FY 2022

CITY OF PORTLAND I BUREAU OF ENVIRONMENTAL SERVICES

Annual CSO and CMOM Report

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Annual CSO and CMOM Report - FY 2022

September 2022

Report prepared for the
Oregon Department of Environmental Quality
Portland, Oregon

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CERTIFICATION

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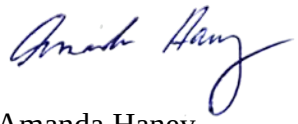

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Glossary

AGCA. Accelerated Grease Cleaning Area

BES. Bureau of Environmental Services

BLM. The Biotic Ligand Model, used for the Oregon DEQ standard for copper criteria. The BLM is a metal bioavailability model that uses grab sample water characteristics to develop site-specific instantaneous water quality criteria.

BOD. Biochemical Oxygen Demand. Values in this report specifically pertain to the amount, in mg/L, of dissolved oxygen consumed by organic material under standard laboratory procedure (known as BOD5 or BOD_5).

CBWTP. Columbia Boulevard Wastewater Treatment Plant

CCC. Criterion Continuous Concentration, an estimate of the highest concentration of a material in ambient water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable adverse effect. This is the chronic criterion.

CCTV. Closed-circuit Television

CEPT. Chemically Enhanced Primary Treatment

CIP. Capital Improvement Program

CIPP. Cured-In Place Pipe

City. The City of Portland, Oregon

CMC. Criterion Maximum Concentration, an estimate of the highest concentration of a material in ambient water to which an aquatic community can be exposed briefly without resulting in an unacceptable adverse effect. This is the acute criterion.

CMMS. Computerized Maintenance Management System

CMOM. Capacity, Management, Operation, and Maintenance

CSO. Combined Sewer Overflow, especially as it pertains to discharge events. Note that during the CSO Program's implementation, "CSO's" were being captured into the new facilities such as the Willamette CSO Tunnels and the Columbia Slough Consolidation Conduit. Technically, CSOs are no longer being "captured" after the implementation completed—rather, the water that used to produce those events is now controlled within the augmented combined sewer system, and the term *CSO* is limited once again to discharges from the combined system to receiving waters.

DEQ. Oregon's Department of Environmental Quality

DO. Dissolved Oxygen

EMC. Event Mean Concentration

EWWPT. Enhanced Wet Weather Primary Treatment

FOG. Fats, Oils, and Grease

FSE. Food Service Establishment

FY. Fiscal Year (FY 2022 is July 1, 2021, through June 30, 2022)

I&I. Inflow and Infiltration

IPS. Influent Pump Station

IWQC. Instantaneous Water Quality Criteria

MGD. Million Gallons per Day

MG. Million Gallons

mg/L. Milligrams per liter

NFAA. No Feasible Alternatives Analysis

NMC. Nine Minimum Controls

NOV. Notice of Violation

NPDES. National Pollutant Discharge Elimination System. This report addresses NPDES permit #101505.

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

RMZ. Regulatory Mixing Zone

SICSO. Swan Island CSO Pump Station

SPCR. Spill Protection and Citizen Response

SRRP. Sewer Release Response Plan

SSO. Sanitary Sewer Overflow

Summer Season. Defined in NPDES permit #101505 as May 1 to October 31.

SWMM. Stormwater Management Manual

TSS. Total Suspended Solids

Winter Season. Defined in NPDES permit #101505 as November 1 to April 30

WWTF. Wet Weather Treatment Facility

Section 1 Introduction

The Annual CSO and CMOM Report for fiscal year 2022 (FY 2022: July 1, 2021, through June 30, 2022) provides a comprehensive review of Portland's integrated combined sewer overflow (CSO) system and the Capacity, Management, Operation, and Maintenance (CMOM) Program during FY 2022. This report provides updates to the previous report submitted for FY 2021.

1.1 Major Changes from FY 2021 Report

There have not been major changes from the FY 2021 report.

1.2 Programs

CSO Program. The City of Portland (City) completed its CSO long-term control plan implementation in 2011. The City is currently proceeding with implementing its *Post-2011 Combined Sewer Overflow Facilities Plan*, published in 2010. This plan looked at ways to cost-effectively exceed the level of control specified in the 1994 Amended Stipulation and Final Order agreement with Oregon's Environmental Quality Commission. This additional work is necessary to handle the pressure on the combined sewer system facilities' capabilities to control CSOs due to increased population and development.

CMOM Program. 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 the Oregon Department of Environmental Quality (DEQ) on June 28, 2013, explains the City of Portland Bureau of Environmental Service's (BES) strategies and activities for the development, reinvestment, operation, and maintenance of the system. The report was developed to comply with National Pollutant Discharge Elimination System (NPDES) permit #101505, Schedule D, Condition 3.b.

The CMOM program specifically addresses proper operation and regular maintenance of the collection system (Nine Minimum Controls, or NMC, #1). The City's wastewater collection system includes mainlines, 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 the building or private sewer laterals extending behind the curb are the responsibility of the property owner. Portland's sewer collection system consists of a network of 2,655 miles of collection system piping (1,009 miles of sanitary sewer including force mains, 914 miles of combined sewer, and 732 miles of sewer laterals) and 41,406 sewer maintenance holes.

The system also maintains two wastewater treatment plants and 98 pump stations. There are 95 City-owned and operated pump stations and three pump stations owned by other public agencies that are operated and maintained by the City under satellite or easement agreements. Ten privately-owned septic tank effluent pumping systems are maintained by the City under agreements with the property owners.

This annual update for FY 2022 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.

1.3 Summary of CSO and CMOM Performance

1.3.1 CSO Program Performance

FY 2022 was a year with above average total rainfall depth. An average of 50.4 inches fell over the area served by the Willamette River CSO control system. Normally, 36-43 inches fall over the city in any given year. Seven CSOs were recorded, all of which met the permit's requirements for storm return periods during CSO events.

For all wet weather events, effluent limits were met. However, an extraordinary filamentous outbreak combined with a national hypochlorite supply shortage led to total suspended solids (TSS) exceedances in June 2021 continuing through July 27th, 2021. For this fiscal year, maximum rolling 7-day concentrations were 28 mg/L (winter) and 82 mg/L (summer) for biochemical oxygen demand (BOD) and 35 mg/L (winter) and 147 mg/L (summer) for TSS; 45 mg/L is the permitted effluent limitation. Similarly, there was also an exceedance for TSS for the maximum rolling 30-day limits: 24 mg/L (winter) and 56 mg/L (summer) for BOD and 29 mg/L (winter) and 80 mg/L (summer) for TSS were calculated, and 30 mg/L is the permitted limitation. The proper prioritization of using the at-risk supplies of the hypochlorite towards disinfecting effluent versus limiting the outbreak in the return activated sludge prolonged the problem.

The Wet Weather Treatment Facility (WWTF) with Chemically Enhanced Primary Treatment (CEPT) continues to operate well, contributing to the plant meeting the

minimum average monthly percent removal efficiencies indicated in the permit (at least 85% efficiency during the summer—May 1 to October 31—and 65% efficiency during the winter—November 1 to April 30—for both BOD and TSS). BOD removal efficiencies were 87% in the summer and 77% in the winter, and TSS removal efficiencies were 89% in the summer and 79% in the winter. The filamentous outbreak occurred in the summer season from May to July 2021. These exceptionally high values during dry weather were omitted from the removal efficiency calculations.

Above average rainfall this fiscal year led to a higher volume of flow captured by the Willamette and Columbia Slough storage facilities of about 8.5 billion gallons. Operators managed the integrated collection system to treat 57% of this volume through the secondary system, with 43% treated through the WWTF. There were 44 events in which flows were sent through the WWTF. The average WWTF event lasted 20 hours and discharged 84 million gallons from the WWTF. During the events, the average flow rate treated by the dry weather/secondary system was 110 million gallons per day (MGD), matching the 110 MGD minimum required in the NPDES permit.

1.3.2 CMOM Program Performance

Portland's CMOM program was 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. CMOM program accomplishments in FY 2022 include:

- Inspection of 0.97 million feet (183 miles) of sewer pipe, or about 9.5% of the mainline sewer system
- Cleaning of 1.25 million feet (236 miles) of sewer pipe, or about 12.3% of the mainline sewer system
- Completion of mainline sewer maintenance repairs on 6,538 feet of pipe; 52% of the repairs were in response to collection system problems
- Repair of 549 service laterals totaling about 6,051 feet of pipe; 57% of those repairs were in response to discovered problems

- Treatment of nearly 307,806 feet (58 miles) of sewer pipe for roots using chemical root foaming
- Completion of 25 inspections of maintenance holes considered to be at greatest risk of failure (Tier 2—see Section 3.1.5).
- Completion of 10 Capital Improvement Program (CIP) projects repairing and rehabilitating portions of the sanitary and combined collection system during the 2021 calendar year, resulting in an estimated risk reduction of $16.7 million. Maintenance activity on mainlines and service laterals also resulted in an estimated risk reduction of $4.6 million.[1]

The number of sewer releases from the City-maintained sanitary and combined sewers decreased significantly in FY 2022. The number of sewer releases per 100 miles of sewer was 5.0 in FY 2022. This met BES's target of 5.0 or fewer releases per 100 miles.

Sewer emergency response crews arrived on site within the City's 2-hour response time target 97% of the time during FY 2022.

[1] Risk reduction values in this bullet are reported on a calendar year basis due to reporting lag times.

Section 2 Integrated CSO System Performance for FY 2022

The integrated CSO system consists of the combined sewer collection system; the CSO collection, storage, and pumping system; and the Columbia Boulevard Wastewater Treatment Plant (CBWTP) treatment system. This section reports on the performance of the overall integrated CSO system during FY 2022.

2.1 Rainfall Patterns for the Past Fiscal Year

FY 2022 was a wet rainfall year for the City of Portland. The area weighted average rainfall for the Willamette CSO area measured 50.4 inches over the year, 136% of the average annual rainfall of 37 inches for Portland.

2.1.1 Summer Storms Review

During FY 2022, three summer storms were large enough to have caused a permittable CSO to the Willamette River, and all of these storms generated CSO discharge (Table 1).

The summer storm of September 17-19, 2021, included high intensity rainfall over the St. Johns area in North Portland and resulted in discharge from one Willamette River CSO outfall. Rainfall in the St. Johns B combined sewer basin exceeded the 1-per-3-summer design storm for the 1 hour to 24 hour durations.

The summer storm of September 26-28, 2021, was caused by high intensity rainfall over the Carolina combined sewer basin in SW Portland and resulted in discharge from one Willamette River CSO outfall. The local rain gauges (#172, #214, #227, and #229) recorded rainfall exceeding the 1-per-10-summer design storm for the 15 minute duration and a selection of these gauges recorded rainfall exceeding the 1-per-3-summer design storm for the 30 minute to 24 hour durations.

The summer storm of June 9-12, 2022, was a Category 5 atmospheric river that generated high intensity rainfall over the Carolina combined sewer basin in SW Portland and resulted in discharge from one Willamette River CSO outfall. The local rainfall contributing combined flows to the Carolina Basin exceeded the 1-per-3-summer design storm for the 1 to 24 hour durations.

Table 1 FY 2022 Summer Storms

Storm	CSO?	Duration (min)		Duration (hours)						Notes	
		15	30	1	3	6	12	24	48		
Willamette River Summer Design Storm (inches)											
3-Year Summer Design Storm		0.15	0.26	0.40	0.60	0.85	1.10	1.41	2.12		
Columbia Slough Summer Design Storm (inches)											
10-Year Summer Design Storm		0.17	0.30	0.51	0.85	1.21	1.68	2.06	3.15		
FY 2022 Summer Storms - Average Rainfall over Willamette CSO Basin (inches)											
September 17-19, 2021	Yes	0.06	0.12	0.19	0.50	0.87	1.28	1.34	1.70	Exceeds 3-year summer design storm for durations from 6 to 12 hour durations.	
June 9-12, 2022	Yes	0.06	0.11	0.17	0.47	0.81	1.24	1.53	1.90	Exceeds 3-year summer design storm for durations from 12 to 24 hour durations.	
FY 2022 Summer Storms - Rainfall near Carolina Combined Sewer Basin (inches)											
September 27, 2021	Yes	0.32	0.52	0.65	0.78	0.95	1.28	1.42	1.42	Gauge #172 Maplewood Elementary School	Exceeds 3-year summer design storm for durations from 15 minute to 24 hour durations.
		0.20	0.30	0.42	0.54	0.68	1.09	1.43	1.60	Gauge #214 OPB Raingage	Exceeds 3-year summer design storm for durations from 15 minute to 1 hour and 24 hour durations.
		0.20	0.27	0.39	0.64	0.79	1.19	1.55	1.73	Gauge #227 Ida B. Wells-Barnett School	Exceeds 3-year summer design storm for durations from 15 to 30 minute, 3 hour, and 12 to 24 hour durations.
		0.24	0.30	0.39	0.56	0.73	1.19	1.52	1.65	Gauge #229 Cleveland School	Exceeds 3-year summer design storm for durations from 15 to 30 minute and 12 to 24 hour durations.

The two storms that exceeded the 3-year summer NPDES Permit design depths over the CSO control area are shown graphically in in Figure 1. This graph is a "Depth-Duration" chart that displays the maximum depth of rainfall that occurred for the range of storm durations, from 15-minutes to 24- hours. The observed rainfall events are compared to the NPDES Summer Design Storm for the Willamette River (3-year) shown with a blue-tinted line. The two storms that exceeded the 3-year summer design storm for the Willamette CSO area and resulted in CSOs are shown in red. Details for the rainfall for the summer rainfall events is provided in Figure 1.

The September 26-28, 2021, storm that exceeded the 3-year summer design storm at four rain gages in the affected sewer basin, resulting in a CSO. The depth-duration curves for that event at each of the four gages is shown in Figure 2.

The September 26-28, 2021, storm also exceeded the NPDES Summer Design Storm for the Columba Slough (10-year) but did not result in a CSO to the Columbia Slough.

Figure 1 FY 2022 CSO Summer Storms Compared to NPDES Summer Storms

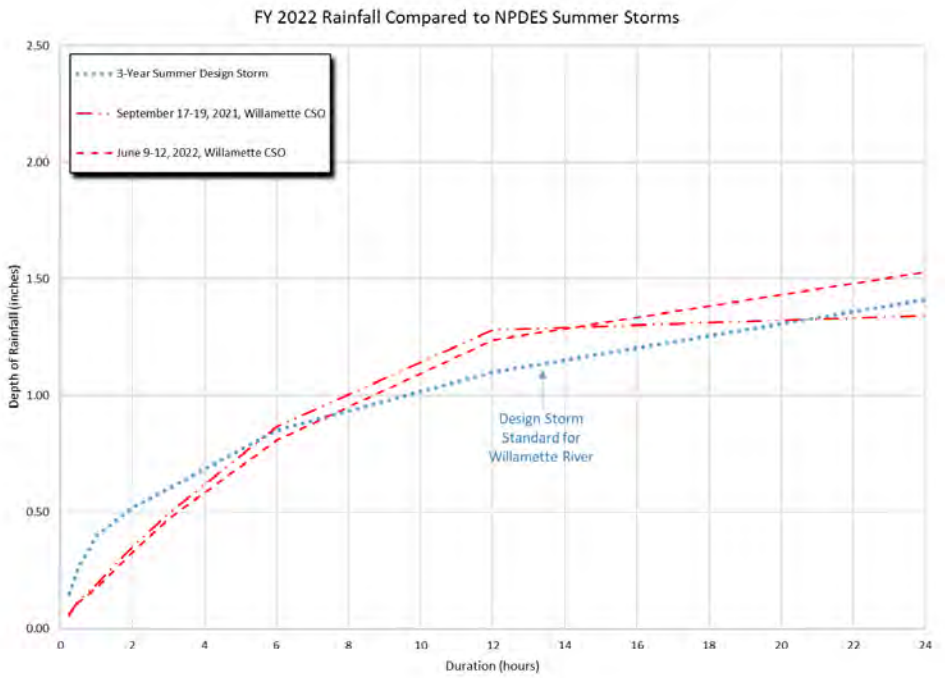
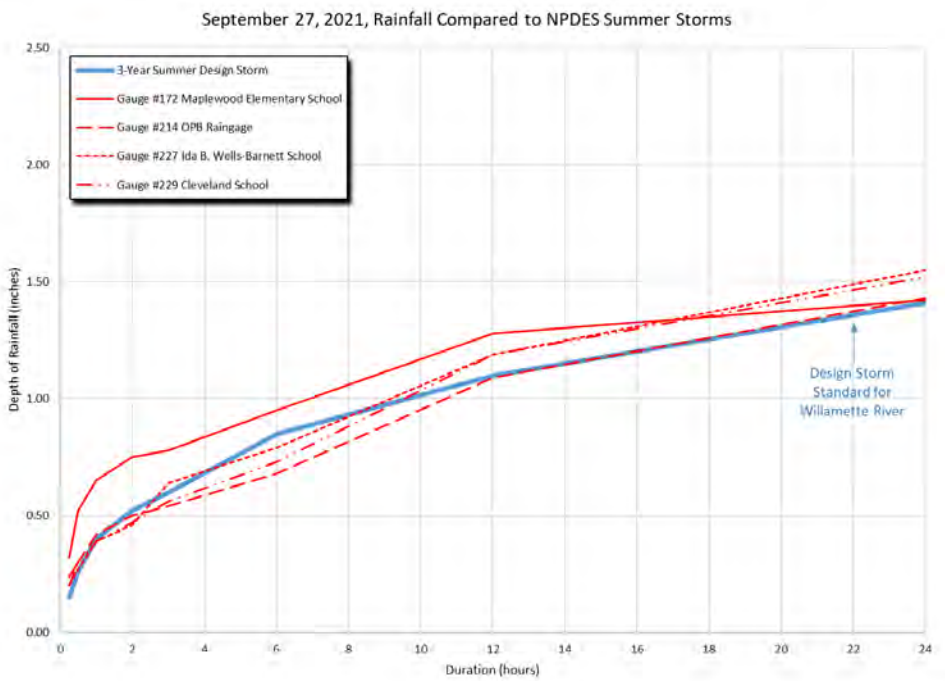


Figure 2 September 26-28, 2021 Storm Compared to NPDES Summer Storms



2.1.2 Winter Storm Review

Eight winter storms were large enough to have caused a permittable CSO to the Willamette River, and four of those storms generated CSO discharge (Table 2).

