— CITY OF PORTLAND —
ENVIRONMENTAL SERVICES

1120 SW Fifth Avenue, Room 1000, Portland, Oregon 97204 ▪ Nick Fish, Commissioner ▪ Michael Jordan, Director

August 31, 2015

Mr. Mark Hynson
Water Quality Specialist
Oregon Department of Environmental Quality
Water Quality Program, NW Region
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232-4100

Subject: **Annual CSO and CMOM Report, FY 2015**
Columbia Boulevard Wastewater Treatment Plant NPDES Permit #101505

Dear Mr. Hynson:

Enclosed, please find two copies of the *Annual CSO and CMOM Report, FY 2015*, submitted as required in the NPDES Permit for the Columbia Boulevard Wastewater Treatment Plant. This annual report provides a comprehensive review of Portland's integrated CSO system and CMOM Program for fiscal year 2015 and addresses the material outlined in section 12.4 of the *Nine Minimum Controls Update Report*, December 2010.

If you have questions regarding this year's report, please do not hesitate to call me at (503) 823-9803.

Sincerely,

Matthew Criblez
Environmental Compliance Manager

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Enclosures (Annual CSO and CMOM Report, FY 2015)

CITY OF PORTLAND | BUREAU OF ENVIRONMENTAL SERVICES

# Annual CSO and CMOM Report FY 2015

**REQUIRED BY NPDES PERMIT #101505**

Environmental Services
City of Portland
working for clean rivers

**Nick Fish, Commissioner**
**Michael Jordan, Director**

# Annual CSO and CMOM Report
# FY 2015

Required by NPDES Permit #101505
for CBWTP and CSO Systems

September 2015

City of Portland
Bureau of Environmental Services

REGISTERED PROFESSIONAL ENGINEER
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# Glossary

**BOD.** Biochemical Oxygen Demand

**CBWTP.** Columbia Boulevard Wastewater Treatment Plant

**CCTV.** Closed-circuit Television

**CEPT.** Chemically Enhanced Primary Treatment

**CIP.** Capital Improvement Project (or Program)

**CMMS.** Computerized Maintenance Management System

**CMOM.** Capacity, Management, Operations, and Maintenance

**COOP.** Continuity of Operations Plan

**CSCC.** Columbia Slough Consolidation Conduit

**CSO.** Combined Sewer Overflow

**DEQ.** Oregon's Department of Environmental Quality

**DO.** Dissolved Oxygen

**EPA.** Environmental Protection Agency

**EMC.** Event Mean Concentration

**FM.** Force Main

**FOG.** Fats, Oils, and Grease

**FY.** Fiscal Year (FY 2015 is July 1, 2014, through June 30, 2015)

**IPS.** Influent Pump Station (pumps water from the Columbia Slough Consolidation Conduit to the CBWTP)

**MAO.** Mutual Agreement and Order

**MGD.** Million Gallons per Day

**NFAA.** No Feasible Alternative Analysis

**NMC.** Nine Minimum Controls

**NPDES.** National Pollution Discharge Elimination System

**RDII.** Rainfall Derived (also, Dependent) Infiltration and Inflow

**SICSO.** Swan Island CSO; used to refer to the pump station pumping water stored by the Willamette River's West Side and East Side CSO Tunnels.

**SPCR.** Spill Protection and Citizens' Response

**SRRP.** Sewer Release Response Plan

**SSO.** Sanitary Sewer Overflow

**TCWTP.** Tryon Creek Wastewater Treatment Plant

**TSS.** Total Suspended Solids

**WWTF.** Wet Weather Treatment Facility

# Executive Summary

The Annual CSO and CMOM Report for fiscal year 2015 (July 1, 2014, through June 30, 2015) provides a comprehensive review of Portland's integrated combined sewer overflow (CSO) system and the Capacity, Management, Operation, and Maintenance (CMOM) Program. The integrated CSO system includes the collection system, CSO facilities, and treatment systems at the Columbia Boulevard Wastewater Treatment Plant (CBWTP). As a result of the integration of CMOM with the combined sewer system, this report also provides the annual review for the CMOM program, thereby addressing the reporting requirements in the CBWTP NPDES Permit for both programs.

This annual report documents the performance of the CSO control and treatment system, as well as the CMOM program activities over the past fiscal year. The report includes a review of the major storm events that caused CSO to be discharged, and it examines the wet weather treatment performance at the CBWTP. In addition, the report documents the ongoing implementation of Portland's CMOM program, which overlaps with Portland's Nine Minimum Control (NMCs) elements of the CSO program.

**Changes from FY 2014 Report.** This report provides major updates specific to FY 2015 in:

- Section 2: CSO Events and System Performance
- Section 3: CMOM Program Implementation
- Section 4: Sewer Release Analysis and Performance
- Section 5: Maximization of Storage in the Collection Systems
- Section 6: Maximization of Flow to the POTW
- Section 8: CSO System and Water Quality Monitoring
- Section 9: System Reinvestment and Risk Reduction

**Integrated CSO System Performance.** Fiscal year 2015 was a dry year in which Portland received 33.9 inches of rainfall compared to the 37 inches per year average. The CSO system successfully captured all the combined sewage except during four storms that exceeded the 4-

per-winter or 3-year summer criteria. One of the four events was caused by a summer storm, and three were caused by winter storms:

1. **October 22-23, 2014:** 69 MG discharged over 4 hours on October 22 from the Willamette River CSO tunnels during this 10-year summer storm.
2. **December 4-6, 2014:** A small discharge of 1.6 MG over 2.5 hours on December 4 was released from the Willamette River CSO tunnels during this 5-year winter storm.
3. **January 17-18, 2015:** 92 MG discharged over 10 hours on January 17 and 18 from the Willamette River CSO tunnels during this 4-per-winter storm.
4. **March 14-15, 2015:** 79 MG discharged over 7 hours on March 15 from the Willamette River CSO tunnels during this 4-per-winter storm (and in some areas, a 5-year winter storm).

Throughout the fiscal year, all active CSO outfalls were controlled to meet and exceed the permit requirements. In total, the system discharged 242 MG of CSO volume to the Willamette River, which is less than 4% of the total 6.2 billion gallons of wet weather combined sewage generated in the combined sewer system.

**CSO Treatment Performance.** During this fiscal year, the CBWTP system consistently met the permit's water quality based effluent limits for BOD and TSS mass loads at the Outfall 001 and 003 discharge points into the Columbia River. During August 2014, the 7-day concentration limit was exceeded although the total TSS mass load limit was achieved. CBWTP's consistent and good performance was disrupted mid-August as the new secondary treatment improvement facilities were being commissioned, which caused different challenges and issues compared to February and March last fiscal year when the improvements were first brought online. The Max-Month and Peak-Week concentration values for the CBWTP outfalls are in Table ES-1.

*Table ES-1 Outfall 001 + 003 Effluent Concentrations During Peak Mass-Loading Periods*

| Parameter | Permit Maximum Concentration | Average Actual Concentration |
|---|---|---|
| | (mg/l) | (mg/l) |
| **Maximum 30-Day Performance** | | |
| BOD5 | 30 | 27 |
| TSS | 30 | 30 |
| **Peak 7-Day Performance** | | |
| BOD5 | 45 | 36 |
| TSS | 45 | **51** |

The Wet Weather Treatment Facility (WWTF) with Chemically Enhanced Primary Treatment continues to operate at similar levels as last year. The improved operations of CEPT enabled CBWTP staff to achieve annual percent removals of 60% for bio-chemical oxygen demand (BOD) and 82% for total suspended solids (TSS) through the WWTF. This performance fully met the permit-required 50% BOD and 70% TSS annual removal rates.

Analysis of the FY 2015 CSO treatment data revealed that the CBWTP received 6.2 billion gallons of captured CSO. The operators were able to treat 59% of this CSO volume through the secondary system, with 41% treated in the WWTF. There were 27 events in which flows were sent through the WWTF. The average WWTF event lasted 22 hours and discharged 94 million gallons from the WWTF. During the events, the average flow rate treated by the dry weather/secondary system was 112 MGD, exceeding the 100 MGD minimum required in the NPDES permit.

**Nine Minimum Controls and CMOM Program.** As envisioned in the permit, this report provides sufficient documentation of the on-going implementation activities for the NMCs and CMOM programs, thereby eliminating the need for large periodic updating reports. In examining the requirements for NMC #1, Proper Operations and Maintenance, it is clear that the CMOM program is the best way to fulfill EPA's requirements for managing the combined sewer system.

Portland's CMOM program has been designed to ensure that components of the collection system are cleaned and inspected at the right frequency and that preventive maintenance and repairs are performed to cost-effectively reduce the number of sewer releases, extend the useful life of the City's sewer infrastructure, and properly manage collection system operations. In FY 2015, the City of Portland's crews were able to:

- Inspect 0.76 million feet of sewer pipe, or about 8% of the mainline sewer system
- Clean 1.89 million feet of sewer pipe, or about 19% of the mainline sewer system
- Complete mainline sewer repairs on 11,600 feet of pipe; 60% of the projects were in response to collection system problems such as a sewer release
- Repair 772 service laterals totaling about 12,000 feet of pipe; 75% of those repairs were in response to discovered problems
- Treat 233,000 feet of pipe for roots using chemical root foaming and root saws

The priorities for the City's NMC and CMOM work are based on Asset Management principles that prioritize actions to reduce risks to public health and the environment. This approach sustains the current devotion of capital and operating towards maintenance-related projects:

- The City continues to focus on risk-based priorities for sewer capacity and condition, as reflected in the 10-year capital improvement program.

- Expenditures for sewer capacity projects to relieve sewer backups by integrating grey and green infrastructure continue to be implemented on a steady basis. These projects were identified in the *Post-2011 CSO Facilities Plan* because they ensure a high level of CSO control by removing additional stormwater from the combined system.
- Treatment and Pump Station capacity and maintenance expenditures continue to address increased capacity needs and aging facilities.

**Monitoring.** As shown in this report, Portland continues to carry out system monitoring, overflow monitoring, and water quality monitoring to ensure that permit requirements are achieved, human health is protected, and receiving streams meet water quality standards. Much of the monitoring data collected will be useful in updating the NPDES permit in 2016.

# Section 1 Introduction

Portland's *Annual CSO and CMOM Program Report* provides an assessment of the combined sewer overflow (CSO) control system performance during the past fiscal year (FY 2015: July 1, 2014, to June 30, 2015), along with a summary of the sanitary sewer overflow (SSO) control performance and accomplishments through the Capacity, Management, Operation, and Maintenance (CMOM) program.

Portland's Columbia Boulevard Wastewater Treatment Plant (CBWTP) National Pollutant Discharge Elimination System (NPDES) permit #101505 for discharging treated effluent includes requirements for the CSO system performance and requirements for managing the wastewater collection system. The NPDES permit requires BES to submit annual CSO reports to the Oregon Department of Environmental Quality (DEQ) on the performance of the overall CSO system. The Annual CSO and CMOM report covers CSO capture, conveyance, overflow characteristics, treatment efficiencies, and on-going implementation of the Nine Minimum Controls (NMC).

Several of the Nine Minimum Controls overlap significantly with the elements of Portland's CMOM program. Together, these two programs provide a comprehensive approach and view of how combined and separated sanitary sewage is managed, collected, conveyed, treated, and discharged throughout Portland's wastewater systems. The topics and overlap between the NPDES permit, the CSO program, and the CMOM program is displayed in Table 1-1. To efficiently and comprehensively address these overlapping topics, Portland reports on the annual CSO performance and the CMOM program together in this integrated document.

*Table 1-1 NPDES Permit, CSO, and CMOM Program Overlap*

| | Regulatory Document | | |
|---|---|---|---|
| | NPDES Permit | EPA CSO Policy | CMOM Guidance |
| System | Treatment Plant | CSO Control System | Collection System |
| Regulatory Requirements Addressed by Regulatory Documents | Outfall Effluent Limits | | |
| | Dry Weather Treatment | | |
| | Wet Weather Treatment | Wet Weather Treatment | |
| | CSO Mixing Zones for WQS | CSO Event Control Levels | |
| | | *Nine Minimum Controls* | |
| | | NMC#1: Proper O&M | Maintenance Practices |
| | System Operating Plan | NMC#2: Maximize Storage | Operations |
| | Pretreatment Requirements | NMC#3: Pretreatment Requirements | |
| | System Operating Plan | NMC#4: Maximize Flow to POTW | Operations |
| | Sewage Overflow Prohibition | NMC#5: Eliminate DWOs | Minimize SSOs |
| | | NMC#6: Control of Solids and Floatables | |
| | | NMC#7: Pollution Prevention | |
| | | NMC#8: Public Notification | Spill Response & Notification |
| | Monitoring | NMC#9: Monitoring | |

# 1.1 Purpose

This report is intended to meet the CSO-related reporting requirements in the CBWTP NPDES permit and the annual reporting commitments contained in the 2013 *CMOM Program Report*. This annual report documents the performance of the CSO capture, conveyance, and treatment systems over the past fiscal year, as well as the activities performed by the City of Portland to improve on the already high level of CSO and SSO 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 NMCs program, especially those controls that overlap with CMOM. The NMC program 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.

**CSO Control Program.** The CSO Control Program is designed and operated to control the magnitude, frequency, and duration of wet-weather-induced CSO discharges in compliance with water quality standards. The permit requires CSO discharges into the Willamette River and the Columbia Slough to be controlled as follows:

- 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.

**CMOM Program.** The purpose of the CMOM program is to reduce the risks to public health, safety, and the environment due to sewage releases from the wastewater collection system. It ensures that the collection system is managed cost-effectively to address other potential risks of failure, such as a pipe collapse or sinkhole.

# 1.2 Regulatory Background for Report

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

- *2011 CBWTP NPDES Permit and Mutual Agreement and Order (MAO)*
- *NMC Implementation Update Report*, December 2010
- *2013 CMOM Program Report*
- *Post-2011 CSO Facilities Plan*, September 2010
- *No Feasible Alternative Analysis (NFAA) Report*, December 2009

These documents include components of the long-term CSO control and Asset Management procedures Portland has followed over the past 24 years. The first three documents direct the majority of the content of this performance report and are summarized in this section.

**2011 CBWTP NPDES Permit and MAO.** 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 (Section 1 through Section 6)
- Post-Construction Monitoring Plan (Section 8)

[1] Winter is defined as November 1 through April 30

[2] Summer is defined as May 1 through October 31

The MAO attached to the CBWTP permit also required the City to implement specific wet weather and secondary treatment improvements, and to implement a monitoring and analysis program to measure the treatment effectiveness during wet weather conditions. A report on the findings from this program will be submitted to DEQ by December 30, 2015.

**2010 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 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.

A key focus of this annual report is to integrate the CSO control information represented in the NMCs with the overlapping CMOM program elements for the collection system's management, operations, and maintenance. The major overlap between the CMOM program and the NMCs occurs with NMC #1 – Proper Operation and Maintenance; however, there is also overlap with:

- NMC #2: Maximize use of collection system for storage (operations controlled)
- NMC #4: Maximize flow to the POTW (operations controlled)
- NMC #5: Eliminate dry weather overflows (part of SSO reduction)
- NMC #9: Public Notification

This CSO and CMOM annual report provides summary tables and graphs for each of the NMCs to document their ongoing implementation.

It should be noted that 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 CSO and CMOM Annual Report does not include information about the City's pretreatment and pollution prevention programs.

**2013 *CMOM Program Report*.** Over several years, the City of Portland has implemented a CMOM program to reduce the likelihood of sewer releases by improving the overall reliability of the sanitary and combined sewer collection systems. The *CMOM Program Report* that was submitted to DEQ on June 28, 2013, explains BES's strategies and activities for the development, reinvestment, operation, and maintenance of the system. The report was developed to comply with Condition 3.b.(1)(B) of Schedule A of the CBWTP NPDES permit.

The CMOM program specifically addresses proper operation and regular maintenance of the collection system (NMC #1). The City's wastewater collection system includes main lines, trunk lines, interceptors, pump stations, and force mains. The City is generally responsible for service laterals from the sewer main up to the curb line, while service laterals extending behind the curb are the responsibility of the property owner. Portland's sewer collection system consists of a network of 2,578 miles of collection system piping (1,001 miles of sanitary sewer including force mains, 910 miles of combined sewer, and 667 miles of sewer laterals) and 40,468 sewer manholes. The system also includes two wastewater treatment plants and 99 pump stations, including two new pump stations brought into operation during FY 2015. There are 82 City-owned and operated pump stations, 6 pump stations owned by other public agencies that are operated and maintained by the City under satellite or easement agreements, and 11 privately-owned septic tank effluent pumping systems that are maintained by the City under agreements with the property owners.

This annual update for FY 2015 provides a review of CMOM program actions and key performance indicators, and an evaluation of the effectiveness of BES's risk-based asset management approach to collection system operation and maintenance.

# Section 2 Integrated CSO System Performance for FY 2015

The integrated CSO system consists of the combined sewer collection system, the CSO collection, storage and pumping system, and the CBWTP treatment system. This section reports on the performance of the overall integrated CSO system during FY 2015.

## 2.1 Expected Control Levels for Portland's CSO Outfalls

The NPDES permit requires all CSO discharges to be eliminated for storms less than specific return periods during the winter and summer seasons. The specific storm-return frequencies or levels of CSO control that Portland expects to achieve (which meet or exceed DEQ required levels) are summarized in Table 2-1.

*Table 2-1 CSO Outfall Control Levels and Methods*

| Basin | CSO Outfall | Method of CSO Control | BES Control Standard[3] |
|---|---|---|---|
| **Willamette River CSO Outfalls - Minimum Control Level** | | | |
| Sheridan | 7B | West Side CSO Facilities | 4-per-Winter Storm and 3-Year Summer Storm |
| CBD/Ankeny | 09 | West Side CSO Facilities | |
| Nicolai | 15 | West Side CSO Facilities | |
| NW 110th | 24 | Cornerstone Projects and Linnton Pump Station Improvements | |
| Taggart | 30 | East Side CSO Tunnel | |
| Alder | 36 | East Side CSO Tunnel | |
| Wheeler | 43 | East Side CSO Tunnel | |
| Beech-Essex | 46 | East Side CSO Tunnel | |
| Riverside | 47 | East Side CSO Tunnel | |
| St. Johns B | 52 and 53 | Cornerstone Projects and System Improvements | |

[3] 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.

| Basin | CSO Outfall | Method of CSO Control | BES Control Standard[3] |
|---|---|---|---|
| **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 | 01 | Sewer Separation, SWPI | |
| Carolina | 03 | Southwest Parallel Interceptor (SWPI) | |
| Sellwood | 26A | Partial Separation, System Improvements | |
| Sellwood - Lents | 27 | Sellwood CSO Storage and Pumping System | |
| **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 and Columbia Slough CSO Facilities | |
| Chautauqua | 58 | Cornerstone Projects and Columbia Slough CSO Facilities | |
| Bayard | 59 | Cornerstone Projects and Columbia Slough CSO Facilities | |
| Kenton | 60 | Cornerstone Projects and Columbia Slough CSO Facilities | |
| Albina | 62/62A | Cornerstone Projects and Columbia Slough CSO Facilities | |
| NE 13th | 65 | Cornerstone Projects and Columbia Slough CSO Facilities | |

## 2.2 Rainfall Patterns for the Past Fiscal Year

FY 2015 was a low rainfall year for the City of Portland. The rainfall gauge at the CBWTP measured 33.9 inches over the year, compared with an average rainfall of 37 inches per year for Portland.

During this period, seven winter storm events occurred that exceeded the 4-per-winter design storms, and one summer storm exceeded the 3-year summer storm depths for different durations. Four of the events were large enough to generate CSO discharges:

1. October 22-23, 2014 – Summer CSO Event
2. November 22-23, 2014 – Winter, No Overflows
3. December 4-6, 2014 – Winter CSO Event
4. December 17-20, 2014 – Winter, No Overflows
5. December 23-25, 2014 – Winter, No Overflows
6. January 17-18, 2015 – Winter CSO Event
7. February 4-9, 2015 – Winter, No Overflows
8. March 14-15, 2015 – Winter CSO Event

### 2.2.1 Winter Storm Review

The seven storms that exceeded the 4-per-winter NPDES Permit 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 the range of storm duration, from 1-hour to 48-hours. The three events that caused CSO to occur are shown with red toned lines, and the four storms that had no CSO are shown in green toned lines. The three CSO events are compared to the two NPDES Winter Design Storms (4-per-winter and 5-year winter) shown with blue-tinted lines.

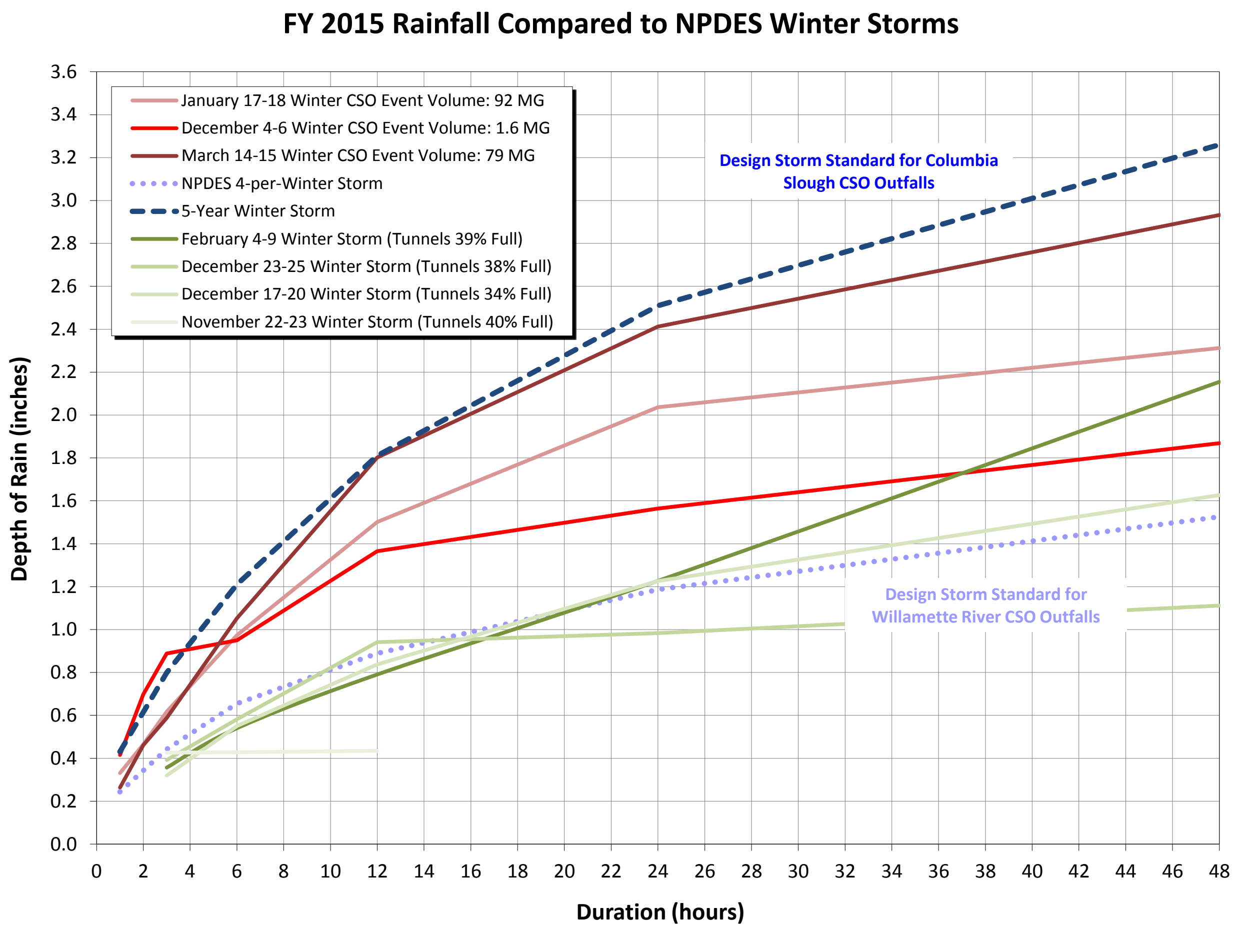



*Figure 2-1 FY 2015 CSO Winter Storms Compared to NPDES Winter Storms*

Details for the rainfall for the overflow events are provided in Table 2-2 below.

*Table 2-2 FY 2015 Winter Storm Comparisons*

| Storm | Duration (hours) | | | | | | Notes |
|---|---|---|---|---|---|---|---|
| | 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 | |
| 5 Year Winter Design Storm | 0.43 | 0.80 | 1.21 | 1.81 | 2.51 | 3.26 | |
| **Historical Storms - Average Rainfall over Willamette CSO Basin (inches)** | | | | | | | |
| December 4-6, 2014 | 0.42 | 0.89 | 0.95 | 1.37 | 1.56 | 1.87 | Exceeds 5 Year Winter Storm 1 and 3 hours, Exceeds 4-per-Winter Design Storm 6-48 hours. |
| January 17-18, 2015 | 0.33 | 0.62 | 0.97 | 1.50 | 2.04 | 2.31 | Exceeds 4-per-Winter Design Storm 1-48 hours. |
| March 14-15, 2015 | 0.26 | 0.59 | 1.05 | 1.80 | 2.41 | 2.93 | Exceeds 4-per-Winter Design Storm 1-48 hours. |

## 2.2.2 Summer Storm Review

Only one storm exceeded the NPDES Permit 3-year Summer Storm, but it was such a severe storm that it also exceeded the 10-Year Summer Storm design depths. This storm is shown graphically in Figure 2-2 below. This graph is a "Depth-Duration" chart that displays the maximum depth of rainfall that occurred for the range of storm duration, from 1-hour to 48-hours. The single event is shown with a bright red line. The two comparison Summer Design Storms (3-year summer and 10-year summer) are shown with blue-tinted lines. Table 2-3 provides rainfall details for this event.

