

The November 24, 2012, event listed in Table 2-4 and displayed in Figure 2-1 reflects the fact that Ankeny Pump Station was offline during a major re-build project. Even though the event exceeded the 4-per-winter criteria, this small overflow likely would not have occurred if Ankeny was available to pump. Portland had postponed this much needed upgrade of Ankeny until the CSO system was proven to meet the required level of control. The extra cushion within the system, as demonstrated by the high level of control shown last year in FY2012, confirmed that sufficient capacity existed in the CSO system to allow it to serve as an alternate route for the Ankeny flows. The new Ankeny pump station is expected to be online before the end of the current fiscal year.

Table 2-4: Record of Willamette River CSO Events Since December 2011

CSO Discharge Events			Storm Characteristics			System Totals		West-Side Totals		East-Side Totals	
Event Count	Dates of Storm / Overflow Events	Description	6-Hour Rainfall (inches)	12-Hour Rainfall (inches)	24-Hour Rainfall (inches)	Overflow (MG)	Duration (hrs)	Overflow (MG)	Duration (hrs)	Overflow (MG)	Duration (hrs)
1	January 17-21, 2012	> 5-year 12-hour Winter Storm	1.48	2.15	2.32	305	10.3	86.4	10.3	219	10.3
2	May 26, 2012	> 100-year, 30-minute storm (.85" in 30-min)				14.9	0.8			14.9	0.8
3	November 17-21, 2012	5-year, 48-hour Winter Storm	1.22	1.65	2.44	176	9.5	44.0	9.5	132	9.3
4	November 24, 2012	3-per Winter, 24-hour Storm	0.61	1.09	1.49	0.5	0.8	0.5	0.8		
5	May 23, 2013	3-year, 12-hour Summer Storm	0.90	1.22	1.50	26.3	2.3	11.9	2.3	14.4	1.8
	Average Values per Event		**1.05**	**1.53**	**1.94**	**105**	**4.7**	**36**	**5.7**	**95**	**5.5**

2.4 CSO Facilities Operations Monitoring Information

2.4.1 Annual Operations Review

There have been no storm-caused CSO discharges from the Columbia Slough Consolidation Conduit since it was completed in 2000. The capacity and operation of the Influent Pump Station (IPS) in conjunction with the storage in the Columbia Slough Consolidation Conduit (CSCC) have been sufficient to control CSO in the Columbia Slough system over the past 13 years without allowing an overflow to occur.

The annual performance of the Willamette CSO system can be viewed through the rates and volumes pumped during FY2013 by the CSO facilities as shown in Table 2-5. The table shows that the Peninsular Force Main 1 conveyed the most pumped volume from the Willamette CSO tunnels. Although this is to be expected, in that Force Main 1 conveys all the dry weather flow sent to Swan Island CSO Pump Station (SICSO) as well as the first amounts of wet weather flow, this large pumped volume in FY2013 was also a result of Ankeny pump station being off-line for a major upgrade during the year. All of the West Side dry weather and CSO flows that Ankeny normally managed were diverted into the West Side CSO tunnel and pumped out by SICSO. The difference in having Ankeny offline can be seen in the comparison against the FY2012 Volume Pumped highlighted in blue text in Table 2-5. Force Main 1 pumped over twice as much in FY2013 as compared to the previous year.

The system performance in FY2013 was also impacted by the temporary closure of the Argyle Gate that allows Willamette CSO to be stored in the CSCC and be pumped out later by the IPS. Table 5 shows that the volume pumped by the IPS in FY2013 was only 42% of the volume it pumped in 2012. The Argyle Gate is being re-configured to ensure it opens according to the updated System

Operating Strategy. Once this and the Ankeny upgrade are completed, the volume pumped by the CSO pump stations will likely be closer to the FY2012 results.

Table 2-5: FY2013 CSO Pumping to CBWTP

Pumping Source		Maximum Pumping Rate (MGD)	Average Rate When Pumping (MGD)	Hours of Operation	FY2013 Volume Pumped (MG)	FY2012 Volume Pumped (MG)
Peninsular System	Forcemain 1	40	21.6	7,137	6,422	2,931
	Forcemain 2	67	23.2	1,051	1,020	519
	Total Peninsular	*102*	*25.0*	*7,155*	*7,442*	*3,450*
Portsmouth Forcemain	Forcemain 3	133	73.2	691	2,113	919
Swan Island CSO PS	Total SICSO	223	32.0	7,160	9,555	4,369
CSCC IPS	Total IPS	106	11.0	2,943	1,349	3,162
Total Pumping from CSO Tunnels					10,904	7,532

2.4.2 CSO Event Operations Review

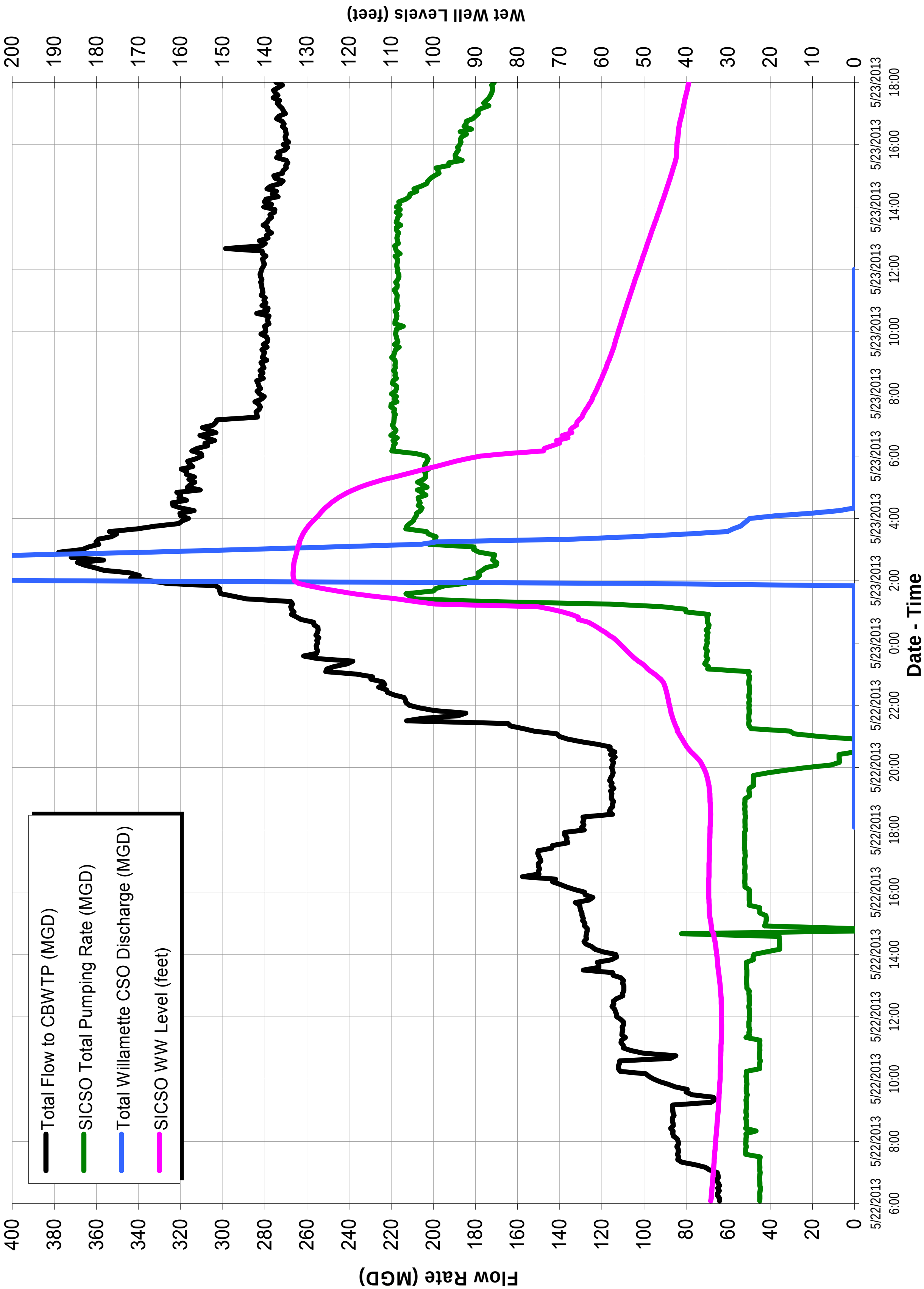
Of the three CSO events that occurred in FY2013, only the May 23, 2013, event displayed unexpected operational issues that required a response to correct the situation. Specifically, the unexpected issue was a delay in accelerating the SICSO pumping rate when the storm flows increased.

The rainfall and overflow statistics for the May 23, 2013, confirm that the storm was larger than the permit-required control levels, and that the system overflowed only when the storm exceeded the 3-year summer storm return frequency criteria. Therefore, there was no permit violation.

The operational issue can be seen in Figure 2-3 which charts the total flow rate to CBWTP, the pumping rate from SICSO, the SICSO Wet Well Level, and the total CSO discharged to the Willamette River during the May 21-24th storm. This information indicates that the pumping rate from Swan Island was maintained near 50 MGD during the early part of the storm. When the tunnel filled, the pumping rate was then increased to the 220 MGD maximum rate. The pumping rate was constrained early in the storm as a result of multiple items:

1. The Operators constrained Swan Island CSO pump station to about 50 MGD, using the tunnel system to equalize the small storm's varying flow rates and prevent sending intermittent peak flows to CBWTP. This is consistent with the CSO System Operating Plan and necessary to minimize secondary bypass and the start/stop of CEPT operations.

Figure 2-3: CSO System Operations During May 23, 2013 Storm



2. The CSO Override automation should have shifted SICSO pumping rate from the 50 MGD "Flow Mode" to the "Maximum Flow from SICSO to CBWTP" which typically allows for higher rates. The Operations managers decided the Rain and the CSO Level Overrides were needed during summer storm that was forecasted to be less than a quarter of an inch.

Within a few weeks after the storm, BES staff developed specific solutions which were then implemented to address the Rainfall Override and the Level Override activation. The iFIX system will now respond to tunnel levels that exceed the setpoints and to the 6-hour rain depths that exceed the Rain Override setpoint.

2.5 Wet Weather Treatment Performance and Effluent Quality

2.5.1 Annual CSO Treatment Characteristics

The key parameters for the treatment system annual performance are derived from the NPDES permit, which specifies annual percent removal efficiencies, and the parameters are based on Portland's No Feasible Alternative Analysis (NFAA). The NFAA relied on computer models that simulated average year conditions and identified expected levels of treatment through the secondary system, the number of bypass events, and the expected effluent quality from the blended wet weather and secondary systems.

Table 2-6 summarizes the main annual treatment performance measures for the CBWTP systems. Portland's CSO system has been completed for nearly two fiscal years as of July 2013, with some treatment components in place for less than one fiscal year. Table 2-6 lists the values for both fiscal years and compares them against the NPDES permit and the model (NFAA) expected values. The key parameters are highlighted in blue text. The results from the table show:

- Secondary treatment rate was maximized during periods of bypass. The average rate of secondary treatment of 126 MGD was more than 25% above the permit minimum requirement of 100 MGD.
- Percent of Captured CSO Treated through Secondary significantly exceeded the model target level (66% compared to 54%)
- BOD and TSS Removal Efficiencies for the Wet Weather System exceeded the permit's minimum requirements: BOD removal was 56% compared to the permit required 50%; and TSS removal was 77% compared to the permit's 70% requirement.

The annual performance data indicates that the CSO system operations strategy enabled improved performance under all the various weather conditions throughout the year.

Table 2-6: CBWTP Annual Treatment Performance Summary Data

Annual Treatment Characteristics	Average Year Model / Permit	*No CEPT* FY2012	*With CEPT* FY2013
Annual Rainfall Depth (inches/year)	37	46.8	40.2
Flows to CBWTP			
Influent Volume (MG/Year)	28,300	28,800	26,625
Dry Weather Sanitary Volume (MG/Year)	22,100	20,200	19,496
Captured CSO Flow - Volume (MG/Year)	6,200	8,600	7,129
Total Volume Treated Thru Secondary (MG)	25,443	25,662	24,197
% of Plant Flow Treated Through Secondary System	90%	89%	91%
WWTF (Secondary Bypass) Events			
Secondary Rate During Bypass (MGD)	100	120	126
Number of Events / Year	32	29	22
WWTF Volume / Year	2,857	3,138	2,429
Amount of Captured CSO Treated via Secondary (%)	54%	64%	66%
Duration of WWTF Events (hours)	919	706	668
Calendar Days of WWTF Discharges (days)	---	66	50
Blended Effluent (OF001 & 003) Treatment			
BOD Loading (pounds / year)	2,510,000	4,000,000	2,957,783
BOD Average Concentration (mg/l)	27	16.6	13.3
Total Plant BOD Removal Efficiency (%)	---	93%	95%
TSS Loading (pounds / year)	2,440,000	5,050,000	3,585,748
TSS Average Concentration (mg/l)	27	21.0	16.1
Total Plant TSS Removal Efficiency (%)	---	92%	94%
Wet Weather Treatment Facility			
BOD TO Wet Weather Facility (pounds/year)	---	2,290,000	1,638,460
BOD FROM Wet Weather Facility (pounds/year)	---	1,510,000	726,541
Wet Weather BOD Removal Efficiency (%)	50%	34%	56%
TSS TO Wet Weather Facility (pounds/year)	---	4,030,000	2,257,182
TSS FROM Wet Weather Facility (pounds/year)	---	1,480,000	520,375
Wet Weather TSS Removal Efficiency (%)	70%	63%	77%

2.5.2 CBWTP Max-Month and Peak-Week Treatment Performance

The CBWTP NPDES permit lists performance requirements for the CBWTP, the dry-weather/secondary system and the wet-weather treatment trains for monthly and weekly extreme weather conditions. Table 2-7 and Table 2-8 below summarize the effluent BOD and TSS concentrations and loads during the most extreme periods in FY2013 for the overall plant site (Outfalls 001 & 003), the Secondary Effluent, and the Wet Weather Effluent.

The maximum 30-day treatment results for BOD and TSS during the past fiscal year are provided in Table 2-7. The maximum 30-day period was determined by searching a moving window of 30 days to find the highest mass loading. After this period was identified, the flow rate and concentrations was calculated for that period. The results of Table 2 show that the effluent discharged to Outfalls 001 and 003 during the maximum 30-day period clearly met the permit's

BOD and TSS concentration and mass load limits. The secondary system performed well during this maximum loading period that occurred in December 2012, showing that the operation strategy for the CSO system successfully protected the biological treatment processes.