Table 2 FY 2022 Winter Storm Comparisons

Storm	CSO?	Duration (hours)						Notes
		1	3	6	12	24	48	
Willamette River Winter Design Storm (inches)								
4-per-Winter Design Storm		0.24	0.44	0.65	0.89	1.19	1.53	
Columbia Slough Winter Design Storm (inches)								
5-Year Winter Design Storm		0.43	0.80	1.21	1.81	2.51	3.26	
FY 2022 Winter Storms - Average Rainfall over Willamette CSO Basin (inches)								
November 10-12, 2021	Yes	0.30	0.51	0.93	1.61	2.49	3.29	Exceeds 4-per-winter design storm for 1 to 48 hour durations. CSO event.
December 10-13, 2021	No	0.15	0.30	0.54	0.97	1.20	1.73	Exceeds 4-per-winter design storm for 12 to 48 hour durations. No CSO event.
December 16-20, 2021	Yes	0.18	0.47	0.89	1.30	1.79	2.68	Exceeds 4-per-winter design storm for 3 to 48 hour durations. CSO event.
December 24, 2021	No	0.25	0.35	0.45	0.55	0.68	0.95	Exceeds 4-per-winter design storm for 1 hour duration. No CSO event.
January 2-7, 2022	Yes	0.37	0.87	1.42	1.77	2.08	2.44	Exceeds 4-per-winter design storm for 1 to 48 hour durations. CSO event.
February 26 - March 3, 2022	No	0.23	0.61	0.83	1.20	1.52	2.08	Exceeds 4-per-winter design storm for 3 to 48 hour durations. No CSO event.
April 9-14, 2022	No	0.15	0.40	0.64	0.86	1.47	1.78	Exceeds 4-per-winter design storm for 24 to 48 hour durations. No CSO event.
FY 2022 Winter Storms - Rainfall at Gauge #160 Water Pollution Control Lab								
April 28-30, 2022	Yes	0.72	0.74	0.79	0.87	1.50	1.63	Exceeds 4-per-winter design storm for 1 to 6 and 24 to 48 hour durations. CSO event.

The winter storm of November 10-12, 2021, was a moderate-to-strong atmospheric river event lasting 2 days and resulting in discharge from seven Willamette River CSO outfalls. The Willamette River CSO Area exceeded the 4-per-winter storm design criteria for the 1 to 48 hour durations.

The winter storm of December 16-20, 2021, was a strong atmospheric river event lasting 3.5 days and resulting in discharge from four Willamette River CSO outfalls.

The Willamette River CSO Area exceeded the 4-per-winter storm design criteria for the 2 to 48 hour durations.

The winter storm of January 2-7, 2022, was a strong atmospheric river event lasting 4.8 days and resulting in discharge from eight Willamette River CSO outfalls. The Willamette River CSO Area exceeded the 4-per-winter storm design criteria for the 1 to 48 hour durations.

The winter CSO of April 28-30, 2022, was caused by high intensity rainfall over the St. Johns area and resulted in discharge from one Willamette River CSO outfall. The local rainfall measured at Gauge #160 exceeded the 4-per-winter storm design criteria for the 1 to 6 and 24 to 48 hour durations. In the CSO letter for this event, the rainfall depths by durations were shifted by one column in error. The correct values are reported in Table 2 and the rainfall depths remain above NPDES permit winter design storm criteria.

The seven storms that exceeded the 4-per-winter NPDES Permit design depths over the CSO control area are shown graphically in Figure 3. This graph is a "Depth-Duration" chart that displays the maximum depth of rainfall that occurred for the range of storm durations, from 1-hour to 48- hours. The observed rainfall events are compared to the NPDES Winter Design Storm for the Willamette River (4-per-winter) shown with a blue-tinted dashed line. The three storms that exceeded the 4-per-winter design storm for the Willamette CSO area and resulted in CSOs are shown in red. The four storms that exceeded the 4-per-winter design storm but did not result in CSOs are shown in grey. Details for the rainfall for the winter rainfall events is provided in Table 2.

The April 28-30, 2022, storm that exceeded the 4-per-winter design storm locally and resulted in a CSO is shown in Figure 4.

Three of the winter storms also exceeded the NPDES Winter Design Storm for the Columba Slough (5-year), but none resulted in a CSO to the Columbia Slough.

Figure 3 FY 2022 CSO Winter Storms Compared to NPDES Winter Storms

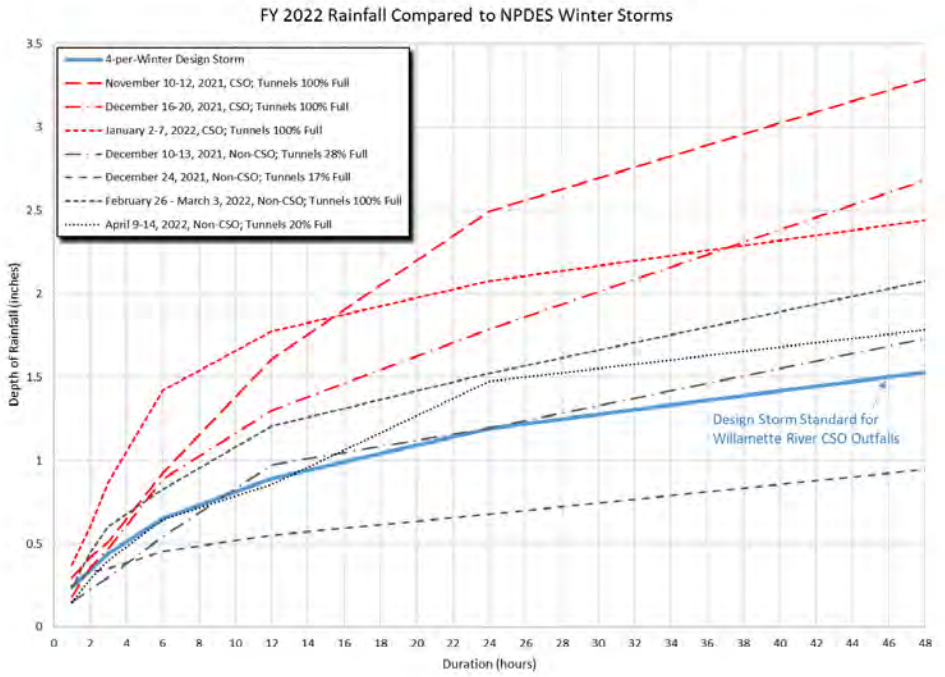
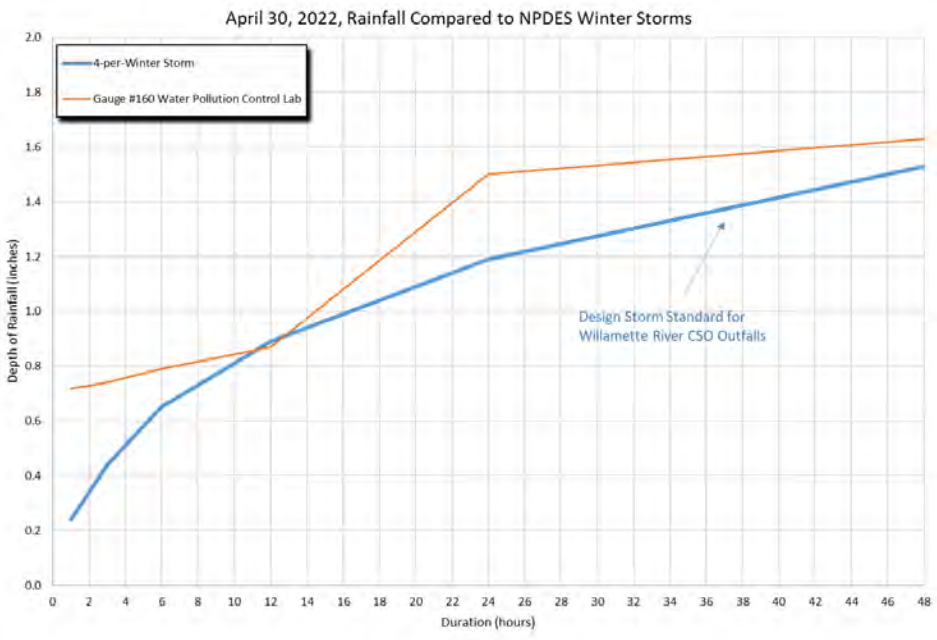


Figure 4 April 28-30, 2022 Storm Compared to NPDES Winter Storms



2.2 CSO Discharges into the Willamette River and Columbia Slough

2.2.1 Discharge Events

In FY 2022, there were three summer and four winter CSO discharge events to the Willamette River and none to the Columbia Slough. Please consult the compliance letters submitted to DEQ for details on the circumstances and validation of these events as allowed by the NPDES permit for CBWTP.

- **September 19, 2021.** 58,300 gallons discharged over 14 minutes from one Willamette River outfall. High intensity rainfall in the St. Johns area in N Portland caused the overflow. Rainfall depths exceeded 1-per-10 summers levels for the 3- to 24-hour durations, and 1-per-3 summers levels for the 1- to 2-hour durations.
- **September 27, 2021.** 32,200 gallons discharged over 21 minutes from one Willamette River outfall. High intensity rainfall over a small corridor through SW Portland caused the overflow. Rainfall depths exceeded 1-per-10 summers levels for the 15-minute to 24-hour durations.
- **November 12, 2021.** 127 MG discharged over 10.6 hours from seven outfalls to the Willamette. An atmospheric river with peak intensities surpassing the 1-per-5 winters level throughout the city caused the overflow.
- **December 19, 2021.** 2 MG discharged over 2 hours from four outfalls to the Willamette. An atmospheric river brought rainfall exceeding 2-per-winter levels for durations 6- to 24-hours at multiple rain gauges.
- **January 3, 2022.** 103 MG discharged over 9.5 hours from eight outfalls to the Willamette. An atmospheric river with peak intensities surpassing the 1-per-5 winters level throughout the city caused the overflow.
- **April 30, 2022.** 4,000 gallons discharged over 5 minutes from one Willamette River outfall. High intensity rainfall again fell in the St. Johns area, causing the overflow. Rainfall depths exceeded 25-year levels for the 15- to 30-minute durations, as well as 5-year winter levels from 1- to 3-hour and 12-hour durations.
- **June 11, 2022.** 340 gallons discharged over 3 minutes from one Willamette River outfall. High intensity rainfall in the aftermath of a late-season atmospheric river caused the overflow rainfall depths exceeded the 1-per-3 summers level for the 1 and 6- to 48-hour durations.

The entire historical record of CSOs discharged from the City's CSO facilities is provided in Appendix A.

2.2.1.1 How Well Were CSO Events Controlled?

System rainfall was above average during the reporting period. The system experienced three winter and four summer overflows out of a total 63 distinct storm events. Approximately 4,460 MG were pumped out of the Willamette CSO tunnels over the course of the year.

Total CSO discharge for the year was 232 MG from the Willamette CSO system, which was less than 2.6% of the wet weather volume handled by the combined and sanitary collection systems. This equates to 97.4% volume control, exceeding the 94% level of control expected from the Willamette CSO system.

2.2.1.2 Were Wet Weather Flows Maximized to the Plant?

In general, flow was maximized to the treatment plant to the greatest extent possible while preserving plant processes.

2.2.1.3 Was System Storage Maximized?

In all events, the CSO system discharged after rainfall intensity exceeded permit levels, and in the applicable winter events, after the tunnels were filled. For all non-CSO sized storm events (less intense that 4-per-winter and 1-per-3 summers), tunnel storage levels did not exceed more than 41% capacity. For the CSO-sized events that the system managed without overflow, tunnel storage peaked at 100% capacity. During a storm on February 28, 2022, that peaked at 2-per-winter levels (enough to permit an overflow), the tunnels filled, but rainfall had abated and tunnel shaft storage was enough to stave off the overflow.

2.2.2 Dry Weather Overflow Events

No dry weather overflow events from the combined system outfalls were recorded in FY 2022.

2.2.3 Control of Floatables and Debris

City maintenance crews inspect and clean the bar screens of certain diversion structures, such as those leading to OF 07B (Sheridan) and 52 (Philadelphia and Burlington) following CSO discharge events when conditions allow. Table 3 provides information on CSO events requiring floatables control cleaning for FY 2022.

Table 3 CSO events with floatables control activity

CSO Event Date(s)	Maint. Date	Location	Description of Maintenance
September 19, 2021	9/27/2021	Burlington Bar Screen (AAE560)	No need to clean off rack. Three leaves in the rack.
November 10, 2022	11/18/2021	Sheridan Bar Screen (ANS918)	Cleaned screen of 10 gallons of debris. Composed of sticks and leaves.
January 2, 2022	1/20/2022	Sheridan Bar Screen (ANS918)	Cleaned screen of 50 gallons of sticks. Composed of leaves and vegetative material.
April 30, 2022	5/2/2022	Philadelphia Bar Screen (AAE648)	No need for extensive cleaning/debris pickup. Some evidence of small debris clinging to rack.

2.3 Wet Weather Treatment Performance and Effluent Quality

2.3.1 CSO Facilities Operations

The CSO System configuration experience no major changes for most of FY2022. The system experienced an above average year of rainfall, receiving 50.4 inches of total rainfall, which is comparable to the wet fiscal years of 2016 and 2017. Influent volumes to CBWTP increased by 16% from FY2021 totaling over 27 billion gallons (Table 6). The percentage treated by the secondary system decreased from 91% to 86%, the same as in fiscal years 2016 and 2017. The percentage of captured CSO treated vis secondary also dropped from 61% in FY 2021 to 57% in FY 2022, which was the average expected for the system when initially planned. Overall BOD and TSS removal efficiencies dropped marginally from last year's 93% for both to 92% for BOD and 91% for TSS. These numbers indicate that the plant reliably exhibits satisfactory performance year over year, with some variation due in large part to the filamentous bacteria outbreak in June 2021 (see Section 2.3.2.1) as well as changes currently in progress with the expansion.

Table 4 shows the total volume pumped from the two major CSO pump stations in the system, Swan Island CSO pump station (SICSO), which drains the Willamette River system, and the Influent Pump Station (IPS), which drains the Columbia Slough system. About 8,500 MG of captured CSO reached the plant (Table 6). About 7,400 MG of tunnel flow was pumped, representing 86% of that captured volume.