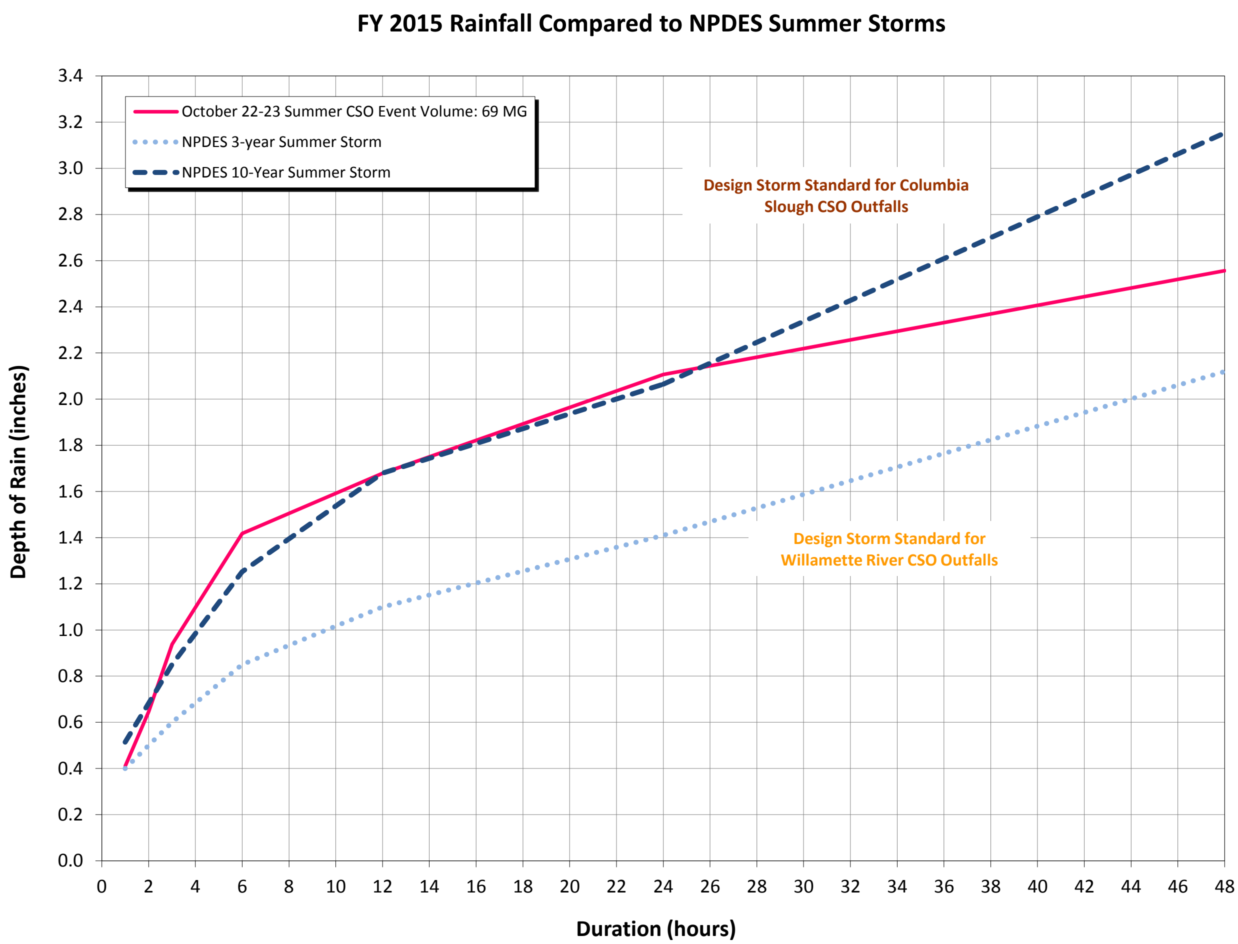



*Figure 2-2 FY 2015 Rainfall Compared to NPDES Summer Storms*

*Table 2-3 FY 2015 Summer Storm Comparisons*

| Storm | Duration (hours) | | | | | | Notes |
|---|---|---|---|---|---|---|---|
| | 1 | 3 | 6 | 12 | 24 | 48 | |
| **Willamette River Summer Design Storms (inches)** | | | | | | | |
| 3-Year Summer | 0.4 | 0.6 | 0.85 | 1.1 | 1.41 | 2.12 | |
| 10-Year Summer | 0.51 | 0.85 | 1.21 | 1.68 | 2.06 | 3.15 | |
| **Historical Storms - Average Rainfall over Willamette CSO Basin (inches)** | | | | | | | |
| October 22-23, 2014 | 0.41 | 0.94 | 1.42 | 1.68 | 2.11 | 2.56 | Exceeds 3-Year Summer Storm 1 and 48 hours, Exceeds 10-Year Summer Storm 3-24 hours. |

# 2.3 CSO Discharges into the Willamette River and Columbia Slough

In FY 2015, there were no CSO discharges into the Columbia Slough. There were four storms large enough to exceed the capacity of the Willamette River CSO system:

- **October 22-23, 2014:** 69 MG discharged over a four-hour period on October 22 from the East and West Side Willamette River CSO Tunnels. The storm included a peak 1 hour and 48 hour intensity that exceeded the 10-year summer storm criteria, as well as 3 to 24-hour intensity durations that exceeded the three-year summer storm.

- **December 4-6, 2014:** 1.6 MG discharged over a two-and-a-half-hour period on December 4th to the Willamette River. The large winter storm exceeded the four-per-winter design criteria, while most gauges of the service area saw precipitation exceeding the five-year winter storm.

- **January 17-18, 2015:** 92 MG discharged over a ten-hour period on January 17-18 from the East and West Side Willamette River CSO Tunnels. The storm exceeded the 4-per-winter design criteria for every measured duration through 48 hours.

- **March 14-15, 2015:** 79 MG discharged over a seven-hour period on March 15 to the Willamette River. The large winter storm exceeded the four-per-winter design criteria for every measured duration through 48 hours, while Southeast Portland saw precipitation exceeding the five-year winter storm.

In FY 2015, 242 MG of CSO were discharged from the CSO system. This volume represents 0.9% of the total 25.8 billion gallons of stormwater and CSO collected by the combined system in FY 2015. This means the CSO system captured and treated more than 99% 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 2-4, with FY 2015's discharges shaded. Twelve CSO events have occurred since the City first officially activated the East Side CSO system, which marked the completion of the Willamette CSO system.

*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 # | Dates of Storm / Overflow Events | Description | 6-Hour Rainfall (inches) | 12-Hour Rainfall (inches) | 24-Hour Rainfall (inches) | Overflow (MG) | Duration (hours) | Overflow (MG) | Duration (hours) | Overflow (MG) | Duration (hours) |
| 1 | January 17-21, 2012 | > 5-year 12-hour Winter Storm | 1.48 | 2.15 | 2.32 | 304.90 | 10.30 | 86.40 | 10.30 | 218.50 | 10.30 |
| 2 | May 26, 2012 | > 100-year, 30-minute Storm (0.85" in 30-min) | - | - | - | 0.17 | 0.42 | - | - | 0.17 | 0.42 |
| 3 | November 17-21, 2012 | 5-year, 24-hour Winter Storm | 1.22 | 1.65 | 2.44 | 176.40 | 9.50 | 44.00 | 9.50 | 132.40 | 9.30 |
| 4 | November 24, 2012 | 3-per Winter, 24-hour Storm | 0.61 | 1.09 | 1.49 | 0.50 | 0.80 | 0.50 | 0.80 | - | - |
| 5 | May 23, 2013 | 3-year, 12-hour Summer Storm | 0.90 | 1.22 | 1.50 | 26.30 | 2.30 | 11.90 | 2.30 | 14.40 | 1.80 |
| 6 | September 27-30, 2013 | 10-year, 24-hour Summer Storm | 1.20 | 1.41 | 2.08 | 88.50 | 7.00 | 27.00 | 7.00 | 61.50 | 5.40 |
| 7 | March 25-30, 2014 | 2-per Winter, 12-hour Storm | 0.89 | 1.26 | 1.53 | 43.10 | 3.00 | 14.30 | 3.00 | 28.70 | 3.00 |
| 8 | June 15-16, 2014 | 3-year, 30-minute Summer Storm | - | - | - | 0.03 | 0.20 | - | - | 0.03 | 0.20 |
| 9 | October 22-23, 2014 | 10-year, 24-hour Summer Storm | 1.42 | 1.68 | 2.11 | 69.4 | 3.92 | 13.41 | 3.50 | 56.00 | 3.92 |
| 10 | December 4-6, 2014 | 5-year, 3-hour Winter Storm | 0.95 | 1.37 | 1.56 | 1.6 | 1.57 | 0.05 | 0.27 | 1.52 | 1.57 |
| 11 | January 17-18, 2015 | 1-per Winter, 24-hour Storm | 0.97 | 1.50 | 2.04 | 91.6 | 7.98 | 15.15 | 6.75 | 76.43 | 7.98 |
| 12 | March 14-15, 2015 | 1-per Winter, 48-hour Storm | 1.05 | 1.80 | 2.41 | 78.9 | 6.48 | 16.61 | 5.92 | 62.31 | 6.48 |

Since being brought online in October 2000, the Columbia Slough Consolidation Conduit (CSCC) and associated CSO facilities have overflowed twice. Table 2-5 lists each CSO event from the CSCC.

*Table 2-5 Record of Columbia Slough CSO Events since October 2000*

| CSO Discharge Events | | | Storm Characteristics | |
|---|---|---|---|---|
| Event # | Dates of Storm/Overflow Events | Description | Overflow (MG) | Duration (hours) |
| 1 | December 28, 2005 | System overflow due to operator error | 0.28 | 0.65 |
| 2 | May 25, 2012 | > 100-year, 30-minute storm (0.85" in 30-min) | 0.022 | 0.20 |

### 2.3.1 Dry Weather Overflow (DWO) Events and Additional Controls

Dry weather overflows (DWOs) have effectively been eliminated from the Portland system under most conditions due to the completion of the CSO facilities in 2011. The occurrence of a DWO is minimized because overflows of diversion structures would be captured by the large CSO facilities downstream of those 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 is approaching the overflow level.

However, on April 11, 2015, concrete chunks from a vandalism event entered the sewer and blocked a diversion manhole near 8610 N Willamette Blvd., causing a DWO that discharged to the Willamette River at OF 52 (Cathedral Park). See page 62 for more details on this event.

## 2.4 Control of Floatables and Debris

All of the outfalls that experienced overflows during the reported events have specific floatables control systems, or are consistent with the CBWTP NPDES Permit requirements for outfalls that discharge without floatables control. Table 2-6 below details each of the outfalls that discharged during the reported events.

*Table 2-6 Floatables Control System Detail for Outfall Locations Experiencing CSO Events in FY 2015*

| Location | Outfall # | Floatables/Debris Control Type |
|---|---|---|
| Sweeney-Macadam/SW48 | 03 | High Level of CSO Control[4] |
| Sheridan OF7B | 07B | Bar Screen System |
| Ankeny OF09 | 09 | WSCSO tunnel/overflow structure |
| Nicolai OF15 | 15 | WSCSO tunnel/overflow structure |
| Riverside OF47 | 47 | ESCSO tunnel/overflow structure |
| Beech OF46 | 46 | ESCSO tunnel/overflow structure |
| Wheeler-River OF43 | 43 | ESCSO tunnel/overflow structure |
| Alder OF36 | 36 | ESCSO tunnel/overflow structure |
| Taggart OF30 | 30 | ESCSO tunnel/overflow structure |

Portland maintenance crews inspect and clean the bar screen within the Sheridan overflow structure (OF07B) following CSO discharge events. As can be seen in Table 2-7, which lists

[4] The NPDES permit does not require outfalls controlled up to the 5-year winter or 10-year summer storms to have floatable control devices.

maintenance conducted at OF07B for this reporting cycle, the solids collected by the bar screen consist of a significant amount of natural debris with some litter. No visible sanitary material was reported to have been present following either of the CSO events.

*Table 2-7 Sheridan Floatables Control System Event Maintenance Summary*[5]

| CSO Event Date(s) | Maint. Date | Description of Maintenance |
|---|---|---|
| October 22-23, 2014 | 10/30/2014 | Removed 20 gallons of mixed debris consisting of leaves and sticks. |
| January 17-18, 2015 | 1/28/2015 | Removed 20 gallons of leaves and sticks from screen. |
| March 14-15, 2015 | 3/19/2015 | Removed 5-10 gallons of debris (leaves, sticks, and plastic bags) off bar screen. Vactor provided water and entry access. |

# 2.5 CSO Facilities Operations Monitoring Information

## 2.5.1 Annual Operations Review

The CSO System configuration experienced no major changes in FY 2015. Some projects improved the capacity of components of the system, but did not change operational procedures or have easily identifiable effects on CSO discharges.

Improvements to the CBWTP's secondary processes (BES CIP #E08909) were completed on April 30, 2014, with testing and startup through the summer. Improvements in the Secondary Diversion Channel (SEDI; BES CIP #E10468) were completed May 5, 2015. These improvements permitted higher sustained throughput of 340-400 MGD at the CBWTP during the larger events this year.

The Ankeny Pump Station remodel (BES CIP #E07833) was completed on July 21, 2014. This project upgraded the four main pumps that convey sewage across the Willamette River to the Peninsular Tunnel. During construction flows to the pump station were diverted to the West Side CSO Tunnel, requiring pumping from the Swan Island CSO Pump Station. After construction, improved capacity at Ankeny reduced pumping requirements at SICSO.

Table 2-8 below provides a summary of the total dry and wet weather volume pumped from the Swan Island CSO pump station through its three force mains, as well as the volume pumped from the CBWTP Influent Pump Station (IPS) that serves the Columbia Slough Consolidation Conduit (CSCC). Compared to last year, SICSO volume went down about 50% and the IPS volume went up about 39%. This reflects the change when Ankeny Pump Station

[5] The Sheridan structure did not overflow during the December 4-6, 2014, CSO event, and therefore no maintenance activity was needed.

resumed operation in FY 15 and the temporary diversion of flows to the Willamette Tunnel system from the Westside ceased.

*Table 2-8 FY 2015 Volume Pumped from CSO Tunnels*

| CSO Tunnel Pumping | Total Pumped Volume (MG) |
|---|---|
| **Swan Island CSO Pump Station** | |
| Forcemain 1 (Peninsular Dry Weather) | 2,826 |
| Forcemain 2 (Peninsular Wet Weather) | 275 |
| Forcemain 3 (Portsmouth Wet Weather) | 879 |
| **Total Swan Island CSO Pumping** | 3,980 |
| **IPS – CSO Pump Station** | 1,561 |
| **Total Volume Pumped to CBWTP from Tunnels** | 5,542 |

The total volume pumped from the CSO tunnels (5,542 MG) compares in magnitude to the CSO-stormwater volume delivered to CBWTP (6,151 MG) as presented below in Section 2.6.1. This comparison indicates the degree to which the dry and wet weather flows arriving at CBWTP are coming from CSO pumping systems versus the gravity inputs from the older combined system.

## 2.5.2 CSO Event Operations Review

Four CSO events occurred in FY 2015. The following sections provide a summary of the CSO system operations during these events.

### *2.5.2.1 October 22-23, 2014*

The storm of October 22-23, 2014 exceeded the 3-year Summer Storm design criteria for all durations for the average gauge in the Willamette area, and exceeded the 10-year Summer Storm design criteria for the 6-hour duration for all gauges in the Willamette area. This storm exceeded the design capacity of the Willamette River CSO system and resulted in overflows with a total volume of 69 MG, and a duration of 4 hours.

Figure 2-3 shows system flows, including flow to the treatment plant, the allowable and actual pumping rate and wetwell level at Swan Island CSO (SICSO) Pump Station, and the CSO discharge to the Willamette River. In order to protect the treatment plant system and continue to meet effluent limits, the SICSO Pump Station was restricted in how much it was allowed to pump. SICSO total pump rates matched the reduced allowable pump rates set by CBWTP operators between 15:15 and 18:30. The CSO event began at 16:00 and continued until 20:00. The

SICSO Pump Station operated at maximum capacity between October 23, 2014, 23:30 and October 24, 2014, 03:30.

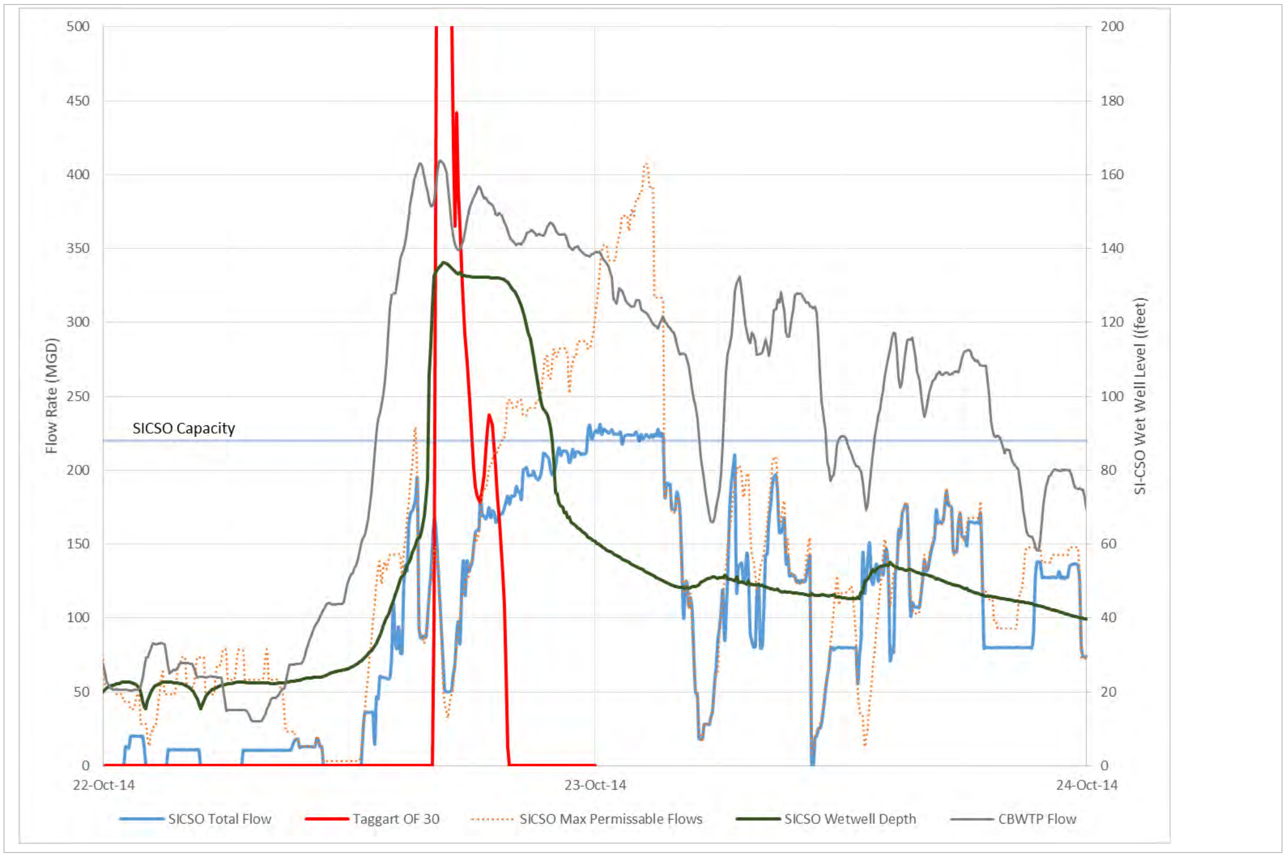



*Figure 2-3 CSO System Performance Data for October 22-23, 2014, Storm*

Table 2-9 provides a summary of the volume treated through CBWTP during the October 2013 storm. CBWTP received an average of 264 MGD for the 30 hour event. An average of 136 MGD (52%) received secondary treatment and the remainder, 128 MGD, was directed to the wet weather treatment system. During this storm, 48% of the flow to CBWTP was sent to the WWTF. The columns to the right in Table 2-9 provide summary data for all the flow generated in the combined system during the 30 hour storm. The volume of CSO represents 17% of the total flow generated in the combined system during the storm.

*Table 2-9 CSO System Capture and Treatment Performance for October 22-23, 2014, Storm*

| | Avg. Flow Rate (MGD) | % of Flow to CBTWP | Volume (MG) | % of Total to Combined System |
|---|---|---|---|---|
| Total Flow to Combined System | n/a | - | 399 | 100% |
| Total Flow to CBWTP | 264 | 100% | 330 | 83% |
| Total Flow to CBWTP Secondary System | 136 | 52% | 171 | 43% |
| Average Dry Weather Flow[6] | 50 | 19% | 62 | 16% |
| Wet Weather Flow Treated | 87 | 33% | 108 | 27% |
| Total Flow to CBWTP Wet Weather System | 128 | 48% | 159 | 40% |
| Total CSO Overflow | n/a | n/a | 69.4 | 17% |

#### *2.5.2.2 December 4-6, 2014*

The December 4-6, 2014, storm consisted of two bursts, each three hours in duration. The three hour volume of this storm exceeded the 5-year winter design storm for most gauges in the Willamette area, and exceeded the 1-per-winter storm for all gauges. The Willamette River CSO system was designed to control the 4-per-winter storm, so this event exceeded the design capacity and resulted in CSO discharges with a total volume of 1.6 MG and a duration of 1.6 hours.

Figure 2-4 shows how the system responded to the two bursts of rainfall in this event. After the first burst at about 05:00 on December 5, 2014, the treatment plant began operating in low wet weather mode to maximize secondary treatment of CSO, and SICSO began pumping at 110 MGD. The SICSO wet well partially filled and began dewatering until the second burst of rainfall at about 12:00. As the wetwell filled, the SICSO pumping rate rose to its maximum 220 MGD, with a period from 14:00 and 16:00 where pumping was restricted to prevent excess flows to the treatment plant. Overflows did occur briefly despite the fact that the level in the SICSO wetwell did not quite reach the tunnel overflow elevation. Factors such as pumping draw-down and head loss in the collection system cause some variability between the overflow elevation in the wetwell and water surface elevation at the upstream overflow locations.

[6] Based on CBWTP Flow during Oct. 1-10, 2014

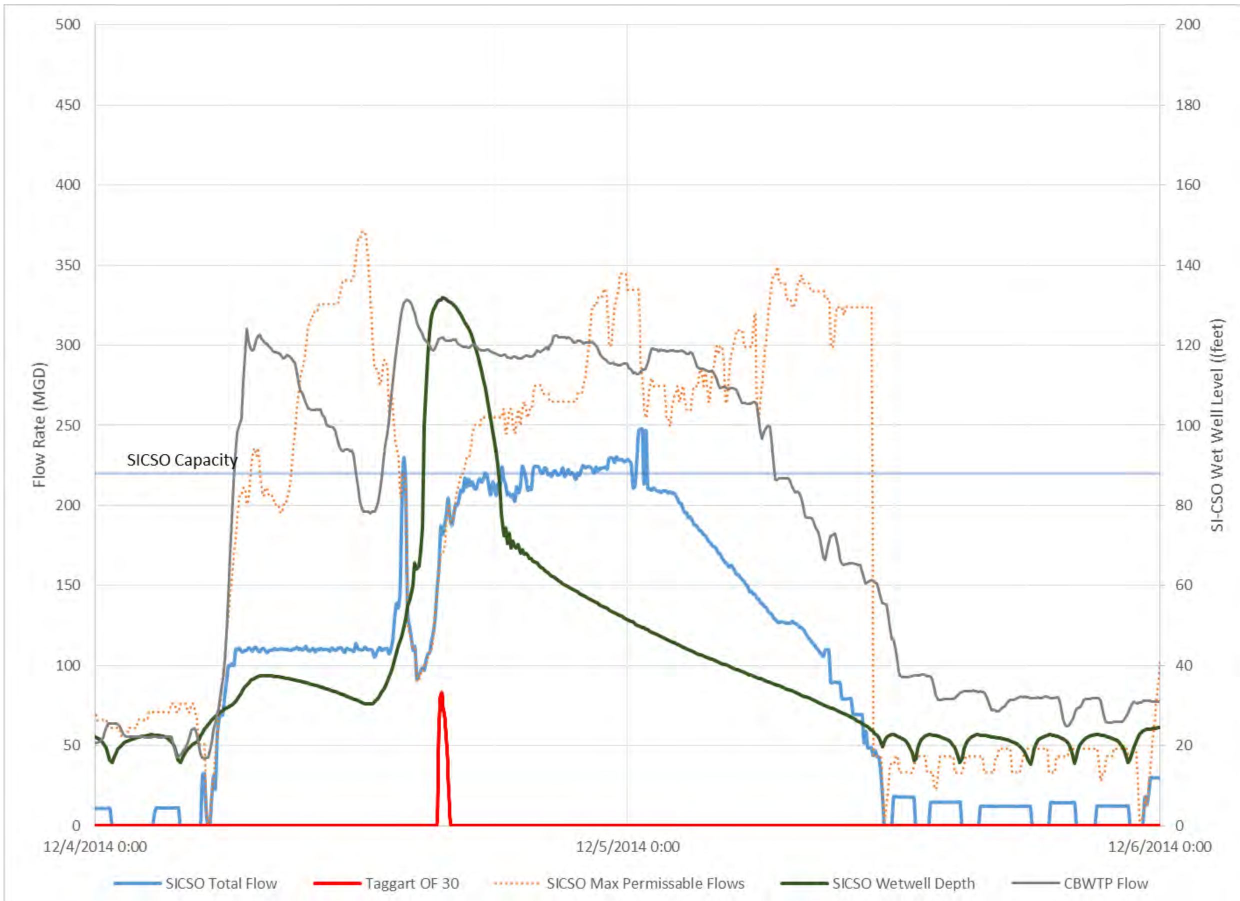



*Figure 2-4 CSO System Performance Data for December 4-6, 2014, Storm*

Table 2-10 below provides a summary of the volume treated through CBWTP during the December 2015 storm. CBWTP received an average of 361 MGD for the two day period. An average of 273 MGD (76%) received secondary treatment and the remainder, 88 MGD, was directed to the wet weather treatment system. During this storm, 24% of the flow to CBWTP was sent to the WWTF. The columns to the right in Table 2-10 provide summary data for all the flow generated in the combined system during the four day storm. The volume of CSO represents less than 1% of the total wet weather flow generated during this storm.