Table 2-7: CSO Max-Month (30-days maximum solids loading) Treatment Performance

Parameters	**Maximum Monthly (30-Day)**						
	Avg Concentration During Maximum Month for Mass Loading			Mass Loading			
	Permit Monthly (mg/l)	Max 30-Day (mg/l)	30-Day Avg Flow (MGD)	Permit Monthly (lbs/day)	Max 30-Day (lbs/day)	Date of 30th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality							
BOD5	30	21	116	45,000	20,738	17-Dec-12	12.2 inches of rain in 30 days
TSS	30	24	116	45,000	23,298	17-Dec-12	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	30	13	101	22,500	10,881	28-Dec-12	9.9 inches of rain in 30 days
TSS	30	19	101	22,500	16,227	28-Dec-12	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	45	15	89	22,500	11,194	17-Dec-12	12.2 inches of rain in 30 days
TSS	45	12	89	22,500	8,972	17-Dec-12	

The Peak Week 7-day period was determined by examining a 7-day continuous record of pollutant loads to the outfalls and selecting the consecutive seven days with the highest mass load. Table 2-8 shows the flow rates, concentrations, and mass loads for the 7-day peak period that occurred November to December 2012. The results indicate that the treatment performance clearly met the permit's BOD and TSS concentration and mass load criteria and that the secondary system was successfully protected by the operational strategy for the CSO system.

Table 2-8: CSO Peak-Week (7-days maximum solids loading) Treatment Performance

Parameters	**Peak Week (7-Day)**						
	Avg Concentration During Peak Mass Loading Week			Mass Loading			
	Permit Weekly (mg/l)	Max 7-Day (mg/l)	7-Day Avg Flow (MG)	Permit Weekly (lbs/day)	Max 7-Day (lbs/day)	Date of 7th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality							
BOD5	45	18	203	118,800	31,298	6-Dec-12	3.6 inches of rain in 7 days
TSS	45	21	203	118,800	35,558	6-Dec-12	
Secondary Biological Treatment - 100 MGD Minimum Instantaneous							
BOD5	45	15	112	37,500	13,595	6-Dec-12	3.6 inches of rain in 7 days
TSS	45	21	112	37,500	19,342	6-Dec-12	
Wet Weather / CEPT System - Intermittent Discharges							
BOD5	65	28	103	81,300	23,731	24-Nov-12	5.8 inches of rain in 7 days
TSS	65	19	103	81,300	16,687	24-Nov-12	

2.5.3 Wet Weather Treatment Performance for Bypass Events

The performance of the CSO wet weather treatment system is be best evaluated by examining the events in which the WWTF discharged treated effluent. The NPDES permit refers to these events as "bypass events" because they do not receive secondary treatment. CSO is not required by federal or state regulations to receive secondary treatment, therefore Portland refers to these events as WWTF discharge events or simply WWTF events. Table 2-9 summarizes the WWTF events that occurred in FY2013. The full list of events is provided in Table 2-9 on the following page.

For this analysis, a WWTF begins when the wet weather system discharges effluent, and ends after either of the following:

- No WWTF discharge AND the secondary flow remains below 80 MGD for 6 hours

OR

- No WWTF discharge occurs for 48 hours (helps to define the end of an event during Portland's long winter storms).

Table 2-9: WWTF Events (Secondary Bypass) Summary for FY2013

		CBWTP Flows		WWTF Flows				WWTF EFFLUENT			
Date & Time Bypass Event Started	Event #	Avg Influent During Bypass (MGD)	Avg Secondary Flow During Bypass (MGD)	Avg WWTF Flow (MGD)	WWTF Discharge Volume (MG)	Duration of WWTF Discharge (hrs)	Calendar Days WWTF Discharge Occurred	Event BOD Load Discharged (lbs)	Event TSS Load Discharged (lbs)	EMC BOD (mg/l)	EMC TSS (mg/l)
Total	**22**				**2,429**	**668**	**50**	**726,541**	**520,375**		
Avg / Event		**199**	**126**	**76**	**110**	**30.3**	**2.3**	**33,025**	**23,653**	**44**	**29**

Note: EMC = Event Mean Concentration

The event summary in Table 2-9 illustrates key aspects of the wet weather system performance:

- Volume of WWTF discharge for the year was 2.4 billion gallons. This represents about 10% of the total volume received at CBWTP for the year (see Table 1).
- There were fewer than 700 hours of discharge (about 8% of the year) and fewer than 50 calendar days per year when discharge occurred (less than one day per week average). This underscores the intermittent nature of the wet weather system discharge.
- The average event mean concentration (EMC) for BOD of 44 mg/l and 29 mg/l for TSS compare very well with the expected values obtained during the pilot testing of the CEPT system.

The EMC varied in relationship to the volume discharged as shown in Figure 11. The small events tended to have higher BOD and TSS concentrations, and larger volume events had lower concentrations. This highlights the challenge for good CEPT performance during small storms. The CEPT design intent was to ensure 50% BOD and 70% TSS removal *annually*, to be achieved by focusing on large storms in which the majority of pollutant mass arrived at the plant, not small events.

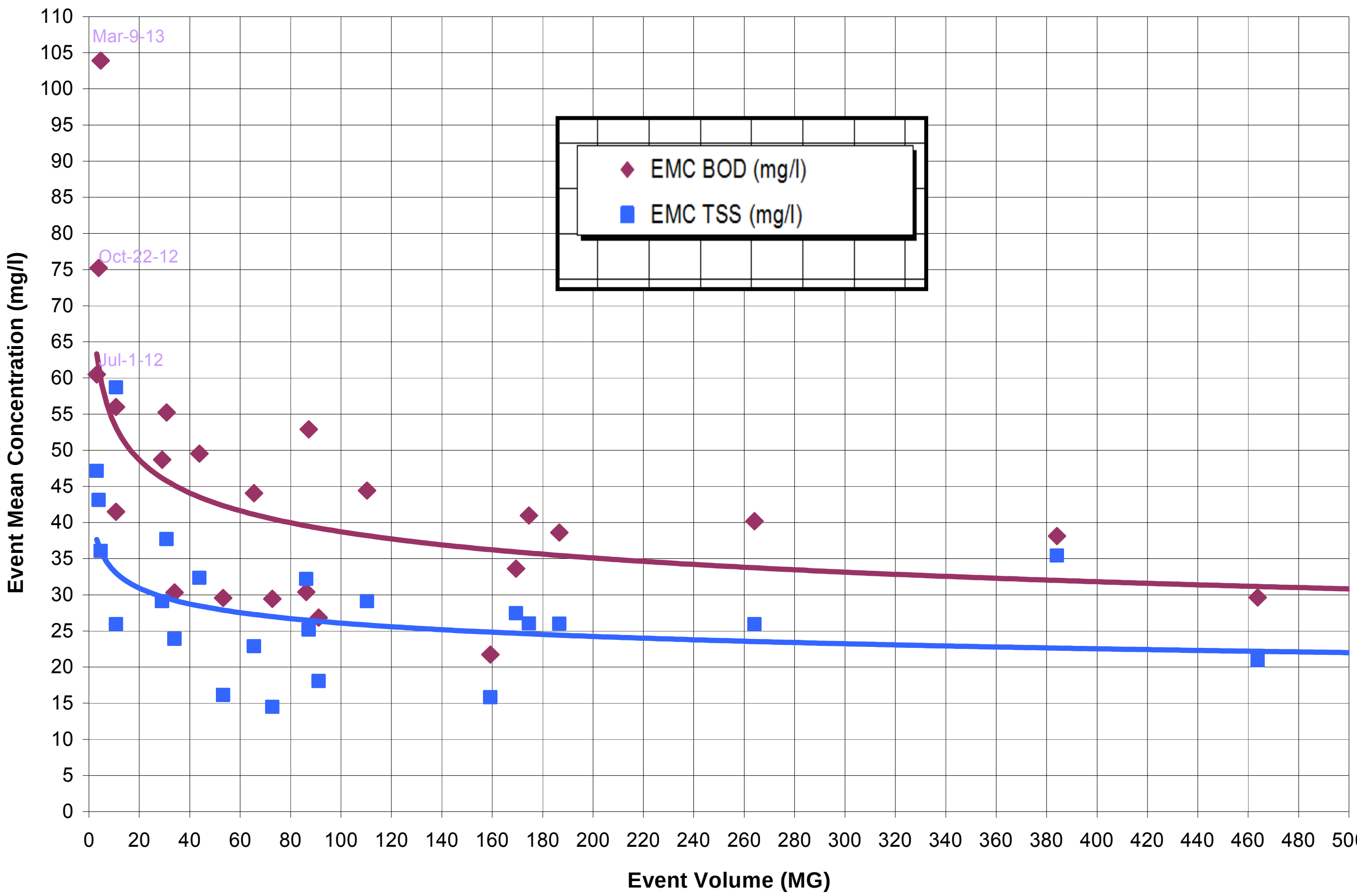


Figure 2-4: WWTF Event Mean Concentration for BOD & TSS versus Event Volume

The WWTF event analysis indicates clearly that the CEPT system is performing well and meeting the design expectations.

Table 2-10 lists the WWTF events that occurred during FY2013, in which excess captured CSO was routed to the Wet Weather Treatment Facility.

- During periods of bypass, operators were able to maintain an average secondary treatment rate of 126 MGD, compared to the permit required 100 MGD.
- The Average/Event rate of 126 MGD treated via the secondary system indicates that 63% of the total Influent (126 MGD of 199 MGD) arriving at the plant during a WWTF event was treated through the secondary system.
- WWTF events lasted about 30 hours on average, and typically occurred across two calendar days.

Table 2-10: Wet Weather Treatment Events - Detailed Information

		CBWTP Flows		WWTF Flows				WWTF EFFLUENT			
Date & Time Bypass Event Started	Event #	Avg Influent During Bypass (MGD)	Avg Secondary Flow During Bypass (MGD)	Avg WWTF Flow (MGD)	WWTF Discharge Volume (MG)	Duration of WWTF Discharge (hrs)	Calendar Days WWTF Discharge Occurred	Event BOD Load Discharged (lbs)	Event TSS Load Discharged (lbs)	EMC BOD (mg/l)	EMC TSS (mg/l)
7/1/12 3:45	1	139	115	17	3	4.5	1	1,569	1,223	61	47
10/12/12 17:45	2	181	111	63	44	16.8	2	18,091	11,807	50	32
10/15/12 0:30	3	182	122	65	86	32.0	2	21,860	23,152	30	32
10/20/12 3:00	4	132	125	16	11	15.8	1	3,715	2,322	41	26
10/22/12 17:45	5	146	129	21	4	4.5	1	2,446	1,402	75	43
10/27/12 17:45	6	160	120	49	159	77.3	4	28,876	21,033	22	16
11/12/12 1:15	7	183	126	67	73	26.0	2	17,867	8,801	29	15
11/17/12 14:30	8	226	128	106	464	105.3	6	114,559	80,985	30	21
11/23/12 16:00	9	256	125	128	187	35.0	3	60,079	40,453	39	26
12/1/12 2:00	10	200	124	86	384	106.8	5	122,162	113,507	38	35
12/15/12 18:15	11	195	124	81	169	50.5	3	47,501	38,795	34	27
12/20/12 0:45	12	262	134	124	175	33.8	2	59,646	37,872	41	26
12/23/12 19:15	13	176	131	48	29	14.5	2	11,799	7,054	49	29
12/25/12 11:45	14	221	132	98	91	22.3	2	20,400	13,745	27	18
1/7/13 3:45	15	203	126	74	11	3.5	1	5,034	5,277	56	59
1/28/13 22:30	16	196	124	80	87	26.3	3	38,479	18,305	53	25
2/22/13 15:00	17	222	134	90	31	8.3	2	14,185	9,682	55	38
3/6/13 17:15	18	172	125	32	5	3.5	1	4,006	1,390	104	36
3/19/13 23:15	19	204	133	76	65	20.8	1	24,073	12,501	44	23
4/6/13 23:00	20	207	131	80	34	10.3	2	8,588	6,775	30	24
5/22/13 22:30	21	265	122	161	264	39.3	3	88,481	57,136	40	26
5/27/13 10:45	22	243	130	116	53	11.0	1	13,125	7,159	30	16
Total	**22**				**2,429**	**668**	**50**	**726,541**	**520,375**		
Avg / Event		**199**	**126**	**76**	**110**	**30.3**	**2.3**	**33,025**	**23,653**	**44**	**29**

Section 3: Maintenance

Control #1 of the Nine Minimum Controls – Proper Operation & Maintenance -- is the broadest single "control" or area of best management practices among the NMCs. The practices included under this NMC cover almost all of the collection system components. For these reasons, it is useful to begin shifting the analysis and reporting from "NMC #1" to the "CMOM" or Capacity, Management, Operations and Maintenance program, which addresses the collection system topics more fully and with a more standardized approach.

This Section briefly discusses CMOM program components and documentation of CMOM activities required by the CBWTP NPDES Permit; collection and treatment systems expenditures and work orders for maintenance activities; cleaning and inspection of the collection system; and future projected CIP budgets for the next 10 years for maintenance of the collection and treatment systems.

3.1 CMOM Program Required Submittals

The 2011 NPDES Permit requires Portland to develop and submit a set of Capacity, Management, Operations and Maintenance (CMOM) program documents for the sanitary and combined sewer collection systems. EPA's CMOM Guidance for Sanitary Sewer Collection Systems (January 2005) sets out the requirements for a CMOM program.

BES submitted the following documents according to the dates specified in the permit:

- ☑ Collection System Inspection & Cleaning Plan: January 1, 2013
- ☑ Collection System Assessment & Rehabilitation Plan: January 1, 2013
- ☑ Pump Station Reliability Program: July 1, 2013
- ☑ Grease Management & Control Program: July 1, 2013
- ☑ Overall CMOM Program Report: July 1, 2013

The data collection, analyses, mapping and initial draft versions of these documents are currently under development. After the final CMOM document is submitted to DEQ, Portland will develop and submit a schedule for implementing CMOM program activities that are not yet being implemented.

3.2 CIP Expenditures for CSO, Collection System and Treatment Maintenance

Portland has always had a significant portfolio of maintenance projects for both the collection system (pipes and pump stations) and the treatment systems. Even during the peak of the CSO program capital expenditures -- when the large tunnels, CSO pump stations and expanded treatment works required most of the CIP budget -- Portland still invested in maintenance of non-CSO systems to ensure that public health and the environment were protected and regulatory requirements were met.

Now that major investment in the CSO system has ended, maintenance expenditures for the collection and treatment systems has increased. The record of the *maintenance-related* CIP expenditures for the past six years is shown in Table 3-1. This table demonstrates that maintenance-based expenditures have increased, especially for pump stations and the collection system. Capital investment for system-wide maintenance has grown from a 3-year average of about $28 million per year to a 3-year average of $42 million per year.