Table 4 Volume pumped from CSO tunnels

CSO Tunnel Pumping	Total Pumped Volume (MG)
Swan Island CSO Pump Station	
Force main 1 (Peninsular Dry Weather)	1,740
Force main 2 (Peninsular Wet Weather)	396
Force main 3 (Portsmouth Wet Weather)	2,324
Swan Island CSO Pump Station Subtotal	4,460
Influent Pump Station Total	2,917
Total Volume Pumped to CBWTP from Tunnels	7,377

2.3.2 Annual Treatment Performance for CBWTP

2.3.2.1 Annual CSO Treatment Characteristics

Key parameters for the treatment of system's annual performance are derived from the NPDES permit for the CBWTP, which specifies seasonal percent removal efficiencies at the plant. Table 5 summarizes this aspect, and the minimum efficiency limits for BOD and TSS were met for both the winter and summer seasons. The summer efficiency calculation omits July 2021 due to an outbreak of filamentous bacteria in the secondary system, with notifications from the City to DEQ in July and August 2021 regarding this circumstance. BES used the CEPT system during these dry weather conditions to aid in system recovery and mitigate for decreased removal efficiencies until the secondary system's biology recovered. This period started July 7th, 2021, and ended July 27th, 2021.

- This outbreak severely impacted the settleability in the activated sludge system.
- This event was exacerbated due to an approximate 25% reduction in secondary treatment capacity caused by mandatory aeration basin rehabilitation work and maintenance on a secondary clarifier, as well as limited sodium hypochlorite availability at both a regional and national level.
- A strong wet weather event in mid-June 2021 compounded the loss of biomass inventory in the secondary system.
- While CEPT usage was an effective tool in alleviating stress on the secondary system and restoring biological process health, the CBWTP experienced effluent limit exceedances in July 2021.

- This usage was well documented and approved by the Oregon Department of Environmental Quality (DEQ) (notification letters in April and July 2021).
- Data for usage of the CEPT process as an auxiliary system may lead to similar usage during the 2022 and 2023 dry seasons should similar outbreaks occur.

Table 5 Combined OF001/003 minimum average 30-day removal efficiency

System	Season	Efficiency Limit	BOD Removal Efficiency	TSS Removal Efficiency
Combined OF001/OF003	Summer	85% or more	87%	89%
	Winter	65% or more	77%	79%

Table 6 summarizes the main annual treatment performance measures for the CBWTP systems. This table provides a comparison of the performance against the average year model and permit values. This table summarizes the 44 wet weather events in Table 12, not including the three dry weather events in July that were affected by filamentous bacteria. Key parameters are in blue text for FY2022.

- Secondary treatment was maintained at 110 MGD, which meets the 110 MGD minimum required by the permit after FY 2014.
- Percent of wet weather volume treated through secondary was 57%, which exceeded the model target level of 54%.

When evaluating wet weather treatment, BES asks three questions:

- **Were wet weather flows treated to a high quality?** Yes. The plant saw minimum BOD and TSS removal efficiencies of 87% and 89%, respectively, during the summer season (with expected efficiencies of both being at least 85%), and 77% and 79%, respectively, during the winter season (with expected efficiencies of both being at least 65%).
- **Were flows to secondary treatment maximized?** Yes. See section 2.2.1.2.
- **Were effluent limits achieved at OF001 and OF003?** Effluent limits were met throughout the year except for the 30-day and 7-day BOD and TSS exceedances in July 2021 during recovery of the secondary system's health after a filamentous outbreak.

Table 6 CBWTP annual treatment performance data[2]

CBWTP Annual Treatment Performance													
Annual Treatment Characteristics	Average Year Model	*No CEPT* FY 2012	*With CEPT* FY 2013	*With CEPT* FY 2014	*With CEPT* FY 2015	*With CEPT* FY 2016	*With CEPT* FY 2017	*With CEPT* FY 2018	*With CEPT* FY 2019	*With CEPT* FY 2020	*With CEPT* FY 2021	*With CEPT* FY 2022	Trend
Annual Rainfall Depth (inches/year)	37	46.8	40.2	40.0	33.9	53.4	59.5	37.6	30.5	33.2	35.4	52.6	
Flows to CBWTP													
Influent Volume (MG/Year)	28,300	28,800	26,625	26,549	25,760	30,665	33,544	26,844	23,763	22,528	23,305	27,026	
Dry Weather Sanitary Volume (MG/Year)	22,100	20,200	19,496	19,471	19,609	20,179	22,358	21,635	20,037	18,624	17,657	18,632	
Captured CSO Flow - Volume (MG/Year)	6,200	8,600	7,129	7,078	6,151	10,485	11,187	5,209	3,726	3,904	5,648	8,523	
Total Volume Treated Thru Secondary (MG)	25,443	25,662	24,197	24,002	23,221	26,301	28,765	24,947	22,173	21,176	21,129	23,345	
% of Plant Flow Treated Through Secondary System	90%	89%	91%	90%	90%	86%	86%	93%	93%	94%	91%	86%	
WWTF (EWWPT) Events													
Rate to DW / Secondary During EWWPT (MGD)	100	120	126	112	112	117	119	117	118	111	111	110	
Number of Events / Year	32	29	22	27	27	39	41	37	35	37	35	44	
WWTF Volume / Year	2,857	3,138	2,429	2,546	2,540	4,363	4,779	1,897	1,590	1,352	2,175	3,681	
Amount of Captured CSO Treated via Secondary (%)	54%	64%	66%	64%	59%	58%	57%	64%	57%	65%	61%	57%	
Duration of WWTF Events (hours)	919	706	668	904	591	1241	1333	602	387	338	556	860	
Calendar Days of WWTF Discharges (days)	---	66	50	65	51	92	99	65	52	53	59	82	
Blended Effluent (OF001 & 003) Treatment													
BOD Loading (pounds / year)	2,510,000	4,000,000	2,957,783	3,472,307	4,176,834	3,871,106	4,554,872	3,046,966	2,786,772	2,925,285	3,014,266	3,907,860	
BOD Average Concentration (mg/l)	27	16.6	13.3	15.7	19.4	15.1	16.3	13.6	14.1	15.6	15.5	17.3	
Total Plant BOD Removal Efficiency (%)	---	93%	95%	94%	93%	93%	92%	95%	95%	94%	93%	92%	
TSS Loading (pounds / year)	2,440,000	5,050,000	3,585,748	4,055,479	4,413,412	4,910,264	5,248,619	3,738,873	3,237,714	2,962,541	3,276,139	4,493,102	
TSS Average Concentration (mg/l)	27	21.0	16.1	18.3	20.5	19.2	18.8	16.7	16.3	15.8	16.9	19.9	
Total Plant TSS Removal Efficiency (%)	---	92%	94%	93%	92%	92%	92%	94%	95%	94%	93%	91%	

[2]* The permit average for "Rate to DW/Secondary During EWWPT (MGD)" rose to 110 MGD from 100 MGD in 2014 (applicable for FY 2015 and onwards).

Examination of the annual results indicates that the CSO system operations strategy continues to sustain desired performance and can handle various conditions throughout the year, even with large changes in rainfall amounts year over year, during normal conditions. However, changes in treatment strategy were incorporated due to ongoing filamentous outbreaks. Usage of the CEPT system during dry weather conditions was attempted and mitigated the loss of secondary treatment capacity and may be employed in future dry weather seasons when needed per Schedule B, Section B1 of the NPDES permit. Operations also initiated a pilot for using different chemicals in the CEPT system to avoid the depressed pH levels that have been observed when ferric chloride and sodium bisulfite are used. BES is progressing with the evaluation of other alternatives to address the low dissolved oxygen (DO) and excessive filamentous bacteria growth.

2.3.2.2 CBWTP Max-Month and Peak-Week Treatment Performance

Table 7 summarizes maximum 30-day treatment results for BOD and TSS for the winter season (November 2021-April 2022). Table 8 summarizes the results for the summer season (July – October 2021 and May – June 2022). While the permit requires reporting of maximums on a calendar month basis, this evaluation uses a more stringent moving 30-day window analysis. Maximum 30-day concentrations and loadings for both BOD and TSS at both outfalls for the maximum 30-day period year-round (ending January 9th, 2022 for both BOD and TSS) were below the maximum monthly limits for the winter season. The maximum monthly concentration allowed by the permit is 30 mg/l for both summer and winter seasons. During the summer season monthly limits were exceeded for BOD with concentrations of 46 mg/l; TSS fared well under the threshold with 20 mg/l. The BOD exceedance was a continued consequence of the secondary system upset described earlier.

Table 9 summarizes peak 7-day treatment results for BOD and TSS in the winter season, and Table 10 summarizes peak 7-day treatment results for BOD and TSS in the summer season. The NPDES permit requires reporting of peaks on a calendar week (Sunday to Saturday) basis. The following analysis uses a more stringent moving 7-day window. Concentrations and loading for both 7-day BOD and TSS for the maximum period during the winter and summer were below the permit's maximum weekly limit of 45 mg/l. The peak week effluent concentrations for the summer season were 30 mg/l and 27 mg/l for BOD and TSS, respectively. For the winter season, the peak week effluent concentrations were 27 mg/l and 35 mg/l for BOD and TSS, respectively.

Table 7 FY2022 CSO Max-Month (30-Days of Solids Loading) Treatment Performance - Winter Season

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	24	143	45,000	28,935	9-Jan-22	12.2 inches of rain in 30d
TSS	30	29	143	45,000	34,056	9-Jan-22	

Table 8 FY2022 CSO Max-Month (30-Days of Solids Loading) Treatment Performance - Summer Season

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	**46**	43	45,000	16,515	1-Aug-21	0.0 inches in 30d (BOD), 5.2 inches in 30d (TSS)
TSS	30	20	97	45,000	15,919	9-May-22	

Table 9 FY 2022 CSO Peak Week (7-Days of Solids Loading) Treatment Performance - Winter Season

Parameters	Peak Week (7-Day)						
	Avg Concentration During Peak Mass Loading Week			Mass Loading			
	Permit	Max	7-Day Avg	Permit	Max	Date of 7th	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality							
BOD5	45	28	203	118,800	47,245	8-Jan-22	4.5 inches of rain in 7d
TSS	45	35	187	118,800	54,870	24-Dec-21	

Table 10 FY2022 CSO Peak Week (7-Days of Solids Loading) Treatment Performance - Summer Season

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	30	92	118,800	22,865	11-Jun-22	2.5 inches of rain in 7d
TSS	45	27	115	118,800	25,893	11-Jun-22	

2.4 Wet Weather Treatment Performance for Enhanced Wet Weather Primary Treatment Events

Wet weather treatment performance is best evaluated by examining the events in which the Wet Weather Treatment Facility (WWTF) discharged treated effluent. These events are called Enhanced Wet Weather Primary Treatment (EWWPT) events to underscore that the wet weather flow diverted from the secondary system receives CEPT.

An EWWPT event begins when the WWTF starts discharging effluent and ends after either of the following:

- WWTF discharge has ended AND the plant inflow remains below 80 MGD for 6 hours (transition to dry weather conditions has completed) OR
- WWTF discharge has ended and no subsequent WWTF discharge occurs for 48 hours. This condition may occur when low level rainfall keeps plant inflows up, but Operations is able to send all inflows through secondary treatment.

As discussed in Section 2.3.2.1, the outbreak of filamentous bacteria forced Operations to use CEPT equipment during dry weather on several occasions to alleviate stress on the secondary system and help restore biological process health. These circumstances of these events have been well-documented and communicated to Oregon DEQ through a series of monitoring reports.

Table 11 summarizes the WWTF events for FY 2022 (required by the permit, Schedule A, Condition 2.f). The full, detailed list of the events is in Table 12.

Table 11 Enhanced wet weather primary treatment events summary

		CBWTP Flows		WWTF Flows				WWTF Effluent			
Events		Avg Influent During EWWPT (MGD)	Avg Secondary Flow During EWWPT (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	44	-	-	-	3,681	860	82	1,304,359	1,115,821	-	-
Average/Event		201	110	78	84	19.6	1.9	29,645	25,360	54	42

Key aspects WWTF performance for FY 2022 include:

- The first three events in Table 12 were omitted from this analysis due to the nature of these events. BES notified DEQ when using the CEPT equipment during dry weather conditions to aid in biological process recovery from the filamentous bacteria outbreak in June 2021. The resulting WWFT effluent statistics should be noted but not regard as a normal EWWPT event.
- Volume of EWWPT events was just under 3.7 billion gallons. This is about 13.6% of the total volume received at the CBWTP for the year (27 billion gallons; see Table 6). This marks an increase from FY 2021 (9% of total CBWTP influent volume).
- An EWWPT event was in progress during 9.8% of the year for a total of 860 hours. WWTF discharge occurred on 82 calendar days (just over 1.5 days per week). This is an increase from FY 2021 which experienced 556 hrs (6% of the year) and 52 calendar days (1 day per week).
- Schedule A, Condition 2.d stipulates that a minimum 110 MGD is required at the onset of any EWWPT event. The lowest flow at the onset of an EWWPT event was 129 MGD on 5/12/22 which meets the permit requirement.
- The average event mean concentrations (EMC) for BOD was 54 mg/l and 42 mg/l for TSS. This is a decrease in performance from FY 2021.
- Operators maintained an average of 110 MGD of flow through secondary treatment during EWWPT events, compared to the permit requirement of 110 MGD. This rate is 55% of the average flow rate reaching the plant during an EWWPT event (201 MGD).
- EWWPT events lasted 20 hours on average and typically occurred across 1.9 days. This is similar to other similarly wet years like FY2016 where the average event lasted 32 hours and typically occurred across 2.4 days.

BOD and TSS removal efficiencies compared to event volume are shown in Figure 5 (BOD) and Figure 6 (TSS). Small events tend to have higher BOD and TSS concentrations, while larger volume events conversely, have lower concentrations. The CEPT system achieves better than 50% BOD and 70% TSS removal efficiencies most of the time overall. Most wet weather events this fiscal year placed above the target efficiencies.