*Table 2-10 CSO System Capture and Treatment Performance for December 4-6, 2014, Storm*

| | Avg. Flow Rate (MGD) | % of Flow to CBTWP | Volume (MG) | % of Total to Combined System |
|---|---|---|---|---|
| Total Flow to Combined System | n/a | - | 750 | 100% |
| Total Flow to CBWTP | 361 | 100% | 748 | 100% |
| Total Flow to CBWTP Secondary System | 273 | 76% | 566 | 75% |
| Average Dry Weather Flow[7] | 55 | 15% | 115 | 15% |
| Wet Weather Flow Treated | 218 | 60% | 451 | 60% |
| Total Flow to CBWTP Wet Weather System | 88 | 24% | 182 | 24% |
| Total CSO Overflow | n/a | n/a | 1.6 | <1% |

#### *2.5.2.3 January 17-18, 2015*

The rainfall that occurred between January 17 and 18, 2015, was a moderate-intensity high-volume event, totaling more than 2 inches of rain over a 24 hour period, with a lull and resurgence late in the event. This event exceeded the 4-per-winter design storm at all Willamette area rain gauges for all durations, and exceeding the 1-per winter storm for 12 and 24 hour durations for most gauges. The capacity of the Willamette River CSO system is based on the 4-per-winter storm, which was exceeded by this storm before the CSO discharge began. The resulting CSO discharges occurred in two waves with a total volume of 91.6 MG and a duration of total duration of eight hours over a 10 hour period.

Figure 2-5 shows the performance of the Willamette CSO system during this event. Two pumps at SICSO experienced maintenance problems during the beginning of the storm, January 17 between 13:00 and 18:30. The SICSO pumps operated below maximum capacity between January 17, 2015, 20:30 and January 18, 2015, 04:30, even though higher flows were permitted. During drawdown, pumping from SICSO was limited to reduce the risk of street flooding at N Mississippi Ave. and Knott St.

Table 2-11 below provides a summary of the volume treated through CBWTP during the January 2015 storm. CBWTP received an average of 332 MGD for the 36 hour period. An average of 140 MGD (42%) received secondary treatment and the remainder, 191 MGD, was directed to the wet weather treatment system. During this storm, 58% of the flow to CBWTP was directed to the WWTF. The columns to the right in Table 2-11 provide the summary data

7 Based on CBWTP Flow during Nov. 30-Dec. 3, 2014

for all the flow generated in the combined system during the 36 hour storm. The volume of CSO represents 15% of the total wet weather flow generated during that storm.

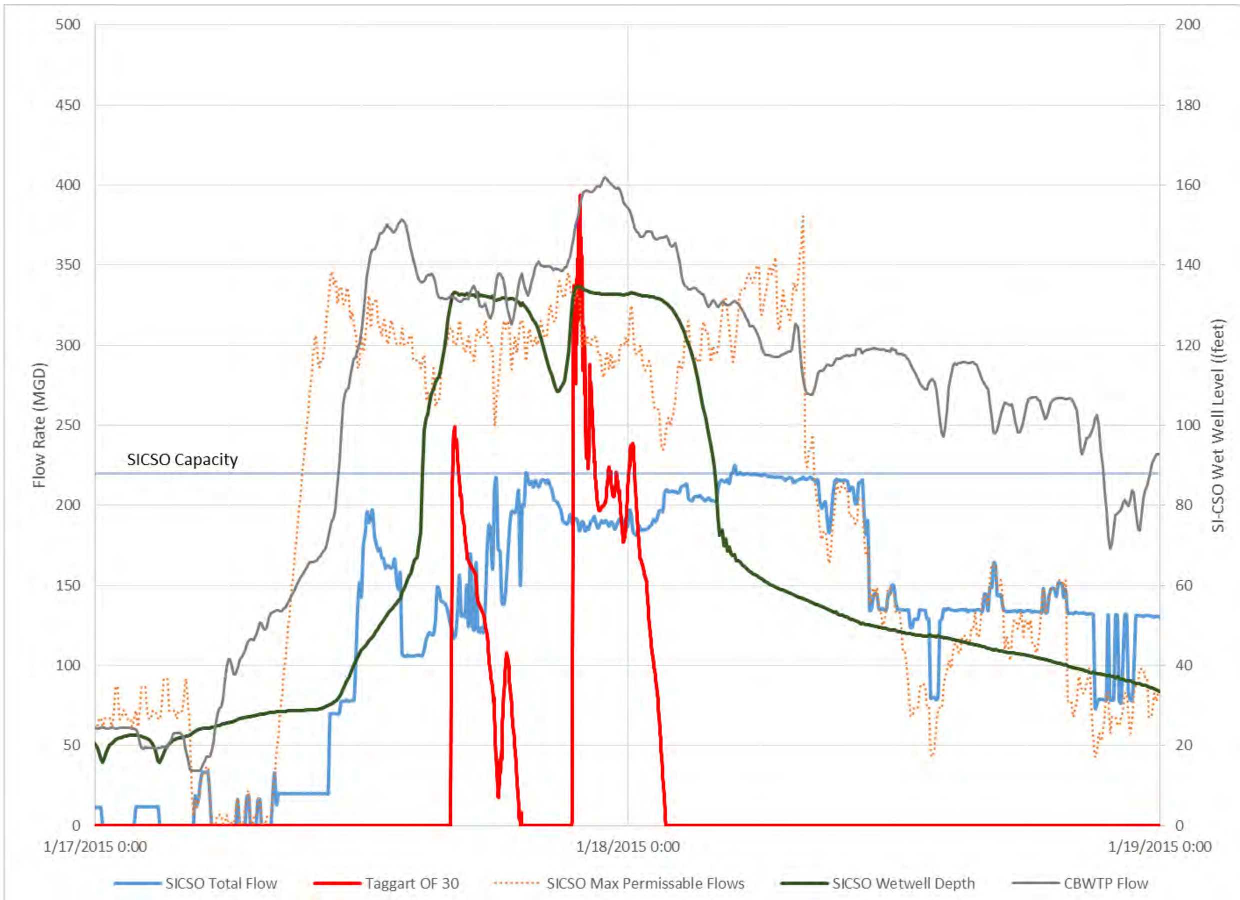



*Figure 2-5 CSO System Performance Data for January 17-18, 2015, Storm*

*Table 2-11 CSO System Capture and Treatment Performance for January 17-18, 2015, Storm*

| | Avg. Flow Rate (MGD) | % of Flow to CBTWP | Volume (MG) | % of Total to Combined System |
|---|---|---|---|---|
| Total Flow to Combined System | n/a | - | 604 | 100% |
| Total Flow to CBWTP | 334 | 100% | 512 | 85% |
| Total Flow to CBWTP Secondary System | 142 | 43% | 218 | 36% |
| Average Dry Weather Flow[8] | 55 | 16% | 84 | 14% |
| Wet Weather Flow Treated | 88 | 26% | 135 | 22% |
| Total Flow to CBWTP Wet Weather System | 191 | 57% | 294 | 49% |
| Total CSO Overflow | n/a | n/a | 91.6 | 15% |

[8] Based on CBWTP Flow during Jan. 12-14, 2015

#### *2.5.2.4 March 14-15, 2015*

The storm of March 14-15, 2015 was a low-intensity high-volume event lasting about 30 hours and delivering about 3" of rain to the Willamette CSO Area, with some geographic variability. The storm volume exceeded the 1-per-Winter design storm for a 24-hour duration for all gauges in the Willamette CSO area. That rainfall exceeded the 4-per-winter design storm for which the Willamette CSO System was designed, and caused CSO discharges with total volume of 78.9 MG and duration of 6.48 hours.

Figure 2-6 shows the performance of the Willamette CSO system during the storm. During this event a flowmeter measuring part of the flow from the SICSO pumping station malfunctioned, and around 00:00 on March 15 Operations manually set pumping to the maximum rate of 220 MGD, which would have been the response of the automated system had the monitor been working. The wet well level monitor or data recorder experienced flatlining after the CSO discharge occurred and the wet well level was declining. Neither of these issues affected the performance of the CSO system during the event or worsened the CSO discharge.

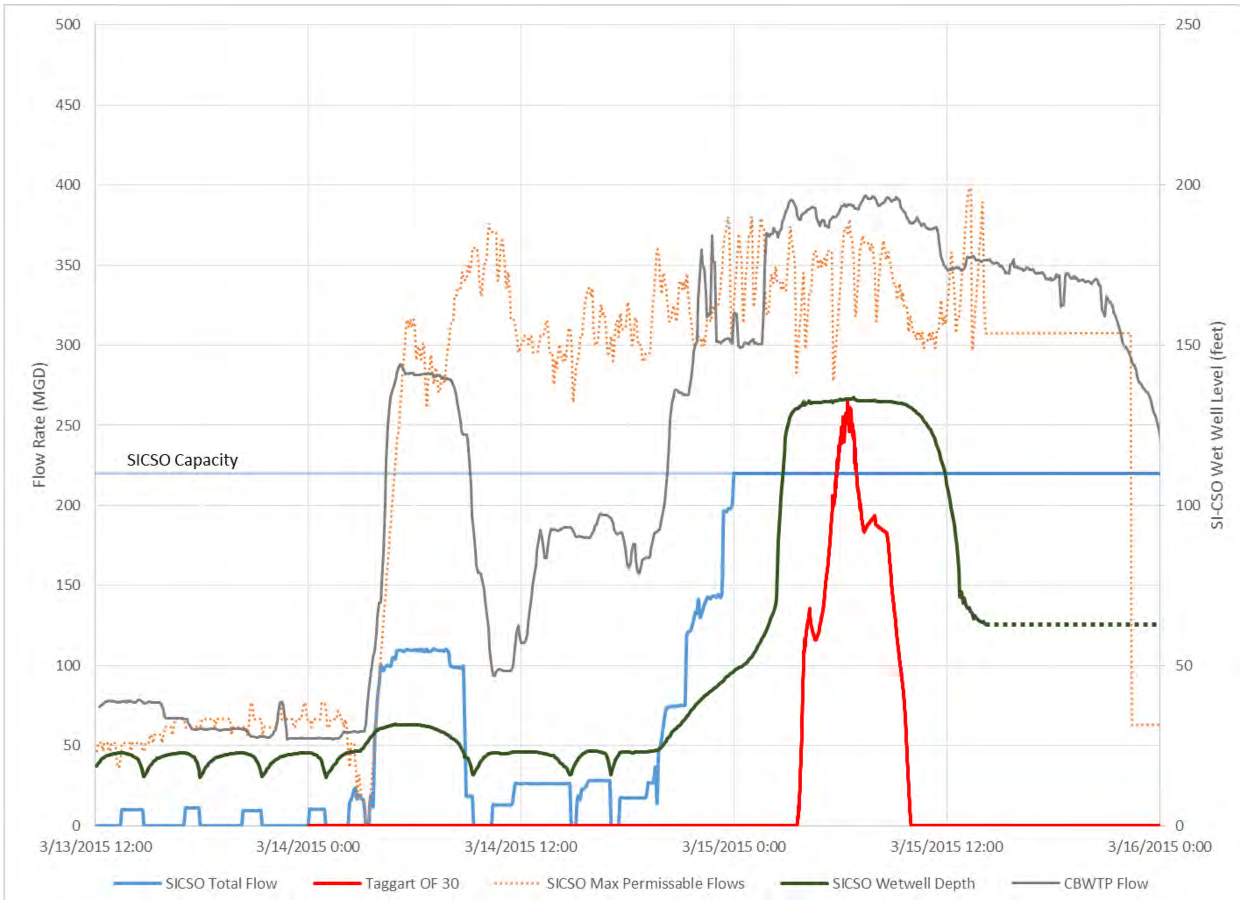



*Figure 2-6 CSO System Performance Data for March 14-15, 2015, Storm*

Table 2-12 provides a summary of the volume treated through CBWTP during the March 2015 storm. CBWTP received an average of 457 MGD for the 36 hour period. An average of 208 MGD (46%) received secondary treatment and the remainder, 249 MGD, was directed to the wet weather treatment system. During this storm, 54% of the flow to CBWTP was directed to the WWTF. The columns to the right in Table 2-12 provide the summary data for all the flow generated in the combined system during the 31 hour storm. The volume of CSO represents 12% of the total wet weather flow generated during that storm.

*Table 2-12 CSO System Capture and Treatment Performance for March 14-15, 2015, Storm*

| | Avg. Flow Rate (MGD) | % of Flow to CBTWP | Volume (MG) | % of Total to Combined System |
|---|---|---|---|---|
| Total Flow to Combined System | n/a | - | 675 | 100% |
| Total Flow to CBWTP | 457 | 100% | 596 | 88% |
| Total Flow to CBWTP Secondary System | 208 | 46% | 271 | 40% |
| Average Dry Weather Flow[9] | 57 | 13% | 75 | 11% |
| Wet Weather Flow Treated | 151 | 33% | 197 | 29% |
| Total Flow to CBWTP Wet Weather System | 249 | 54% | 325 | 48% |
| Total CSO Overflow | n/a | n/a | 78.9 | 12% |

# 2.6 Wet Weather Treatment Performance and Effluent Quality

## 2.6.1 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. 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 2-13 summarizes the main annual treatment performance measures for the CBWTP systems. Portland's CSO system has been completed for nearly four years as of July 2015, with some treatment components in place for less than three years. Table 2-13 lists the values for this fiscal year 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 112 MGD was more than 10% above the permit minimum requirement of 100 MGD.
- Percent of Captured CSO Treated through Secondary exceeded the model target level (59% compared to 54%).

[9] Based on CBWTP Flow during Mar. 8-11, 2015

- BOD and TSS Removal Efficiencies for the Wet Weather System exceeded the permit's annual requirements: BOD removal was 60% compared to the permit-required 50%, and TSS removal was 82% compared to the permit's 70% requirement.

The annual performance data indicates that the CSO system operations strategy enabled improved performance under various weather conditions throughout the year. In addition, Portland's use of CEPT has resulted in a significant reduction in BOD and TSS from the Wet Weather Treatment Facility.

*Table 2-13 CBWTP Annual Treatment Performance Summary Data*

| Annual Treatment Characteristics | Average Year Model / Permit | No CEPT FY 2012 | With CEPT FY 2013 | With CEPT FY 2014 | With CEPT FY 2015 | Trend |
|---|---|---|---|---|---|---|
| **Annual Rainfall Depth (inches/year)** | 37 | 46.8 | 40.2 | 40.0 | 33.9 | |
| **Flows to CBWTP** | | | | | | |
| Influent Volume (MG/Year) | 28,300 | 28,800 | 26,625 | 26,549 | 25,760 | |
| Dry Weather Sanitary Volume (MG/Year) | 22,100 | 20,200 | 19,496 | 19,471 | 19,609 | |
| Captured CSO Flow - Volume (MG/Year) | 6,200 | 8,600 | 7,129 | 7,078 | 6,151 | |
| Total Volume Treated Thru Secondary (MG) | 25,443 | 25,662 | 24,197 | 24,002 | 23,221 | |
| % of Plant Flow Treated Through Secondary System | 90% | 89% | 91% | 90% | 90% | |
| **WWTF (Secondary Bypass) Events** | | | | | | |
| Rate to DW / Secondary During Bypass (MGD) | 100 | 120 | 126 | 112 | 112 | |
| Number of Events / Year | 32 | 29 | 22 | 27 | 27 | |
| WWTF Volume / Year | 2,857 | 3,138 | 2,429 | 2,546 | 2,540 | |
| Amount of Captured CSO Treated via Secondary (%) | 54% | 64% | 66% | 64% | 59% | |
| Duration of WWTF Events (hours) | 919 | 706 | 668 | 904 | 591 | |
| Calendar Days of WWTF Discharges (days) | --- | 66 | 50 | 65 | 51 | |
| **Blended Effluent (OF001 & 003) Treatment** | | | | | | |
| BOD Loading (pounds / year) | 2,510,000 | 4,000,000 | 2,957,783 | 3,472,307 | 4,176,834 | |
| BOD Average Concentration (mg/l) | 27 | 16.6 | 13.3 | 15.7 | 19.4 | |
| Total Plant BOD Removal Efficiency (%) | --- | 93% | 95% | 94% | 93% | |
| TSS Loading (pounds / year) | 2,440,000 | 5,050,000 | 3,585,748 | 4,055,479 | 4,413,412 | |
| TSS Average Concentration (mg/l) | 27 | 21.0 | 16.1 | 18.3 | 20.5 | |
| Total Plant TSS Removal Efficiency (%) | --- | 92% | 94% | 93% | 92% | |
| **Wet Weather Treatment Facility** | | | | | | |
| BOD TO Wet Weather Facility (pounds/year) | --- | 2,290,000 | 1,638,460 | 2,361,933 | 2,414,044 | |
| BOD FROM Wet Weather Facility (pounds/year) | --- | 1,510,000 | 726,541 | 874,387 | 962,545 | |
| Wet Weather BOD Removal Efficiency (%) | 50% | 34% | 56% | 63% | 60% | |
| TSS TO Wet Weather Facility (pounds/year) | --- | 4,030,000 | 2,257,182 | 3,048,027 | 3,130,925 | |
| TSS FROM Wet Weather Facility (pounds/year) | --- | 1,480,000 | 520,375 | 520,252 | 560,013 | |
| Wet Weather TSS Removal Efficiency (%) | 70% | 63% | 77% | 83% | 82% | |

## 2.6.2 CBWTP Max-Month and Peak-Week Treatment Performance

The CBWTP NPDES permit lists 1) effluent limits for the CBWTP outfalls and 2) performance requirements for the dry-weather/secondary system and the wet-weather treatment trains for monthly and weekly extreme weather conditions. Table 2-14 and Table 2-15 below summarize effluent BOD and TSS concentrations and loads during the most extreme periods in FY 2015 for the overall plant site (Outfalls 001 and 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 2-14. 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 were calculated for that period. Table 2-14 shows that the effluent discharged to Outfalls 001 and 003 during the maximum 30-day period met the permit's BOD concentration and mass load limit. TSS concentrations met the permit requirement for the combined outfall, but the total TSS mass loadings for the 30-day limit was within the permit requirements.

*Table 2-14 CSO Max-Month (30-days maximum solids loading) Treatment Performance*[10]

| 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 | 27 | 97 | 45,000 | 21,606 | 20-Dec-14 | 8.5 inches of rain in 30 days |
| TSS | 30 | 30 | 97 | 45,000 | 23,988 | 20-Dec-14 | |
| **Secondary Biological Treatment - 100 MGD Minimum Instantaneous** | | | | | | | |
| BOD5 | 30 | **31** | 63 | 22,500 | 16,236 | 9-Sep-14 | 0.4 inches of rain in 30 days |
| TSS | 30 | **42** | 63 | 22,500 | 22,044 | 8-Sep-14 | |
| **Wet Weather / CEPT System - Intermittent Discharges** | | | | | | | |
| BOD5 | 45 | 30 | 46 | 22,500 | 11,586 | 20-Dec-14 | 8.5 inches of rain in 30 days |
| TSS | 45 | 21 | 46 | 22,500 | 8,247 | 20-Dec-14 | |

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 2-15 shows the flow rates, concentrations, and mass loads for the 7-day peak period. The results indicate that the treatment performance for the final effluent discharged from OF001 and OF003 met the permit's BOD concentration and mass load criteria. The permit's TSS concentration was exceeded but the total TSS mass loading for the 7-day limit was within the permit requirements. This exceedance was caused by destabilization of secondary processes associated with the commissioning of the secondary improvements finished earlier in the year. The City worked with CH2M Hill to solve the problems and prevent them from recurring, eventually stabilizing the process. The City reported these issues to DEQ and received a

[10] As stated in the DMRs, Portland applies the System-Based Performance Requirements for Secondary and WWTF as in-plant guidelines. Permit compliance is required for the combined OF001 and OF003 effluent.

warning letter, which included an acknowledgment by DEQ that these system commissioning complexities were the source of the exceedances.

*Table 2-15 CSO Peak-Week (7-days maximum solids loading) Treatment Performance*[11]

| 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 | 36 | 125 | 118,800 | 37,698 | 28-Oct-14 | 5.3 in/0.0 in of rain in 7 days |
| TSS | 45 | **51** | 125 | 118,800 | 53,577 | 17-Aug-14 | |
| **Secondary Biological Treatment - 100 MGD Minimum Instantaneous** | | | | | | | |
| BOD5 | 45 | **69** | 59 | 37,500 | 33,804 | 19-Aug-14 | 0.0 inches of rain in 7 days |
| TSS | 45 | **109** | 59 | 37,500 | **53,577** | 17-Aug-14 | |
| **Wet Weather / CEPT System - Intermittent Discharges** | | | | | | | |
| BOD5 | 65 | 47 | 62 | 81,300 | 24,583 | 10-Dec-14 | 3.6 inches of rain in 7 days |
| TSS | 65 | 40 | 62 | 81,300 | 20,939 | 10-Dec-14 | |

## 2.6.3 Wet Weather Treatment Performance for Bypass Events

The performance of the CSO wet weather treatment system is 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 generally refers to these events as WWTF discharge events or simply WWTF events. Table 2-16 summarizes the WWTF events that occurred in FY 2015. The full list of events is provided in Table 2-17 on the following page.

[11] As stated in the DMRs, Portland applies the System-Based Performance Requirements for Secondary and WWTF as in-plant guidelines. Permit compliance is required for the combined OF001 and OF003 effluent.

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 plant inflow remains below 80 MGD for 6 hours. This was changed from prior years due to plant operations now increasing return activated sludge flow to the secondaries, and therefore secondary flow is no longer a clear indicator for these events.

OR

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

*Table 2-16 FY 2015 WWTF Events (Secondary Bypass) Summary*

| | | CBWTP Flows | | WWTF Flows | | | | WWTF Effluent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Events | 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** | **27** | | | | **2,540** | **591** | **51** | **962,545** | **560,013** | | |
| **Average/Event** | | **204** | **112** | **90** | **94** | **21.9** | **1.9** | **35,650** | **20,741** | **56** | **31** |

The event summary in Table 2-16 illustrates key aspects of the wet weather system performance:

- Volume of WWTF discharge for the year was 2.5 billion gallons. This represents about 10% of the total volume received at CBWTP for the year (see Table 2-13).

- There were about 600 hours of discharge (about 7% of the year) and 51 calendar days per year when discharge occurred (about 1 day per week average), which underscores the intermittent nature of the wet weather system discharge.

- The average event mean concentration (EMC) for BOD of 56 mg/l and 31 mg/l for TSS compare very well with the expected values obtained during the pilot testing of the CEPT system.

Table 2-17 lists the WWTF events that occurred during FY 2015, 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 112 MGD, compared to the permit required 100 MGD.

- The Average/Event rate of 112 MGD treated via the secondary system indicates that 55% of the total influent (112 MGD of 204 MGD) arriving at the plant during a WWTF event was treated through the secondary system.
- WWTF events lasted about 22 hours on average and typically occurred across two calendar days.

The EMC over the past few years varied in relationship to volume discharged, as shown in Figure 2-7 (BOD) and Figure 2-8 (TSS). 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, achieved by focusing on larger storms in which the majority of pollutant mass arrived at the plant, not small events.

*Table 2-17 Wet Weather Treatment Events - Detailed Information*[12]

| | | 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) |
| 7/22/14 8:30 | 1 | 148 | 101 | 41 | 15 | 9.0 | 1 | 9,437 | 3,109 | 73 | 24 |
| 7/23/14 14:45 | 2 | 187 | 110 | 77 | 29 | 9.0 | 1 | 14,026 | 3,713 | 59 | 16 |
| 9/24/14 1:15 | 3 | 173 | 108 | 66 | 35 | 12.8 | 1 | 14,868 | 5,055 | 51 | 17 |
| 10/14/14 4:00 | 4 | 181 | 110 | 70 | 12 | 4.0 | 1 | 6,644 | 3,570 | 68 | 37 |
| 10/22/14 14:15 | 5 | 257 | 103 | 152 | 262 | 41.5 | 3 | 108,553 | 50,223 | 50 | 23 |
| 10/30/14 22:00 | 6 | 300 | 114 | 180 | 180 | 24.0 | 2 | 58,745 | 17,976 | 39 | 12 |
| 11/4/14 2:30 | 7 | 223 | 110 | 112 | 36 | 7.8 | 1 | 8,352 | 8,352 | 28 | 28 |
| 11/21/14 16:00 | 8 | 160 | 102 | 62 | 60 | 23.5 | 2 | 33,083 | 23,479 | 66 | 47 |
| 11/23/14 15:30 | 9 | 186 | 105 | 88 | 48 | 13.0 | 2 | 19,164 | 14,968 | 48 | 38 |
| 11/28/14 13:15 | 10 | 222 | 111 | 108 | 55 | 12.3 | 2 | 38,290 | 29,642 | 83 | 64 |
| 12/4/14 6:45 | 11 | 208 | 108 | 105 | 230 | 52.3 | 3 | 121,951 | 130,288 | 64 | 68 |
| 12/9/14 12:30 | 12 | 161 | 106 | 55 | 113 | 49.8 | 3 | 62,236 | 22,092 | 66 | 23 |
| 12/19/14 0:30 | 13 | 196 | 110 | 81 | 20 | 6.0 | 1 | 8,789 | 2,535 | 52 | 15 |
| 12/20/14 6:00 | 14 | 253 | 119 | 134 | 137 | 24.5 | 2 | 67,841 | 26,353 | 59 | 23 |
| 12/24/14 1:00 | 15 | 271 | 115 | 155 | 121 | 18.8 | 1 | 40,296 | 18,133 | 40 | 18 |
| 1/15/15 21:45 | 16 | 247 | 112 | 135 | 62 | 11.0 | 2 | 36,163 | 12,582 | 70 | 24 |
| 1/17/15 11:15 | 17 | 297 | 121 | 176 | 297 | 40.5 | 3 | 70,802 | 47,328 | 29 | 19 |
| 2/2/15 7:00 | 18 | 256 | 112 | 142 | 37 | 6.3 | 1 | 9,163 | 5,498 | 30 | 18 |
| 2/5/15 15:45 | 19 | 202 | 121 | 79 | 351 | 106.3 | 6 | 110,851 | 51,878 | 38 | 18 |
| 3/14/15 5:30 | 20 | 280 | 119 | 153 | 301 | 47.3 | 3 | 78,543 | 57,114 | 31 | 23 |
| 3/21/15 0:45 | 21 | 182 | 111 | 66 | 24 | 8.8 | 1 | 6,936 | 3,672 | 34 | 18 |
| 3/23/15 9:30 | 22 | 157 | 108 | 43 | 85 | 47.5 | 3 | 23,318 | 14,881 | 33 | 21 |
| 3/31/15 18:00 | 23 | 154 | 116 | 31 | 4 | 2.8 | 1 | 3,333 | 1,299 | 112 | 44 |
| 4/11/15 7:00 | 24 | 153 | 116 | 27 | 3 | 2.8 | 1 | 0 | 1,382 | 0 | 53 |
| 4/13/15 20:00 | 25 | 193 | 118 | 66 | 19 | 7.0 | 2 | 8,926 | 3,914 | 56 | 25 |
| 4/24/15 22:30 | 26 | 129 | 107 | 24 | 2 | 1.5 | 1 | 1,408 | 416 | 112 | 33 |
| 5/12/15 1:30 | 27 | 134 | 119 | 12 | 1 | 1.5 | 1 | 827 | 559 | 135 | 91 |
| **Total** | **27** | | | | **2,540** | **591** | **51** | **962,545** | **560,013** | | |
| **Avg/Event** | | **204** | **112** | **90** | **94** | **22** | **1.9** | **35,650** | **20,741** | **56** | **31** |

12 Quality control checks on the 4/11/15 WWTF Event resulted in unreportable BOD results (high blanks), as reported in the April 2015 DMR.