Table 3-1: Capital Expenditures for System-wide Maintenance

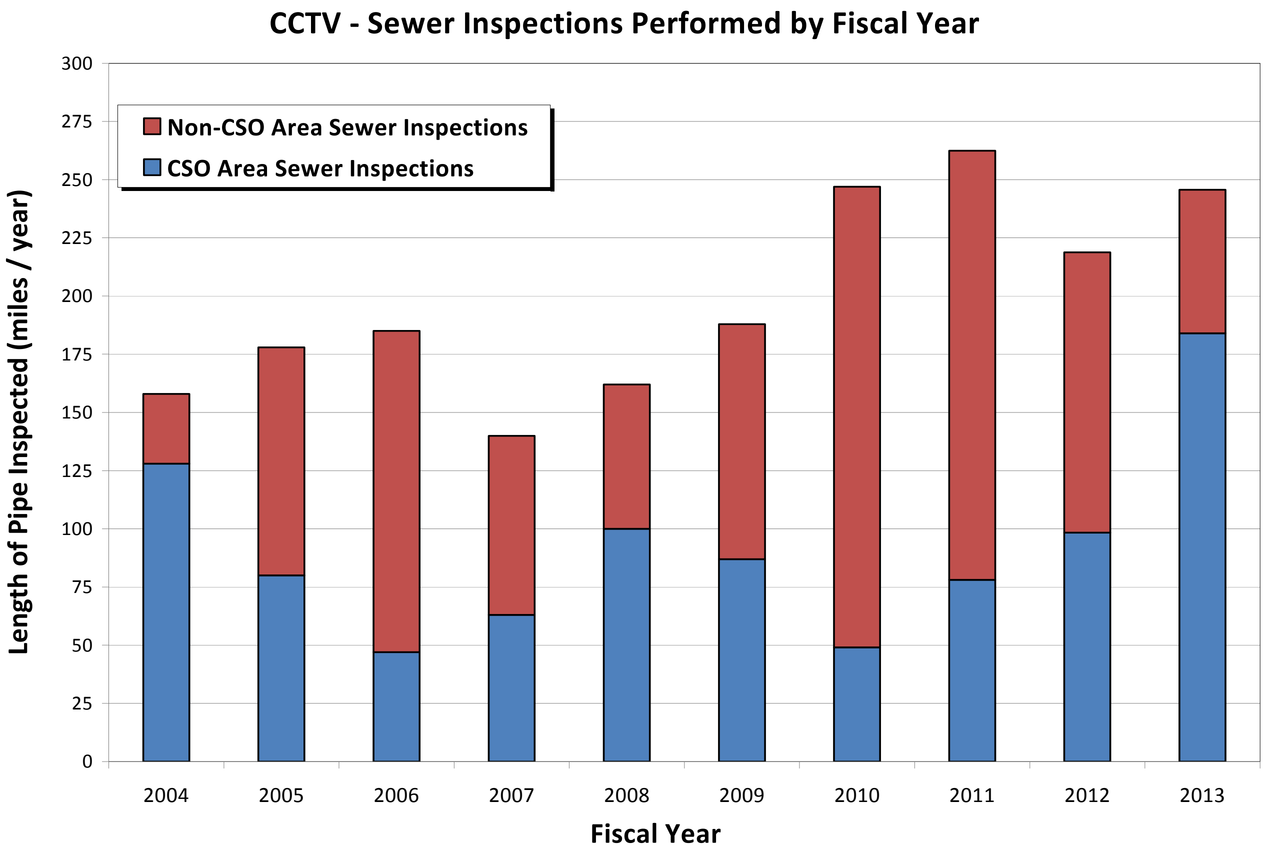
Component	Expenditures per Fiscal Year (Millions of Dollars)							
	2008	2009	2010	2011	2012	2013	Total	Average
Sullivan Pump Station	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.80	$0.11
Ankeny Pump Station	$0.08	$0.33	$2.59	$1.83	$1.45	$3.32	$9.68	$1.38
Guilds Lake Pump Station	$0.00	$0.11	$0.22	$0.38	$0.28	$2.36	$3.35	$0.48
All Other Pump Stations	$1.20	$1.73	$1.61	$3.02	$2.30	$2.83	$15.06	$2.15
Pump Station Total	$1.28	$2.17	$4.42	5.23	4.03	$8.51	$28.89	$4.13
Treatment Plant	$1.97	$1.21	$1.75	$1.42	$2.04	$2.07	$12.12	$1.73
Collection System	$17.7	$23.8	$30.9	$42.8	$28.6	$32.6	$201.7	$28.8
System Total	***$21.0***	***$27.2***	***$37.1***	***$49.5***	***$34.7***	***$43.1***	***$242.7***	*$34.7*
System Total 3-Year Averages		***$28.4***			***$42.4***			

3.3 Collection System Inspections and Cleaning

BES has modified its inspection and cleaning strategy to improve utilization of inspection data to better prioritize pipe cleaning efforts. This modified approach has achieved a higher rate of CCTV inspection.

Collection System Inspections: Over the last 10 years (2004-2013), BES has inspected 105% of the total length of the combined and sanitary sewer pipes; 62% of the total sewer pipe length has been inspected over the past 5 years (2009-2013). Figure 3-1 illustrates the increased rate (miles per year) of pipe inspection over the past few years. The recent increase in CSO area sewer inspections reflects the large increase in inspections performed to support the Phase II Pipe Rehab Program design and construction work that is fully underway.

Figure 3-1: CCTV Sewers Inspections Since 2004



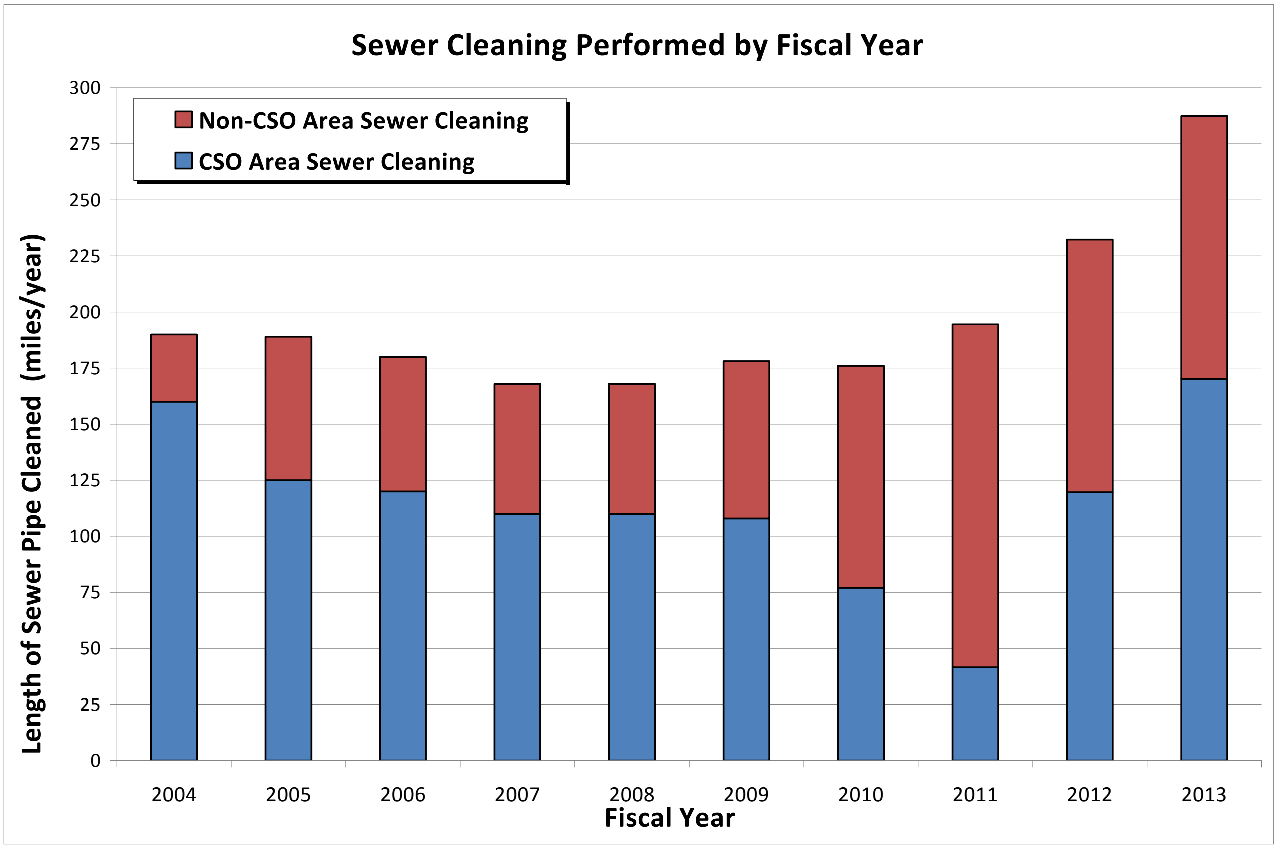
Collection System Cleaning: Figure 3-2 displays ongoing collection system cleaning since 2004 for both combined and separated sewer pipes. Between FY 2004 and FY 2013, Portland has cleaned 2000 miles of sewers (105% of system total) and averaged 210 miles (11% of system total) per year over the past five years.

Collection system inspection, cleaning, and repair are critical aspects of the maintenance program for CSO control facilities that helps to support Minimum Control #2—Maximum Use of the Collection System for Storage.

3.4 Work Orders Completed for Treatment Plants and Pump Stations

Maintenance activities are also reflected in the operations-based work order system. Although the City's Operating budgets have been constrained over the past few years of economic difficulties, staff have continued to focus on completing critical tasks as seen in the work order records.

Figure 3-2: Ongoing Collection System Cleaning Since 2004



3.4.1 Pump Station Maintenance

Figure 3-3 shows the completed work orders for pump station maintenance recorded in the Synergen CMMS since 2006. Synergen was brought online in 2005. The data show that the number of work orders performed over the past seven years on average is about 3,100. During FY2013, the City performed 4,437 work orders for the 98 pump stations, indicating that the recent annual level of maintenance activities for pump stations continue to be funded at similar levels.

3.4.2 Treatment Maintenance

Figure 3-4 shows the completed maintenance work orders for the two wastewater treatment plants, Columbia Boulevard and Tryon Creek, as recorded in the Synergen CMMS. The data show that about 6,000 work orders per year were completed for the two plants during FY2013.

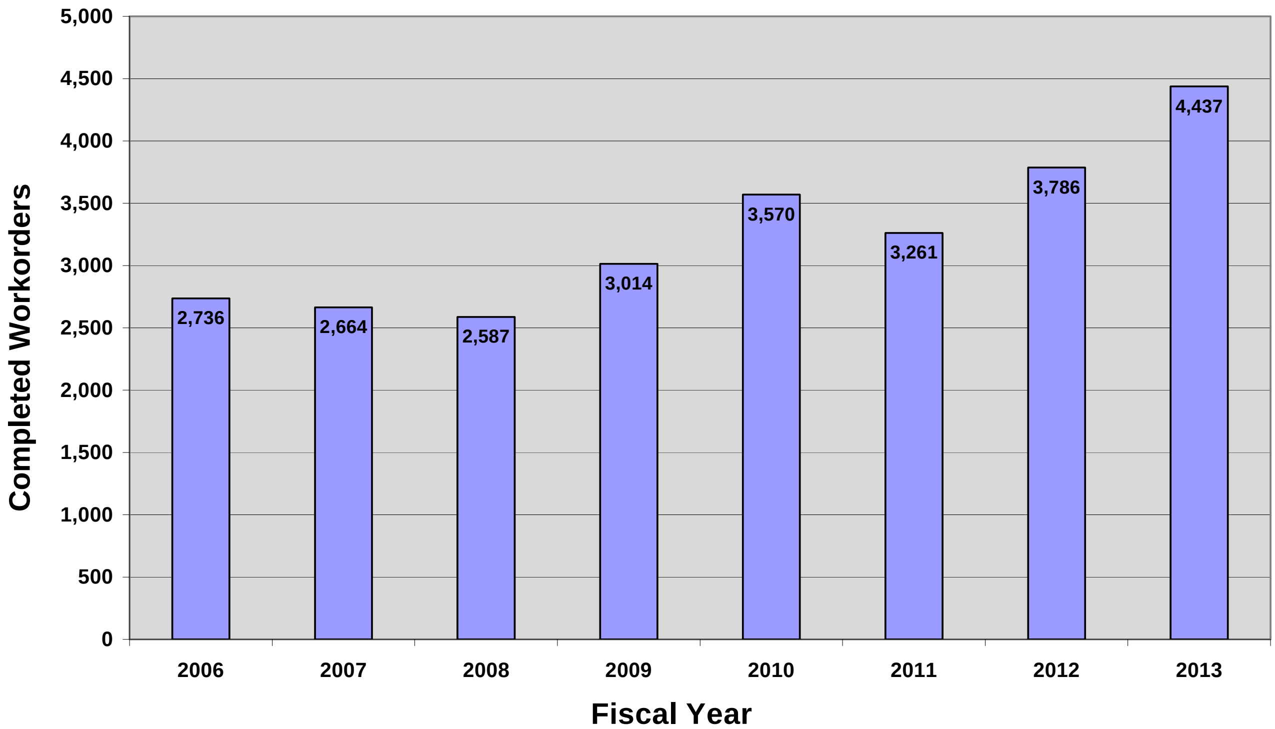


Figure 3-3: Pump Station Work Orders Completed Each Year

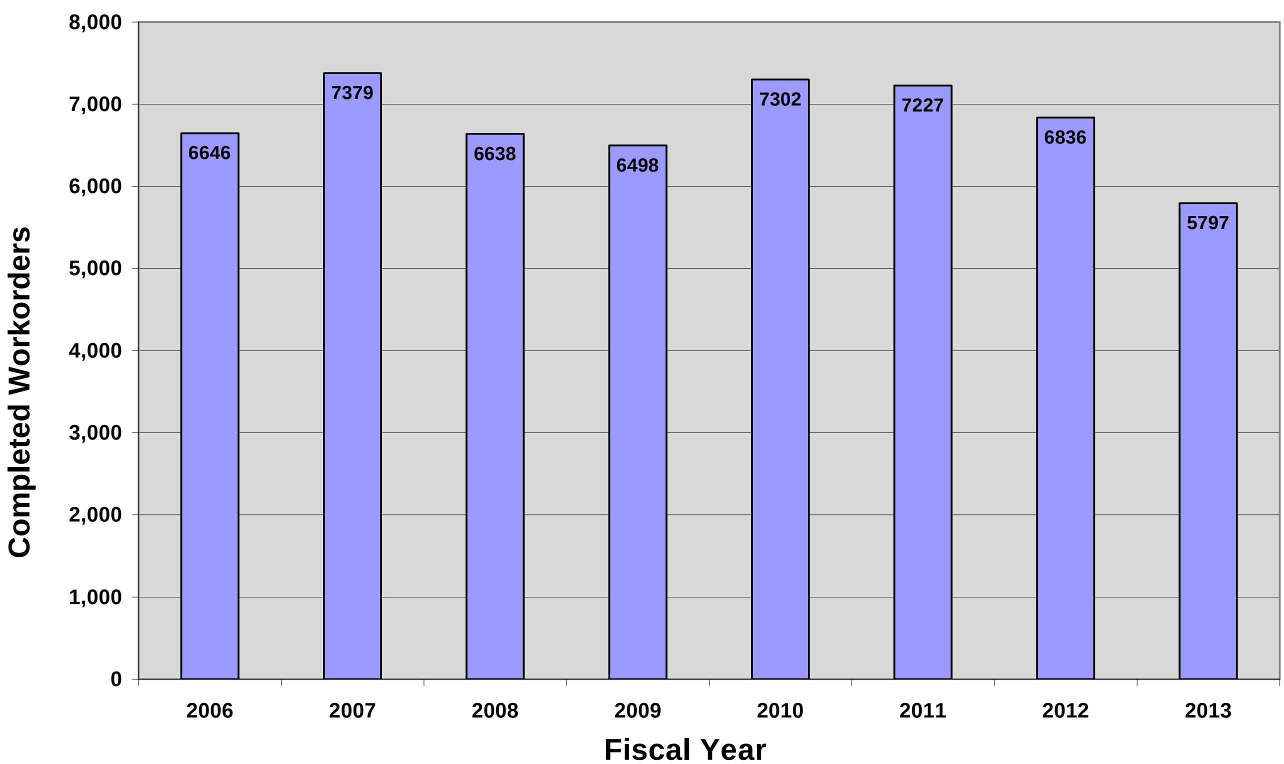


Figure 3-4: Number of Treatment Plant Work Orders Completed Each Year

3.5 CIP Budgets for CSO, Collection System and Treatment Maintenance

Figure 3-5 illustrates part of BES's 10-year capital improvement program (CIP). The 10-year CIP clearly anticipates ongoing and significant investments for all the collection system, pumping and treatment facilities necessary to maintain the functioning and useful life of these systems. The increase in collection system rehabilitation addresses the large number of high-risk pipes recommended for replacement or repair in the Phase II Pipe Rehabilitation Plan effort.