Table 12 Enhanced wet weather primary treatment events - detailed information

		CBWTP Flows		WWTF Flows				WWTF Effluent			
Date & Time Bypass Event Started	Event #	Avg Influent During EWWPT (MGD)	Avg Secondary Flow During EWWPT (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)
7/7/21 23:00	1*	46	27	13	214	385.8	18	317,793	71,591	178	40
7/24/21 12:00	2*	50	38	9	5	13.8	2	6,908	1,871	154	42
7/26/21 16:30	3*	57	49	8	0	0.8	1	186	36	91	18
9/18/21 5:00	4	212	108	97	120	29.8	2	47,740	32,969	48	33
9/27/21 10:15	5	255	113	133	126	22.8	2	35,385	30,825	34	29
10/5/21 15:30	6	199	109	81	12	3.5	1	6,343	2,883	65	29
10/21/21 20:45	7	220	113	96	64	16.0	2	23,113	16,101	43	30
10/23/21 10:30	8	227	112	102	36	8.5	1	13,504	11,407	45	38
10/29/21 4:30	9	244	112	120	39	7.8	1	11,559	8,348	36	26
11/4/21 2:15	10	206	109	81	10	3.0	1	12,438	8,707	147	103
11/4/21 15:30	11	169	111	47	8	4.0	1	12,438	8,707	190	133
11/6/21 13:15	12	147	102	42	23	13.0	2	10,587	6,806	56	36
11/9/21 3:30	13	223	109	80	12	3.8	1	3,287	2,545	32	24
11/11/21 6:30	14	288	117	162	380	56.3	3	112,651	108,501	36	34
11/15/21 16:15	15	152	109	32	5	3.8	1	2,838	2,927	68	70
11/18/21 21:00	16	132	101	23	13	13.5	2	5,687	3,239	53	30
11/23/21 0:45	17	182	109	61	17	6.8	1	8,830	8,536	61	59
11/26/21 3:00	18	180	108	50	5	2.5	1	2,670	2,416	61	55
11/29/21 7:00	19	139	109	11	1	1.3	1	201	143	41	29
12/6/21 9:15	20	255	112	131	44	8.0	1	13,874	10,954	38	30
12/11/21 5:30	21	265	114	141	135	23.0	2	50,065	32,947	44	29
12/12/21 20:00	22	184	110	66	70	25.5	2	28,149	19,503	48	33
12/15/21 14:15	23	184	110	66	39	14.0	2	20,193	11,261	63	35
12/18/21 18:30	24	313	123	180	421	56.0	4	134,451	135,041	38	38
12/22/21 18:00	25	174	109	65	34	12.5	2	17,150	11,132	60	39
12/24/21 5:45	26	234	111	111	80	17.3	1	24,583	23,254	37	35
1/3/22 1:30	27	260	117	135	644	114.8	5	203,084	169,257	38	31
1/13/22 15:30	28	135	109	11	1	1.5	1	148	162	26	29
1/19/22 13:45	29	149	107	34	33	23.3	2	18,454	12,068	67	44
2/27/22 19:15	30	232	110	115	466	97.5	5	155,469	164,016	40	42
3/14/22 23:00	31	152	111	32	2	1.5	2	1,121	1,063	67	64
3/21/22 10:45	32	149	110	32	22	16.3	2	7,659	4,662	42	26
4/4/22 4:15	33	235	110	114	50	10.5	1	15,349	15,349	37	37
4/10/22 22:15	34	182	109	65	206	76.0	5	95,560	94,617	56	55
4/14/22 20:15	35	225	109	96	19	4.8	2	10,765	10,820	68	68
4/18/22 16:15	36	229	110	95	23	5.8	1	10,074	10,074	53	53
4/19/22 11:45	37	208	110	83	19	5.5	1	9,608	9,680	60	61
4/29/22 23:45	38	178	107	49	43	20.8	2	15,584	0	44	0
5/5/22 12:45	39	233	109	106	27	6.0	1	12,094	6,495	55	29
5/6/22 9:00	40	223	110	101	113	26.8	2	39,736	31,414	42	33
5/8/22 21:00	41	212	109	70	9	3.3	1	4,050	2,187	51	28
5/12/22 15:00	42	129	108	7	1	4.8	1	628	1,137	51	93
5/13/22 23:15	43	204	110	81	52	15.3	2	14,031	5,739	33	13
5/15/22 15:30	44	203	109	68	9	3.3	1	3,858	4,173	50	54
5/28/22 17:00	45	134	98	34	18	12.8	2	7,294	4,824	49	32
6/9/22 22:30	46	220	110	101	221	52.5	4	78,183	68,718	42	37
6/17/22 20:30	47	162	109	38	9	5.5	2	3,876	212	54	3
Total	**44**				**3,681**	**860**	**82**	**1,304,359**	**1,115,821**		
Avg/Event		**201**	**110**	**78**	**84**	**20**	**1.9**	**29,645**	**25,360**	**54**	**42**

*BES notified DEQ of using the CEPT process during dry weather conditions, which falls outside of normal plant operation, as described in Section 2.3.2.1.

Figure 5 WWTF BOD removal efficiency vs. event volume

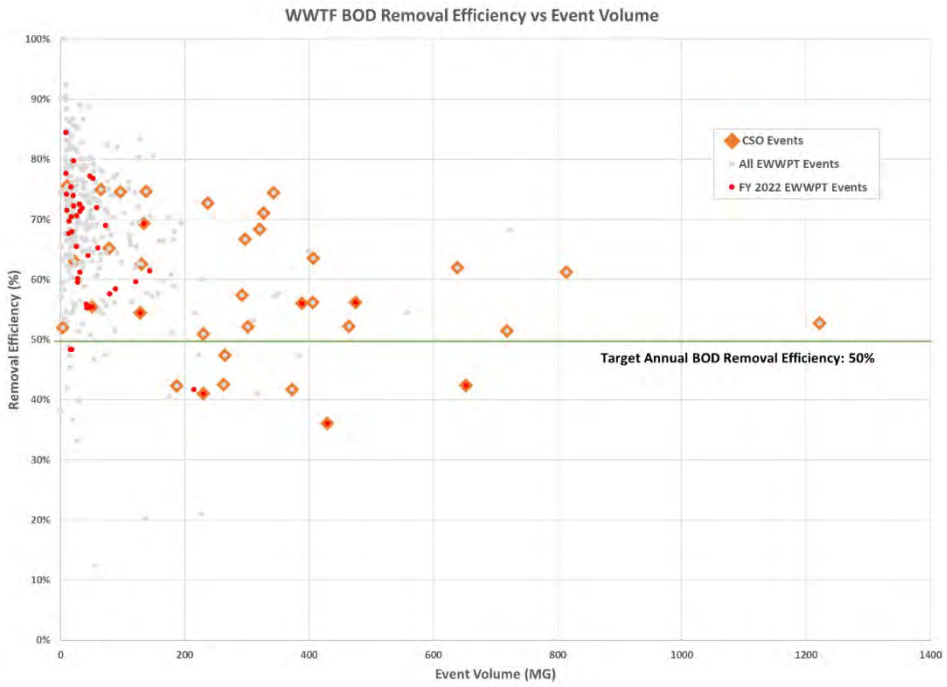
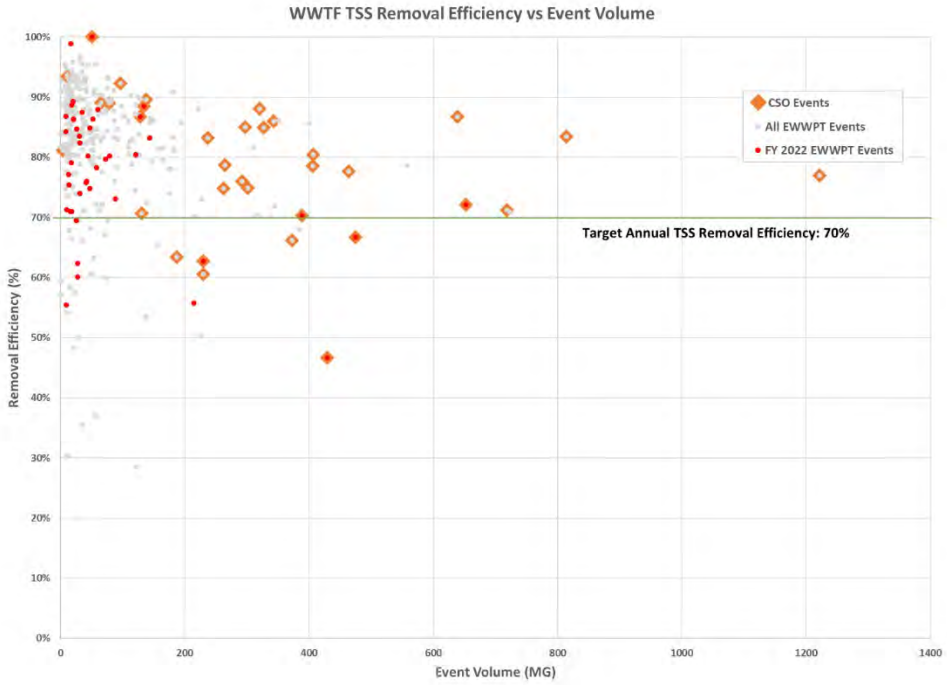


Figure 6 WWTF TSS removal efficiency vs. event volume



2.5 CSO System and Water Quality Monitoring

2.5.1 CSO Discharge Sampling

The CBWTP NPDES permit requires opportunity-based sampling of CSO discharges from the Willamette CSO Tunnel system. The purpose of this sampling is to confirm that CSO discharges protect beneficial uses and provide for attainment of the Willamette River water quality standards (Schedule A, Condition 5.b.iii). The City reports results of the sampling in this section for each year in which viable samples are collected.

The 2020 NPDES permit modifies the CSO sampling program dictated by the 2011 permit by requiring analysis for Total Dissolved Copper plus biotic ligand model (BLM) parameters instead of just Total Dissolved Copper. Otherwise, the discharge sampling is identical to that reported in the FY 2015 Annual CSO/CMOM report.

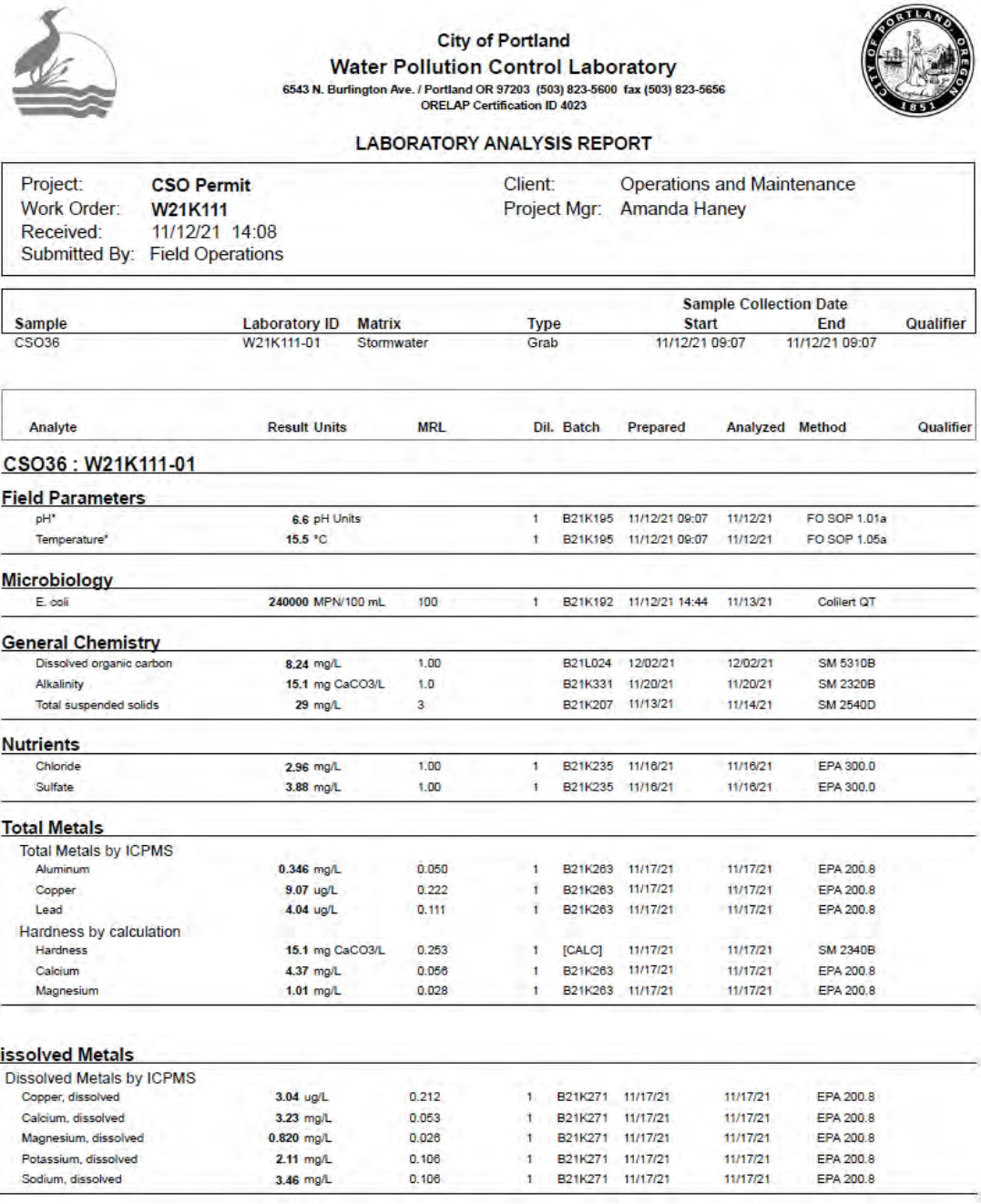
Portland obtained its third sample for the current NPDES permit, of which five are required for the current cycle, per Schedule A, Condition 5.b.iii.(A). Figure 7 shows the laboratory analysis report for the November 12, 2021, event. This grab sample was collected near Outfall 36 (Alder).

BLM and Oregon Copper Rule. Table 13 compares the instantaneous water quality criteria (IWQC) calculated using the copper BLM with the grab samples above. For the November 12, 2021, event the CSO sample of 3.04 µg/L exceeded the IWQC for chronic criteria (CCC) of 2.54 µg/L at the end of pipe. NPDES Permit #101505, Schedule A, Condition 3.b grants a regulatory mixing zone (RMZ) for the SE Alder outfall with a 10:1 dilution for total copper. Applying the dilution, the November 12, 2021, discharge event does not have reasonable potential to exceed the water quality criteria.

Table 13 Copper BLM comparison

	Ambient Values					Event Comparison	
Event	Final Acute Value (µg/L)	CMC (µg/L)	CCC (µg/L)	Cu (µg/L)	Acute Toxic Units (µg/L)	CSO Sample (µg/L)	CSO Sample > CCC?
11/12/2021	8.1657	4.0828	2.5359	0.485	0.1188	3.04	Yes

Figure 7 November 12, 2021, CSO Discharge Water Quality Sample Result - OF 36



City of Portland
Water Pollution Control Laboratory
6543 N. Burlington Ave. / Portland OR 97203 (503) 823-5600 fax (503) 823-5656
ORELAP Certification ID 4023

LABORATORY ANALYSIS REPORT

Project:	**CSO Permit**	Client:	Operations and Maintenance
Work Order:	**W21K111**	Project Mgr:	Amanda Haney
Received:	11/12/21 14:08		
Submitted By:	Field Operations		

Sample	Laboratory ID	Matrix	Type	Sample Collection Date Start	Sample Collection Date End	Qualifier
CSO36	W21K111-01	Stormwater	Grab	11/12/21 09:07	11/12/21 09:07	

Analyte	Result	Units	MRL	Dil.	Batch	Prepared	Analyzed	Method	Qualifier
CSO36 : W21K111-01									
Field Parameters									
pH*	**6.6**	pH Units		1	B21K195	11/12/21 09:07	11/12/21	FO SOP 1.01a	
Temperature*	**15.5**	°C		1	B21K195	11/12/21 09:07	11/12/21	FO SOP 1.05a	
Microbiology									
E. coli	**240000**	MPN/100 mL	100	1	B21K192	11/12/21 14:44	11/13/21	Colilert QT	
General Chemistry									
Dissolved organic carbon	**8.24**	mg/L	1.00		B21L024	12/02/21	12/02/21	SM 5310B	
Alkalinity	**15.1**	mg CaCO3/L	1.0		B21K331	11/20/21	11/20/21	SM 2320B	
Total suspended solids	**29**	mg/L	3		B21K207	11/13/21	11/14/21	SM 2540D	
Nutrients									
Chloride	**2.96**	mg/L	1.00	1	B21K235	11/16/21	11/16/21	EPA 300.0	
Sulfate	**3.88**	mg/L	1.00	1	B21K235	11/16/21	11/16/21	EPA 300.0	
Total Metals									
Total Metals by ICPMS									
Aluminum	**0.346**	mg/L	0.050	1	B21K263	11/17/21	11/17/21	EPA 200.8	
Copper	**9.07**	ug/L	0.222	1	B21K263	11/17/21	11/17/21	EPA 200.8	
Lead	**4.04**	ug/L	0.111	1	B21K263	11/17/21	11/17/21	EPA 200.8	
Hardness by calculation									
Hardness	**15.1**	mg CaCO3/L	0.253	1	[CALC]	11/17/21	11/17/21	SM 2340B	
Calcium	**4.37**	mg/L	0.056	1	B21K263	11/17/21	11/17/21	EPA 200.8	
Magnesium	**1.01**	mg/L	0.028	1	B21K263	11/17/21	11/17/21	EPA 200.8	
Dissolved Metals									
Dissolved Metals by ICPMS									
Copper, dissolved	**3.04**	ug/L	0.212	1	B21K271	11/17/21	11/17/21	EPA 200.8	
Calcium, dissolved	**3.23**	mg/L	0.053	1	B21K271	11/17/21	11/17/21	EPA 200.8	
Magnesium, dissolved	**0.820**	mg/L	0.026	1	B21K271	11/17/21	11/17/21	EPA 200.8	
Potassium, dissolved	**2.11**	mg/L	0.106	1	B21K271	11/17/21	11/17/21	EPA 200.8	
Sodium, dissolved	**3.46**	mg/L	0.106	1	B21K271	11/17/21	11/17/21	EPA 200.8	

2.5.2 Willamette River Instream Water Quality Sampling

Figure 8 through Figure 12 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 sampling results indicate continued similar performance as previous recent fiscal years.