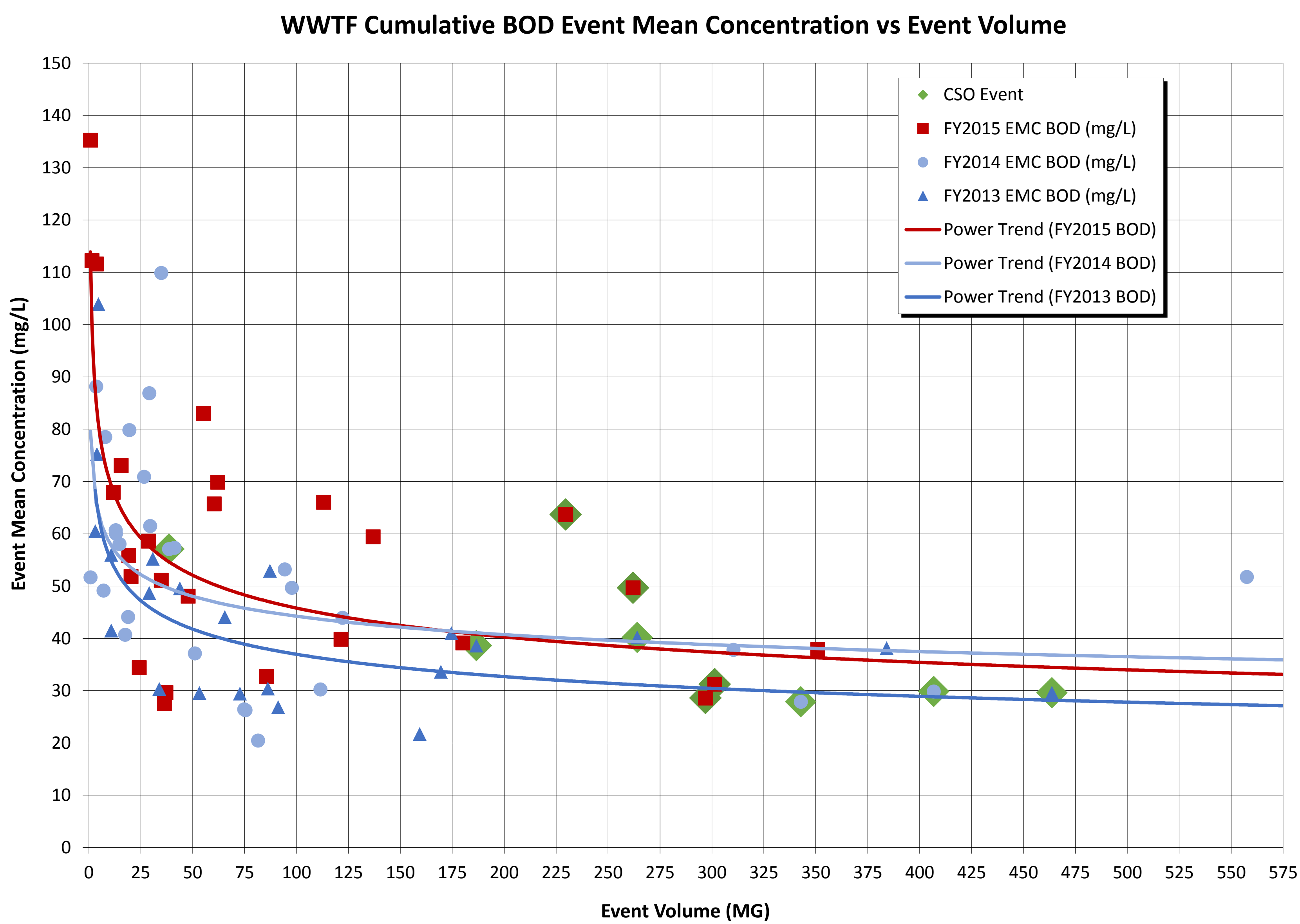



*Figure 2-7 WWTF Cumulative BOD Event Mean Concentration vs Event Volume*

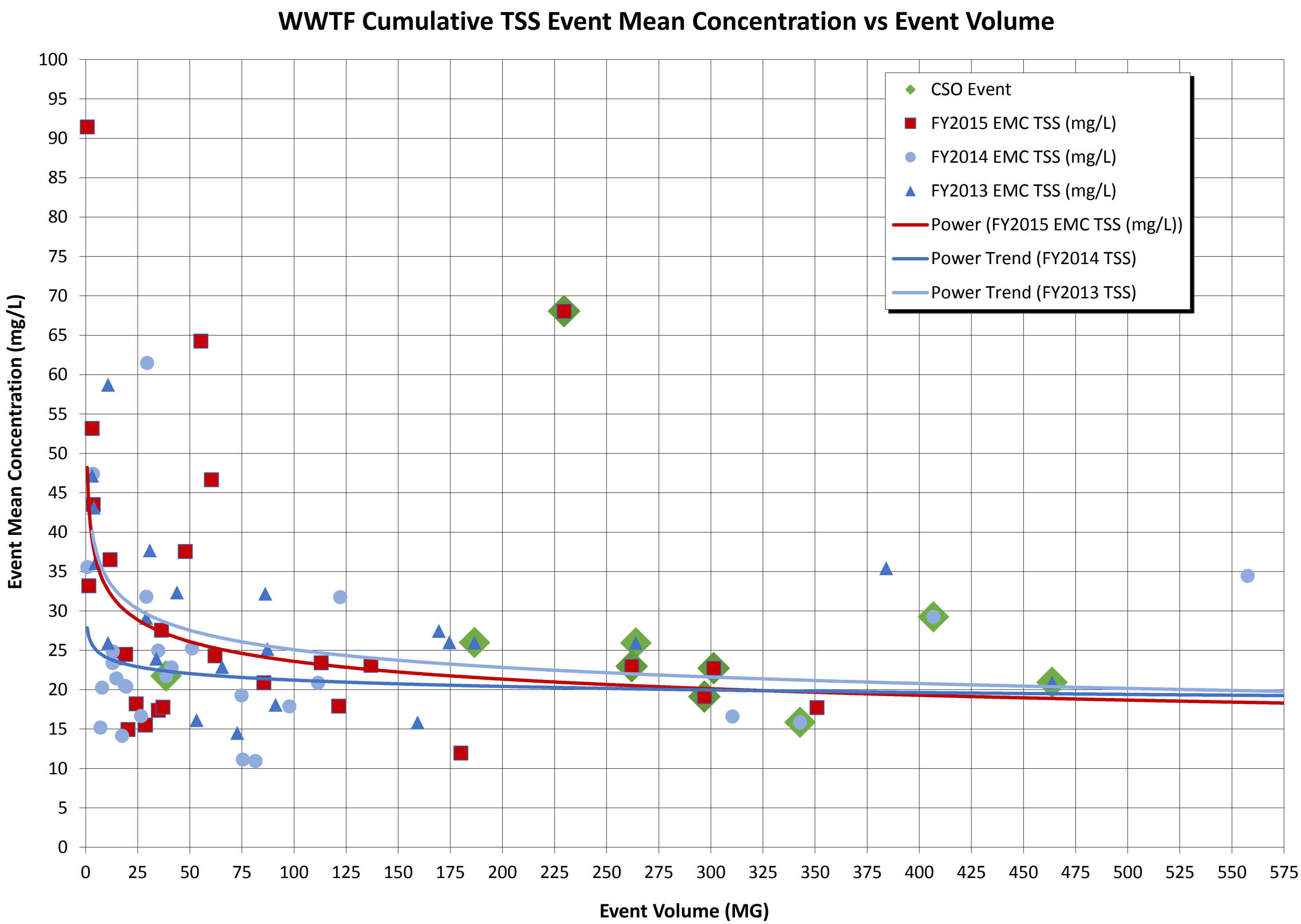



*Figure 2-8 WWTF Cumulative TSS Event Mean Concentration vs Event Volume*

# Section 3 CMOM Program Implementation

The City of Portland's CMOM program has been designed to ensure that components of the collection system are cleaned and inspected at the right frequency and that preventive maintenance and repairs are performed to cost-effectively reduce the number of sewer releases, extend the useful life of the City's sewer infrastructure, and properly manage collection system operations. This annual summary for FY 2015 provides a brief overview of collection system operation and maintenance programs and practices as context for evaluation of the effectiveness of CMOM activities. Section 4 of this report includes sewer release analysis and performance information.

## 3.1 Collection System – Gravity Sewers Operation and Maintenance

BES has programs in place to ensure that gravity sewers and manholes are properly inspected, cleaned, and repaired. Closed-circuit television (CCTV) inspection activities are key for an accurate determination of the structural and operational condition of collection system assets. Cleaning helps maintain asset condition and hydraulic capacity, enhances the effectiveness of inspections, and helps to control odors. Repairing structural deterioration protects the community's infrastructure investment and reduces the potential for catastrophic failures.

### 3.1.1 Sewer Inspections and Cleaning

In FY 2015, the sewer inspection program inspected 761,460 lineal feet of mainline sewer pipe, which corresponds to approximately 8 percent of the mainline sewer system. Sewer mainlines are inspected for general preventive maintenance, for special investigations in support of the chemical root and grease management programs, in response to sewer problems, and in support of Capital Improvement Program (CIP) projects. In FY 2015, approximately 9 percent of the work orders in the inspection program were considered unplanned work; that is, work in response to special sewer investigations or collection system problems. The remainder of the program was dedicated to general preventive maintenance and support of the City's CIP Sewer Rehabilitation Program. The CCTV inspection program provides the condition assessment information that is instrumental to the risk prioritization process used to drive the CIP Rehabilitation Program work.

In FY 2015, the sewer cleaning program cleaned 1,892,804 feet of sewer pipe, which corresponds to approximately 19 percent of the mainline sewer system. The sewer cleaning program includes preventive maintenance, accelerated cleaning in grease management areas, special investigations related to collection system problems, and CIP projects for pipes generally up to 15 inches in diameter. In addition to the City's sewer cleaning crews, a specialty contractor was utilized to clean select larger diameter sewers with known sediment accumulation.

In FY 2015, approximately 97 percent of mainline cleaning work orders were considered planned maintenance; that is, the cleaning was performed for general preventive maintenance, to support a planned CCTV inspection, cleaning of grease management areas, and cleaning to support root treatment activities.

Compared to aging sewer mainline pipes, the majority of manholes in the combined and sanitary collection systems have not been shown to pose inordinate structural or infiltration and/or inflow hazards. Therefore, in keeping with the City's risk-based asset management strategy, manholes are inspected and cleaned during preventive maintenance of sewer mains.

### 3.1.2 Sewer Assessment and Repairs

Maintaining the wastewater collection system in good repair is a core service BES provides to its ratepayers. The City has a well-established sewer and manhole repair program. Priority codes in Hansen[13] are assigned when work orders are created. The priority codes are used when scheduling and assigning work and to help manage the backlog of open work orders to ensure that repairs are completed according to their relative risk and consequence of failure (e.g., top priority is given to SSO- and hazard-related repairs).

During FY 2015, for minor urgent or emergency repairs BES relied preferentially on services from City crews for sewer cleaning, investigation, inspection, and repair. However, for larger urgent or emergency projects BES Maintenance Engineering coordinated closely with BES Engineering Services to conduct work under the BES Small Maintenance Capital contracts or emergency CIP projects.

City crews completed mainline sewer repairs totaling nearly 10,000 lineal feet. Approximately 60 percent of these repairs were considered to be unplanned. Repairs are considered unplanned if the work is in direct response to a collection system problem, such as a sewer release or surface cavity, or if the severity of the problem is significant enough to warrant the deployment of repairs within a week. The majority of planned repairs occur from either defects identified by the preventive maintenance CCTV inspection program or when additional repairs on a line are

[13] *Hansen* refers to Infor Public Sector, © 2015 Infor. All rights reserved. www.infor.com

made in conjunction with an unplanned repair. Repairs on mainline sewers are localized spot repairs where pipe sections are excavated and replaced or renewed using cured-in-place pipe (CIPP) liners.

City crews completed 772 service lateral repairs totaling approximately 11,200 lineal feet. Approximately 75 percent of these repairs were unplanned. Unplanned service lateral repairs are typically in response to a sewer system problem such as a sewer backup or a positive dye test from a sewer investigation.  Planned service lateral repairs generally occur in conjunction with adjacent repairs on mainline sewers. Service lateral repairs typically involve the complete replacement of the lateral and the addition of a cleanout at the curb for improved future maintenance.

### 3.1.3 Root Management and Control Actions

Portland is renowned for its urban forest and must balance the need to protect both trees and sewer infrastructure. During FY 2015, BES Maintenance Engineering continued to manage the chemical root control program using third-party service providers who apply dense herbicidal foam that kills roots on contact without harming trees or surface vegetation. The City's Root Control Program uses a priority ranking system so that sewers with the greatest need for chemical root treatment are addressed first. During FY 2015, 233,000 lineal feet of mainline sewer were chemically treated for roots. In addition to chemical root foaming, City crews utilize mechanical root saws to locally remove roots in support of sewer inspection and cleaning activities as well as in response to sewer system problems.

### 3.1.4 Grease Management and Control Actions

In FY 2015 there were only two sewer releases attributable to grease from the City-maintained sewer system. This very low number emphasizes the effectiveness of the Portland's program to control fats, oils, and grease (FOG), which was described in the *City of Portland Grease Management and Control Program* document that was included in the *CMOM Program Report*. The FOG management program has continued to proactively inspect food service establishments for installation and operation of grease interceptors. FOG enforcement actions in FY 2015 are summarized in Table 3-1.

The FOG Coordination Team continues to meet quarterly to improve FOG-related activities performed by work groups responsible for FOG inspection and compliance, maintenance engineering, sewer cleaning and maintenance, pump station operations and maintenance, and asset management and data management. Based on CCTV inspection results and similar information, the FOG Coordination Team determines areas that are cleaned at an accelerated frequency.

*Table 3-1 FOG Enforcement Activities in FY 2015*

| Description | Number | Requirement |
|---|---|---|
| Warning Notice | 395 | Increase cleaning frequency |
| | 112 | Repair or replace grease removal devices |
| Notice of Violation with Civil Penalties/ Cost Recovery | 13 | Plumb all fixtures to a grease interceptor |
| | 5 | Establish City-required cleaning frequency |
| | 5 | Implement on-site best management practices to reduce FOG discharge |
| | 2 | Make required grease interceptor repairs |

## 3.1.5 Rainfall Derived Inflow and Infiltration Assessment and Removal

BES uses detailed hydrologic models along with extensive flow monitoring to identify and quantify sources of rainfall derived infiltration and inflow (RDII). The *I&I Reduction Status Report* submitted annually to DEQ is developed in coordination with the City of Lake Oswego to comply with Schedule C, Compliance Conditions and Schedules, of the NPDES Permit for the Tryon Creek Wastewater Treatment Plant (TCWTP).

Additionally, in May 2015 the "Phase II – Private Systems Report for SW DeWitt Control Project Required under Mutual Agreement and Order: WQ/M-NWR-11-09" was submitted to DEQ. The report summarized the accomplishments of two RDII pilot projects implemented by the City wherein property owners could voluntarily participate in a private sewer lateral inspection and repair program. The Upper Hillsdale Project was completed in 2014; in this program area, of the 134 homes that participated (out of a total of 142 homes) 18 laterals were determined to be in good condition, and the remaining 116 laterals were rehabilitated by pipe-bursting, directional drilling, or cured-in-place pipe lining. In the Middle Hillsdale Project, of the 178 homes that participated (out of a total of 241 homes) 28 laterals were found to be in good condition and the remainder are scheduled to be rehabilitated this summer. The next steps for the program are:

- Complete hydraulic modeling analysis to determine the effectiveness of the first pilot project, the Upper Hillsdale RDII Pilot Project.
- If the data confirms BES's assumptions for total system (public and private) inflow and infiltration (I&I) reduction of 60 percent, then proceed with the Hillsdale East RDII Project. If the data does not confirm I&I reduction assumptions, then perform additional

analysis and alternatives evaluation to determine a new recommended approach to reduce I&I in this basin.

- Develop recommendations for Phase III, the Integrated Basin-wide System Plan. This plan will recommend the path forward to complete SSO control as required by the Mutual Agreement and Order.

BES is also performing extensive sewer flow monitoring in the Fanno sewer system in order to better characterize sewer catchments with high RDII. Next steps in the Fanno basin are to do a hydraulic model and to analyze the system, perform alternatives analysis and develop a recommended plan to reduce RDII.

BES is also working with Clean Water Services on a coordinated predesign to arrive at a plan to identify and address the RDII in the southern sewer basins of Portland that drain to their system. These sewer basins are Metzger, Elmwood, and Locust. BES and Clean Water Services are currently performing sewer flow monitoring and hydraulic modeling for these basins.

## 3.1.6 Emergency Preparedness and Response

The Portland Bureau of Emergency Management coordinates emergency planning, training and exercises for the City. In FY 2015, BES updated its *Preparedness, Response and Continuity of Operations Plan* (COOP). This plan provides an operational framework for continuing organization-wide essential functions in the event of an emergency when normal operations are disrupted. As of FY 2016, BES has established an emergency preparedness improvement program and a full-time emergency program coordinator position to better prepare for maintaining safety and continuity of essential services in a disaster such as an earthquake, flood or major fire in Portland. The City also has mutual aid and cooperative assistance agreements with agencies and organizations in the Portland metropolitan area and surrounding counties and is a member of the Oregon Water/Wastewater Agency Response Network (ORWARN).

## 3.1.7 Odor Management

The potential for corrosion and odor problems in the sewer collection system is relatively low due to Portland's moderate climate and frequent rainfall throughout the year, which reduces conditions conducive to stagnation of flow. Nonetheless, when sewer odors are reported they are investigated by City crews and follow up action is initiated according to the procedure shown in Figure 3-1. As odors are typically transient in nature, to be considered confirmed, a sewer odor typically must be observed by field staff at the same asset or in the same general location on more than one occasion. Collection system odors associated with source control issues or illicit discharges are addressed by BES Pollution Prevention Services.

The City has a long-standing Odor Control and Corrosion Protection Committee responsible for evaluating recurring odor reports and issues and recommending potential mitigation. During FY 2015 actions taken by the City to address odor issues included installing flap valves on stormwater catch basin inlets; cleaning sewers to remove odor-causing debris; installing bolts in manhole lids; installing carbon inserts in selected manholes; and making improvements to existing engineered odor control systems. Under the direction of the odor committee, monitoring will continue in areas of ongoing concern.

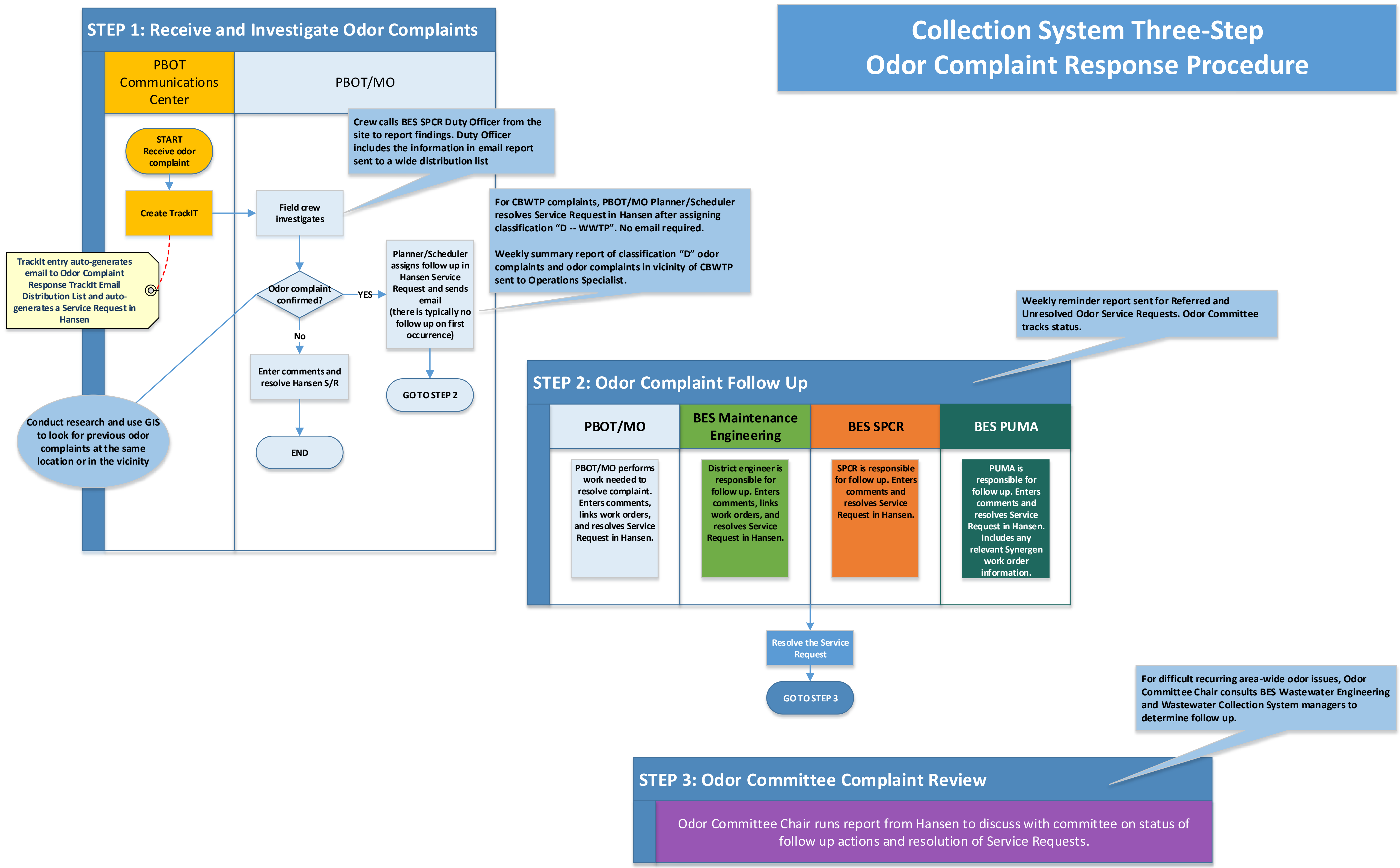



*Figure 3-1: Odor Complaint Response Procedure*

# Section 4 Sewer Release Analysis and Performance

The City of Portland's *Sewer Release Response Plan* (SRRP), establishes the process for responding to sewer releases from the City's combined and sanitary sewer system and reporting to DEQ as required by the National Pollutant Discharge Elimination System (NPDES) permit. The *CMOM Program Report* further describes the organizational structure for implementing the SRRP.

BES has a long history of implementing best management practices for collection system operation and maintenance to reduce the number and severity of sewer releases. Under the CMOM program, additional emphasis is placed on understanding why releases have occurred and how to prevent future releases.

## 4.1 Sewer Release Tracking and Reporting

The BES Spill Protection and Citizen Response (SPCR) Section is responsible for coordination of the overall response to sewer release events, maintaining official City sewer release records, and carrying out reporting to DEQ. BES's SPCR routinely provides SRRP training to ensure that every report of a sewer release is dispatched for immediate response and investigation, reported as required by the NPDES permit, and documented completely and accurately. Each month SPCR prepares the report of sewer releases that is submitted to DEQ with the monthly discharge monitoring report for the Columbia Boulevard Wastewater Treatment Plant.

In 2013, BES integrated sewer release data into the Hansen computerized maintenance management system (CMMS), which has created a connection to the work history of assets. Better data controls have been added to help manage work orders, such as more specific problem codes and standardization of planned and unplanned maintenance work types. Well-defined work order priority codes are used to ensure that work related to sewer releases receives top priority. The resources the City uses for operation and maintenance planning are explained in the *CMOM Program Report*.

BES has developed a standardized list of causes to facilitate tracking and analysis of sewer releases, as shown in Table 4-1. Additional terminology has been developed for weather-related sewer releases, as shown in Table 4-2, to more directly associate these releases with the City's levels of service established through the BES Asset Management Improvement Program.

*Table 4-1 Sewer Release Cause Descriptions*

| Sewer Release Cause | Description |
|---|---|
| Structural Defect | Release caused by a physical failure of the pipeline |
| Equipment Failure | Release directly resulting from equipment failure typically either at a pump station or during a bypass pump around |
| Maintenance | Release caused by a City-related maintenance activity |
| Weather Event | Release caused by hydraulic capacity issues associated with weather (there are three subcategories described in Table 4-2) |
| Grease | Release caused by a blockage due primarily to grease |
| Debris | Release caused by a soft blockage due to sediment or other material |
| Roots | Release caused by a blockage due primarily to roots |
| Water Bureau Break | Water main break that surcharges the BES collection system |
| Cause Unknown | A release where the investigation does not identify a specific cause |

*Table 4-2 Weather-related Sewer Release Terminology*

| Term | BES Definition |
|---|---|
| Hydraulically overloaded system | Rainfall less than or equal to the 5-year, 24 hour storm (the BES level of service is to prevent sewer releases to surface waters for all storm events up to a 5-year frequency) |
| Extreme weather | Rainfall in excess of the 5-year, 24 hour storm but less than or equal to the 25 year storm |
| *Force majeure* | Rainfall exceeds 25 year storm (the BES level of service is to convey sewer to prevent releases to buildings or streets up to a 25-year storm frequency) |

# 4.2 Sewer Release Key Performance Indicators

Striving for continuous improvement is a cyclical process of evaluating current practices, identifying needed improvements, and measuring performance. BES has developed a set of key performance indicators to gauge the effectiveness of the CMOM program.