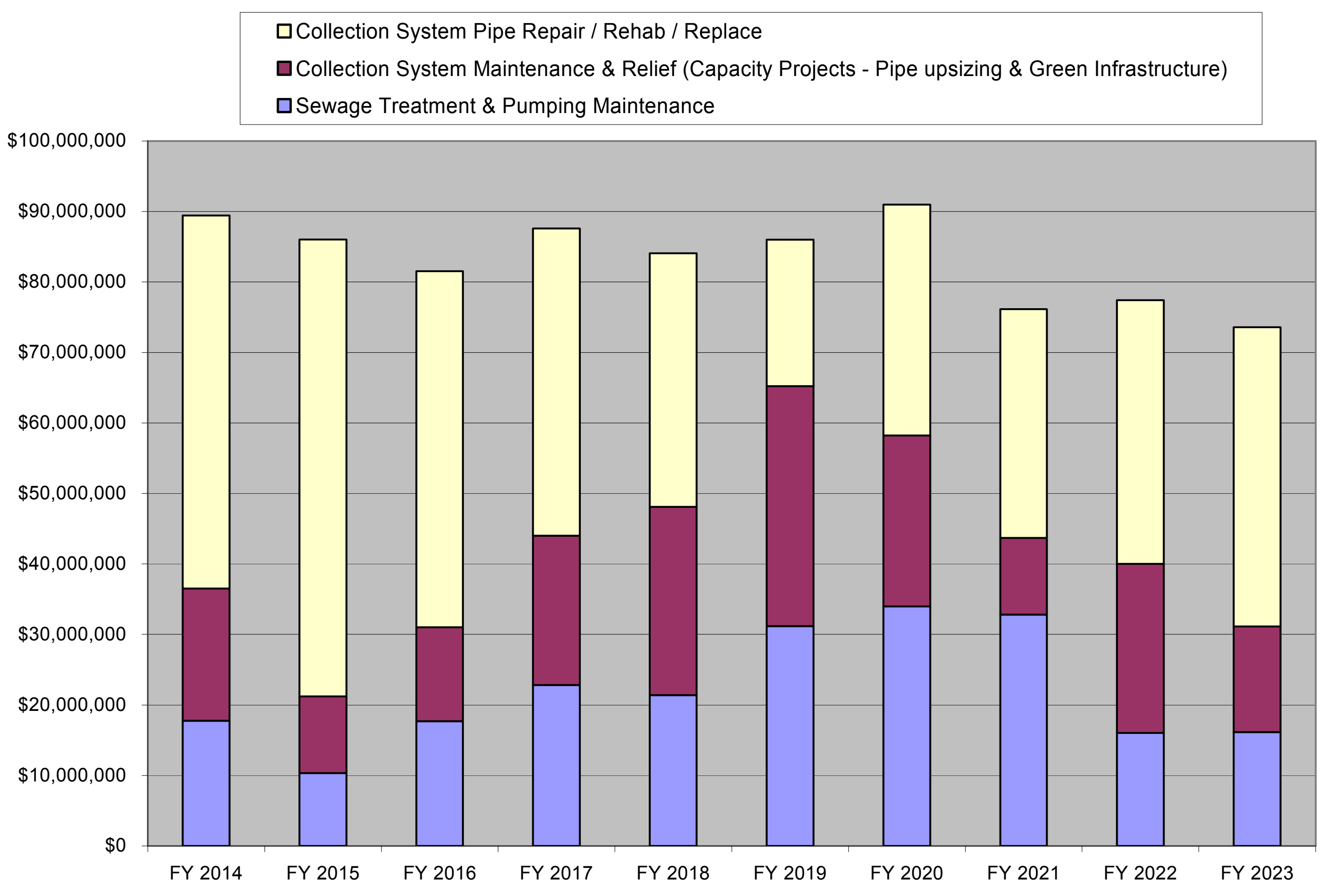


Figure 3-5: Projected 10-Year CIP Budget for System Maintenance & Capacity Needs

Section 4: Maximize Storage in the Collection Systems

The purpose of this Control is to ensure that combined sewage is kept in the sewer system for as long as possible using available in-system storage without adding new storage facilities. The available storage is used for minimizing secondary bypasses and overflow events. Portland's CSO tunnels and consolidation conduits have provided significant additional storage volume. This requirement originally focused on keeping sewers free of blockages to allow full utilization of sewer capacity. Removing clean stormwater from the collection system also contributes to maximizing available conveyance capacity.

4.1 Collection System & CSO Storage

4.1.1 Trunkline and Interceptor Storage

As a result of full implementation of the CSO system at the end of 2011, the frequency of CSO discharges has been reduced dramatically. After the CSO control system became operational, "maximizing in-system storage" no longer required keeping diversion structure and overflow relief weirs at the high settings established prior to 2011. The "SSO" or basement-backup risk created by having the relief weirs too high and surcharging the interceptor system is a concern in specific locations. For this reason, relief structures are being modified as needed to provide hydraulic relief where the risk of SSO justifies the insignificant risk of slightly increasing the wet weather flow sent to the CSO tunnels.

In FY2013, no overflow weir was modified to provide local hydraulic relief. Currently, a new relief structure is designed and being constructed at SE Alder and 6^{th} to relieve the 36-inch trunkline where it connects into the SE Interceptor. This will reduce the level of surcharge in the interceptor and reduce the risk of SSOs in the SE Alder local collection system without impacting CSO discharges.

4.1.2 CSO System Storage

The CSO tunnel and consolidation conduit system storage are designed to be fully utilized and filled to elevation 18.0 feet before discharges to the Willamette River can occur. The use of storage capacity to minimize CSO discharges is part of the balance between maximizing the system storage volume and maximizing flow to the treatment plant. The potentially conflicting CSO and treatment objectives are optimized in the CSO System Operating Plan, which is discussed more fully in Section 5 on NMC #4 - Maximizing flow to treatment.

The CSO system has been designed to ensure that the tunnels are completely full before overflows can occur. This was accomplished by designing both the consolidation conduits that connect the outfalls to the drop shafts and the drop shafts themselves to be able to convey the 25-year storm peak flow rates into the tunnels. This system has worked successfully for the CSO events that have occurred since December 2011, as listed in Table 2-3 above. The 100-year storm that occurred on May 26, 2012, (two fiscal years ago) generated peak flows that far exceeded the 25-year design storm capacity of the Alder OF36 drop shaft. As a result, the Alder OF36 discharged excess peak CSO flows (15 MG) even though the CSO tunnel storage was not fully used because the shaft couldn't deliver all of the intense high flow rate into the tunnel. No event has occurred since that time that was so intense the peak flows couldn't be managed by the drop shafts to the tunnel.

4.2 Stormwater Management Program Accomplishments

Portland's major objective for stormwater management in the combined sewer area is to continue reducing stormwater runoff into the combined sewer system. This effort reduces basement backups, retains a high level of CSO control, and provides stormwater as a natural resource for vegetated systems that capture and infiltrate water into the ground.

4.2.1 Downspout Disconnection Program (1993 – 2011)

The Downspout Disconnection Program ended active outreach in June 2011 after 18 years of partnering with property owners, contractor, and community organizations to disconnect downspouts in Eastside combined sewer basins. The final accomplishments include over 54,500 disconnected downspouts at more than 26,500 properties. In addition, more than 35,000 properties were found to have one or more downspouts already disconnected or were already managing stormwater onsite. In total, the Downspout Disconnection Program implemented or documented 1.2 billion gallons of stormwater removed per year from the combined sewer system.

Although the Downspout Disconnection Program is no longer doing active outreach and has ended all financial incentives for disconnection work, the Program continues to provide customer service support and technical assistance to property owners in the program area. Program staff are also systematically tracking redevelopment at properties in the program area, as the requirements for redevelopment will provide an even higher level of stormwater management.

To ensure that downspouts disconnected through the Program remain disconnected, the Downspout Disconnection Program conducts maintenance and reliability outreach. This effort includes sending maintenance postcards to all past program participants and doing spot surveys of previously completed work. The results of the spot survey indicate that disconnections are being maintained and the disconnection rate is actually increasing. The survey results (dated August 13, 2012) indicate that for the surveyed properties:

- The estimated average disconnection rate from the survey is 77% of the roof-area.
- The best estimate [of the disconnection rate of those same surveyed properties] using previous DISCO data is 76.8%.

4.2.2 Private Property Retrofit Program (2010-Current)

The 2012 Combined Sewer System Plan recommends stormwater facilities on private property as an approach to solve local capacity problems. In implementing the recommended projects, BES works with targeted private property owners to retrofit their on-site stormwater facilities to keep runoff out of the combined sewers. These stormwater facilities help reduce local sewer capacity problems and reduce CSO flows. BES assists property owners to install rain gardens, stormwater planters, swales, ecoroofs, and pervious pavement on sites that meet program criteria. Participation is voluntary and all stormwater facilities are privately owned and maintained, backed by an enforceable Operations and Maintenance agreement on the property's title and deed. For completed projects, maintenance outreach includes personal follow up for two years and seasonal maintenance task reminder postcards.

For fiscal year 2013, one acre of impervious surfaces was managed by twenty-three private property stormwater retrofit projects. Examples of private property stormwater retrofit projects are shown in Figure 4-1 below.

The PPR program also determined that 30 acres of private impervious area, previously considered connected to the combined system, was actually disconnected.

Infiltration Basin – Western Seminary east parking lot

SE 11th Residential Rain Garden

SE Madison Residential Rain Garden

Figure 4-1: Examples of Private Property Retrofits

4.2.3 Sustainable Stormwater Projects in Combined Sewer Area

In addition to the Downspout Disconnection Program, Portland is a leader in implementing various sustainable stormwater programs that use green infrastructure stormwater controls in the public right-of-way, as well as on private properties through partnerships with private and institutional property owners. These stormwater controls use natural vegetated facilities to act as small constructed wetlands that capture stormwater for infiltration and evapotranspiration.

City staff and residents promote the use of green street facilities for the protections they afford for local sewer capacity relief, public health, and water resources, as well as for providing community benefits including green space and habitat connectivity, enhancement of the bicycle and pedestrian environment, and neighborhood livability and vitality.

4.2.3.1 Ecoroofs

Ecoroofs replace conventional roofing with a layer of vegetation over a growing medium on top of a synthetic, waterproof membrane. An ecoroof significantly decreases stormwater runoff, saves energy, reduces pollution and erosion, absorbs carbon dioxide, and reduces heat island effects.

The City of Portland strongly supports the installation of ecoroofs through the City's Green Building Policy, Stormwater Management Manual, developer floor area ratio bonuses in specific portions of the city, and the Ecoroof Incentive Program, part of the Grey to Green Initiative, which provides grants of up to $5 per square foot for qualifying ecoroof projects.

As of June 2013, Portland has over 380 ecoroofs installed throughout the city, managing almost 19 acres of roof. Approximately 270 of those ecoroofs are in the combined sewer area.

During FY2013, 21 new ecoroofs were installed in the combined sewer area, managing approximately 0.92 acres of roof. This roof area represents 920,000 gallons of rainfall to the combined system annually, and Portland's monitoring data indicates that approximately 460,000 gallons are retained by the roofs and returned to the atmosphere through evapotranspiration.

4.2.3.2 Green Streets

As of June 2013, Portland has implemented almost 1,300 green streets in the right of way, with approximately 750 in the combined sewer area. The *Post-2011 Combined Sewer Overflow Facilities Plan* identifies specifically how Portland will continue to implement both public and private stormwater controls to further reduce stormwater entering the combined sewer system and thereby increase the storage available for capturing CSO discharges.

Specific benefits of green street facilities in the combined sewer system area include:

- Reducing the amount of stormwater that enters the city's sewer collection system, which can help to minimize basement sewer back-ups and combined sewer overflows (CSOs).

- Allowing clean, cool stormwater to soak into the ground, which helps recharge groundwater.
- Increased green space, improved air quality and reduced air temperature.
- A more cost-effective way to manage stormwater than upsizing existing sewer pipes or building new pipes in many cases.

The City promotes the use of green street facilities through a variety of methods including the Stormwater Management Manual for private development and public right-of-way improvements, the City's Green Street Policy, the Grey to Green Initiative, internal design teams, and long-term facilities planning efforts.

During FY2013, 50 new green street facilities were installed in the combined sewer area. Some projects were implemented by private development, some were CIP-budgeted cost-beneficial combined sewer system plan projects, and some were PBOT projects that required stormwater management. Collectively, these facilities manage approximately 6 acres of impervious area that generates 6.0 million gallons of stormwater to the combined sewer system annually. Based on the City's performance monitoring of green street facilities, these facilities will remove approximately 4.2 million gallons of runoff annually from the combined sewer system through infiltration and evapotranspiration.