Figure 8 Willamette River monitoring results for zinc

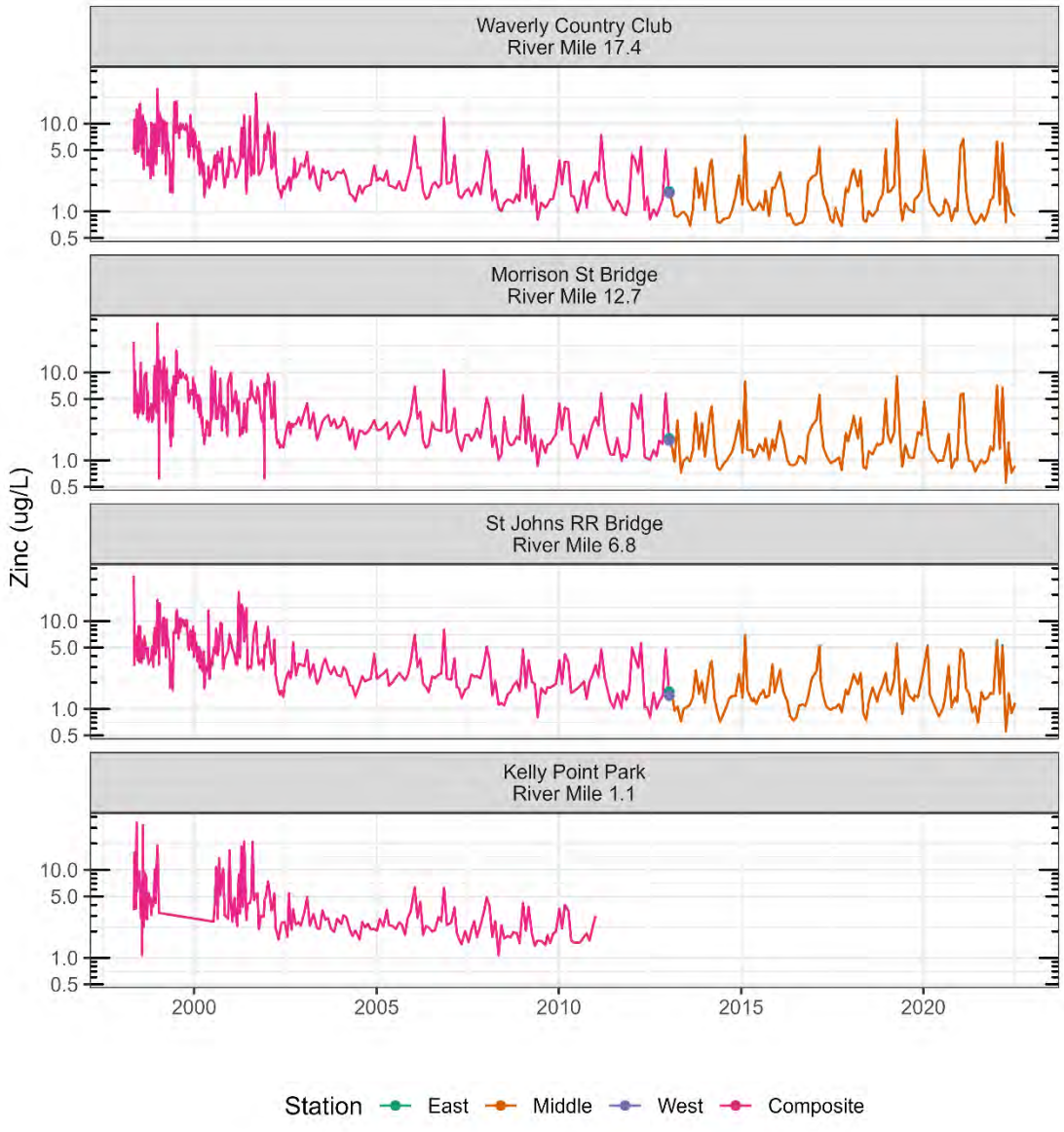


Figure 9 Willamette River monitoring results for lead

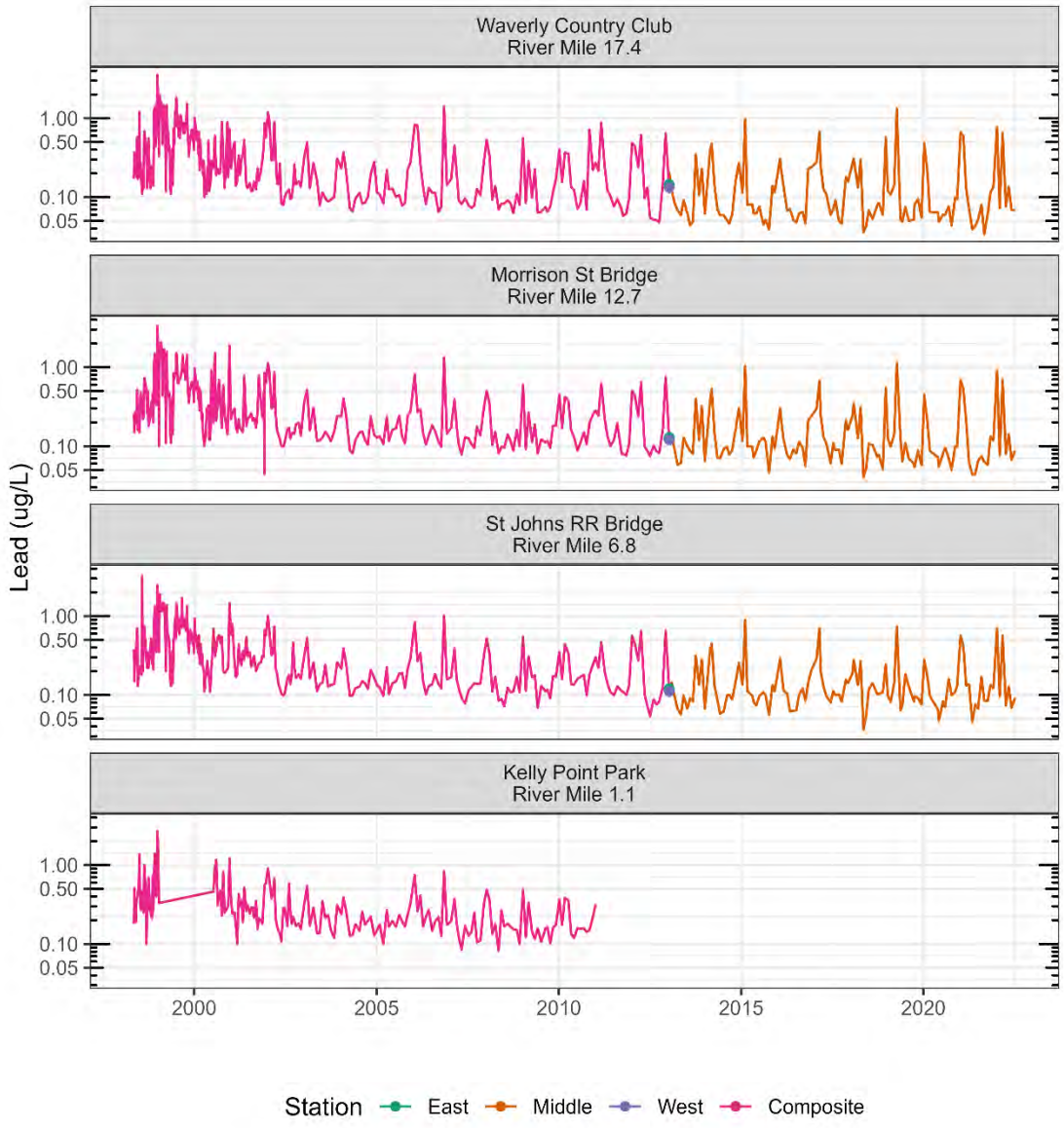


Figure 10 Willamette River monitoring results for copper

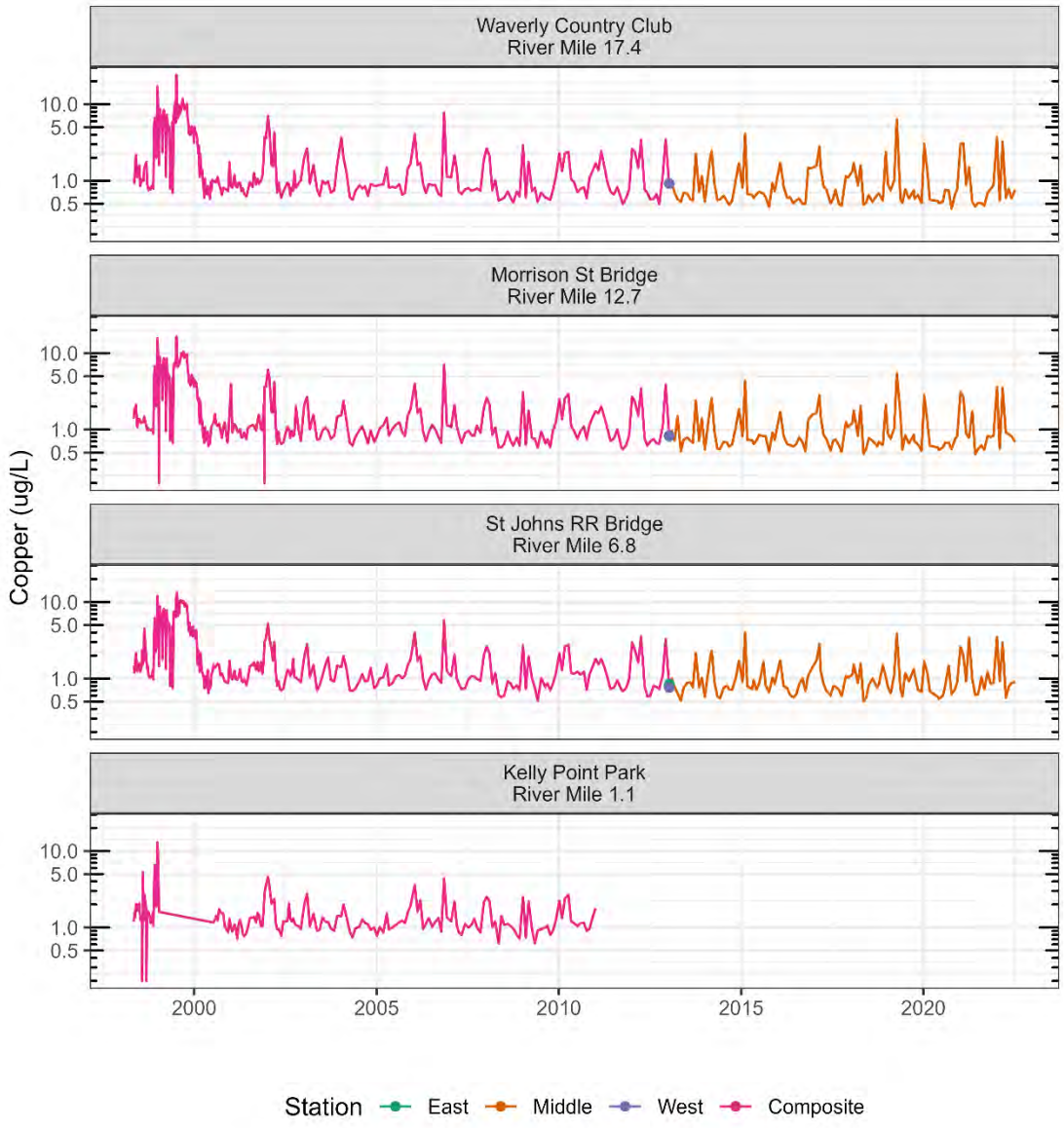


Figure 11 Willamette River monitoring results for TSS

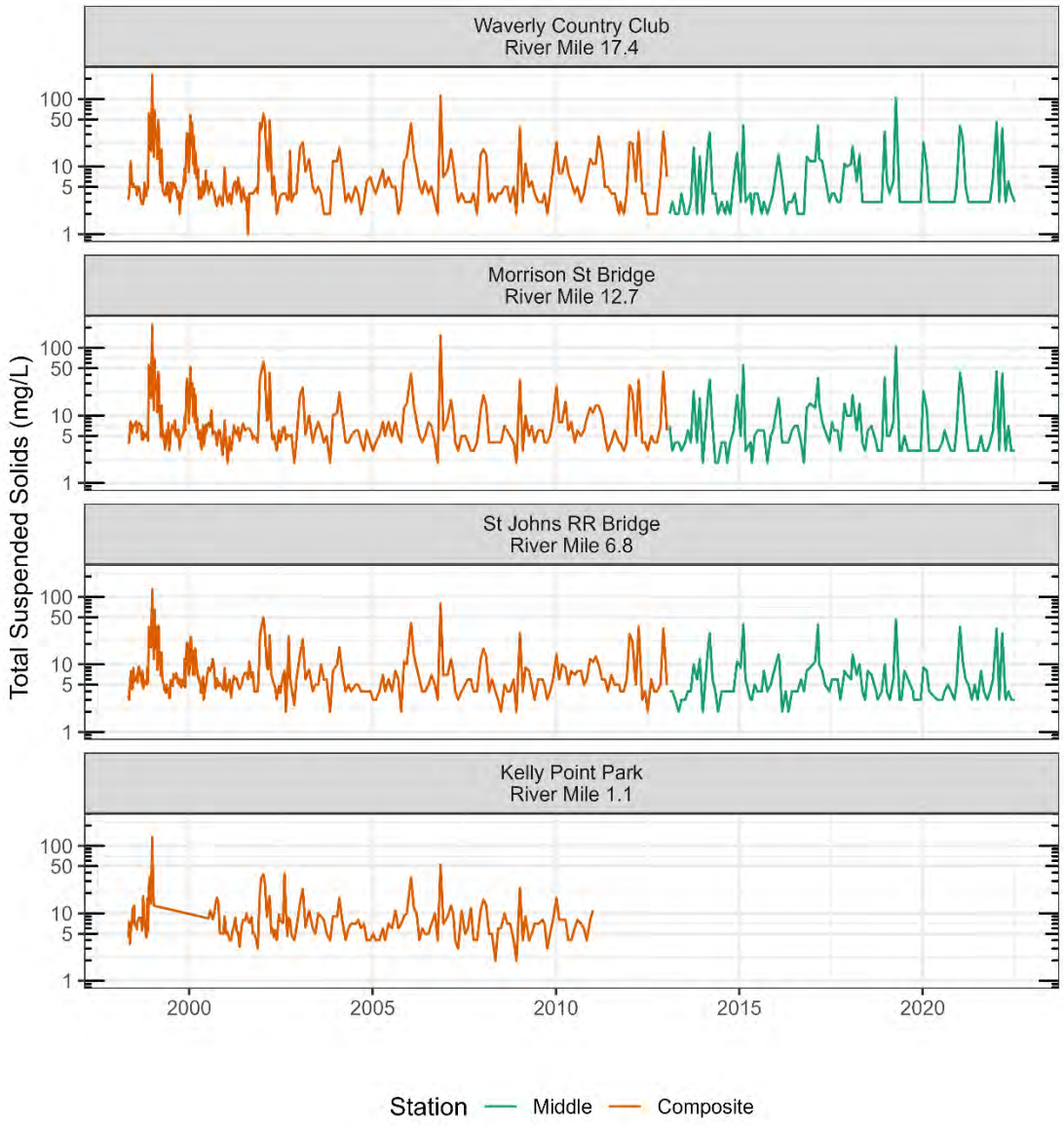
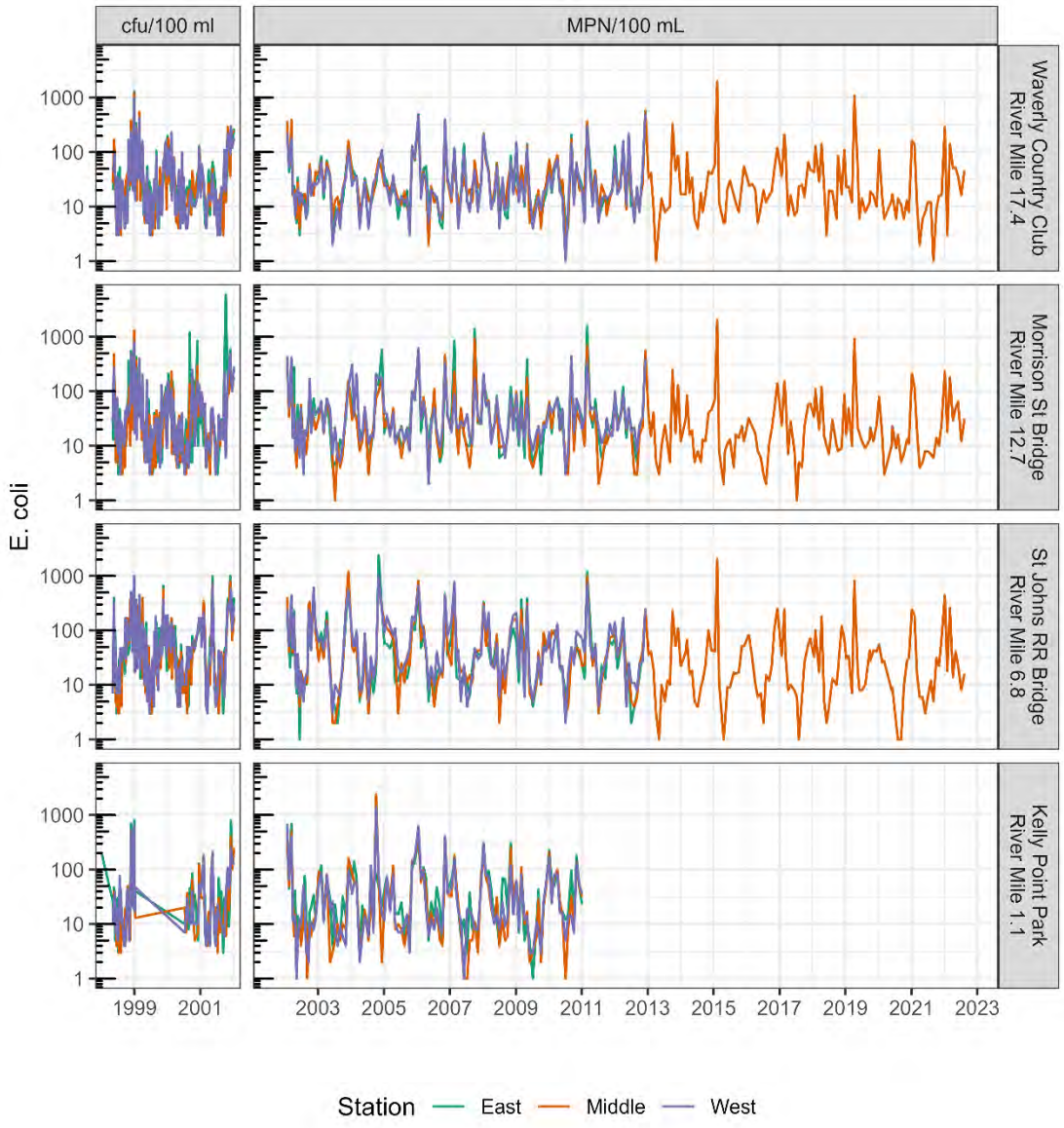