## 4.2.1 SSOs per Hundred Miles of Pipe

SSOs provide a good measure of the overall effectiveness of maintenance programs for controlling roots, fats, oils, and grease, structural failures, and pump station performance. By tracking SSOs per 100 miles of sewer, BES has a succinct metric for gauging overall success toward minimizing SSOs.

As of the end of FY 2015, BES owned and maintained approximately 1,911 miles of main line sanitary and combined sewers, and 667 miles of sewer laterals. The City is typically responsible for maintaining the portion of the service lateral extending from the main sewer to the curb. During FY 2015, the City experienced 146 sewer releases over the 2,578 miles of collection system, which is approximately 5.7 releases per 100 miles of sewer.

Sewer release data is updated by BES SPCR as more complete information becomes available and investigations are conducted, and thus cause totals in this report reflect current records. Last fiscal year's (FY 2014) baseline number of releases was adjusted from 226 to 227 because one event was re-categorized when it was determined that the release occurred in the City-maintained system rather than on private property. This slight adjustment did not change the previously-reported number of approximately 8.8 sewer releases per 100 miles of sewer. A comparison with FY 2015 is shown in Figure 4-1.

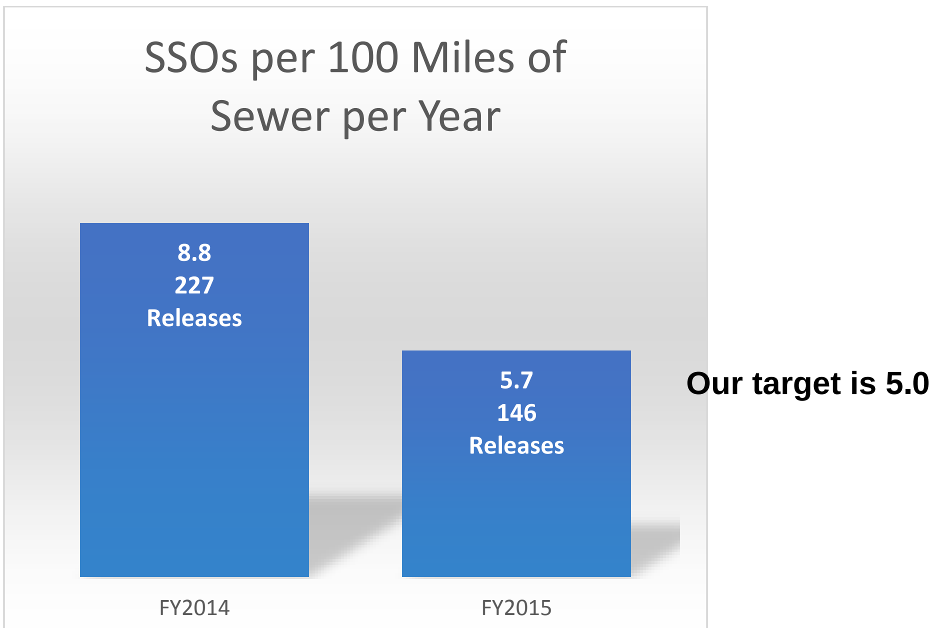



*Figure 4-1: SSOs per Miles of Sewer*

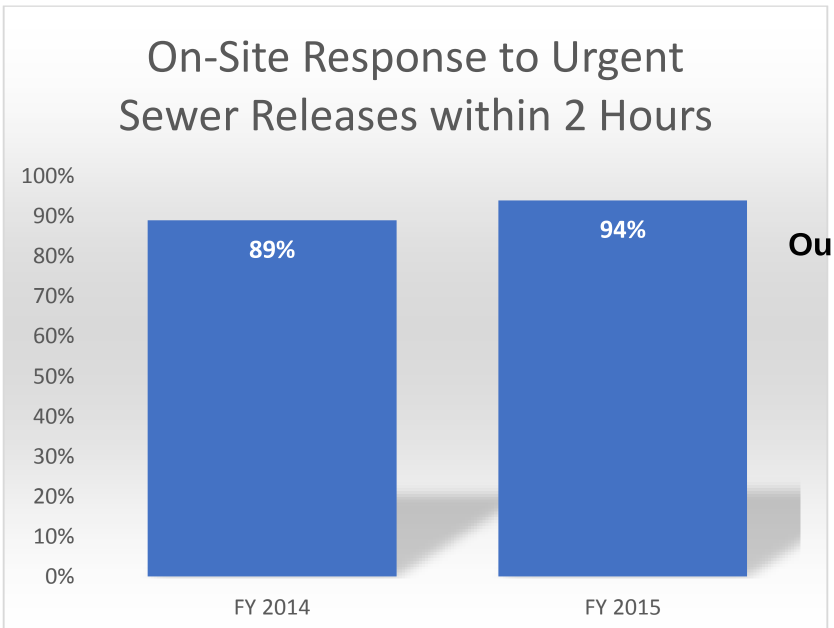
## 4.2.2 Response to Urgent Health and Safety-Related Service Requests

The City's goal is for a sewer emergency crew to be on site within two hours of receiving the initial call reporting an urgent sewer release. BES's SPCR is responsible for maintaining electronic records of sewer releases, and their records are used to assess the response time of the on-site emergency crew. Under certain circumstances, such as when the caller is reporting a release that occurred in the past or is requesting to meet the City crew at a prearranged time, a sewer release is considered non-urgent, and the two-hour on-site response goal does not apply.

Response time performance for FY 2015 is shown in Table 4-3. Response time performance was very good during FY 2015. A comparison with FY 2014 is shown in Figure 4-2.

*Table 4-3 SSO Response Time and Counts for FY 2015*

| FY 2015<br>Total Urgent Calls Sewer Release Calls | Number of Calls | Percent of Total |
|---|---|---|
| Urgent Calls with Response Time Less Than 2 Hours | 358 | 94 |
| Urgent Calls with Response Time 2 Hours or More | 23 | 6 |
| Total | 381 | 100 |




**Our target is 90%**

*Figure 4-2: SSO Response Time Comparison*

# 4.3 Analysis of Causes and Locations of Sewer Releases

During FY 2015, the City experienced 146 releases from the sanitary and combined sewer systems. Fifteen weather-related release events in FY 2015 that exceeded the design capacity of the collection system (referred to as *force majeure*) were intentionally excluded for the purposes of analyses and tracking trends, although these releases were included in reporting to DEQ. There was only one *force majeure* event in the previous fiscal year, FY 2014.

A chart comparing the causes of releases in FY 2014 and FY 2015 is shown in Figure 4-3. The release data shown are for releases due to problems in the City-maintained portion of the collection system (excluding releases due to causes resulting from problems in privately-owned sewers or laterals). The locations of the sewer releases in FY 2015 are shown on the map in Figure 4-4.

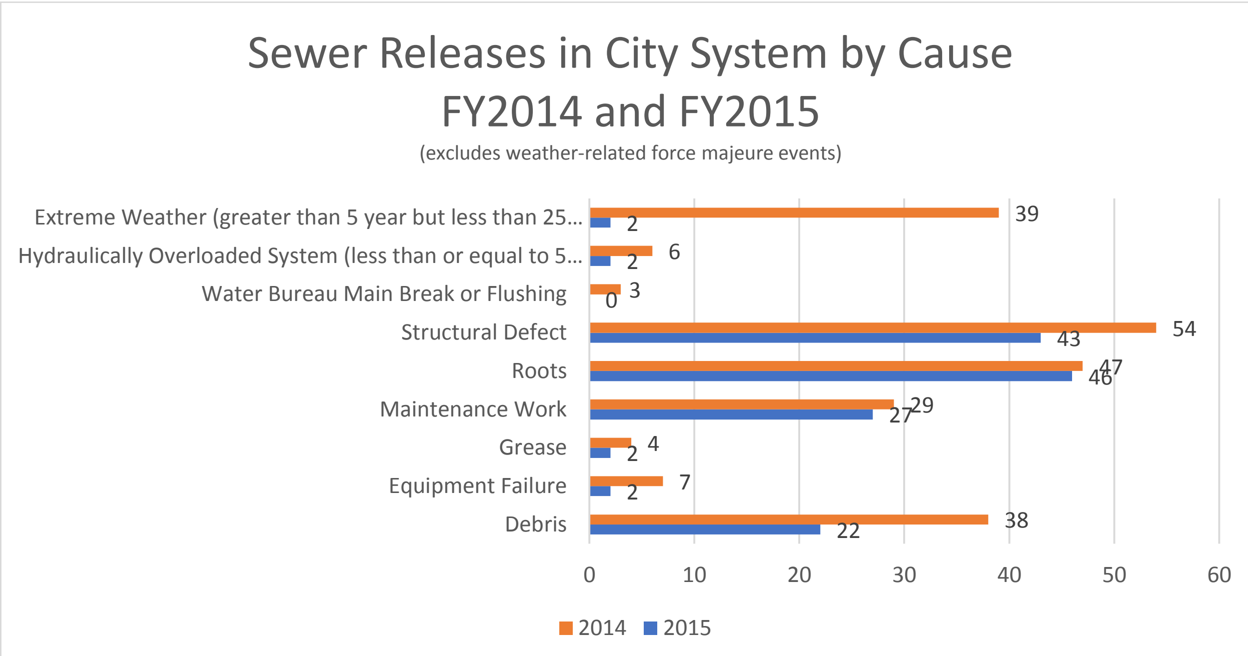



*Figure 4-3 Comparison of Causes of FY 2014 and FY 2015 Sewer Releases*

Several factors have likely contributed to the decrease in the number of releases. There were only four weather-related sewer releases in FY 2015, compared to 45 in FY 2014 (not including *force majeure* events, which are intentionally excluded as previously noted). Fewer high intensity storms in FY 2015 also likely meant that less storm-related debris entered the combined sewer system.

After experiencing several sewer releases in FY 2014 caused by problems with flow diversion systems operated by BES sewer contractors, new written procedures were developed and implemented to better define how to plan and design flow diversion facilities for City sewer construction projects. Subsequently, in FY 2015 no releases associated with flow diversion conducted during BES construction projects were reported.

In addition to the rigorous investigatory research conducted by BES's SPCR to determine the cause of sewer releases, improvements have been made to facilitate the use of the Hansen CMMS to track initial and actual problem codes on work orders. This enhanced capability provides a clearer understanding of the underlying reasons why a problem occurred or why work on (or near) an asset was required. For example, a work order may have an initial problem code "REL" for a release, or "SBU" for a sewer backup such as a plugged line. An actual problem code such as "GRS" (for grease) or "ROOTS" is also recorded on the work order and is typically based on the findings of the field crew, supervisor, or engineer.

These problem codes supplement the City's customized coding system used to characterize CCTV operators' observations and the degrees of severity (for structural defect, debris, roots, grease, etc.), as explained in the *CMOM Program Report* and the *Collection System Inspection and Cleaning Plan*. This broader array of information sources will become more useful over time, as asset histories can be more closely aligned with system performance.

**Structural Defects.** Approximately two-thirds of the sewer releases associated with structural defects in FY 2015 occurred in service laterals. The number of releases from structurally defective laterals decreased from 34 to 29 compared to FY 2014. Use of more effective lateral launch CCTV equipment has enabled City crews to become more efficient at investigating laterals. However, the work tends be reactive in response to problems and does not match the effectiveness of preventive maintenance inspections for proactively identifying and prioritizing problems in sewer mains and manholes. Nonetheless, the risk of releases associated with structural defects should continue to decrease as the large number of sewer repair, rehabilitation, and replacement CIP projects currently in design or under construction are completed.

**Maintenance.** In FY 2015, there were 27 releases associated with maintenance activities. Seventeen releases were reported due to "blow back" incidents where pressure from City sewer cleaning operations resulted in releases from plumbing on private property; most of these releases were "bowl water" from toilets and the volume was less than 10 gallons. While precautions are taken to prevent these occurrences, some private plumbing systems lack adequate venting and the configuration of some City sewers makes it very challenging for cleaning equipment operators to work in some locations. Cleaning crews tried using a new nozzle designed to address the blow back issue, but the results were inconsistent.

Four releases involved CIPP liners installed by City crews. Two releases occurred when sewer lines were damaged during maintenance activities conducted by the City's Water Bureau. Four maintenance-related releases were related to work by sewer contractors working for the City. As previously noted, many CIP projects are under construction to correct problems in some of the City's assets that are in the poorest condition, often in locations where working conditions are difficult.

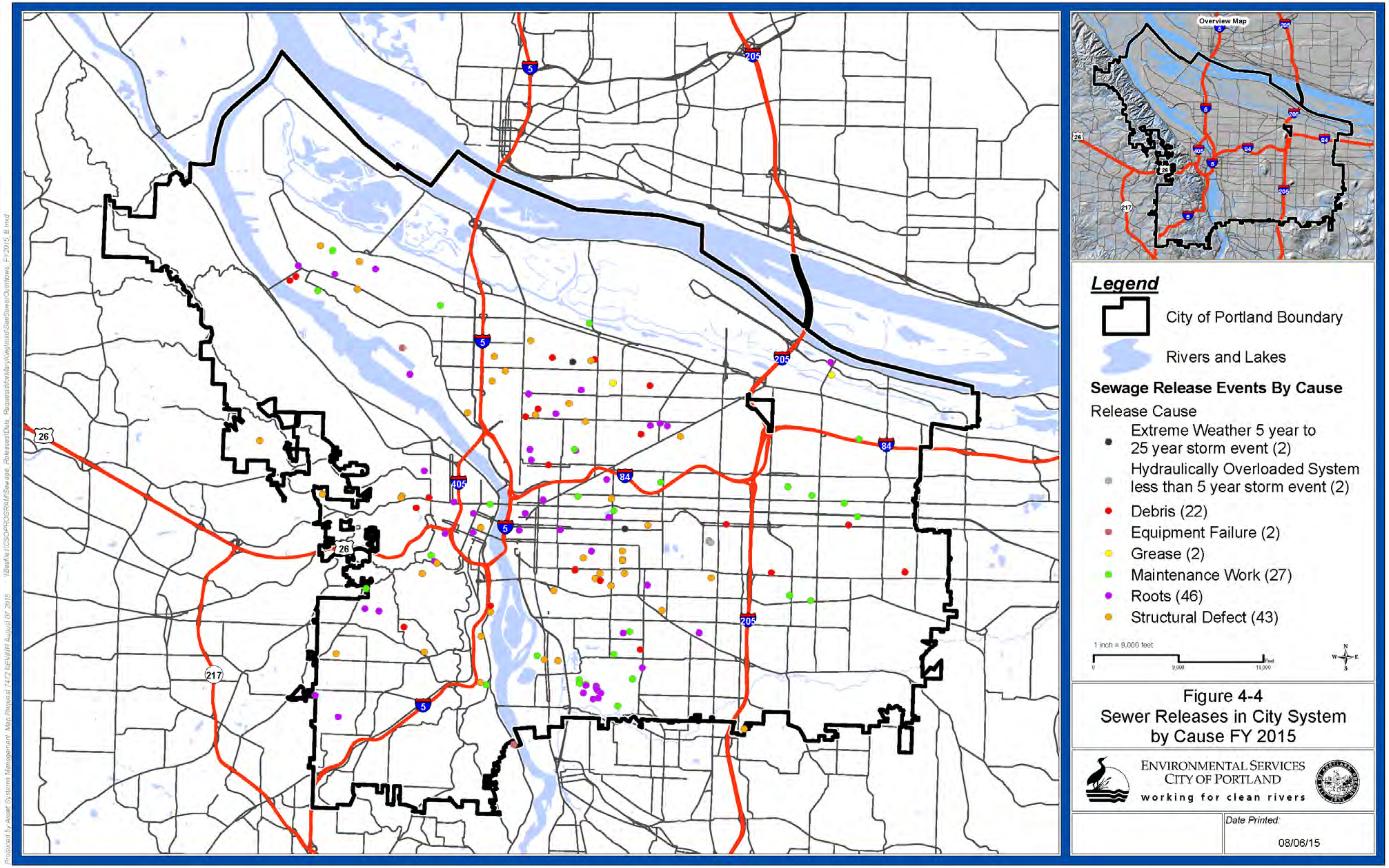



*Figure 4-4 Sewer Releases in City System by Cause, FY 2015*

**Debris.** There were 22 releases caused by debris in FY 2015, down from 38 in FY 2014. Of these, 11 releases (50%) were caused by debris in sewer mainlines, 9 (41%) occurred because of debris in laterals, and 2 (9%) were from debris in manholes. The relatively low number of releases due to debris appears to validate the effectiveness of the City's risk-based approach to sewer cleaning, which includes accelerated frequency of cleaning sewers that have a higher potential for sediment and debris accumulation. Additionally, BES conducts public outreach to try to minimize sewer backups and releases associated with disposable wipes and similar products, for example on the BES website http://www.portlandoregon.gov/bes/whatnottoflush.

**Roots.** During FY 2015, of the 46 releases caused by roots, 4 were in sewer mainlines and 42 (approximately 88 percent) were in service laterals. The majority of laterals where releases occurred in FY 2015 have been repaired by City crews using CIPP liners, or were excavated and replaced, thereby reducing the risk of future root intrusion.

## 4.3.1 Sewer Releases to Surface Water in FY 2015

Sewer releases to surface water occurred at five locations in FY 2015. The circumstances of these release events are described below.

**6221 N Basin Avenue** (release to the Willamette River): On September 28, 2014, the City was notified that a pressure vault on the Portsmouth force main was overflowing. An estimated 500 gallons (of the total release volume of 1,500 gallons) reached the Willamette River at the Swan Island Basin. The release occurred because floatable objects (tennis balls, plastic bottles) prevented an air release vacuum valve from fully closing. In response to this release, the City has developed a preventive maintenance program to inspect and remove any accumulated debris from this valve, and other similar valves on the Portsmouth force main, just prior to and just after storm events.

**4300 SW 47th Avenue** (release via a storm sewer to an unnamed tributary to Fanno Creek): On February 7, 2015, there was a sewage release from a manhole at the Bridlemile School (estimated total volume 6,600 gallons, with the majority likely soaking into the ground in a nearby grassy area). Maintenance crews stopped the discharge by clearing a sewer pipe that was blocked by roots and rags. To minimize future root intrusion, a cured-in-place pipe liner was installed in the sewer. Due to discrepancies in recording and reporting the presence of a storm drain inlet near the discharging manhole, emergency crews received sewer release response refresher training on February 24, 2015.

**9021 SW 55th Avenue** (release to unnamed tributary to Ash Creek): On April 5, 2015, a sewage release occurred when a plumber assisting the homeowner removed a cleanout cap allowing sewage to flow onto the ground and into a nearby creek (estimated volume 7,200 gallons). City crews responded the following morning and cleared a blockage in the main sewer, stopping the release. Subsequent CCTV investigation revealed the cause to be roots in the main sewer. Pursuant to this release event, the Collection System Management Team and staff were briefed to ensure that an emergency crew is dispatched to check site conditions in accordance with the City's Sewer Emergency Crew Training and Reference Manual, and that thorough information is obtained when after-hours contact is made by telephone. Additionally, duty supervisors and district maintenance engineers received refresher training on sewer release response procedures on April 30, 2015.

**8610 N Willamette Boulevard** (release to the Willamette River): At 6:30 p.m. on April 11, 2015 an automatic notification was sent from the City's HYDRA monitoring system that there was sanitary flow over the diversion dam to outfall OF52 near the St Johns Bridge. A maintenance crew immediately responded to the diversion manhole at 8610 N Willamette Boulevard and determined that a blockage was diverting flow over the diversion dam to the storm line that leads to outfall OF52. A Vactor® truck was immediately dispatched to the site to remove the blockage and the diverted flow ceased at 11:30 p.m. The volume of the release was estimated at 6,000 gallons. The City conducted a CCTV survey of the sewer lines leading to and from the blocked diversion manhole. The sewer lines appeared to be in good condition, and records show that the line is being maintained on a regular scheduled basis. The cause of the line blockage was likely vandalism, because concrete chunks were found in the sewer line, interfering with the function of the diversion structure. No conclusive evidence was found to identify who caused the vandalism.

**9825 SW Riverside Drive** (release to the Willamette River): At 10:00 a.m. on June 22, 2015 the electrical power supplied by PGE to the Riverview pump station failed. The on-site backup generator immediately turned on; however, at 10:28 a.m. the generator failed due to a clogged fuel filter. The pump station emergency crew arrived at the pump station at 10:34 a.m. and inspected the backup generator but were unable to restart it. A portable backup generator was immediately dispatched to that location. At 12:48 p.m., the bypass occurring alarm triggered, indicating that the wet well was full, and that sewage was now bypassing the pump station and diverting to the nearby Willamette River. At 1:23 p.m. an emergency generator was installed and the sewage pumps were activated. At 1:26 p.m., the bypass stopped. Based on engineering flow data from that pump station, it is estimated that 2,919 gallons of sewage were released to the river during this bypass event. Preventive maintenance procedures for the standby power system have been reviewed and enhancements are being developed and implemented.

# 4.4 Conclusions and Follow-On Actions for Sewer Release Reduction

The City of Portland's CMOM program is now being fully implemented. Shifting toward risk-based operation and maintenance of the collection system should, over time, result in a positive trend toward planned, proactive maintenance and fewer sewer releases. BES continues to develop and improve the Hansen CMMS to facilitate work prioritization and asset management in the gravity collection system. Although BES's CMOM program effectively incorporates the essential elements and best management practices for proper operation and maintenance of the collection system, analysis of sewer releases in FY 2015 has highlighted several opportunities for potential improvement.

Roots in service laterals receive some degree of treatment during application of root foaming agents in sewer mainlines; however, the amount of treatment varies and is not a reliable treatment for service laterals. Typically, when City crews repair service laterals because of releases caused by roots, cleanouts at or near the curb are routinely installed to facilitate future maintenance, including chemical root treatment.

The majority of structurally-defective laterals where releases occurred in FY 2015 have been repaired by City crews using CIPP liners, or were excavated and replaced. Additionally, to proactively prevent sewer releases from laterals, CIP projects for replacement, repair, and rehabilitation of sewer mainlines include inspection and repair/replacement of service laterals based on the risk of structural or operational failure. The City will continue to utilize opportunities for making cost-effective improvements to laterals.

BES anticipates that the number of releases attributable to structural defects will gradually decrease as CIP projects under construction and in design are completed. These projects to replace, repair, and rehabilitate collection system assets that pose the highest risk and consequence of failure will position the City to be better able to provide proactive rather than reactive maintenance. The methodology used for risk-based prioritization of CIP projects was presented in the *Collection System Assessment and Rehabilitation Plan* that was submitted to DEQ in December 2012.

"Lessons learned" presentations have proven to be an effective way to share information about what has and has not worked during BES construction projects, and this practice will be continued so that as construction managers and inspectors become more experienced they can share information and increase awareness about ways to reduce the likelihood of sewer releases during construction. Over 90 people attended the BES staff training in September 2014 on diversion of flow procedures, and since that time there have been no reports of sewer releases associated with flow diversions. In addition to addressing technical aspects of projects, lessons learned presentations also provide opportunities to use post-construction feedback from residents and property owners to improve communication on future projects.

Overall, continued implementation of the *BES System Plan—Combined and Sanitary Sewer Elements*, dated March 2012, will address condition and capacity risks in both the combined and separated sanitary sewer systems. The System Plan's consolidated system-wide approach for prioritizing reinvestment and business risk reduction through CIP projects should also reduce the potential for sewer releases.

# Section 5 Maximization of 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 that is effectively managed through the system operating plan. This NMC 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 storage and conveyance capacity.

## 5.1 Collection System and CSO Storage

### 5.1.1 Trunkline and Interceptor Storage

Prior to completing the CSO control system, Portland maintained high weirs at pump stations and relief structures in order to surcharge the interceptor pipes and utilize as much in-system storage as possible. These practices helped reduce CSO discharges to the receiving streams, but also resulted in increased risk of basement backups and street flooding when the trunklines and interceptors were overloaded during large storms. Such events are considered sanitary sewer overflows (SSOs).

As a result of full implementation of the CSO system at the end of 2011, the frequency of CSO discharges has been reduced dramatically. Since the full system has been operational, keeping the relief weirs at a high setting is no longer necessary. In contrast, the "SSO risk" created by having the relief weirs too high and surcharging the interceptor system is a concern in certain locations. For this reason, relief structures were built as needed to provide local hydraulic relief where the risk of SSO is high enough to justify the insignificant risk of sending the excess wet weather flow into the tunnel system.

### 5.1.2 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 4, *Maximize Flow to the POTW*.

The CSO system is designed to ensure that the tunnels are almost always completely full before overflows can occur. This result was accomplished by designing both the consolidation conduits that connect the outfalls to the drop shafts and the drop shafts themselves to convey the 25-year storm peak flow rates into the tunnels. This system has worked successfully for all events but two that have occurred since December 2011, as listed in  above: the 100-year storm that occurred on May 26, 2012, and a localized 3-year summer storm cloud burst on June 16, 2014, that caused the Alder Pump Station to pump CSO to the river to avoid basement backups (SSOs). A project upgrading the Alder Pump Station is currently in design and will provide more storage capacity to resolve its vulnerability to highly localized storms.

# 5.2 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.

## 5.2.1 Downspout Disconnection Program (1993-2011)

The Downspout Disconnection Program ended active outreach in June 2011 after 18 years of partnering with property owners, contractors, 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. In FY 2013, the neighborhoods surveyed indicated a disconnection rate of about 77%. This mix of neighborhoods were from the northern parts of the City. In FY 2014, the neighborhoods surveyed from the central areas of the east side of the City indicated a disconnection rate of about 73%. A much smaller set was surveyed in FY 2015 to complete the audit, but did not appreciably change the previous years' numbers. See Figure 5-1 for a map of the areas surveyed. The program's disconnection rates at the end of the CSO Program's implementation in 2011, based on data gathered as disconnections occurred, indicated an overall disconnection rate of about 71.3%. Based on the combined sample data from the past four fiscal years in the above neighborhoods, the current overall disconnection rate is estimated at 72.6% (with 95% certainty of that disconnection rate being between 68% and 77%). So overall, the City has seen an increase in disconnected roof area.