City staff also continued multiple efforts in FY2013 to improve design and long-term performance of green street facilities, including:

- Investigating soil characteristics for all facilities and drainage systems for lined facilities to improve overall flow control.
- Continued outreach and growth of the Green Street Stewards program which allows members of the public – individual property owners, business associations, or neighborhood associations – to adopt green street facilities and perform basic maintenance tasks. Neighborhood involvement provides a local presence and more day-to-day facility observation to ensure that facilities are functioning at peak efficiency during storm events.
- Exploring different material and design options for check dams in green street facilities to improve reliability and maintenance, which will allow more infiltration
- Development of a green street design guidance document to capture lessons learned from past projects and provide more standardization for future green street facilities.

Section 5: Maximize Flow to the POTW

Maximizing flow to the treatment plant, as well as maximizing the use of storage, are both part of the overall system operations strategy. The method by which these elements of the NMCs are implemented must be viewed in the context of the overall CSO system operating strategy that achieves multiple prioritized objectives.

5.1 CSO System Operating Plan – December 2011

The CSO System Operating Plan (submitted to DEQ in December 2011) presents the strategy and procedures for operating Portland's CSO controls by integrating three major systems – the collection system, the CSO facilities and the CBWTP treatment trains. Two major documents -- the CBWTP NPDES Permit and EPA's Guidance for CSO Programs -- set out the objectives for the System Operating Plan.

Nine System Operating Objectives were developed and are prioritized. Prioritization is important because CSO control and treatment objectives can often conflict and operations staff must know what is more important to achieve when a conflict arises. The prioritized objectives first protect the treatment processes as the top priority, followed by protecting human health and then the environment. Protection of the treatment processes is the first priority because the highest risks facing the overall system is the risk of damaging the treatment processes. If the treatment plant is damaged by washing out biosolids or flooding the plant, then major environmental harm that impacts human health could occur. Similarly, the collection system must be kept intact to keep sewage away from the public. Finally, the lower risk issues of energy cost savings, odor control and maintenance costs are discussed.

5.1.1 CSO Operating Objectives by Priority

1. **Protect & Maintain Biological System and Meet Effluent Discharge Limits**
   - Maintain and/or limit flow to 100 or 110 MGD through secondaries in wet weather
   - Meet secondary effluent limits: Maximum Month: < TSS 30 mg/l; < BOD 30mg/l
2. **Capture and convey all dry weather flow**
   - Treat all through primary & secondary system
3. **Prevent Releases to Streets & Basements (SSOs)**
   - Control pumping rates to keep sewage away from human contact
4. **Capture & convey maximum volume of wet weather flow**
   - Optimize capacity of conveyance and storage system

- Treat all CSO via screening, primary treatment & disinfection at a minimum

5. **Protect Columbia Slough (Sensitive Area)**
   - Give priority to the Columbia Slough Influent Pump Station to pump high rates and close the Argyle gate to eliminate excess inflows from the Willamette system.
6. **Treat as much CSO through secondary as possible**
   - Dewater CSO tunnels and Wet Weather primaries slowly enough to treat more through secondary system but soon enough to avoid septic conditions (within 24 hours)
7. **Minimize Odor problems via Operations**
   - Direct dry weather sewage away from neighborhoods and odor generating facilities
   - Activate odor control facilities when pumping through neighborhoods
8. **Minimize energy usage & pumping costs**
   - Keep flows moving through the collection system at the highest elevation possible and prevent sending flow to tunnel where possible
   - Pump at rates and times that reduce chemical and electrical costs
9. **Minimize sedimentation / settling in tunnels and maintenance problems**
   - Keep flows at high rate through interceptors and tunnels to prevent sedimentation
   - Employ self-cleaning cycles at CSO pump stations

5.1.2 Integrating Permit & Regulations via CSO Operating Strategy

The CSO system operating strategy is Portland's best method of achieving NPDES permit requirements for CBWTP, the Nine Minimum Controls, and the operational elements of CMOM. These regulatory requirements are addressed in the nine prioritized objectives.

The comprehensive communications and controls that serve the collection system, CSO system and the treatment system have been programmed to follow these prioritized objectives. The detailed strategy for controlling specific facilities and sub-systems within these larger systems is presented fully in the December 2011 CSO Systems Operating Plan. The City is currently in the process of updating the CSO Systems Operating Plan based on the experience and observations over the past few months since the overall CSO system was completed in December 2011.

Section 6: Eliminate Dry Weather Overflows

6.1 Summary of Sewer System Releases & Response

Dry weather overflows (DWOs) have effectively been eliminated from the Portland system with the completion of the 2011 CSO facilities. It is now extremely unlikely that a diversion structure can become blocked to the degree that it could cause a DWO because the overflow would instead be captured by the large CSO facilities downstream of the diversions. In addition, all overflow points (whether drop shaft structures or large diversion structures) that can overflow to the Willamette River or the Columbia Slough have level monitoring and alarms to signal if the water in the structure approaches the overflow level. As a result, no dry weather overflows occurred in fiscal year 2013.

6.2 Diversion Structure Modifications

Prior to December 1, 2011, diversion structures were critical in preventing dry weather overflows and minimizing CSO discharges by maximizing flow to the interceptor and accessing available inline storage upstream of diversion dams. The 1991 SFO required diversion structure improvements and subsequent NPDES permits have required weekly inspections of diversion structures. After completion of all CSO control facilities in December 2011, diversion structures became simply flow-split manholes that divide the flow between the interceptors and the CSO tunnels. The diversions are no longer critical for dry weather overflow control and no longer reduce CSO in a measurable amount compared to the overall CSO tunnel system. For these reasons, most diversion structure changes will not affect CSO control performance. Only diversion structures that directly overflow to the river or slough are reviewed in the Annual CSO Performance report. In FY2013, there were no modifications to those diversion structures that would affect their level of CSO control.

Section 7: Update of the Public Notification Program

The goals of the CSO public notification program are to:

1. Make the public aware that the City has a combined sewer system that can overflow.
2. Explain what CSO is and how it impacts water and can threaten public health.
3. Inform the public when a CSO has occurred and warn against contact with the receiving waters.
4. Raise public awareness of the benefits to the community of the City's investment in CSO Control.

When the CSO Policy was adopted, this element of the NMC focused mostly on outreach through brochures and public meetings and posting warnings at public access points on the Willamette River and Columbia Slough.

With changing communication technology, public notification is more diverse.

Portland's CSO notification procedures changed with completion of the CSO abatement program in December 2011. Throughout the 20-year program, the City relied on its HYDRA System to measure rainfall and trigger the CSO notification process. As of December 2011, all combined sewer outfalls that can discharge are monitored and public notification takes place when an overflow is measured at a specific location.

7.1 Public Notification/River Alert Program

The River Alert system notifies the public of CSO events. The system includes ten permanent, folding signs installed at public access points to the Willamette River. A contractor travels the river by boat and opens the warning signs each time there is a CSO. Forty-eight hours after each CSO event ends, the contractor closes the warning signs. Signs identifying CSO outfall pipes are posted at each outfall.

The warning signs display the phone number of the River Alert Hotline, a 24-hour recorded message the public can call to learn if a CSO advisory is in effect and to hear a message about the CSO Control Program. The hotline number is 503-823-2479.

The River Alert program notifies the media by email every time there is CSO event. Internet users can go to www.portlandonline.com/bes/overflow (Figure 7-1) to learn if a CSO advisory is in effect. Internet users can also subscribe to automatic email notification (Figure 7-2) each time BES issues a CSO advisory by going to www.portlandoregon.gov, signing in or creating an account, choosing "subscribe" and selecting "Sewer Overflow Notification.". BES issues CSO alerts on https://twitter.com/BESPortland and the notifications are re-tweeted by PublicAlerts.org.

Figure 7-1: Clean River Program Web Page with CSO Advisory Information – http://www.portlandoregon.gov/bes/36989

Portland Bureau of Environmental Services
City of Portland, Oregon

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Fall/Winter CSO Advisory - Printable Version

River Alert

The winter CSO advisory is in effect.

Winter rains will cause combined sewer overflows (CSOs) to the Willamette River in the coming months. Environmental Services advises the public to avoid recreational activities in the river, such as water skiing or swimming, during which water could be swallowed. CSOs are contaminated with bacteria and Environmental Services suggests these precautions to protect public health.

Environmental Services issues summer overflow advisories each time it rains between mid-May and mid-October when recreational use of the river is at its highest. During the rainy season, from late fall through the winter and early spring, a blanket advisory goes into effect. CSO warning signs on the river will remain open this winter. The summer advisories will resume in mid-May.

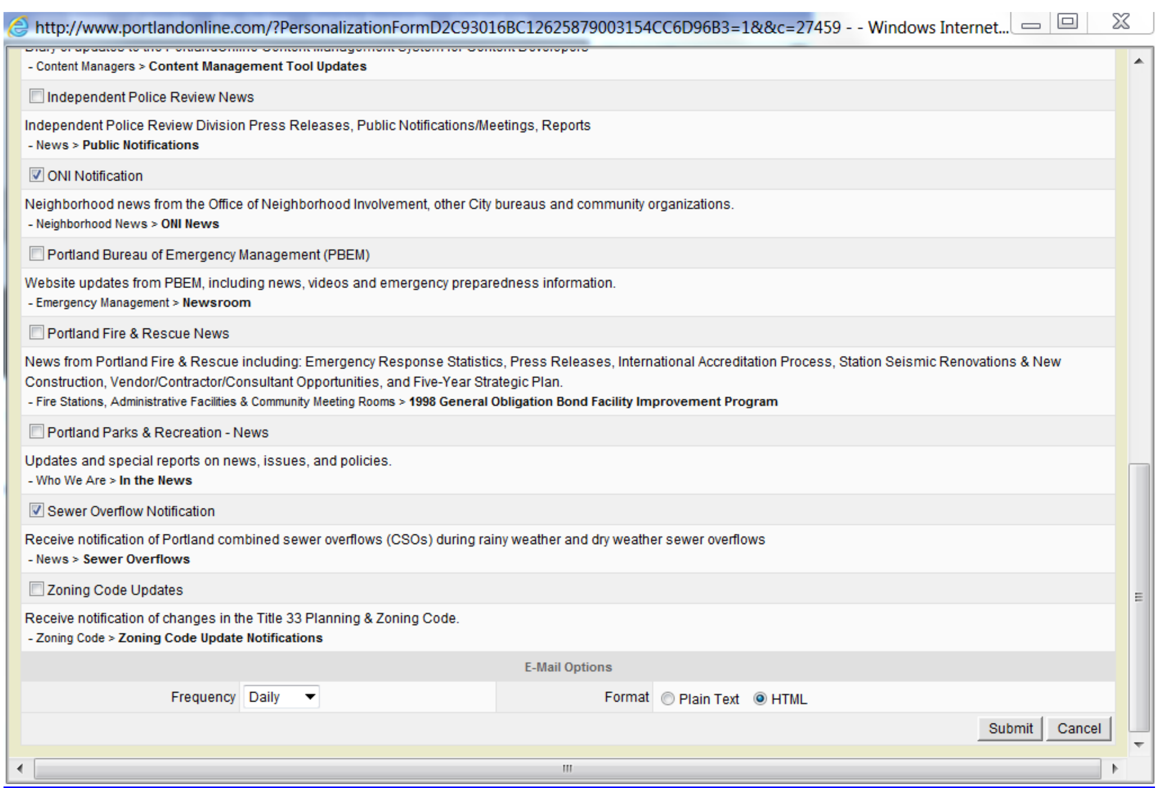
Portland will complete its 20-year CSO control program next year, in December 2011. Completion of the program will reduce CSOs to the Willamette River by 94%. After December 2011, Portland's combined sewers will overflow to the Willamette an average of four times each winter and once every three summers, instead of every time it rains.

For more information about the River Alert program, call 503-823-2479.

Questions & Comments

If you have any questions or comments, please contact our site administrator.

Figure 7-2: River Alert E-Mail Subscribe Website - http://www.portlandonline.com/index.cfm?c=25777



http://www.portlandonline.com/?PersonalizationFormD2C93016BC12625879003154CC6D96B3=1&&c=27459 - - Windows Internet...

- Content Managers > **Content Management Tool Updates**

☐ Independent Police Review News

Independent Police Review Division Press Releases, Public Notifications/Meetings, Reports
- News > **Public Notifications**

☑ ONI Notification

Neighborhood news from the Office of Neighborhood Involvement, other City bureaus and community organizations.
- Neighborhood News > **ONI News**

☐ Portland Bureau of Emergency Management (PBEM)

Website updates from PBEM, including news, videos and emergency preparedness information.
- Emergency Management > **Newsroom**

☐ Portland Fire & Rescue News

News from Portland Fire & Rescue including: Emergency Response Statistics, Press Releases, International Accreditation Process, Station Seismic Renovations & New Construction, Vendor/Contractor/Consultant Opportunities, and Five-Year Strategic Plan.
- Fire Stations, Administrative Facilities & Community Meeting Rooms > **1998 General Obligation Bond Facility Improvement Program**

☐ Portland Parks & Recreation - News

Updates and special reports on news, issues, and policies.
- Who We Are > **In the News**

☑ Sewer Overflow Notification

Receive notification of Portland combined sewer overflows (CSOs) during rainy weather and dry weather sewer overflows
- News > **Sewer Overflows**

☐ Zoning Code Updates

Receive notification of changes in the Title 33 Planning & Zoning Code.
- Zoning Code > **Zoning Code Update Notifications**