Figure 12 Willamette River monitoring results for *E. coli*



Section 3 CMOM Program Implementation

The City of Portland's CMOM program is 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 2022 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.

3.1 Collection System – Gravity Sewers Operation and Maintenance

BES has programs in place to ensure that gravity sewers and maintenance holes 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, can extend an asset's useful life, and reduces the potential for catastrophic failures.

3.1.1 Sewer Inspections and Cleaning

The *Collection System Inspection and Cleaning Plan* submitted to DEQ in December 2012 provides detailed information about the City's "needs-based" maintenance strategy for prioritizing maintenance, inspection and cleaning activities and expenditures. The inspection and cleaning programs contain both preventive maintenance and unplanned work.

In FY 2022, the sewer inspection program inspected 967,199 linear feet (183 miles) of mainline sewer pipe, which corresponds to approximately 9.5% of the mainline sewer system. Sewer mainlines are inspected for general preventive maintenance, special investigations in support of the chemical root and grease management programs, in response to sewer problems, and to support asset reinvestment

projects through the CIP. In FY 2022, approximately 94% of the work orders in the mainline inspection program were considered planned work, including general preventive maintenance and support of the City's CIP Sewer Rehabilitation Program. The CCTV inspection program provides the pipeline condition assessment information that is instrumental to the risk prioritization process used to drive the CIP Rehabilitation Program work. In addition to mainline sewer inspections, the City performed service lateral inspections on 561 assets in FY 2022.

In FY 2022, the sewer cleaning program cleaned 1,246,479 feet (236 miles) of sewer pipe, which corresponds to approximately 12.3% of mainline sewer system. The sewer cleaning program includes preventive maintenance, accelerated cleaning in grease management areas, support for the root treatment program, special investigations related to collection system problems, and support of CIP projects.

In FY 2022, 96% 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.

In support of BES's integrated approach towards overall watershed health, Maintenance Engineering and Watershed Services staff conducted stream walks and data analysis to assess external factors that might affect sewer pipes near streams.

Stream walks were conducted in March and April 2022. They were all in the West Willamette watershed and included the upper Marquam canyon, Iowa canyon, and the Illinois canyon. These walks followed 5,721 linear feet of sanitary and combined sewer mainline and 33 maintenance holes.

BES will continue to evaluate all the stream walk data collected to assess the usefulness of external visual inspection and observations of site conditions in conjunction with other preventive maintenance activities. BES has improved the data collection processes used in the field on stream walks. These improvements include fine-tuning the inspection observation and severity codes entered into Hansen and also gaining the ability to enter them into a Hansen compatible system directly while in the field.

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 maintenance

hole repair program. Priority codes in Hansen[3] 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 Sanitary Sewer Overflow (SSO) and hazard-related repairs). The *CMOM Program Report* includes descriptions of sewer repair maintenance activities and equipment.

During FY 2022, 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 Maintenance Capital Contract Program or emergency CIP projects.

City maintenance crews completed mainline sewer repairs totaling 6,538 linear feet. Approximately 52% of these repairs were considered 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 either from defects identified by the preventive maintenance CCTV inspection program or when additional repairs on a line are made in conjunction with an unplanned repair. Repairs on mainline sewers are typically localized spot repairs where pipe sections are excavated and replaced or renewed using cured-in-place pipe (CIPP) liners.

City crews completed 549 service lateral repairs totaling approximately 6,051 linear feet. Approximately 57% 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 or renewal 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 2022, 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

[3] *Hansen* refers to Infor Public Sector, © 2017 Infor. All rights reserved. www. infor.com

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 2022, 307,806 linear feet (58 miles) of mainline sewer were chemically treated for roots. In addition to chemical root foaming, City crews cleaned approximately 9900 linear feet of sewer to locally remove roots using root saws and conventional cleaning in support of sewer inspection activities as well as in response to sewer system problems.

3.1.4 Grease Management and Control Actions

In FY 2022, one sewer release from the City-maintained sewer system was attributable to grease. This low number emphasizes the effectiveness of 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*.

Areas of the collection system vulnerable to FOG buildup and blockages are managed on a more frequent preventive maintenance and cleaning cycle (AGCA – Accelerated Grease Cleaning Area). In FY 2022, there were 23,398 linear feet (4.4 miles) of Accelerated FOG-related sewer lines in the program. Not all mains in the program are cleaned or inspected every year. Cleaning and inspection frequencies are variable depending on the severity of the issue. During the FY, 16,851 linear feet of cleaning was completed, and 5,575 linear feet of mainline sewer received FOG-related CCTV inspections.

The FOG management program has continued to proactively inspect food service establishments in the City of Portland and the City of Lake Oswego to ensure that grease interceptors are installed correctly, in a proper state of repair, and are cleaned at the proper frequency. FOG staff completed 180 program educational outreach inspections at food service establishments, 1,021 grease interceptor cleaning inspections, and 64 CCTV inspections of food service establishment (FSE) sewer laterals in FY 2022. FOG enforcement actions in FY 2022 are summarized in Table 14.

Table 14 FOG Enforcement Activities in FY 2022

Description	Number	Requirement
Warning Notice	87	Increase grease removal device cleaning frequency
	26	Repair or replace grease removal devices
Notice of Violation (NOV) with Civil Penalties/ Cost Recovery	7	Plumb all fixtures to a grease interceptor
	0	Service grease interceptor at prescribed cleaning frequency
	1	Make required grease interceptor repairs
	0	Escalated enforcement for failing to meet compliance dates for original NOV

The FOG Coordination Team continues to meet three times a year 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.

The Plan Review Section is an important component of BES's control of FOG. In FY 2022 the work of the Plan Review Section resulted in the FOG program adding 51 food service establishments with grease interceptors installed to current Oregon Plumbing Specialty Code due to new development, redevelopment, or enforcement requirements.

3.1.5 Maintenance Hole Inspection

Early in FY 2022, BES made the decision to temporarily suspend the risk-based Tier 2 maintenance hole inspections. Due to limited staffing, difficult decisions needed to be made with regards to the prioritization of various tasks. While past maintenance hole inspections have been useful in identifying the need for repairs, a higher priority was placed on completing routine mainline sewer cleaning and CCTV inspections. In FY 2023, the City plans on resuming the Tier 2 maintenance hole inspection program.

In FY 2022, 25 Tier 2 maintenance hole inspections were completed. Of the Tier 2 maintenance holes inspected in FY 2022, one needed total replacement and one needed a minor repair.

Section 4 Sewer Release Analysis and Performance

The City of Portland's *Sewer Release Response Plan* (SRRP), submitted to the Oregon Department of Environmental Quality (DEQ) in December 2011 and adopted on January 1, 2012, 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 reporting releases to DEQ. BES 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.

BES maintains sewer release data within the Hansen computerized maintenance management system (CMMS), allowing service call information to be connected with follow-up actions and 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 15. BES further categorizes weather-related sewer releases, as shown in Table 16, to more directly associate these releases with the City's levels of service established through the BES Asset Management Improvement Program.

Table 15 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 16)
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
Surcharge	BES collection system surcharging but not weather event related
Cause Unknown	A release where the investigation does not identify a specific cause

Table 16 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, 6-hour storm
Force majeure	Rainfall exceeds 25-year storm (the BES level of service is to convey combined sewage 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.

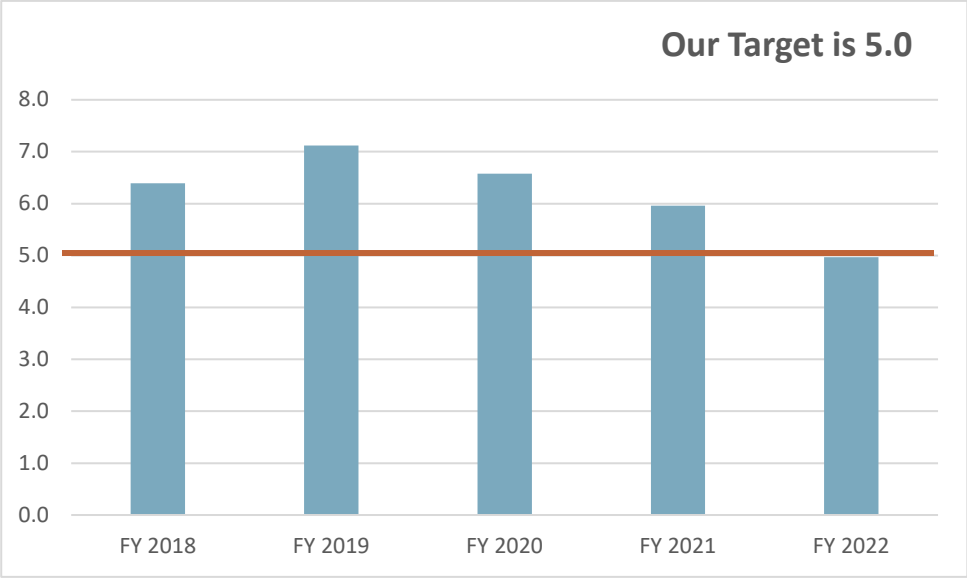
4.2.1 SSOs per Hundred Miles of Pipe

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 2022, BES owned and maintained approximately 1,925 miles of mainline sanitary and combined sewers, and 733 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 2022, the City experienced 132 sewer releases over the 2,658 miles of collection system, which is approximately 5.0 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 totals in this report reflect current records and may not match previous years' reports and/or monthly discharge monitoring report submittals. A comparison with previous fiscal years is shown in Figure 13.

Figure 13 SSOs per 100 miles of sewer (lower numbers are better)



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 2 hours of receiving the initial call reporting an urgent sewer release. BES 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 2-hour on-site response goal does not apply.

Response time performance for FY 2022 is shown in Table 17. A comparison with previous fiscal years is shown in Figure 14. Sewer emergency response crews arrived on site within the City's 2-hour response time target 97% of the time during FY 2022.

Figure 14 SSO response time comparison

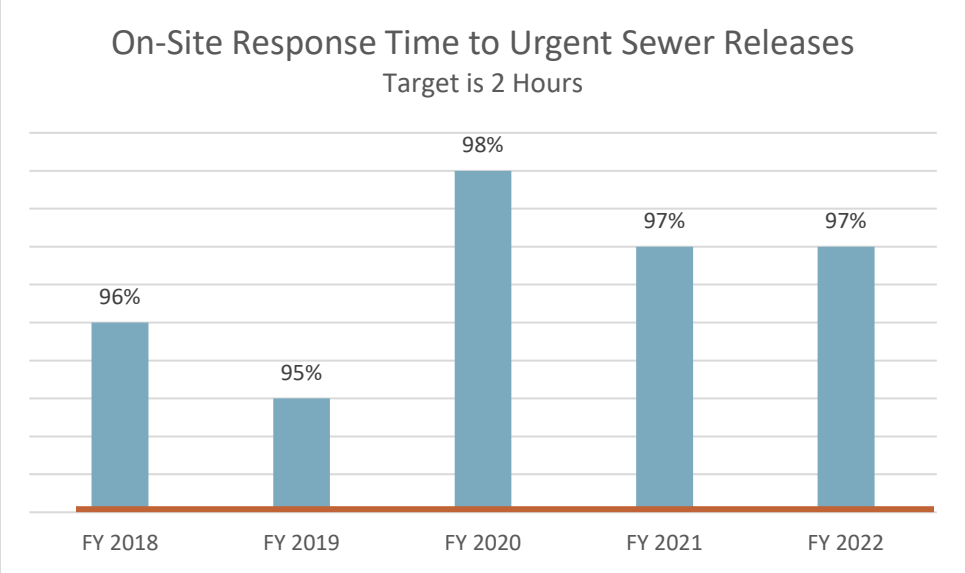


Table 17 SSO Response Time and Counts for FY 2022

FY 2022 Urgent Sewer Release Calls	Number of Calls	Percent of Total
Urgent Calls with Response Time Less Than 2 Hours	387	97%
Urgent Calls with Response Time 2 Hours or More	13	3%
Total	400	100%

4.3 Analysis of Causes and Locations of Sewer Releases

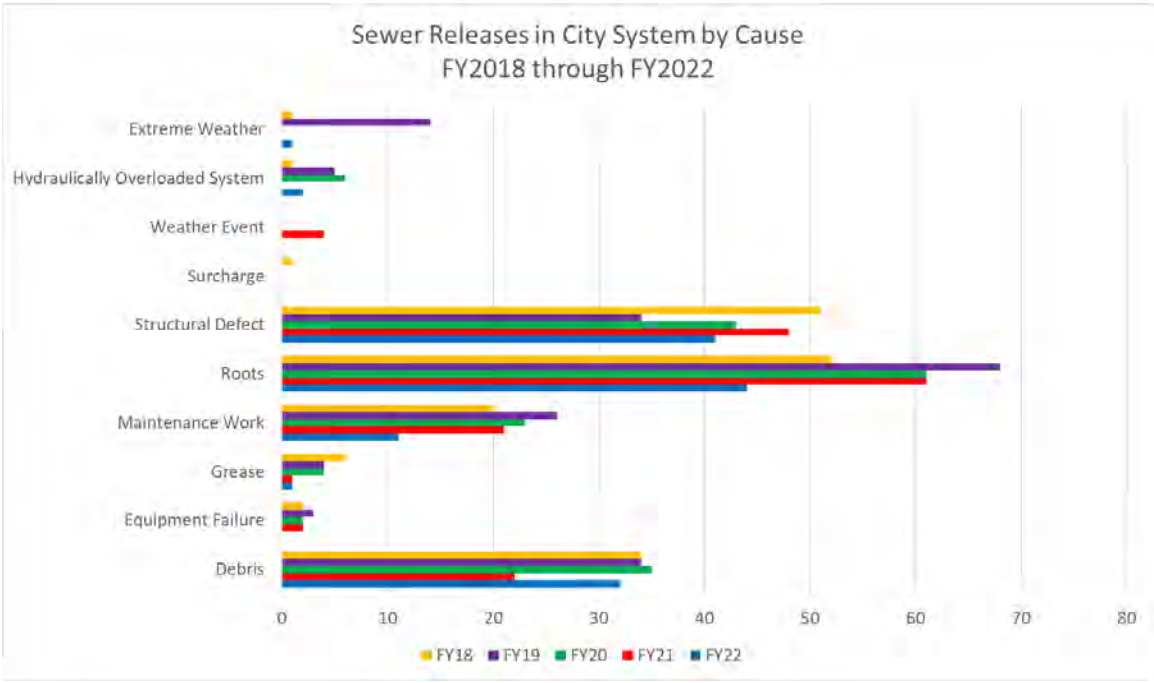
During FY 2022, the City experienced 132 releases from the sanitary and combined sewer systems. There were no weather-related release events in FY 2022 that exceeded the design capacity of the collection system (referred to as *force majeure*). However, there were three releases related to weather issues. There were 51 sewer releases associated with mainlines, maintenance holes, and pump stations, which equates to 2.6 releases per 100 miles of mainline sewer. There were also 81 sewer releases caused by issues in the sewer laterals, which is approximately 11.1 releases per 100 miles of sewer lateral pipe.