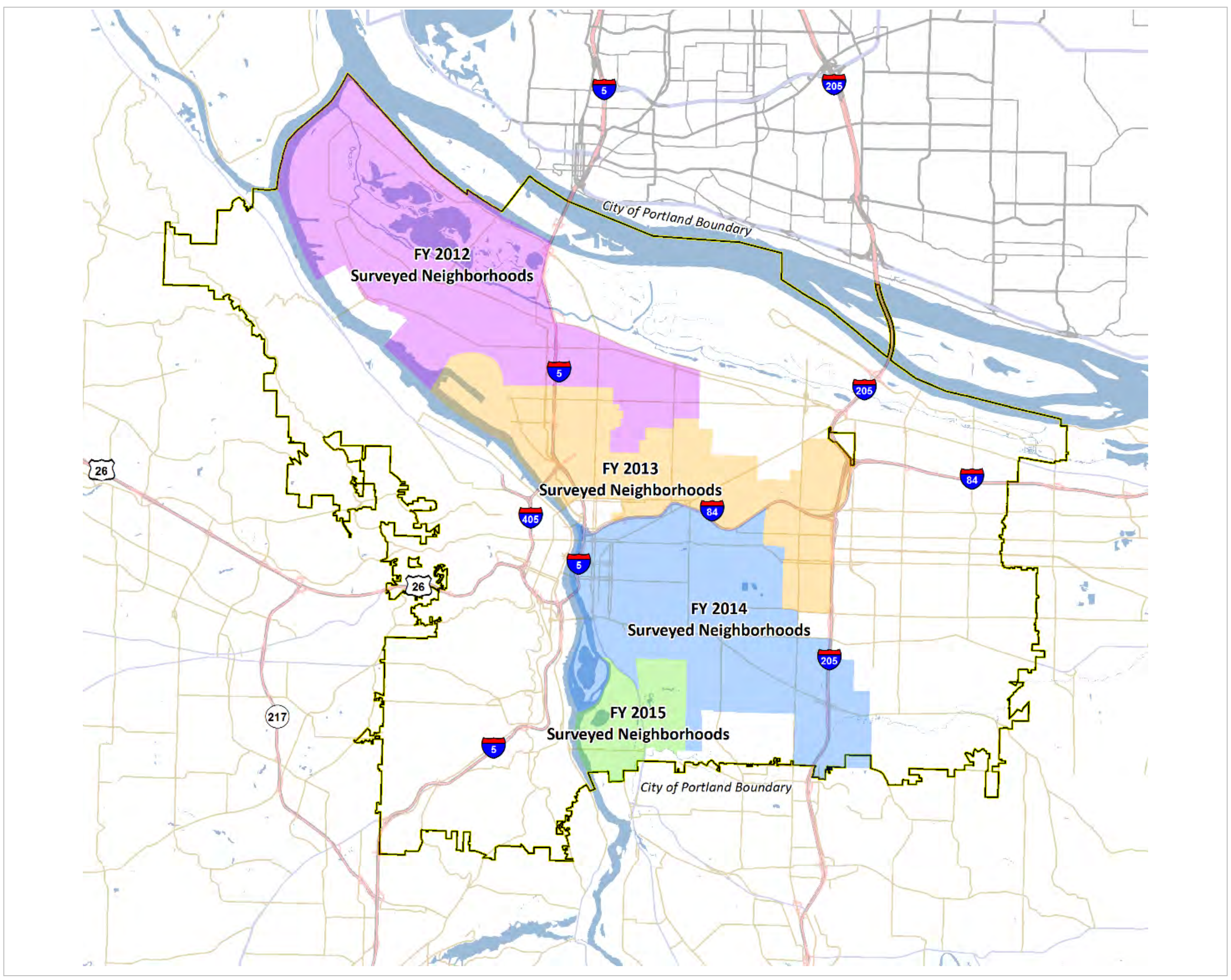



*Figure 5-1 Neighborhoods Surveyed for Downspout Disconnections*

## 5.2.2 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 FY 2015, 0.7 acres of impervious surfaces were managed by twenty-four private property stormwater retrofit projects. An example of a private property stormwater retrofit project is shown in Figure 5-2 below

*Figure 5-2 Example rain garden, installed in FY 2014*

## 5.2.3 Private Development and Redevelopment

The Stormwater Management Manual (SWMM) applies to all development and redevelopment proposals that create or redevelop over 500 square feet of impervious area. The Stormwater Management Manual protects CSO system capacity by implementing a stormwater infiltration and discharge hierarchy. Building permit applicants must first consider feasibility of onsite infiltration or offsite discharge to storm-only systems prior to offsite discharge to the combined sewer system. In FY 2015, implementation of the SWMM in combined sewer basins led to construction of stormwater facilities at 720 parcels, managing 109 acres of private impervious area (including the ecoroof control discussed in Section 5.2.4.1). City staff continued multiple efforts in FY 2015 to improve design and long-term performance of private stormwater management facilities, including:

- Continuing to implement the Maintenance Inspection Program, which conducts post construction inspections of private stormwater management facilities to ensure compliance with recorded operations and maintenance plans.
- Scoping and workplan development for the next SWMM revision, anticipated for spring 2016.

## 5.2.4 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.

### *5.2.4.1 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, and developer floor area ratio bonuses in specific portions of the city.

As of June 2015, Portland has over 440 ecoroofs installed throughout the city, managing almost 24 acres of roof. Approximately 285 of those ecoroofs are in the combined sewer area.

During FY 2015, 5 new ecoroofs were installed in the combined sewer area, managing approximately 0.8 acres of roof. This roof area represents 800,000 gallons of rainfall to the combined system annually, and Portland's monitoring data indicate that approximately 400,000 gallons are retained by the roofs and returned to the atmosphere through evapotranspiration.

### *5.2.4.2 Green Streets*

As of June 2015, Portland has implemented over 1,500 green streets in the right-of-way, with approximately 860 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.

During FY 2015, 60 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.

# Section 6 Maximization of Flow to the POTW

Maximizing flow to the treatment plant, as well as maximizing the use of storage, are both part of the overall integrated 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.

## 6.1 CSO System Operating Plan – December 2011

The CSO System Operating Plan (originally submitted to DEQ in December 2011) was updated in December 2013 with the latest control 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 regulatory documents—the CBWTP NPDES Permit and EPA's Guidance for CSO Programs—set out the objectives for the System Operating Plan.

### 6.1.1 Integrating Permit and Regulations via CSO Operating Strategy

Nine System Operating Objectives were developed and prioritized based on risk to human health and the environment. Prioritization is important because objectives for the collection system, CSO control, and wastewater treatment can often conflict, and operations staff must have clear direction to determine what is most important to achieve when conflicts arise.

The prioritized objectives protect the treatment processes as the top priority, followed by protecting the public from exposure to sewage, and then protecting the environment from CSO. Protection of the treatment processes is the first priority because the highest risk across the integrated system is the risk of damaging the treatment processes. If the treatment plant is compromised by washing out the biosolids or flooding, then major harm could occur in the environment, to human health, and to worker safety. Similarly, the collection system must be controlled to keep sewage away from the public. As a result, minimizing CSO is a midlevel priority.

The nine prioritized objectives are as follows:

1. Protect and 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 dry weather flow through primary and secondary system
3. Prevent releases to streets and basements (SSOs)
    - Control pumping rates to keep sewage away from human contact
4. Capture and convey maximum volume of wet weather flow to treatment
    - Optimize capacity of conveyance and storage systems
    - Treat all CSO via screening, primary treatment and disinfection at a minimum
5. Protect Columbia Slough (sensitive area)
    - Prevent CSO discharges to the sensitive area by giving priority to the Columbia Slough Influent Pump Station to pump high rates when needed and close the Argyle gate to shut-off inflows from the Willamette system
6. Treat as much CSO through secondary as possible
    - Dewater CSO tunnels slowly enough to treat more through secondary system but soon enough to avoid septic conditions (within 24 hours)
7. 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 soon after wet weather events
8. Minimize odor problems via operations
    - Direct dry weather sewage away from neighborhoods and odor generating facilities
    - Activate odor control facilities when pumping through neighborhoods
9. Minimize energy usage and 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

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 2013 CSO Systems Operating Plan.

These prioritized objectives are implemented through a decision-making hierarchy that Operators follow before, during and after storms such that the regulatory requirements are considered and addressed at all times. The decision hierarchy can be represented as four sequential decisions or questions to be answered in the following order:

1. "What flow rate can CBWTP treat?"
   - Determine the maximum flow the facility can accept without causing problems to the secondary or wet weather systems. See the individual event summaries in
2. "What flow rate can the downstream system convey?"
   - Determine the maximum flow rate the Peninsular and Portsmouth Interceptors can receive without overflowing to streets or basements.
3. "What pumping rate should be used to drain the system protecting the sensitive area?"
   - Determine the pump-out rate of the Columbia Slough Influent Pump Station to prevent CSO discharges to the sensitive Columbia Slough.
4. "What pump-out rate should be used to drain the Willamette CSO tunnels?"
   - Determine the rate at which the SI-CSO should pump to control CSO while being constrained by Decisions 1 through 3.

The results from the past four years of integrated system operations show excellent performance in achieving the objectives, providing good flexibility across the integrated system, and steadily increasing/maintaining CSO capture and treated effluent quality.

# 6.2 CSO System Performance Review

This section provides summary evaluations of the information to determine how the overall integrated system performed during FY 2015. The analyses generally follow the system operating objectives by simply asking – Were the major objectives achieved during the year?

## 6.2.1 Summary of Analysis for CSO Events

**How well were CSO events controlled?** The CSO discharges for FY 2015, which was a relatively dry year, were on par with expectations of a normal year in terms of frequency and volume. In terms of frequency, there were three major CSO events in which the Willamette tunnels discharged through all of their outfalls, and one minor event that affected relatively few outfalls and emitted a small discharge. Similarly, the volume of CSO discharged was 242 MG, or 4.1% of the total wet weather CSO volume generated by the entire system. This equates to 95.9% CSO control, which still exceeds the 94% level of control expected. (This CSO volume also shows the City had 99% stormwater and sewage capture when compared to the total 25,760 MG that CBWTP received during FY 2015.)

**Were wet weather flows maximized to the plant?** The answer can be seen by examining the charts provided in Section 2.5 (Figure 2-3 through Figure 2-6) for the four CSO events. For the integrated system, flows to the plant are maximized when Swan Island pumps at its top capacity or at the "Maximum Permissible" rate when restricted by the available treatment capacity at CBWTP or flow capacity in Peninsular Tunnel. As seen in the charts and discussed in Section 2.5, this occurred for the October 22-23, 2015, event, but not necessarily for the other three. There were issues with SICSO's pumps and flowmeters during those events that prevented matching of apparent pumping with the acceptance capability of the plant. Also, because of the novelty of the secondary improvements at the plant, operators were slightly more conservative than in the past to protect those processes, yet still met the higher of the nine priorities outlined above.

**Was system storage maximized?** The CSO system was designed and configured to ensure that the available storage was fully utilized before a CSO discharge could occur, and that continues to be the case. The tunnels and consolidation conduits must physically fill before the water level can rise high enough to overflow the weirs set at elevation 18.0 feet. The benefit of this configuration is that CSO volume is always minimized and the frequency of events is minimized. None of the non-CSO-inducing rainfall events came close to filling the tunnels (no such events occurred in the summer season, and four occurred in the winter). Of the four winter rainfall events that produced no CSOs, the tunnels only filled to 34-40% of capacity. Operations have been handling these borderline rainfall events well and provided more than sufficient storage capacity. The December 22-23, 2015, event, which produced 1.6 MG of CSO, was an event in which rainfall intensity over the CSO area increased rapidly and unexpectedly caused the overflow.

## 6.2.2 Summary of Analysis for Wet Weather Treatment

**Were wet weather / CSO flows treated to a high quality?** The annual performance results for the Wet Weather Treatment Facility show that in FY 2015 the wet weather flows were slightly treated to a slightly lesser extent this year than last. Using the fine screening and aggressive CEPT, the operations staff were able to achieve 82% TSS removal and 60% BOD removal, which is still significantly higher than the permit required levels.

**Were flows to secondary treatment maximized?** Wet weather flows were maximized to the secondary system during FY 2015, although not as high a rate as in previous years. This was likely due to temporary changes introduced by the secondary process improvements to ensure the processes did not suffer more upset. Also, after the process improvement issues were worked out, drier weather ensued and there were fewer wet weather events to offset those initial wet-weather-to-secondary-treatment numbers. As shown in Table 2-13, the volume of CSO sent to the secondary system was around 59%, less than the 64+% rates the previous years. The rate of flow directed to the dry weather[14] and secondary treatment system during periods of bypass was 112 MGD, or about 12% above the require 100 MGD minimum.

**Were effluent limits achieved at OF001 and OF003?** The CBWTP permit effluent limits were achieved for the Wet Weather Treatment Facility, the secondary treatment system, and the blended effluent from OF001 and OF003, except for 1 event. The exception was the unusually high solids loading that occurred during August and September 2015 from the secondary treatment system. Table 2-14 shows that the 30-day BOD and TSS loading within the secondary system resulted in exceeding the 30-day TSS effluent standard within the secondary system. 30-day Limits for both BOD and TSS were met at OF001 and OF003, however. Similarly, Table 2-15 shows that the 7-day TSS loading from the secondary system resulted in the 7-day TSS effluent limit being exceeded for OF001 and OF003. Within the secondary system, limits for both 7-day BOD and TSS were exceeded.

These unusually high mass loadings were a result of the complex commissioning procedures and sensitivity of the components of the Secondary Process Improvements Project. A combination of circumstances led to the exceedances:

- Attempts were made to improve higher-than-desired Sludge Volume Indices during June and July. The resulting technique (feeding of primary effluent to the second zone of the aeration basins and return activated sludge into the first zone) caused difficulty in maintaining desired dissolved oxygen (DO) levels. The organism inventory was also increased in the aeration basins to improve the indices, but this increased the DO problem.
- A separate problem occurred: the aeration basins were taken offline in early August due to a failure of the air distribution headers at the bottom of these tanks. This

[14] Previous years calculated the flow to the secondary system based on the flow measured in the secondary treatment train. Due to operational changes for improved secondary capacity, this flow rate now includes significant return activated sludge (RAS), and so is not an appropriate measure for determining the flows directed to the dry weather and secondary system.

caused a solids overload through the system to the primary clarifiers, and led to the plant upset and subsequent exceedance event.

- City staff quickly applied a modified plug flow configuration to achieve a large and healthy population of Phosphorus Accumulating Organisms, increasing the DO levels in the critical zones within the aeration basins.

The overall objective of the Secondary Process Improvements will help the plant and its operators achieve better long term health and performance. Discoveries of what worked and what didn't during the commissioning period help increase the knowledge of proper operation of the improved treatment system.

# 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 a CSO is and how it impacts water quality 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. 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 http://www.portlandorgon.gov/bes/overflow (Figure 7-1) to learn if a CSO advisory is in effect.

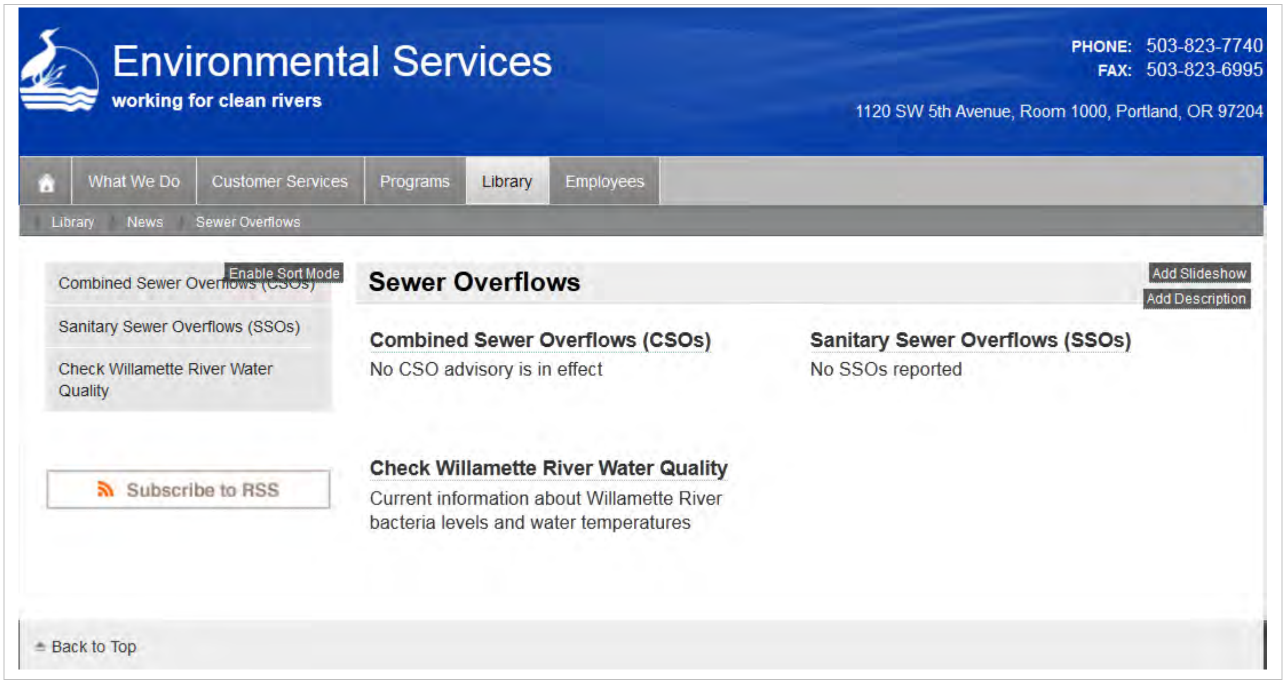



*Figure 7-1 CSO advisory information online at http://www.portlandoregon.gov/bes/36989*

Internet users can also subscribe to automatic email notification (Figure 7-2) each time BES issues a CSO advisory by going to http://www.portlandoregon.gov, signing in or creating an account, choosing "subscribe" in the footer of the web page and selecting "Sewer Overflow Notification." BES issues CSO alerts on https://twitter.com/BESPortland and the notifications are re-tweeted by PublicAlerts.org.

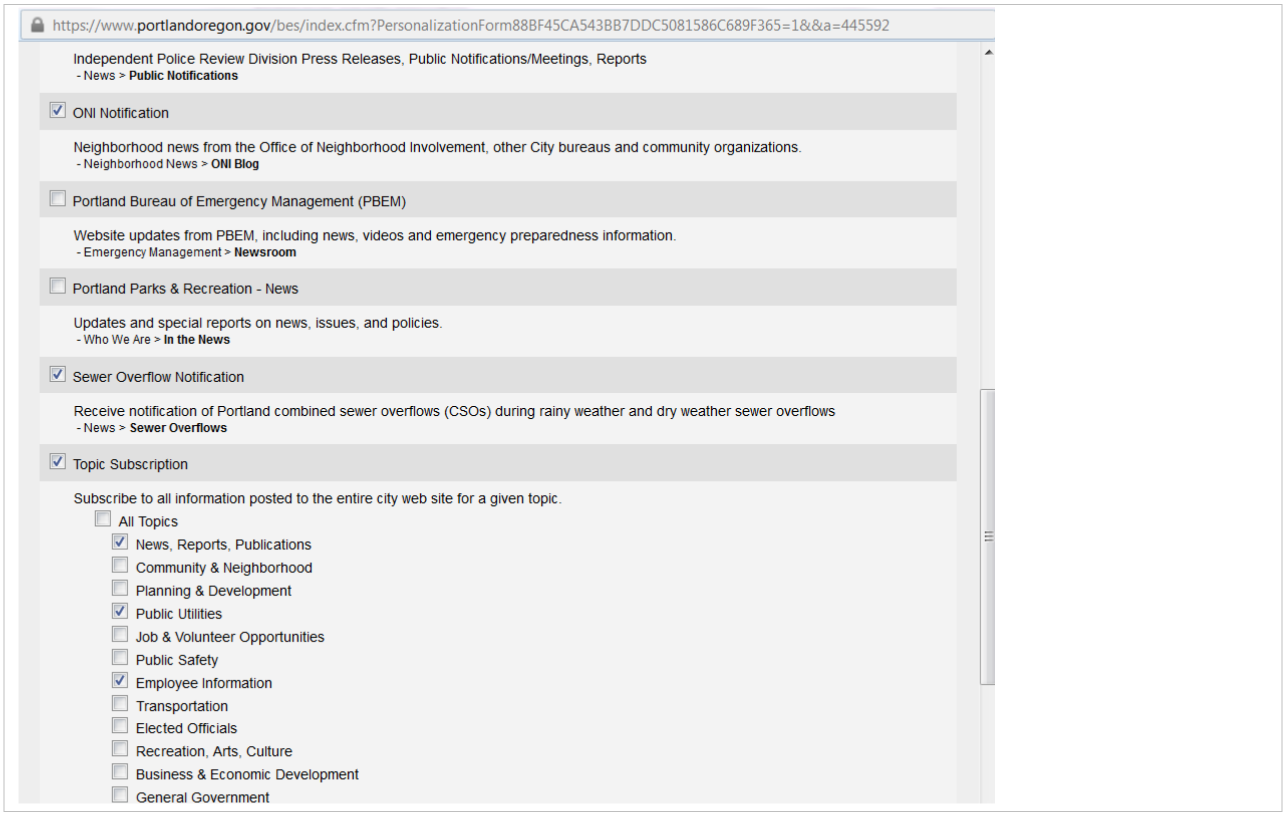



*Figure 7-2 River Alert E-Mail Subscribe Web Page*

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 http://portlandoregon.gov (Figure 7-3):

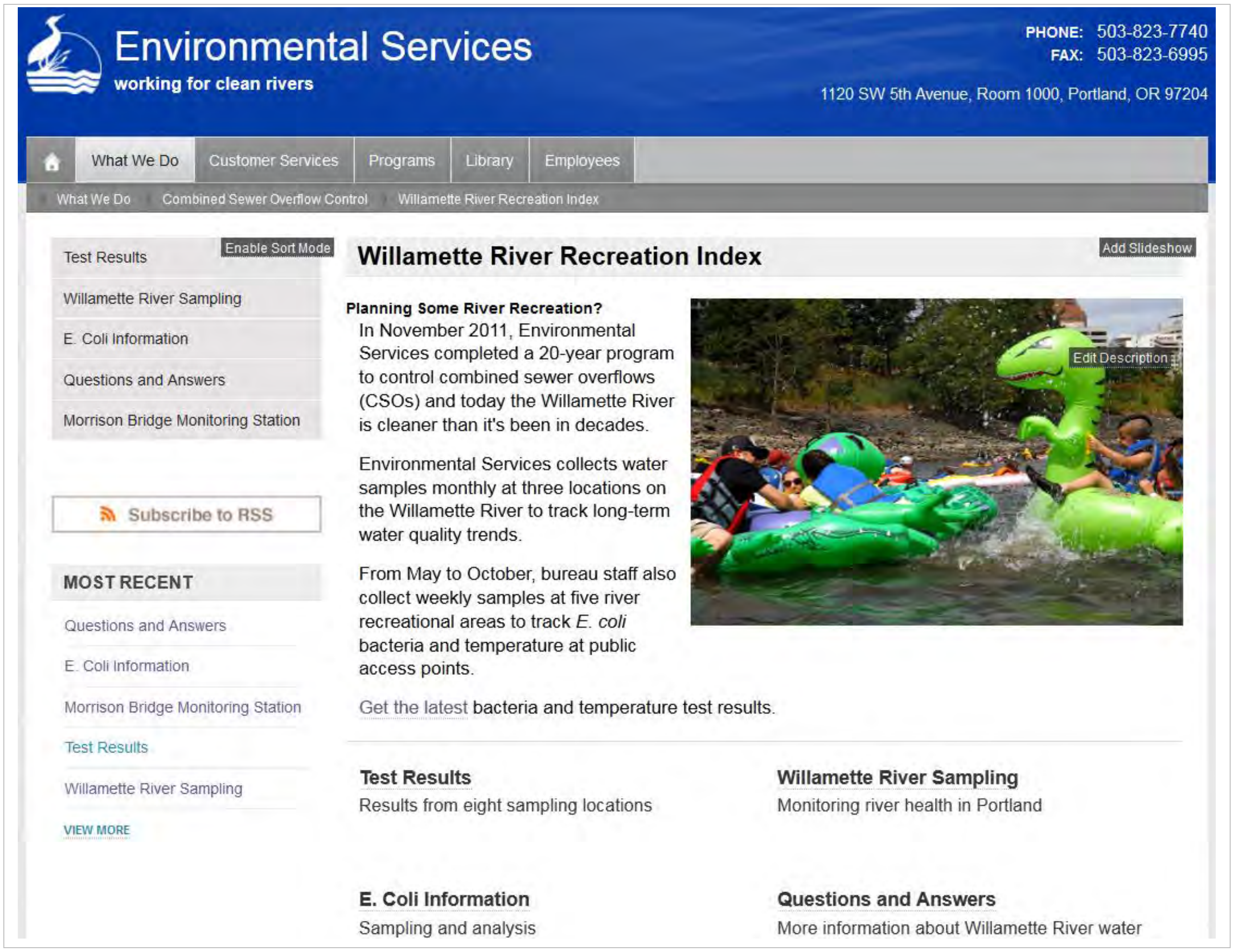



*Figure 7-3 Water Quality Monitoring Web Page: http://www.portlandoregon.gov/bes/57781*

# Section 8 CSO System and 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 for a Monitoring and Analysis Program report due December 30, 2015

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. This report represents our 4$^{th}$ year of monitoring after the Willamette CSO Facilities were completed in December 2011.

# 8.1 Separated System Flow Monitoring

One of the goals of the Monitoring and Analysis Program in the MAO is to "Provide data to inform CBWTP Facilities Plan Update and the NFAA for determining adequate secondary capacity." Part of achieving that goal is to reliably quantify the dry and wet weather flows from the separated portion of sanitary sewer collection systems that send flows directly into the combined sewer system. These sanitary basins are shown in Figure 8-1 below. The basins that flow into the CBWTP system are listed in Table 8-1 along with the mechanism by which the sanitary flows are being measured, including flow monitors installed by the June 30, 2012, deadline.