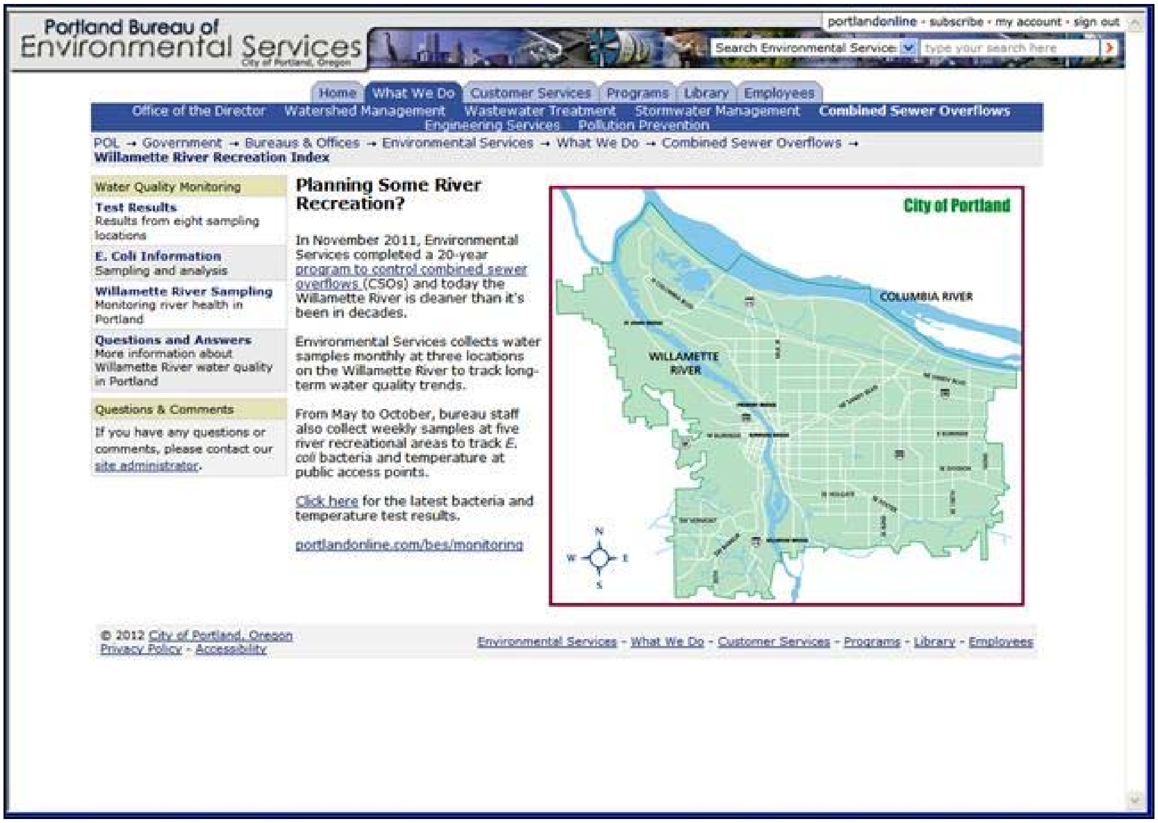
E-Mail Options

Frequency: Daily | Format: ○ Plain Text ◉ HTML

Submit | Cancel

In addition to public CSO notification, other activities that include public information and education about CSOs have also been extensively implemented by BES since 2003. In spring 2012, the city began posting water quality information on portlandoregon.gov:

Figure 7-3: Water Quality Monitoring Website –
http://www.portlandoregon.gov/bes/57781



Section 8: CSO System & Water Quality Monitoring

The NPDES Permit and the MAO require that specific Post-Construction Monitoring Program (PCMP) activities be implemented to ensure that the CSO Control Program complies with the NPDES permit and water quality standards. The PCMP includes monitoring for:

- Rainfall across the service area for comparison against design storm event frequency criteria for compliance
- CSO discharges with alarms to determine occurrence, duration, volume and peak rates
- CSO system and treatment facilities operations to confirm performance compared to design expectations and permit limits
- Separated sanitary flows into the combined sewer system (new requirement in MAO)

In addition to CSO discharge monitoring, CSO system operations and treatment process monitoring discussed earlier in this report, the PCMP also includes three areas of water quality monitoring:

- Water quality sampling of CSO discharges at overflow structures to confirm that water quality will be achieved outside of permitted mixing zones.
- Routine monthly in-stream water quality sampling in the Willamette River to support analysis of completed CSO control facilities, and to demonstrate compliance with water quality standards and TMDL allocations, as applicable.
- Routine monthly in-stream water quality sampling in the Columbia River to demonstrate efficacy of the CSO treatment system and compliance with water quality standards.

The NPDES permit requires receiving stream sampling to be conducted as described in the December 2010 Nine Minimum Controls Update report. The Willamette River in-stream sampling program is to continue for five years after controlling all CSO outfalls to the required performance standard.

8.1 CSO Discharge Sampling

The CBWTP NPDES permit requires opportunity-based sampling of CSO discharges to the Willamette River. The purpose of this sampling is to confirm that the remaining CSO discharges protect beneficial uses and provide for attainment of the Willamette River water quality standards consistent with permit requirements for overflows from storms exceeding the CSO control standards. In the years that the sampling is performed, the results are to be included in the annual CSO report.

The sampling program will be implemented for five different events throughout the 5-year permit cycle, and is focused on storms that last at least four hours in order to provide sufficient time to mobilize the sampling crew. Grab samples are to be taken and analyzed for the CSO Pollutants of Concern: *E.coli*, Total Lead and Total Copper. Zinc is typically included in the analyses, but it has not been identified as a CSO Pollutant of Concern.

CSO discharges are considered protective of beneficial uses and do not preclude attainment of water quality standards when monitoring results do not exceed the appropriate numeric standards for the Pollutants of Concern. Standards take into account a 10:1 dilution in the mixing zones with the exception of E. coli, for which a mixing zone is not allowed.

Portland was able to obtain one grab sample of CSO discharge from Outfall 46 (Beech-Essex) during the November 19-20, 2012 CSO event. This was a 10-hour discharge that occurred during a 5-year winter storm and released 176 MG to the Willamette River. The laboratory analysis report is provided in Table 8-1.

Table 8-1: November 19, 2012 CSO Discharge Water Quality Sample Result – Outfall 46

LABORATORY ANALYSIS REPORT

Project:	**CSO Permit**	Client:	Asset Management
Work Order:	**W12K159**	Project Mgr:	Virgil Adderley
Received:	11/19/12 16:18	WQDB #:	Janus800
Submitted By:	Field Operations		

Sample	Laboratory ID	Matrix	Type	Sample Collection Date Start	Sample Collection Date End	Qualifier
CSO46	W12K159-01	Stormwater	Grab	11/19/12 15:50	11/19/12 15:50	

Analyte	Result	Units	MRL	Dilution	Batch	Prepared	Analyzed	Method	Qualifier
CSO46 : W12K159-01									
Microbiology									
E. coli	**>24000**	MPN/100 mL	10	1	B12K300	11/19/12	11/20/12	Colilert QT	
Total Metals									
Total Metals by ICPMS									
Copper	**10.2**	ug/L	0.200	1	B12K312	11/20/12	11/20/12	EPA 200.8	
Lead	**5.76**	ug/L	0.100	1	B12K312	11/20/12	11/20/12	EPA 200.8	

This was the first CSO sampling event for the newly completed system. When additional events are sampled, the data will be presented and analyzed on a cumulative basis in the Annual CSO Performance Report.

8.2 Willamette River Instream Water Quality Sampling

Since the beginning of the CSO Control Program, Portland has implemented an extensive in-stream water quality monitoring effort to characterize the impacts of CSO and track the benefits of implementing the CSO facilities. Improved water quality in the Willamette is one of the measurable outcomes of Portland's 20-year, $1.4 billion CSO Control Program.

Figures 8-2 through 8-5 below show the water quality trends along the Portland stretch of the Willamette River for four parameters: zinc, lead, copper and *E.coli*. These metals and bacteria parameters are the pollutants of concern for Portland CSO discharges. The figures provide a view of the four different transects of sampling taken across the river at the far upstream (Waverly), the center of the CSO area (Morrison Bridge), the downstream end of the CSO area (St Johns Bridge), and near the end of the city limits (Kelly Point).

As the Willamette River water quality sampling results show, there has been a steady improvement (reduction) in the concentrations measured for these four parameters for the long-term trending period. The most dramatic improvement is visible in zinc (Figure 8-1), which shows a steady decline through time as seen at the Waverly transect, and so is mostly due to upstream sources and influences. An improvement (reduction) is also noticeable in copper and in *E.coli* measurements in the reaches of the Willamette downstream of the major CSO outfalls, specifically at the St Johns Bridge (Figure 8-3).

Figure 8-1: Willamette River Monitoring Results for Zinc (log): Pre & Post Ultra-Clean Change

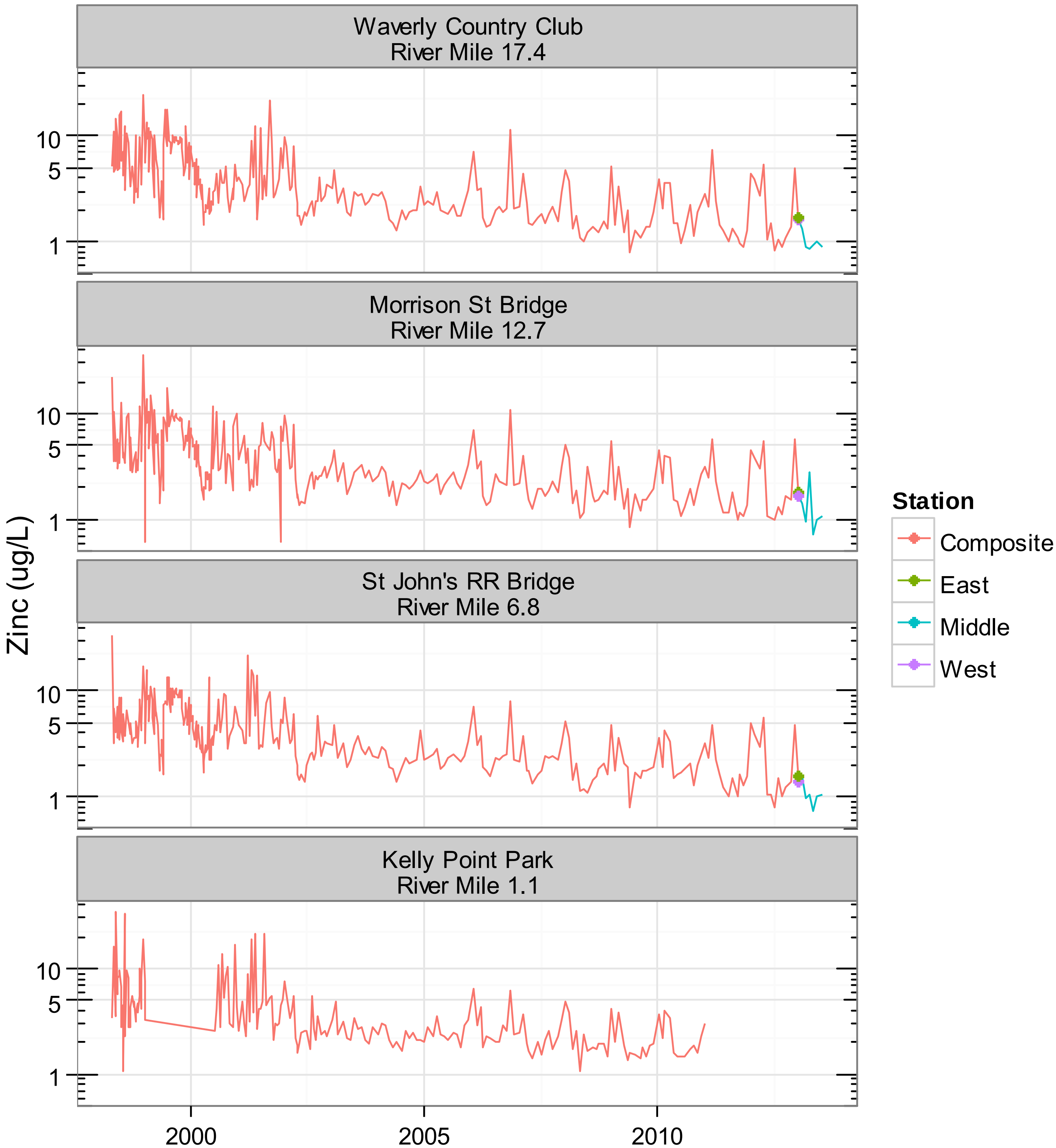


Figure 8-2: Willamette River Monitoring Results for Lead (log): Pre & Post Ultra-Clean Change

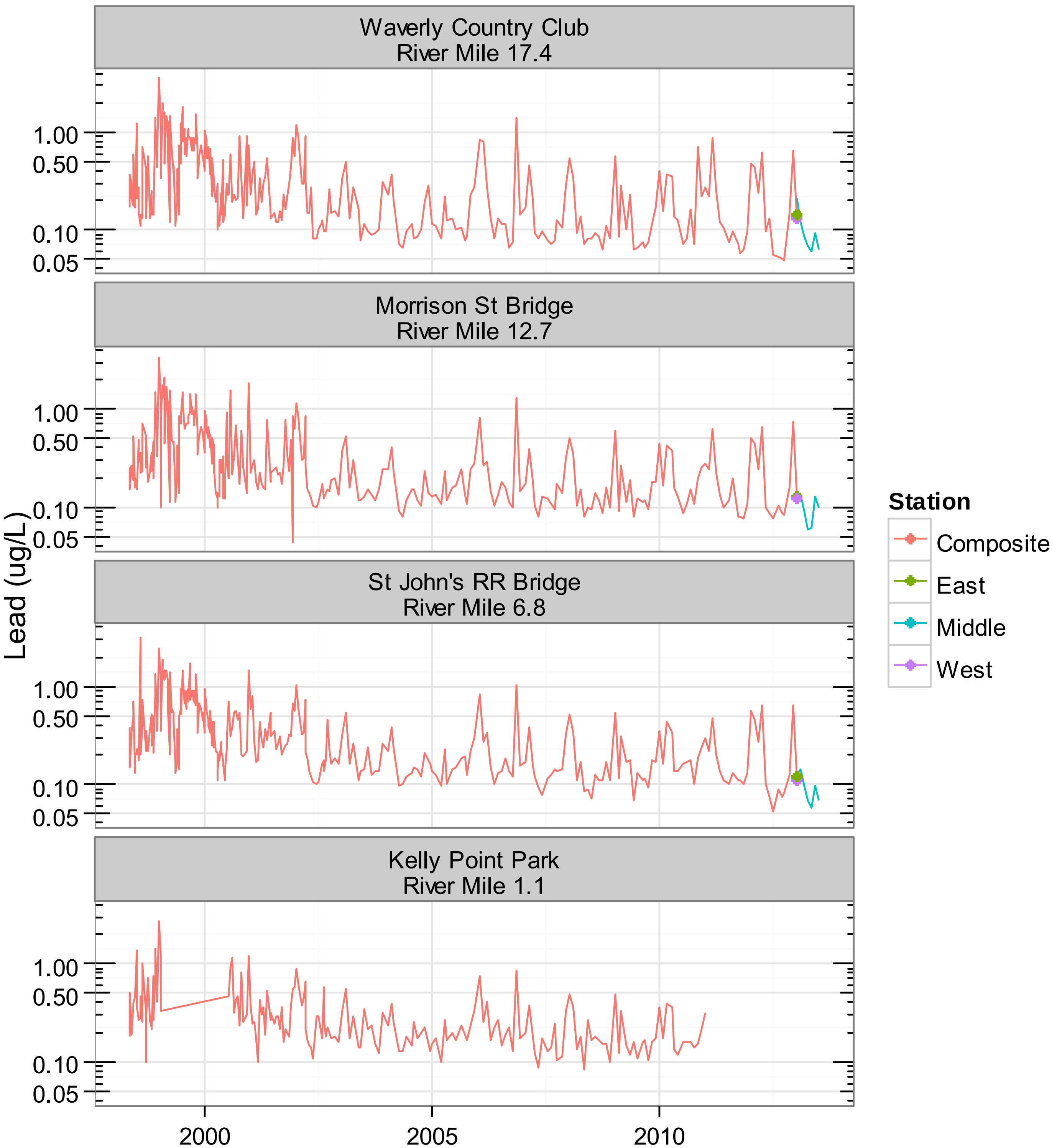


Figure 8-3: Willamette River Monitoring Results for Copper (log): Pre & Post Ultra-Clean Change