A chart comparing the causes of releases in FY 2018 through FY 2022 is shown in Figure 15. 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 2022 are shown on the map in Figure 16.

In addition to the rigorous investigatory research conducted by BES 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.

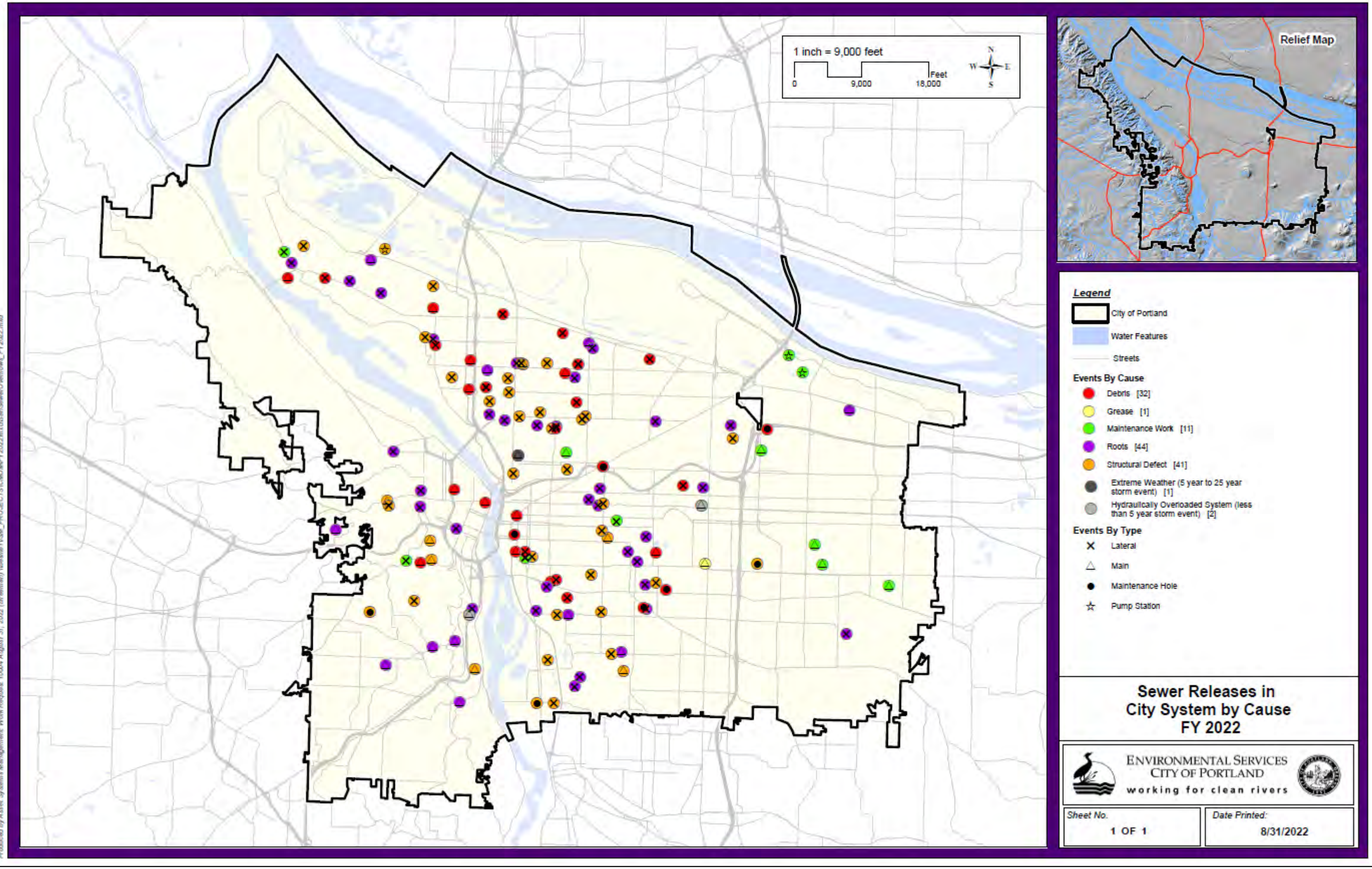
Figure 15 Comparison of causes of sewer releases in FY 2018 through FY 2022



Notes:
[1]The chart excludes weather related force majeure events from storms with greater than 1-per-25 year return interval
[2]Extreme Weather includes storms greater than 1-per-5 year but less than 1-per-25 year, and ice or snow events
[3]Hydraulically Overloaded System includes storms less than equal to 1-per-5 year return interval
[4]Weather Event includes release caused by ice/snow issues
[5]Surcharge is a release caused by a non-weather event

Structural Defects. There were 41 releases caused by structural defects in FY 2022: 30 were associated with defective laterals, seven from mainline sewers, three from maintenance holes, and one from a pump station. As part of the City's CIP sewer rehabilitation program, poor condition mainline sewers are identified for repair. The laterals connecting to those pipes are inspected during the design process and included for replacement or rehabilitation if structurally deficient. The risk of releases associated with structural defects should decrease as the large number of sewer repair, rehabilitation, and replacement CIP projects currently in design or under construction are completed.

Figure 16 FY 2022 sewer release map



Roots. During FY 2022, of the 44 releases caused by roots, 11 were in sewer mainlines and 33 were in service laterals. To reduce the risk of future root intrusion, City crews installed CIPP liners or excavated and replaced the majority of laterals where releases occurred in FY 2022.

Maintenance. In FY 2022, there were 11 releases associated with maintenance activities: 5 of the occurrences were associated with mainlines, four were associated with laterals, and two were associated a pump station failure. Seven of the 11 releases were associated with sewer cleaning operations; many of these releases were "bowl water" from toilets and the volume was less than 10 gallons (two of these releases were attributed to BES contractors). While precautions are taken to prevent these "blow back" 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. Special precautions, such as using cleaning nozzles with steeper jet angles and running lower pressures, are taken in areas prone to blow back.

Two maintenance-related releases were associated with either sewer repairs or other construction projects. One release involved installation of a CIPP liner by a City crew. The other release occurred when a city paving crew damaged a shallow sewer lateral. The two releases related to pump station issues were from the same incident on the same day and are described in Section 4.3.1 below.

Debris. There were 32 releases caused by debris in FY 2022, 12 of which were associated with mainlines, six from maintenance holes, and 14 from service laterals. In addition to accumulation of debris during normal system operation, introduction of foreign objects and debris into the system by third parties resulted in sewer releases in FY 2022. BES has requested inspections of maintenance holes to look for foreign objects in the sewer system in all areas where camping areas around the city had recently been cleared. This initiative began in response to specific incidents where foreign objects had been deposited into the sewer system and resulted in sewer releases. In addition, enforcement action is being pursued in response to utility contractors who bored through public sewers at several locations. Also, BES continues to conduct "what not to flush" public outreach.

4.3.1 Sewer Releases to Surface Water in FY 2022

Sewer releases to surface water occurred at four locations in FY 2022. The circumstances of these release events are described below. Although volume estimates are not always available, they are included in each event below when

possible. Public notifications were made following each release, as required by the NPDES permit and the City's SRRP.

4620 SW 42nd Place (release to Ivy Creek - a tributary of Fanno Creek). On September 18, 2021, a resident reported that a tree had fallen on the elevated section of main sewer line behind their house. They reported that the sewer line was damaged. The sewer line is above ground and on a concrete trestle as it crosses over Ivy Creek.

A City of Portland emergency crew immediately responded to the site and confirmed that the main sewer line was damaged, and that sewage was discharging to the creek below. DEQ was notified and BES issued a public notification reporting impact to the creek that same day.

The damaged section of sewer line was repaired, and the release was stopped at 11:20 AM on September 18th. The volume of the release was estimated at 1,000 gallons.

On September 23, 2021, BES followed up by installing a cured-in-place liner through the elevated section of sewer main to give it extra structural protection due to its proximity to surface water and to reduce the likelihood of failure if a similar incident occurs in the future at this location.

Due to the impact to Ivy Creek, water samples from the creek were collected for *E. coli* on September 22 and then again on September 29, 2021. The *E. coli* sample results indicated a return to baseline conditions not long after the release was stopped.

10420 NE Klickitat Street (release to the Columbia River). On December 14, 2021, city employees near the Portland Water Bureau's Klickitat facility observed sewage coming out of a maintenance hole. They reported this to PBOT's Maintenance Operations dispatch who immediately sent a crew to investigate.

On arrival, the PBOT crew observed sewage coming out of BES sanitary sewer maintenance hole AAZ525 located near the address of 10420 NE Klickitat Street. Released material was observed flowing across the ground surface and towards an inlet about 30 feet away. That inlet leads to a series of storm sewer mains which eventually outfall to the Columbia River near the I-205 bridge. The distance from the inlet to that outfall is approximately 2.5 miles.

The PBOT crew immediately called for a vactor truck to come to the site and clear the blocked main storm sewer main. The blockage was cleared at 15:30 on December 14th, stopping the release. The volume of the release was estimated at

6,000 gallons. DEQ was notified and sewage release signage was placed in the area that same day.

A follow up CCTV inspection of the previously blocked main sewer line segment was conducted. Evidence indicated that the blockage was caused by debris, including rags, in the sanitary sewer main. No structural defects were identified, and no repairs were needed.

5001 N Columbia Blvd. (release to the Columbia Slough). On March 3, 2022, a 30" diameter force main failed near a pedestrian bridge at the Columbia Boulevard Wastewater Treatment Plant (CBWTP). That pipe failure led to sewage escaping the pipe and reaching the ground surface. Sewage flowed over the ground surface for about 60 feet, ran under a fence, and then down an embankment into the Columbia Slough. A construction crew working in that area observed the sewage release and shut down the pump that supplied flow to that section of force main.

A PBOT emergency crew responded immediately and conducted an investigation. The release occurred within the fenced area of the CBWTP, reaching a heavily vegetated, steeply sloped area that leads to the Columbia Slough. There is no public access within the fenced area and little to no public access outside of it. There were no residual solids remaining on the ground after the released material had soaked into the ground. The volume of the release was estimated to be 2,000 gallons. DEQ was notified and BES also issued a public notification that same afternoon.

E.coli samples were collected from the Columbia Slough, both upstream and downstream of the point of impact, on March 3rd and on March 9th with the samples collected on March 9th indicating a return to baseline conditions. This portion of the force main has since been repaired.

BES is developing a force main condition assessment program to assess and manage that aspect of the sewer system. As that program develops, BES will be more likely to identify and repair problem locations within the force main system to reduce the likelihood of instances like these occurring in the future.

12002 NE Inverness Drive (release to the Columbia Slough). On June 2, 2022, a sewage release occurred at 12002 NE Inverness Drive (Inverness Pump Station) that resulted in sewage entering the Columbia Slough. The City was replacing a section of the Inverness Force Main at the Columbia Boulevard Treatment Plant that required the temporary shutdown of the Inverness Pump Station. The release was a result of operational issues associated with the shutdown and startup of the pumping system.

Prior to start of work, the City conducted a modeling analysis of flows into the Inverness PS. The analysis assumed dry weather conditions and was based on a review of previous inflow measurements at Inverness. It was determined that the pump station had 530,000-630,000 gallons, or approximately 6 hours of storage capacity, which was enough time to accommodate the repair activity. During the time the pump station is turned off, flows would be held in the wet well, and in the immediate upstream sewer lines. As an added safety factor, a plan was developed to shut off the Holman pump station, upstream of Inverness PS, which would further reduce flow going to the Inverness PS, and would create additional time for repair.

On June 2, 2022, the Inverness and Holman pump stations were taken offline to accommodate the force main repair work. BES staff were assigned to monitor water levels in the wet well. As the repair work progressed, staff observed water levels rising in the influent structure at 11:58 and it appeared the pump station was not able to move incoming flow from the influent structure to the storage tanks fast enough and would potentially overflow before the repair work would be completed. Two vactor trucks were dispatched to the site to remove some of the volume from the influent structure and help extend the time before an overflow occurred. However, before they arrived, a release of sewage occurred from the emergency outfall pipe at Inverness PS. The overflow pipe discharges to the nearby Columbia Slough.

Once the repair work at the Columbia Boulevard WTP was completed, and the Inverness and Holman pump stations were re-started, which stopped the release. A second release occurred from the outfall pipe at Inverness Pump Station when the Holman PS was turned on to pump its stored volume into the Inverness PS System. Since the water surface elevation (WSE) in the collection system was already elevated, the Inverness PS pumps could not manage both the stored volume in its collection system and the inflow from Holman PS fast enough, causing a surcharge spike. When crews became aware of the overflow, Holman PS was turned off, which stopped the release. The volume of the first release was 2,300 gallons, and the volume of the second release was 2,200 gallons, for a total release volume of 4,500 gallons.

BES is using the data collected during this event to review inflow and storage capacity assumptions to provide more confidence in shutdown timing of this Inverness PS system. BES is also optimizing the operations of the retention pumping and storage system to maximize the ability to store flows on site while the Inverness System is out of service. In addition, pipes exiting the inflow control structure will be dye tested to verify their function and surveyed if necessary to refine overflow alarm

settings. Lastly, the process for restoring operations when both the Holman and Inverness pump stations are taken out of service concurrently will be reviewed and formalized to ensure that excessive surcharge conditions are not created during the startup process.

4.4 Conclusions and Follow-Up Actions for Sewer Release Reduction

The City of Portland's CMOM program is 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. The City is also implementing a force main condition assessment program to create a framework by which the force main network assets can be assessed and managed. The intent is to develop a long-term, systematic maintenance plan for preventative activities such as inspection, cleaning, and repairs. BES continues to develop and improve the Hansen CMMS to facilitate work prioritization and asset management in the gravity collection system. BES's CMOM program effectively incorporates the essential elements and best management practices for proper operation and maintenance of the collection system.

BES continues to evaluate ways to improve the overall effectiveness of the sewer mainline cleaning program, specifically focusing on ways to reduce sewer releases related to operational problems such as grease, roots, and debris. There are multiple ways in which BES is pursuing this goal. For one, BES continues to reassess the thresholds for placing pipes into the chemical root treatment program. BES is also working on a methodology to expand the threshold for the accelerated cleaning program which would result in more main line sewers with grease, roots, and debris being included. In addition to enhancing our general preventative maintenance approach, our current practice is to place any pipe that experiences a sewer release associated with roots or debris onto an enhanced monitoring schedule. Although operational issues continue to challenge the daily operations of the collection system, it should be noted that the number of mainline sewer releases associated with grease, debris, and roots totaled 30 or 1.56 per 100 miles of mainline for FY 2022.