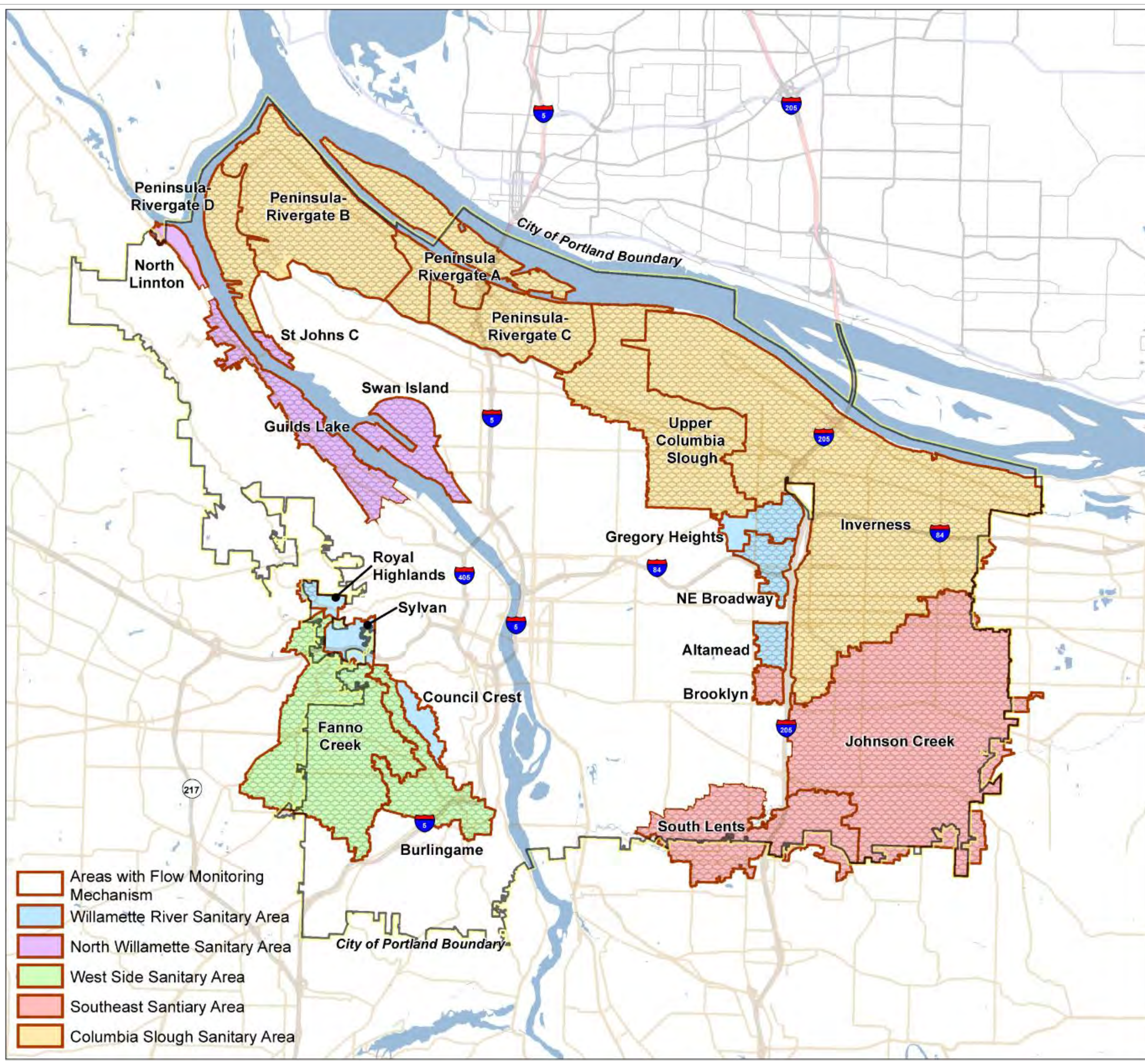



*Figure 8-1 Sanitary Basins*

*Table 8-1 Sanitary Flow Monitoring for Separated Areas Contributing to CBWTP*

| Sewer Basin Name | Basin Area (ac) | Flow Rate Measurement Location | Flow Rate Measurement Mechanism | Contributing Area (ac) | % Basin Measured |
|---|---|---|---|---|---|
| **Willamette River Sanitary Area** | | | | | |
| Royal Highlands | 77 | Royal Highlands Pump Station | Cycle Data | 77 | 100% |
| Sylvan | 400 | n/a | n/a | 0 | 0%[15] |
| Council Crest | 307 | n/a | n/a | 0 | 0%[16] |
| Altamead | 276 | Altamead Pump Station | Cycle Data | 276 | 100% |
| NE Broadway | 461 | Broadway & 87th Pump Station | Cycle Data | 461 | 100% |
| Gregory Heights | 561 | Fremont Pump Station | Cycle Data | 364 | 65% |
| **North Willamette Sanitary Area** | | | | | |
| Guilds Lake | 1,397 | Guilds Lake Pump Station | Mag meters | 1,397 | 100% |
| Swan Island | 912 | Swan Island Pump Station | Cycle Data | 912 | 100% |
| St Johns C | 108 | St. Johns Pump Station | Cycle Data | 108 | 100% |
| **West Side Sanitary Area** | | | | | |
| Burlingame | 1,376 | AMS195 | Temporary Flow Monitor | 1,376 | 100% |
| Fanno Creek | 4,347 | | | 4,347 | 100% |
| **Southeast Sanitary Area** | | | | | |
| South Lents | 2,778 | Multiple | HYDRA SLRT and temporary flow monitor | 2,778 | 100% |
| Johnson Creek | 8,800 | ACU227 | Temporary Flow Monitor | 8,800 | 100% |
| Brooklyn | 215 | Brooklyn Pump Station | Cycle Data | 215 | 100% |
| **Columbia Slough Sanitary Area** | | | | | |
| Inverness | 11,640 | Inverness Pump Station | Mag Meters | 11,640 | 100% |
| Upper Columbia Slough | 3,713 | NE 13th & Lombard | Temporary Monitor | 3,712 | 100% |
| | | 13th & Argyle Pump Station | Cycle Data | 193 | |
| Peninsula-Rivergate A | 2,368 | Force Ave Pump Station | Cycle Data | 2,368 | 100% |

[15] Insignificant to the total sanitary monitoring scheme: this area is more a part of the combined sewer system than the separated area

[16] Insignificant to the total sanitary monitoring scheme: this area is too small to monitor; BES will use models to estimate flows

| Sewer Basin Name | Basin Area (ac) | Flow Rate Measurement Location | Flow Rate Measurement Mechanism | Contributing Area (ac) | % Basin Measured |
|---|---|---|---|---|---|
| Peninsula-Rivergate B | 3,892 | Lombard Pump Station | Cycle Data | 3,839 | 99% |
| Peninsula-Rivergate C | 1,919 | Schmeer Pump Station | Cycle Data | 1,919 | 100% |
| Peninsula-Rivergate D | 972 | Shipyard Pump Station | Cycle Data | 972 | 100% |
| **TOTAL** | 46,882 | | | 45,925 | 98% |

# 8.2 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 three grab samples for FY 2015, bringing the total to six event samples for the current permit cycle (five are required, if possible). Figure 8-2 through Figure 8-4 shows the laboratory analysis reports for the discharges for the October 22-23, 2014; January 17-18, 2015; and March 14-15, 2015, CSO events. All of these grab samples were collected near Outfall 36 (Alder). Note that all three grab samples coincidentally resulted in the same *E. coli* value. This was checked and determined to be accurate.

City of Portland
**Water Pollution Control Laboratory**
6543 N. Burlington Ave. / Portland OR 97203 (503) 823-5600 fax (503) 823-5656

**LABORATORY ANALYSIS REPORT**

| | | | |
|---|---|---|---|
| Project: | **CSO Permit** | Client: | Asset Management |
| Work Order: | **W14J230** | Project Mgr: | Virgil Adderley |
| Received: | 10/22/14 18:17 | | |
| Submitted By: | Field Operations | | |

| Sample | Laboratory ID | Matrix | Type | Sample Collection Date Start | End | Qualifier |
|---|---|---|---|---|---|---|
| CSO36 | W14J230-01 | Stormwater | Grab | 10/22/14 17:25 | 10/22/14 17:25 | |

**CSO36 : W14J230-01**

| Analyte | Result Units | MRL | Dil. | Batch | Prepared | Analyzed | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|
| **Microbiology** | | | | | | | | |
| E. coli | **98000** MPN/100 mL | 100 | 1 | B14J394 | 10/22/14 18:55 | 10/23/14 | Colilert QT | |
| **General Chemistry** | | | | | | | | |
| Total suspended solids | **104** mg/L | 2 | | B14J445 | 10/25/14 | 10/26/14 | SM 2540D | |
| **Total Metals** | | | | | | | | |
| Total Metals by ICPMS | | | | | | | | |
| Copper | **15.2** ug/L | 0.200 | 1 | B14J461 | 10/27/14 | 10/28/14 | EPA 200.8 | |
| Lead | **13.5** ug/L | 0.100 | 1 | B14J461 | 10/27/14 | 10/28/14 | EPA 200.8 | |

*Figure 8-2 October 22, 2014, CSO Discharge Water Quality Sample Result - OF 36*

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**LABORATORY ANALYSIS REPORT**

| | | | |
|---|---|---|---|
| Project: | **CSO Permit** | Client: | Asset Management |
| Work Order: | **W15A162** | Project Mgr: | Arnel Mandilag |
| Received: | 1/17/15 18:45 | | |
| Submitted By: | Field Operations | | |

| Sample | Laboratory ID | Matrix | Type | Sample Collection Date Start | End | Qualifier |
|---|---|---|---|---|---|---|
| CSO36 | W15A162-01 | Stormwater | Grab | 01/17/15 17:45 | 01/17/15 17:45 | |

**CSO36 : W15A162-01**

| Analyte | Result Units | MRL | Dil. | Batch | Prepared | Analyzed | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|
| **Microbiology** | | | | | | | | |
| E. coli | **98000** MPN/100 mL | 100 | 1 | B15A247 | 01/17/15 19:04 | 01/18/15 | Colilert QT | |
| **General Chemistry** | | | | | | | | |
| Total suspended solids | **45** mg/L | 2 | | B15A270 | 01/20/15 | 01/20/15 | SM 2540D | |
| **Total Metals** | | | | | | | | |
| Total Metals by ICPMS | | | | | | | | |
| Copper | **9.93** ug/L | 0.200 | 1 | B15A369 | 01/27/15 | 01/29/15 | EPA 200.8 | |
| Lead | **7.76** ug/L | 0.100 | 1 | B15A369 | 01/27/15 | 01/29/15 | EPA 200.8 | |

*Figure 8-3 January 17, 2015, CSO Discharge Water Quality Sample Result - OF 36*

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**LABORATORY ANALYSIS REPORT**

| | | | |
|---|---|---|---|
| Project: | **CSO Permit** | Client: | Asset Management |
| Work Order: | **W15C122** | Project Mgr: | Arnel Mandilag |
| Received: | 3/15/15 8:59 | | |
| Submitted By: | Field Operations | | |

| Sample | Laboratory ID | Matrix | Type | Sample Collection Date Start | End | Qualifier |
|---|---|---|---|---|---|---|
| CSO36 | W15C122-01 | Stormwater | Grab | 03/15/15 07:52 | 03/15/15 07:52 | |

| Analyte | Result Units | MRL | Dil. | Batch | Prepared | Analyzed | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|
| **CSO36 : W15C122-01** | | | | | | | | |
| **Microbiology** | | | | | | | | |
| E. coli | **98000** MPN/100 mL | 100 | 1 | B15C220 | 03/15/15 09:45 | 03/16/15 | Colilert QT | |
| **General Chemistry** | | | | | | | | |
| Total suspended solids | **22** mg/L | 2 | | B15C235 | 03/16/15 | 03/16/15 | SM 2540D | |
| **Total Metals** | | | | | | | | |
| Total Metals by ICPMS | | | | | | | | |
| Copper | **5.30** ug/L | 0.200 | 1 | B15C273 | 03/18/15 | 03/18/15 | EPA 200.8 | |
| Lead | **4.08** ug/L | 0.100 | 1 | B15C273 | 03/18/15 | 03/18/15 | EPA 200.8 | |

*Figure 8-4 March 15, 2015, CSO Discharge Water Quality Sample Result - OF 36*

# 8.3 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.

Figure 8-5 through Figure 8-9 below show the water quality trends along the Portland stretch of the Willamette River for five parameters: zinc, lead, copper, TSS, 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). Kelly Point was discontinued in 2011 as part of budget cuts and since its measurements tend to reflect those of the Columbia River when it backs up into the Willamette.

As the Willamette River water quality sampling results show, there continues to be a steady improvement (reduction) in the concentrations measured for these four parameters for the long-term trending period.