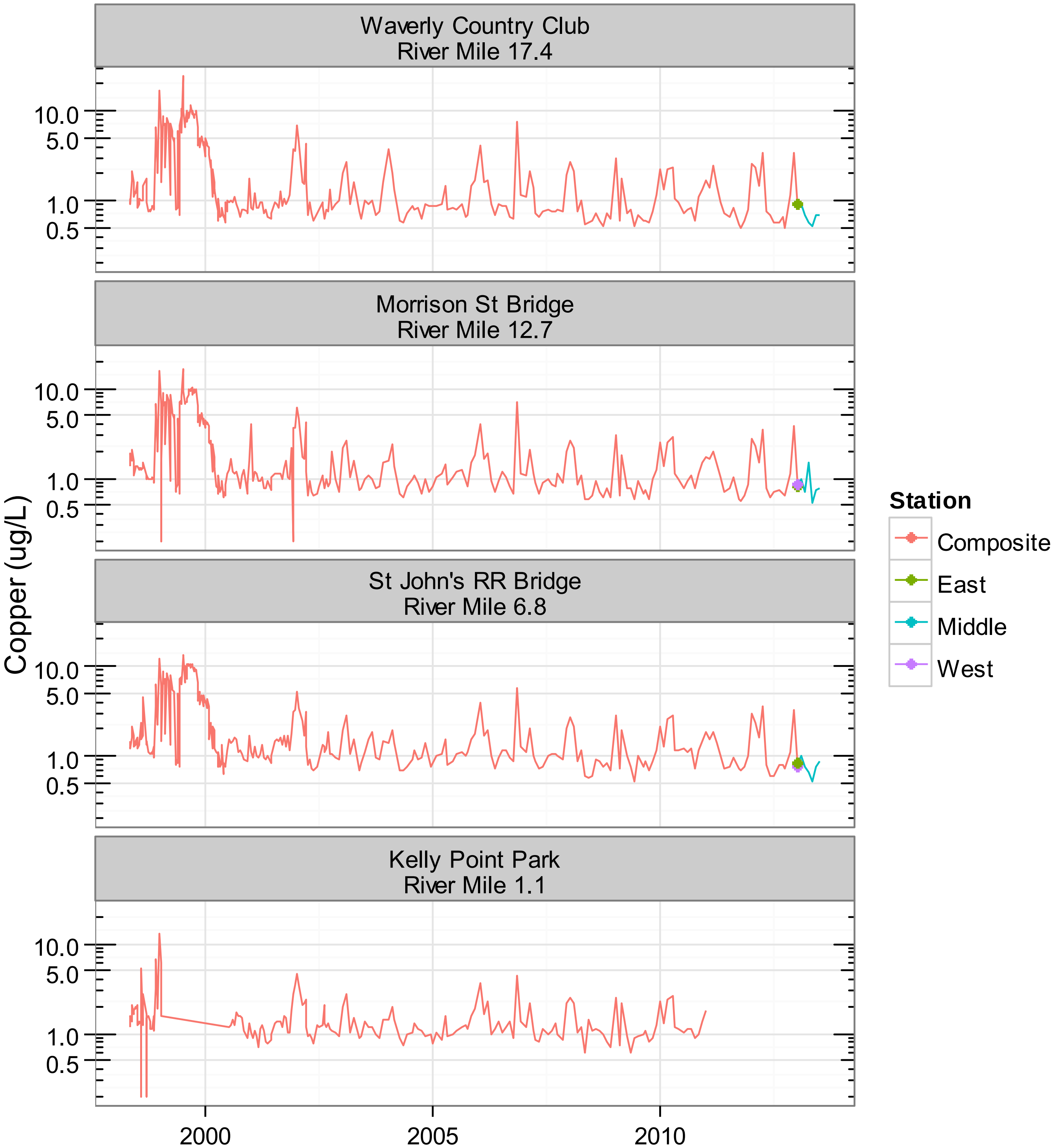
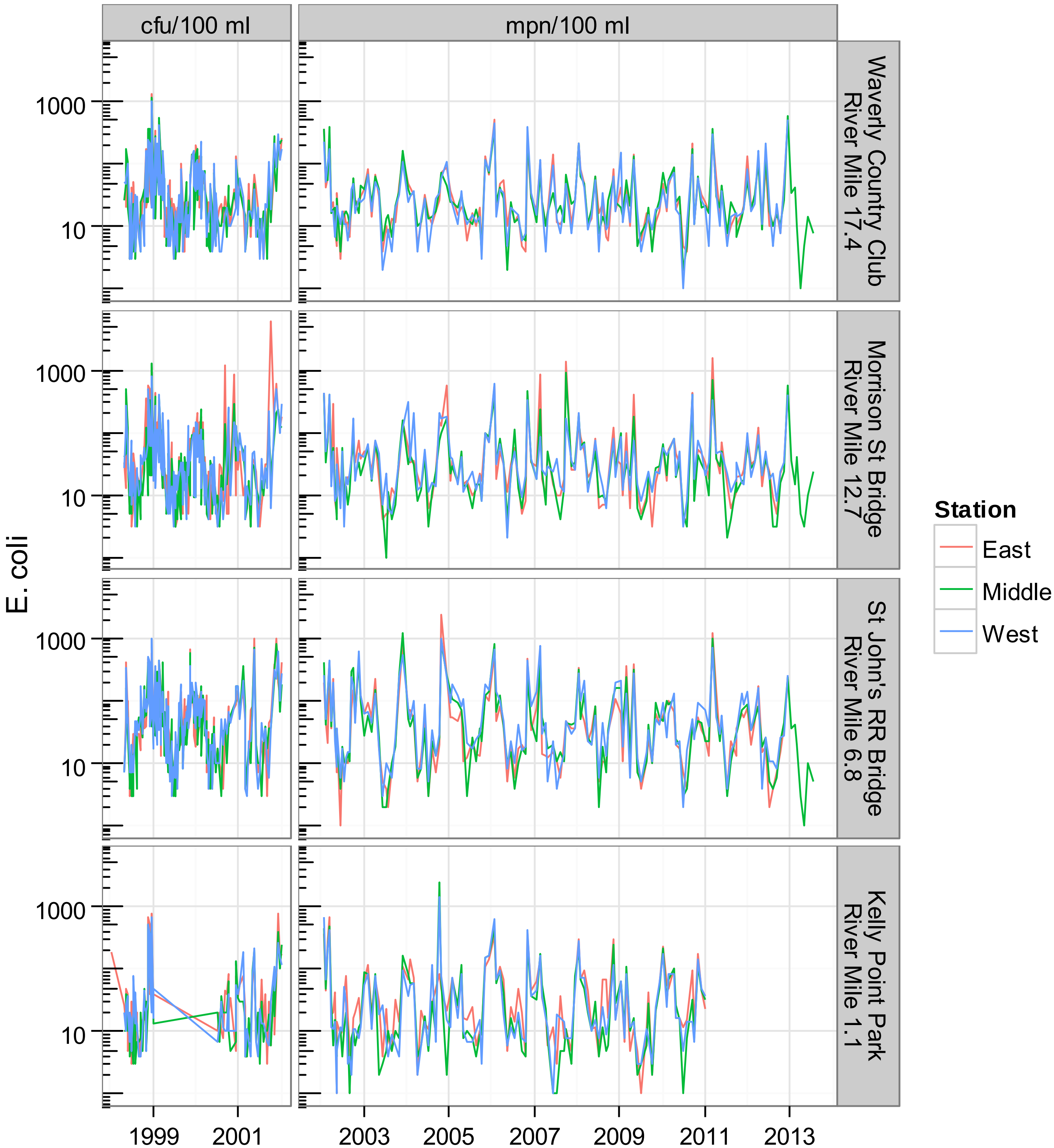


Figure 8-4: Willamette River Monitoring Results for E-Coli (log)



8.3 Field Study for Outfall 001 Mixing Zone

The NPDES Permit (Schedule D - Special Conditions) required the City to submit a plan for a field study to validate the Outfall 001 modeled dispersion, mixing and dilution characteristics under critical flow conditions. This plan was submitted to DEQ on December 30, 2011, and later approved. Over the past fiscal year, the following elements of the study were completed:

- In August 2012, a detailed external inspection of all three Columbia River Outfalls was conducted. Results show Outfall 001 in good condition with minor corrections needed that were quickly performed. Also, a bathymetric survey of the Columbia River upstream and downstream of the outfalls was completed.
- In October 2012, field measurements and a dye tracer study were conducted to measure the dilution performance of Outfall 001 under low flow river conditions. Measurements were taken to examine dilution in the zone of initial dilution (ZID) and the mixing zone plume.

The results from the field work are being analyzed alongside modeling data to provide a complete assessment of the mixing and dilution characteristics of the outfalls. The study is due to be completed and submitted to DEQ in January 2014.

8.4 Columbia River Instream Water Quality Sampling

Portland also has been monitoring the Columbia River water quality upstream and downstream of Outfall 001 & 003 to assess impacts of increased treated CSO effluent to the river. The first sets of results were reported to DEQ in the December 2009 NFAA report to demonstrate that CSO treatment systems at CBWTP meet water quality standards and are protective of beneficial uses.

The main parameters of interest related to CSO treatment and the Columbia River are *E. coli*, TSS, copper, lead and zinc. The results of a comparison of measurements from upstream of the combined mixing zone versus downstream of the mixing zone (measuring impact of the effluent on the water quality) are provided in Figures 8-6 through 8-10. In addition to sampling data, the chart shows the relevant numeric water quality standard for each parameter. For the metals, the range of chronic water quality standards (WQS) values is based on the measured total hardness of the river, which varies from a low of 45 to a high of 78; the chart shows the reasonable range of chronic standards based on the hardness values measured in the river during that sampling period.

As can be seen in the charts below, all parameters are well below the numeric water quality standards. In general, apart from noise in the data, there is little difference in the values from upstream to downstream of the Outfalls 001 and 003 combined mixing zone.

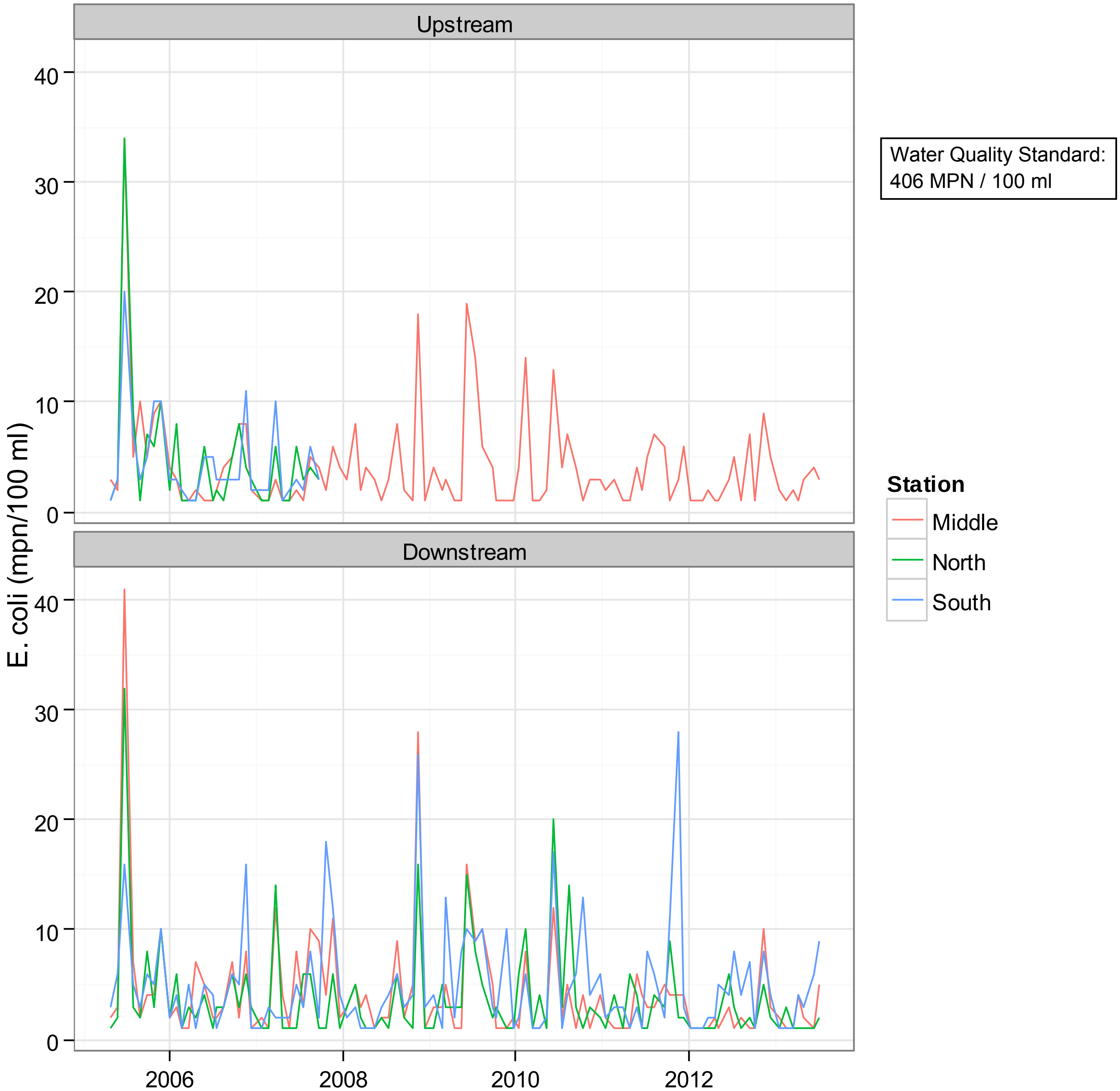


Figure 8-5: Columbia River Mixing Zone Sampling for E. Coli

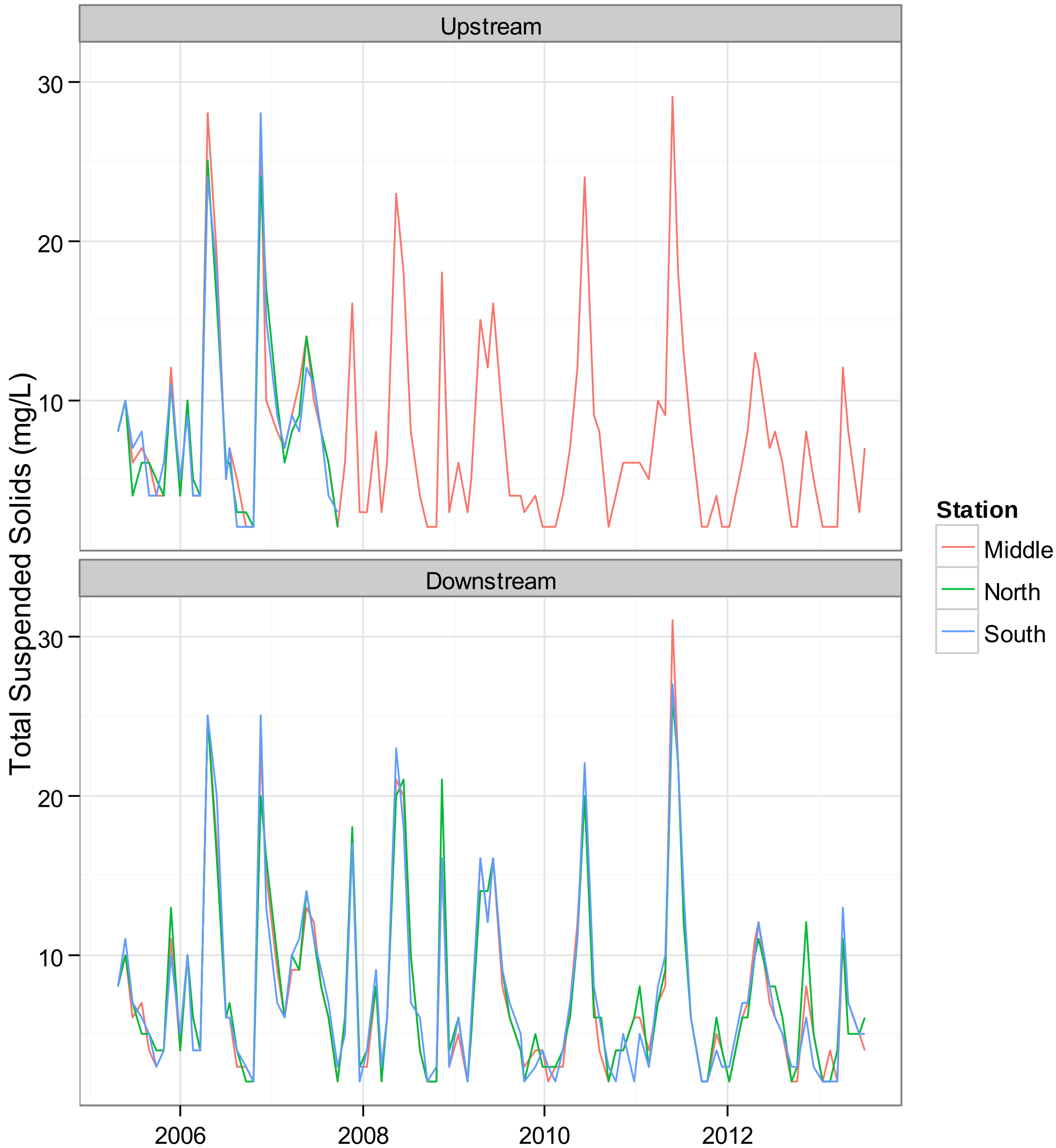


Figure 8-6: Columbia River Mixing Zone Sampling for TSS

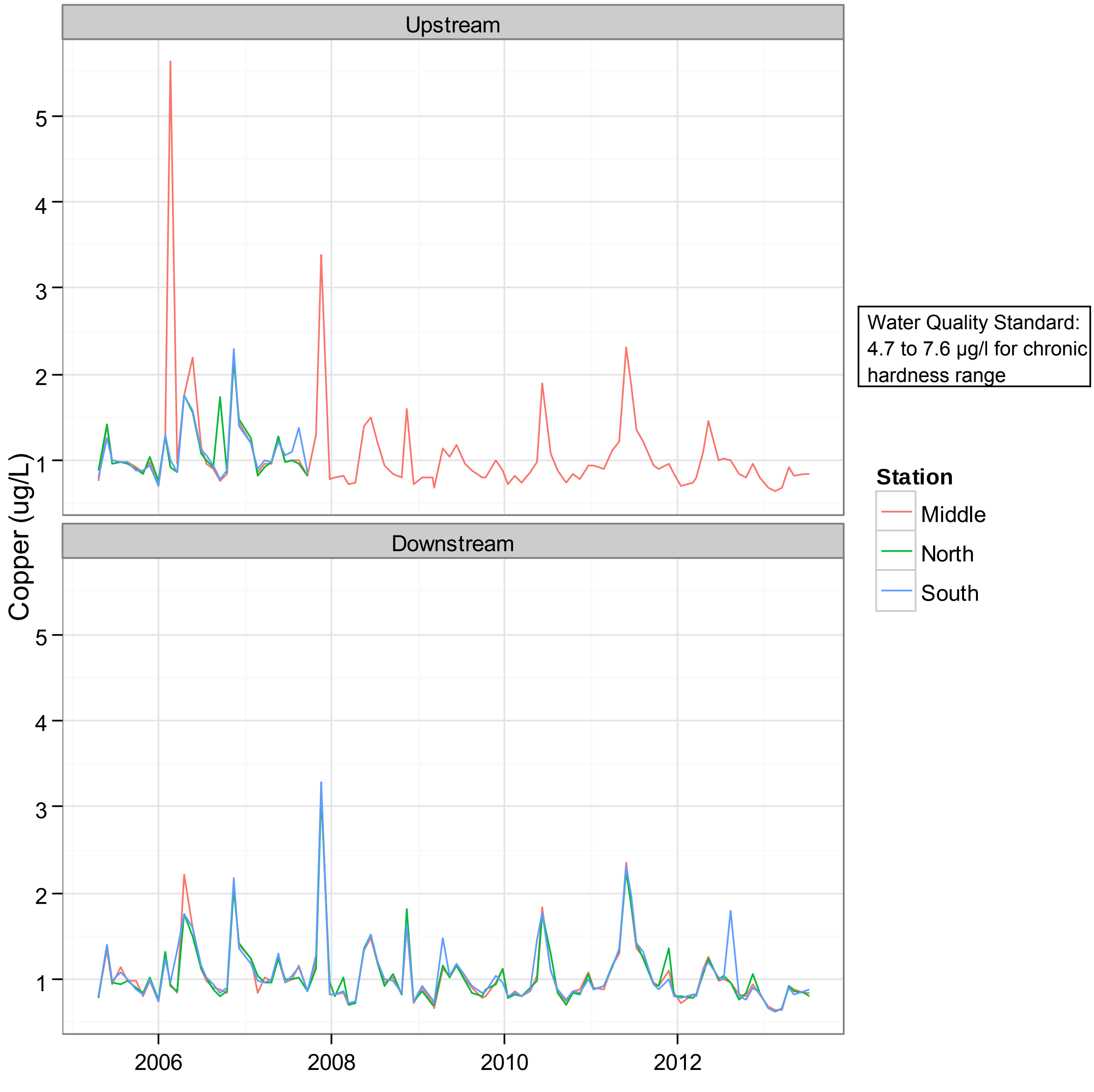


Figure 8-7: Columbia River Mixing Zone Sampling for Copper

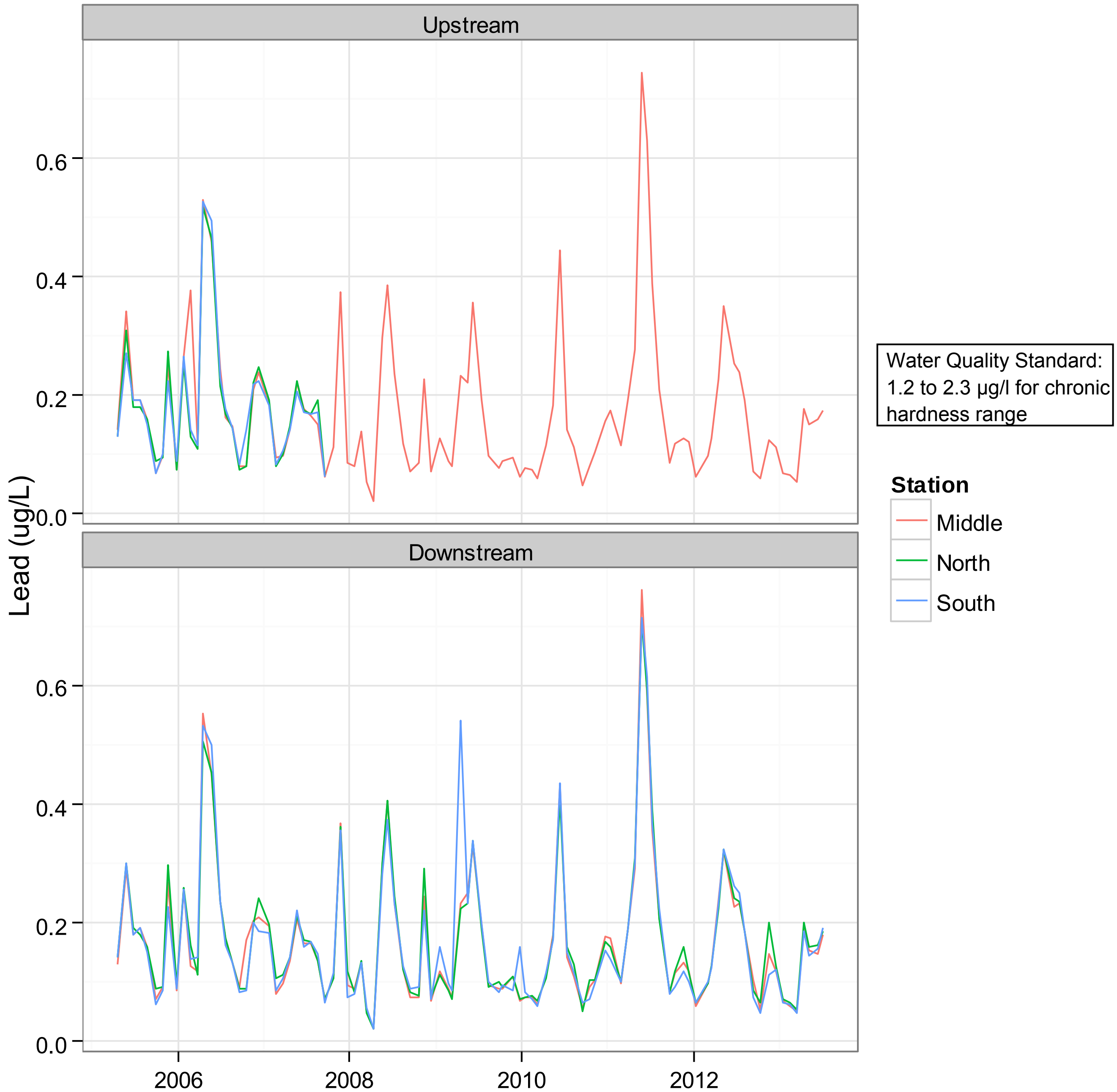


Figure 8-8: Columbia River Mixing Zone Sampling for Lead

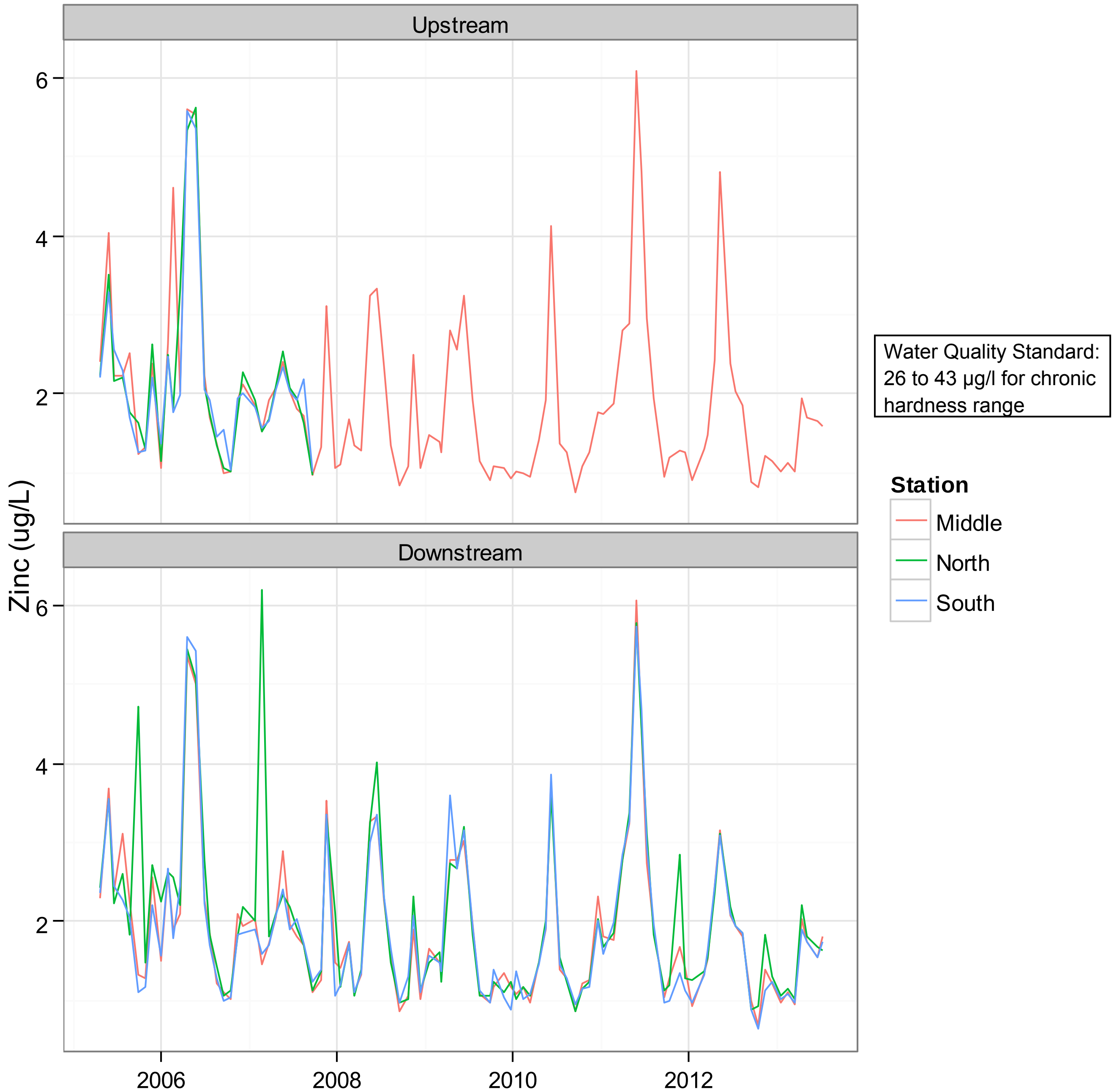


Figure 8-9: Columbia River Mixing Zone Sampling for Zinc