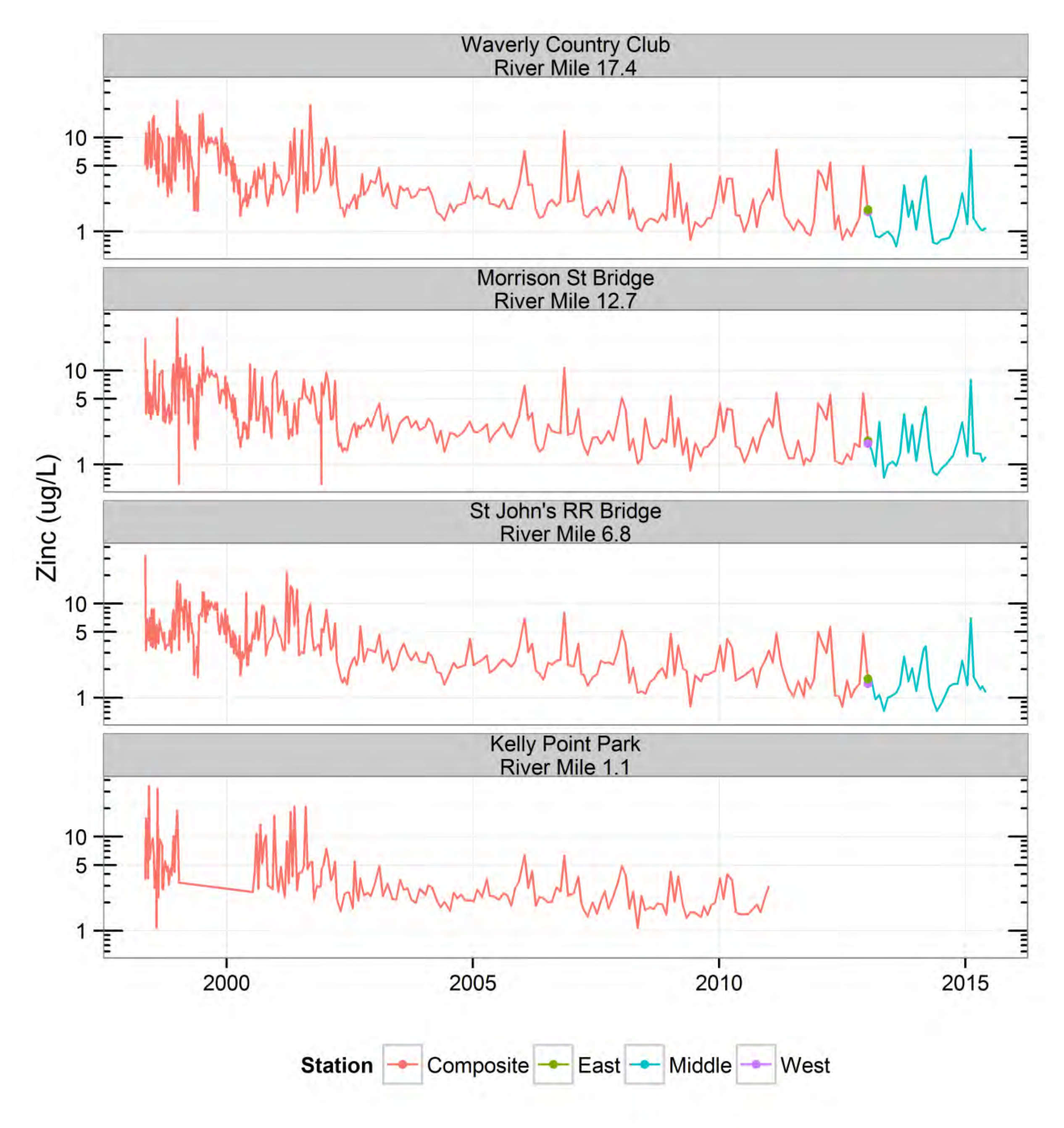



*Figure 8-5 Willamette River Monitoring Results for Zinc*

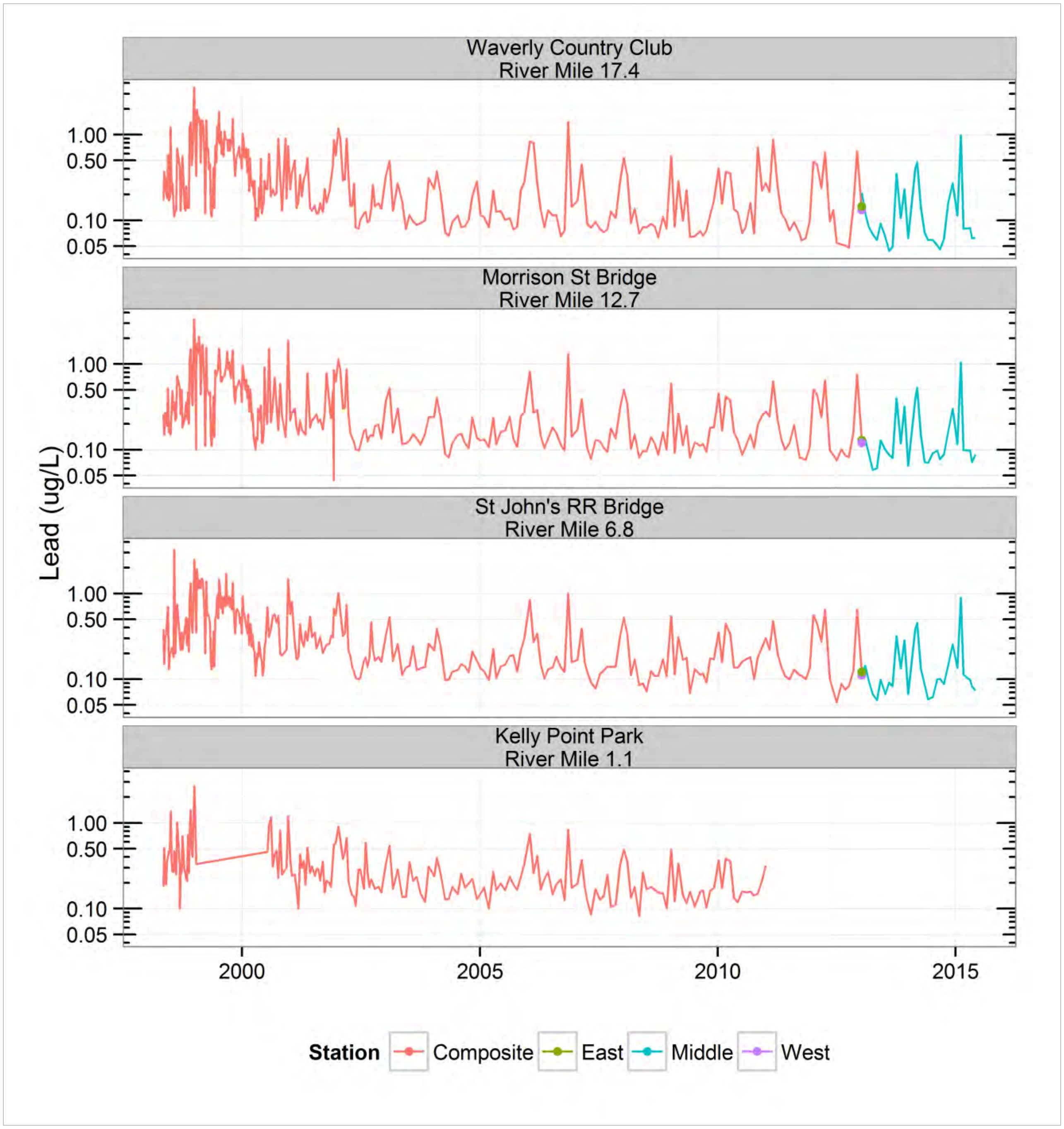



*Figure 8-6 Willamette River Monitoring Results for Lead*

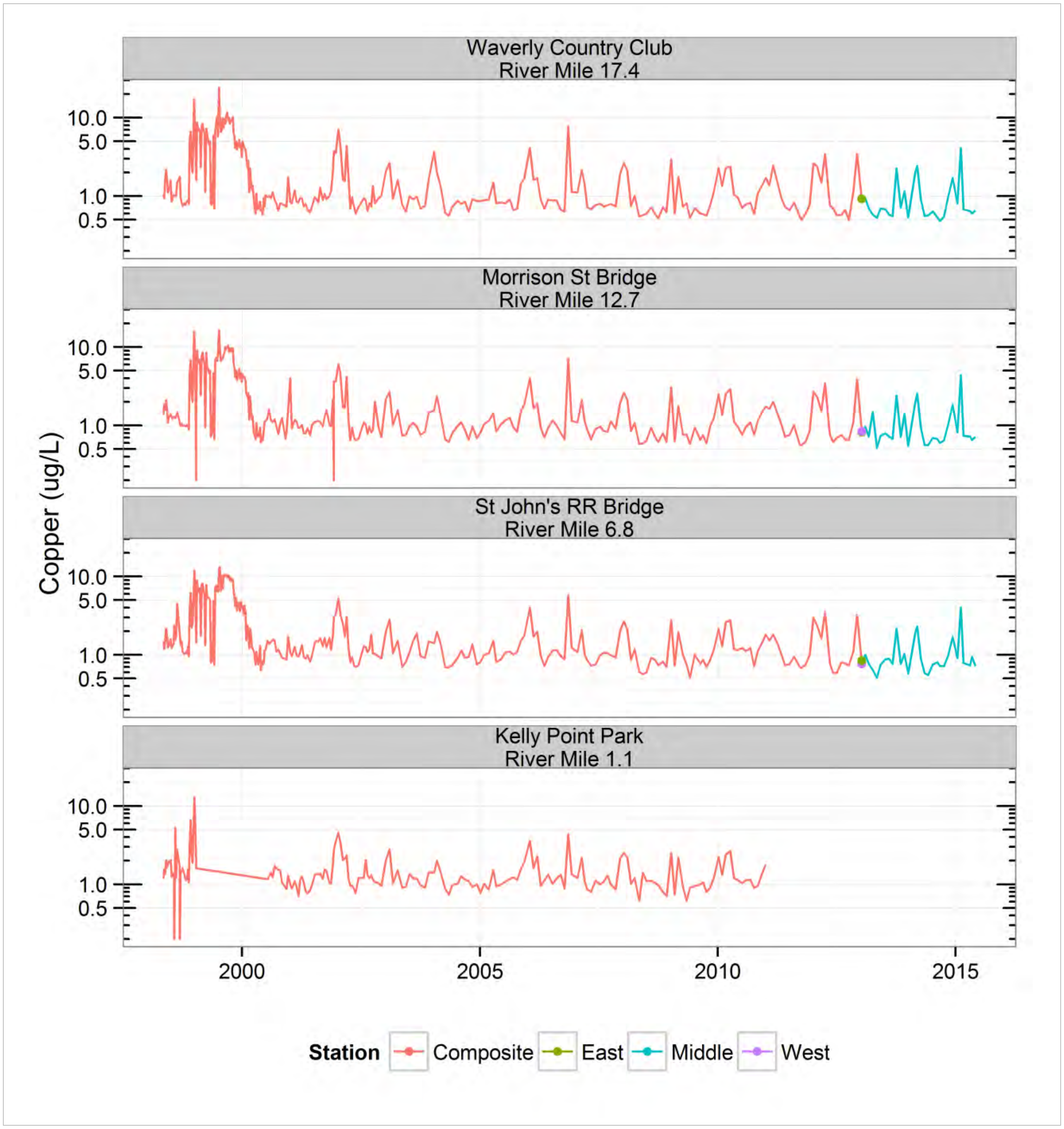



*Figure 8-7 Willamette River Monitoring Results for Copper*

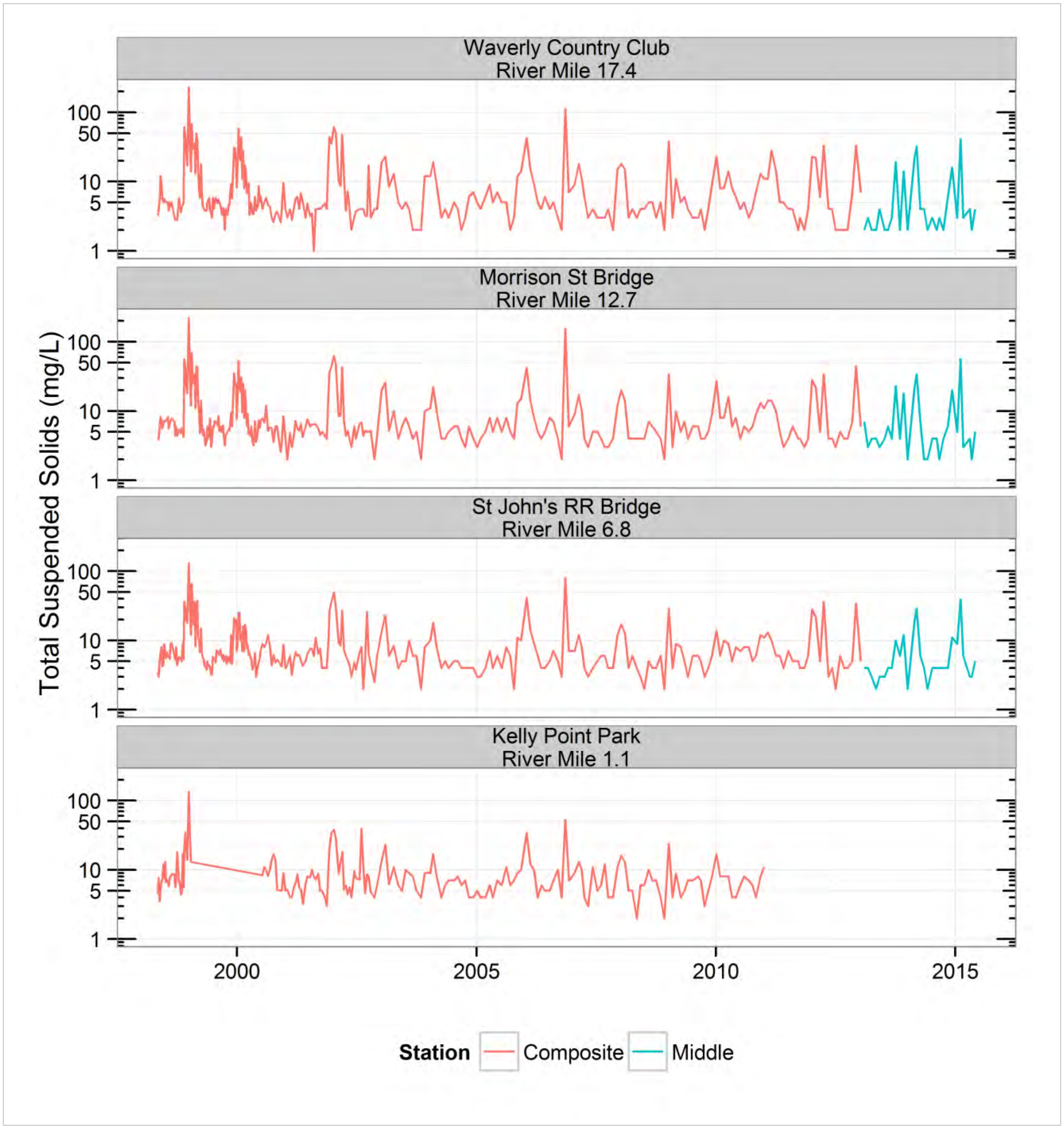



*Figure 8-8 Willamette River Monitoring Results for TSS*

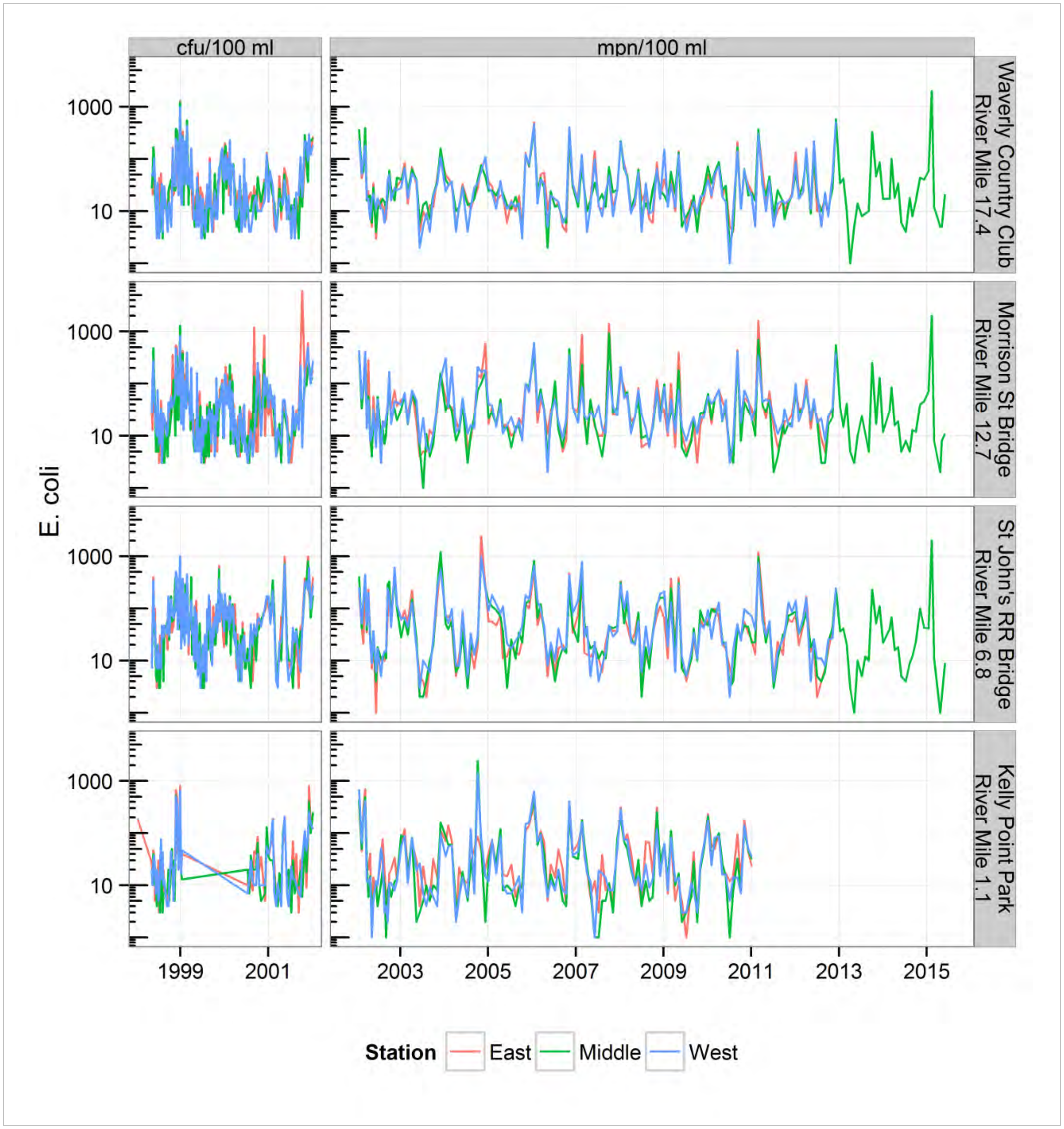


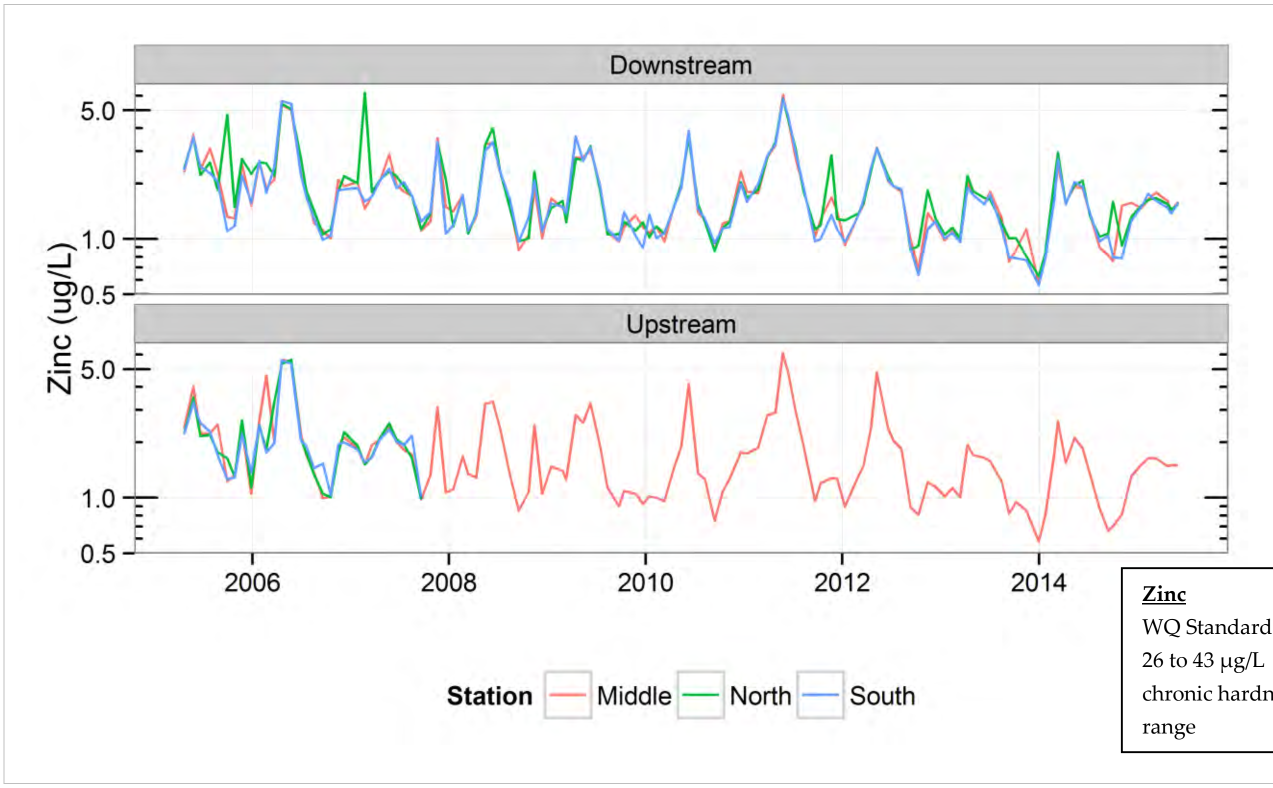

*Figure 8-9 Willamette River Monitoring Results for* E. coli

# 8.4 Columbia River Instream Water Quality Sampling

Portland also has been monitoring the Columbia River water quality upstream and downstream of Outfall 001 and 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.

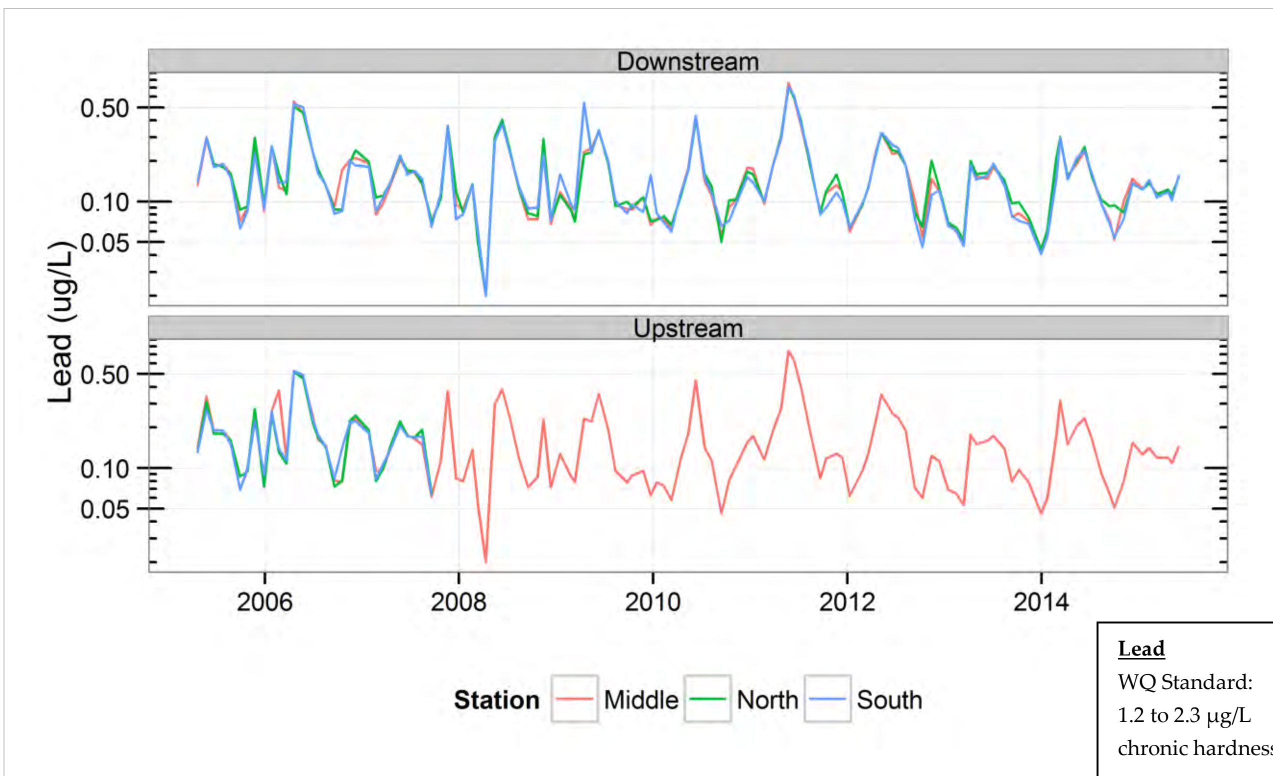
The main parameters of interest related to CSO treatment and the Columbia River are *E. coli*, TSS, copper, lead, and zinc. The results of a comparison of measurements from upstream of the combined mixing zone versus downstream of the mixing zone (measuring impact of the effluent on the water quality) are provided in Figure 8-10 through Figure 8-14 below. In addition to sampling data, the chart shows the relevant numeric water quality standard for each parameter, except for TSS, which is not a toxic. For the metals, the range of chronic 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.



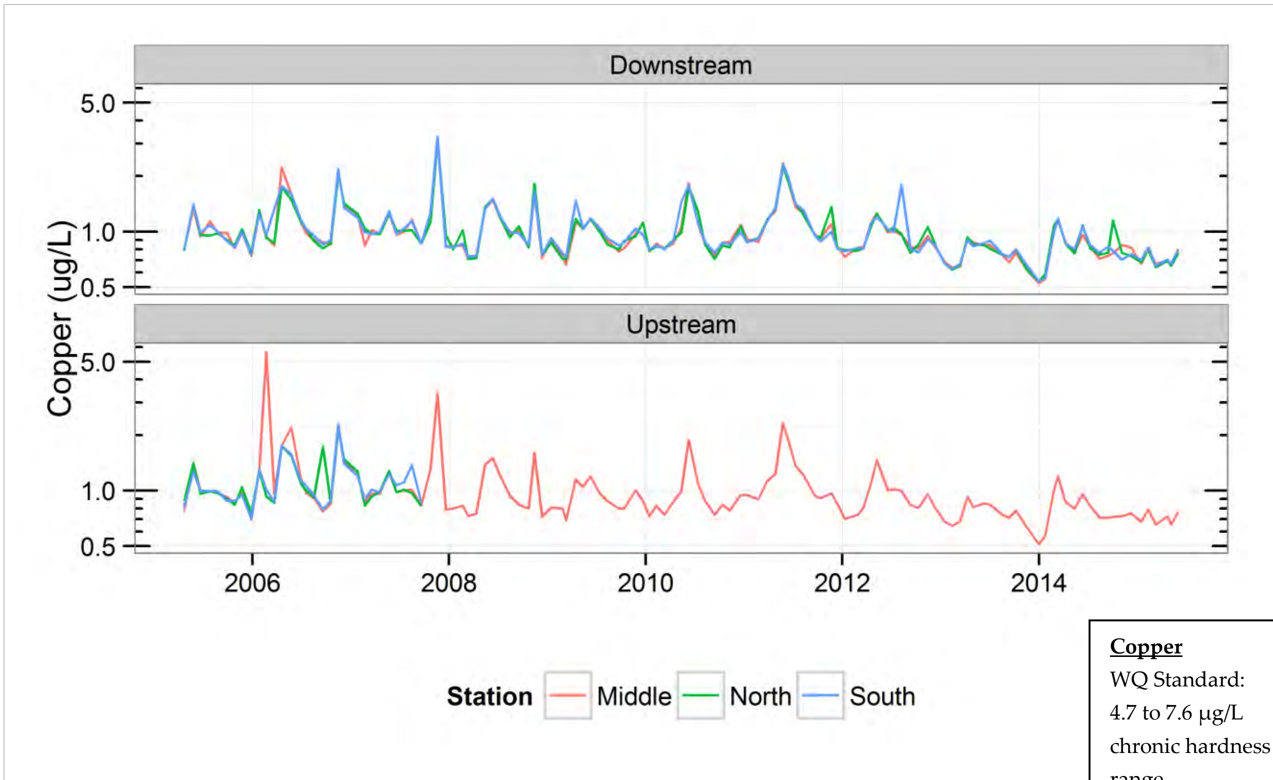

**Zinc**
WQ Standard:
26 to 43 µg/L
chronic hardness
range

*Figure 8-10 Columbia River Mixing Zone Sampling for Zinc*



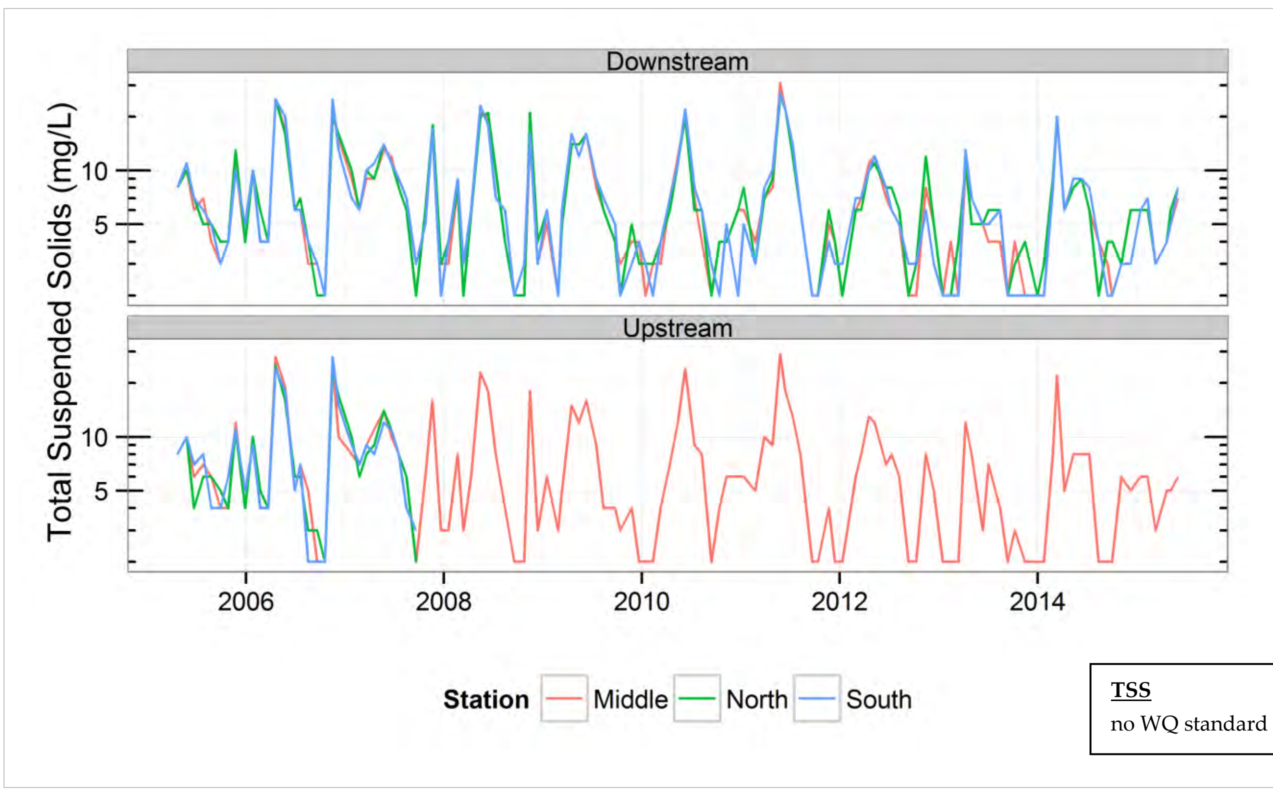

**Lead**
WQ Standard:
1.2 to 2.3 µg/L
chronic hardness
range

*Figure 8-11 Columbia River Mixing Zone Sampling for Lead*




**Copper**
WQ Standard:
4.7 to 7.6 µg/L
chronic hardness range

*Figure 8-12 Columbia River Mixing Zone Sampling for Copper*




**TSS**
no WQ standard

*Figure 8-13 Columbia River Mixing Zone Sampling for TSS*

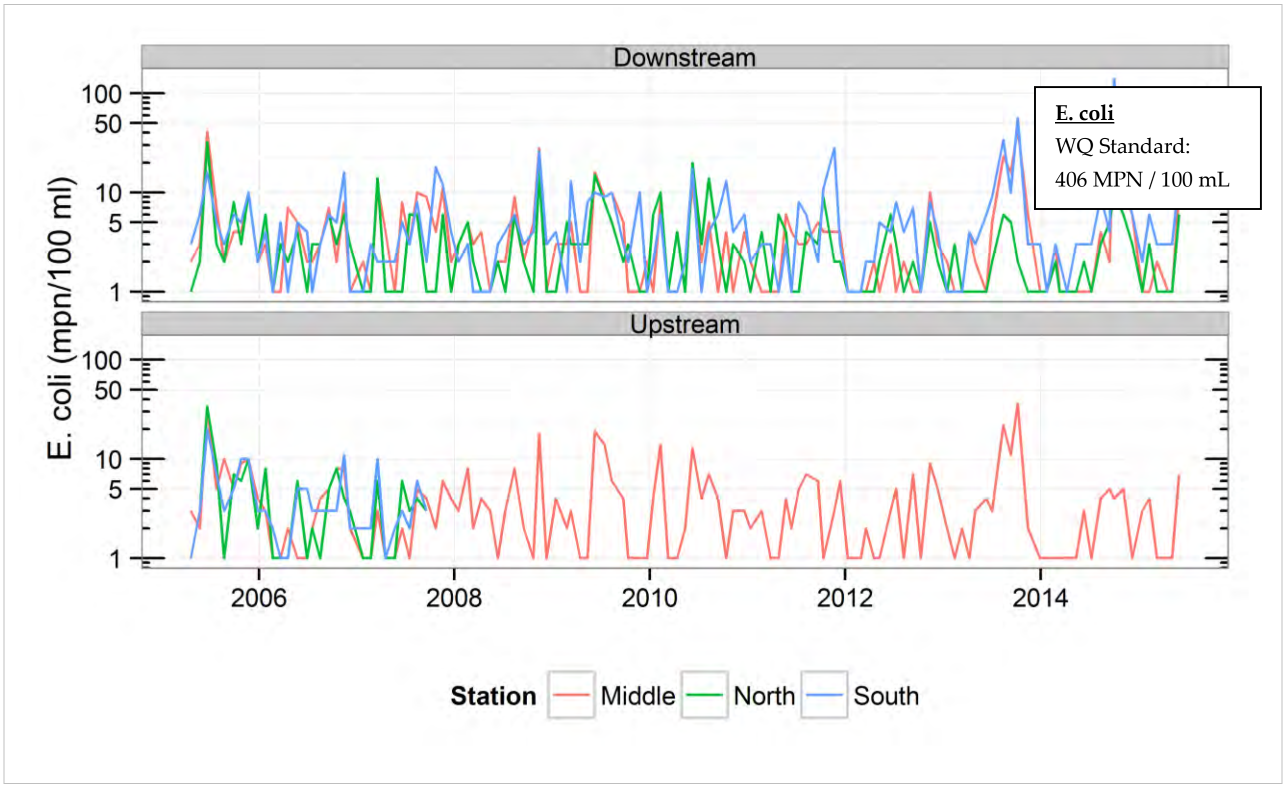



*Figure 8-14 Columbia River Mixing Zone Sampling for* E. coli

# Section 9 System Reinvestment and Risk Reduction

Risk reduction and cost-effective decisions regarding where to reduce risk is an important part of conducting a healthy asset management program. The City of Portland is improving its methods for calculating risk and how its activities reduce risk. This section presents various methods that the City is currently using to value the existing risk in the system and how much it is investing to reduce risks and still meet service levels.

Three major areas of investment were initially identified to monitor the risk change in the system:

- Risk change due to the Capital Improvement Program: capital projects that repair or rehabilitate existing assets or introduce new ones seek to reduce capacity (level of service) risk and structural (mortality) risk in the system.
- Risk change due to maintenance: maintenance work orders seek to reduce structural risk in the system by applying targeted repairs or emergency replacements and rehabilitation on high-risk assets.
- Risk change indicated through inspections: inspections of assets help the City correct assumed degradation in the pipes over time.

The City is currently developing methods for calculating the risk for large diameter (greater than or equal to 36 inches in vertical and/or horizontal dimension) assets. This section presents the current state of our efforts to monitor risk changes in smaller pipes where much of the current investment is occurring. In future reports, more complete details will be provided regarding fiscal year activity and risk reductions.

## 9.1 FY 2015 Activity for Risk Reduction

*Risk reduction* is the present value of the cost of repairing or replacing infrastructure, thereby delaying failure and the consequences of failure to the expected life of the repair or replacement.

Analysis of inspections that occurred in FY 2015 show there was a reduction in risk of $61 million, compared to a total risk of $3.6 billion (a change of about 1.8%), in the smaller diameter assets. This reduction in risk was a result of various capital improvements actions, maintenance activity, and monitored changes observed through inspections.

### 9.1.1 Risk Change Due to Capital Improvements and Inspections

Structural and capacity risks tend to be resolved in the same capital improvement projects. The risk reduction can be calculated to reflect both the reduction due to capacity improvements and replacement of a pipe in poor condition, even when those conditions are coincident. We are currently developing methodologies to account for varying risk reductions associated with structural failure within a project. Risk reductions for capacity are straightforward and can be determined now (for FY 2015, this was estimated to be about $12.6 million). Project costs cannot currently be separated between structural risk and capacity risk at this time, and some development work is needed to separate risk reduction due to capital projects and the risk change monitored by inspections. Capital project costs in FY 2015 were about $3.6 million.

Inspections this fiscal year showed a reduction in the total apparent risk in smaller diameter pipes of about 1.8%. We anticipate that each year for the next couple of years at least, our identified risk may increase, not because we are falling behind, but because our inspections will be higher quality and provide more current remaining life estimates. Once we have achieved consistent currency and quality of our inspections across the system, this will be a good, although lagging, indicator of the change in risk in our system from year to year.

### 9.1.2 Risk Change Due to Maintenance Activity

Maintenance activity includes installation of linings and spot repairs on sections of pipe. The majority (about 60%) of mainlines undergoing this activity are unplanned (see Section 3.1.2 for the precise definition). The majority (about 75%) of laterals undergoing this activity are also unplanned. Investments towards failed or imminently failed assets tend to be more costly than planned investments. As the City strengthens its asset management program in terms of its operational decisions and targeted maintenance plans, these returns on investment are expected to increase. Table 9-1 shows the risk change, cost, and return on investment on mainline repairs and rehabilitation, and Table 9-2 shows those figures for service line repairs and rehabilitation.

*Table 9-1 Mainline Risk Change Due to Maintenance Activity*

| Risk change | Cost | ROI |
|---|---|---|
| $3.5 million, reduction | $3.6 million | -0.03 |

*Table 9-2 Lateral (Service Line) Risk Change Due to Maintenance Activity*

| Risk change | Cost | ROI |
|---|---|---|
| $4.7 million, reduction | $5.4 million | -0.12 |