Mainline sewer releases associated with structural defects totaled just 11 for FY 2022 or 0.57 per 100 miles of mainline sewer. This relatively low number shows the benefits of the large number of sewer mains that have been rehabilitated or replaced in Capital Improvement Program projects in recent years. It also reflects the benefits of spot repairs done by city repair crews on sewer mains in response to issues found in preventative maintenance CCTV inspections.

Significant annual project reinvestments within the Capital Improvement Program will continue to renew and replace structurally deteriorated sewers. These projects focus on collection system assets with the highest risk and consequence of failure. In doing so, the completion of these projects is helping the City provide more 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.

Service laterals continue to challenge the daily operation of the collection system and are the location where most sewer releases originate from. The Bureau's two primary methods for addressing poor condition laterals are through the maintenance and mainline sewer rehabilitation projects in the Capital Improvement Program. That will continue to be the case going forward.

Structurally defective laterals where releases occurred in FY 2022 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 also 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.

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

One of the Nine Minimum Controls, *Maximization of Storage in the Collection Systems,* ensures that combined sewage is kept within the sewer system using existing in-system storage. This optimizes the volume sent to enhanced wet weather treatment, increasing the volume treated by the biological secondary processes and reducing the number and volume of CSO events. While this control originally focused on keeping sewers free of blockages, removing relatively clean stormwater from the collection system also contributes to maximizing available storage and conveyance capacity. The programs documented here also have the added benefits of increased visibility of these efforts and public education opportunities.

5.1 Private Development and Redevelopment

BES's Stormwater Management Manual (SWMM) applies to all development and redevelopment proposals that create or redevelop over 500 square feet of impervious area.

In FY 2022, implementation of the SWMM in combined sewer basins led to construction of stormwater facilities at 259 properties, managing 28 acres of private impervious area onsite, thereby reducing stormwater volume into the combined system.

City staff are implementing a newly revised SWMM that went into effect December 2020.

5.2 Private Property Retrofit Program

Installation of stormwater facilities on private property continues in the Private Property Retrofit Program (PPRP). Guided by BES's 2012 *System Plan—Executive Report: Combined and Sanitary Sewer Elements* and its Capital Improvement Program, this program implements opportunities with private property owners to voluntarily retrofit or install on-site stormwater infiltration facilities such as rain gardens, drywells, and pervious pavers to keep runoff out of the combined sewers.

Eliminating runoff helps reduce local sewer capacity problems and CSO volumes. For more information, see previous Annual CSO and CMOM reports (FYs 2014 and 2015).

Installation season started in October of 2021 and lasted through the end of June 2022. PPRP partnered with property owners in three target program areas located in the Boise Eliot, Laurelhurst and Richmond neighborhoods. In total, the program installed 69 rain garden and drywell projects during FY 2022, controlling 1.8 acres of impervious surfaces in the City's Eastside CSO area. Examples of FY 2022 retrofit projects are shown in Figure 17 through Figure 19.

Figure 17 PPRP Example Project #1, Richmond area rain garden

Figure 18 PPRP Example Project #2, Laurelhurst area right-of-way rain garden

Figure 19 PPRP Example Project #3, Boise Eliot area rain garden

5.3 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 Central City requirements, the City's Green Building Policy, SWMM, and developer floor area ratio bonuses in specific portions of the city.

As of June 2022, Portland has 554 ecoroofs installed throughout the city, managing over 38.7 acres of roof. Approximately 435 of those ecoroofs are in the combined sewer area. There was comparatively little ecoroof construction during FY 2022 which can likely be attributed to the COVID-19 pandemic. One new ecoroof was installed in the combined sewer area, managing approximately 0.1 acres of roof. This roof area represents 100,000 gallons of rainfall to the combined system annually, and Portland's monitoring data indicate that approximately 50,000 gallons are retained by the roof and returned to the atmosphere through evapotranspiration.

5.4 Public Right-of-Way Development and Redevelopment

As of June 2022, Portland has implemented over 2,570 green streets in the right-of-way, with approximately 1,150 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 2022, 45 new green street facilities were installed in the combined sewer area. The facilities were implemented by a BES CIP project. Collectively, these facilities manage approximately 5.2 acres of impervious area that generate 5.2 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 3.7 million gallons of runoff annually from the combined sewer system through infiltration and evapotranspiration.

Section 6 System Reinvestment and Risk Reduction

The City of Portland, Bureau of Environmental Services' asset management program is founded on strategically reducing risk through cost effective investments. The City has improved its methods for calculating risk and making cost effective decisions to reduce risk through investment activities. This section discusses how the City values existing risk in the collection system and how its investments reduce risk to meet levels of service.

6.1 FY 2022 Reporting Methodology, Changes, and Improvements

Risk in mainline pipes and pump stations are generally determined by inspections and hydraulic modeling.

Pipe inspections provide the condition data used to determine the risk of structural failure. The inspections include routine maintenance inspections to determine the structural condition of the pipes, and post-repair acceptance inspections to ensure that repairs meet designated standards and/or contract specifications. Structural risk of laterals is assumed based on quantity of lateral repaired.

Hydraulic modeling is done to determine the risk of capacity failure, specifically to determine the likelihood of basement and surface flooding with respect to the Bureau's adopted levels of service.

Likewise, pump station inspections also provide condition data used to determine the risk associated with operational failure of the critical assets within a pump station. Hydraulic modeling is done to determine the risk of capacity failure, specifically to determine the likelihood of overflows.

System risks change over time as a result of the following:

1. **Capital Improvement Program:** Capital projects repair or rehabilitate existing assets or introduce new ones to reduce capacity (level of service) risk and structural (mortality) risk in the system.

2. **Maintenance:** Maintenance work orders seek to reduce structural risk in the system by applying targeted repairs and rehabilitation on high-risk assets.

3. **Change in pipe condition due to aging:** Inspections provide more accurate information about pipe condition than simple age-based assumptions. Changes in risk can be due to actual aging as indicated by consecutive inspections, or due to the inspection-based condition of pipes varying from the age-based assumed condition. Since actual pipe condition can be better than the age-based assumed condition, risks can decrease for a particular pipe when it is first inspected.

4. **Unexpected changes to hydrologic conditions:** In general, future development conditions are modeled to allow BES to provide sufficient capacity to meet anticipated hydrologic conditions in the future. Future conditions are largely defined by the City's currently adopted Comprehensive Plan. In some instances, development may occur that is different than was set in the Comprehensive Plan. These changes may have a positive or negative effect on capacity risk.

5. **Inflation and increased costs:** Risk increases as the cost of responding to emergency failures increases.

Items 1 and 2, above, are the focus of the risk reduction reporting in the next section. Item 5 is automatically factored into these reports by the City's asset management cost estimating tools. The City has made continual improvements to our asset management systems over the past year, including improvements to our large diameter (36 inches and larger) pipe risk assessment, and pipeline rehabilitation and replacement cost estimating tools.

The highest risk pump station identified by the System Plan, Inverness Pump Station, is being addressed by a multi-phase project where the immediate likelihood and consequence of failure are being reduced while a long-term solution is being developed. The major products from this effort are an Emergency Response Plan (ERP), a short-term (0-15 year) CIP plan to address assets at imminent risk of failure, and a recommended solution that will serve the long-term (15-50+ year) needs for this area. The projects are being selected on their overall ability to protect human health, water quality, and the environment along with other BES core services such as economic prosperity, climate and seismic resiliency, equity, and worker health and safety.

6.2 FY 2022 Activity for Risk Reduction

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

Risk reduction for capital work is now reported on a calendar year basis as fiscal year reporting is delayed due to construction during the summer and end of the fiscal year. Risk is not reported for investments in correcting non-conforming sewers (e.g., sewers not constructed to current standards).

6.2.1 Risk Change Due to Capital Improvements and Inspections

Capital improvement projects are designed and installed to resolve capacity and structural risk. Resolution of both types of risk are included in the risk reduction calculations. The changes in capacity and structural risk due to rehabilitation is summarized in Table 18. This data is currently incomplete, and the actual risk reduction is likely much higher. BES is continuing to work on improving the data systems required to develop these risk reductions more accurately.

Table 18 Risk change due to capital improvement projects with available data

Type	Value
Total Risk Reduction Due to CIP Investment in Repaired/Replaced Gravity and Pressurized Assets	$16,710,000

The Capital Improvement Program completed 10 projects in the sanitary and combined collection system during the 2021 calendar year. These projects repaired and rehabilitated 237 sanitary and combined sewer gravity mains.

6.2.2 Risk Change Due to Maintenance Activity

Maintenance repairs reduce risk in the collection system and involve localized repairs on sewers and the replacement of service laterals. Planned maintenance activities included approximately 4,876 linear feet of repair and lining work on sewer main assets and 265 laterals which were replaced or lined. The total risk reduction due to maintenance activity during the 2021 calendar year is summarized in Table 19.

Table 19 Risk change due to maintenance activity with available data

Type	Value
Total risk reduction due to maintenance activity	$4,550,000

Section 7 Inflow and Infiltration

Inflow and Infiltration (I&I) activities for the City of Portland are now limited to planned local capacity improvements. In the past, the City made concerted efforts to study and mitigate problems caused by I&I. Significant historical improvements to the collection system and CBWTP, as well as the City's execution of its Nine Minimum Controls, means the City no longer needs a widespread I&I program to improve the CBWTP's ability to treat all the wastewater and stormwater reaching it. Ongoing I&I projects are focused in the Fanno and Burlingame basins.

7.1 FY 2022 Activities

Construction of the Hillsdale Crest Rainfall Dependent Inflow and Infiltration (RDII) project was completed in March 2022. This project rehabilitated approximately 18,000 linear feet of sanitary sewer mains and 170 individual sanitary sewer laterals in an area with known issues of groundwater infiltration into the sanitary sewer system in an area with known capacity constraints downstream.

The Council Crest sewer basin is currently undergoing a wider, integrated planning effort that includes addressing I&I issues. Progress made in the past year included field investigation work to evaluate connections from roof downspouts to the sanitary sewer system for many of the houses in the upper area of the basin by Council Crest Park.

7.2 Planned FY 2023 Activities

Solving I&I issues in West Hills areas where there is currently no dedicated storm or combined system requires more comprehensive stormwater planning to strategically handle the flows that used to enter the sanitary system. The City has upcoming projects to help address the I&I issues in this area.

Work will continue on the Council Crest Integrated RDII project. The pre-design phase for that project is currently scheduled to continue until December 2022 with the design and construction phases to follow.

The results of these various RDII projects will determine the fate of the nearby Cambridge Village Pump Station. Analysis will include an overall evaluation of I&I in

the Fanno/Burlingame basins. This will include an evaluation of the effectiveness of the recently completed Hillsdale Crest RDII project and consider the correlation between this pump station and the proposed Vermont and Beaverton Hillsdale Highway RDII reduction projects. Depending on the results of this analysis, this pump station could be abandoned, upgraded, or left in service as is.

Proposed I&I projects for the Burlingame and Fanno basins have been delayed due to funding issues resulting from the CBWTP Secondary Treatment Expansion program's budgetary requirements.

7.3 SSOs Summary

See Section 4.3.1, Sewer Releases to Surface Water in FY 2022.

Section 8 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, Public Notification, focused mostly on outreach through brochures and public meetings and posting warnings at public access points on the Willamette River and Columbia Slough. Changing communication technology provides additional tools for public notification.

Portland's CSO notification procedures changed with completion of its CSO implementation 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.

8.1 Changes in the Public Notification/River Alert Program

The program continues to use these communications tools:

- CSO advisories sent to the news media when incidents occur.

- Website postings of those CSO media advisories, along with explanations of what a CSO is: https://www.portland.gov/bes/about-csos.
- Twitter postings of the CSO media advisories.
- CSO warning signage at eight public access points along the Willamette River.

BES launched an additional public information tool last year for the Big Pipes (the common euphemism for the CSO storage tunnels) along the Willamette River: an online Big Pipe Tracker that allows the public to see a visualization of how the Big Pipe is keeping the Willamette River sewage- free. The tracker also serves as an additional visualization tool in case CSOs occur. See https://www.portland.gov/bes/big-pipe-tracker.

In less than a year since launch, it has proven to be a valuable tool for the public and news media. BES has recorded over 15,000 page views from November 2021 through June 2022, with spikes in viewing occurring during storms—as expected and intended.

In addition, the news media has specifically cited data from the tracker in their weather reports. While precise media numbers are not possible, we can include a comment from KOIN's assignment editor, received on June 7, 2022: "…the Big Pipe Tracker has been an invaluable resource for us and our weather team during storm coverage. Thank you for this tool!"

Appendix A CSO Event History

When reporting on *how the Portland CSO system has performed*, the City of Portland usually refers to the number of events and the size of overflows that have occurred since the system became fully operational in December 2011. From that standpoint, BES has validated and reported 38 permitted events from the Willamette River and Columbia Slough facilities.

Prior to December 2011, the Amended Stipulation and Final Order from DEQ required the City of Portland to eliminate most overflows to the Columbia Slough by December 1, 2000. Another 16 outfalls (represented by a mix of outfalls from the West Side and East Side of the Willamette River) were controlled by December 1, 2006.

Columbia Slough CSO Events since October 2000

Table 20 presents the CSO events to the Columbia Slough since the Columbia Slough CSO system became fully operational in October 2000. There were no CSO events to the Columbia Slough in FY 2022. Winter events are shaded in green, and summer events are shaded in yellow. All events were permitted under the NPDES permit at the time.

Table 20 Columbia Slough CSO events since October 2000

CSO Discharge Events			Storm Characteristics			System Totals		West 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)
1	May 26, 2012	> 100-year, 30-minute storm	-	-	-	0.022	0.20	0.022	0.20
2	December 5-13, 2015	25-year, 3-6 hour storm	2.04	2.61	3.19	0.01	0.15	0.01	0.15

Willamette River CSO Events from December 2006 to December 2011

Table 21 presents the CSO events to the Willamette River since the West Side Willamette River CSO Tunnel became fully operational in December 2006 until the full Willamette system became operational in December 2011. Winter events are shaded in green, and summer events are shaded in yellow. All events complied with the requirements of the NPDES permit and the 1994 Amended Stipulation and Final Order in effect at the time.

Table 21 Willamette River CSO events, December 2006-December 2011

CSO Discharge Events*			Storm Characteristics			System Totals		West 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)
1	Dec 14, 2006	4-per-Winter Storm	0.82	1.17	1.60	66.85	18.37	66.85	18.37
2	Jan 3, 2007	4-per-Winter Storm	0.69	1.04	1.54	5.15	4.35	5.15	4.35
3	Dec 2-3, 2007	> 5-year 24-hour Winter Storm	0.97	1.76	3.09	154.5	26.85	154.5	26.85
4	Nov 12, 2008	4-per-Winter Storm	0.76	1.02	1.38	8.1	4.1	8.1	4.1
5	Jan 1-2, 2009	5-year Winter Storm	1.12	1.52	2.73	122.60	21.58	122.60	21.58
6	May 4, 2009	3-year Summer Storm (3-6 hr duration)	0.94	1.02	1.18	5.26	1.05	5.26	1.05
7	Nov 7, 2009	2-per-Winter Storm	0.93	1.22	1.51	9.60	2.92	9.60	2.92
8	June 6, 2010	3-year Summer Storm	1.07	1.25	1.43	26.02	3.08	26.02	3.08
9	Nov 17, 2010	1-per-Winter Storm	1.03	1.56	1.77	11.48	5.58	11.48	5.58
10	Dec 8-12, 2010	5-year Winter Storm	1.43	1.52	2.34	41.82	8.92	41.82	8.92
11	Dec 28, 2010	2-per-Winter Storm	0.57	0.89	1.58	6.85	5.50	6.85	5.50
12	Jan 15-16, 2011	1-per-Winter Storm	0.94	1.21	2.13	26.27	8.92	26.27	8.92
13	Feb 27-Mar 4, 2011	1-per-Winter Storm	1.15	1.70	2.41	75.98	28.25	75.98	28.25
14	Nov 21-23, 2011	5-year Winter Storm	1.44	1.66	2.24	115.96	6.25	115.96	6.25

Willamette River CSO Events since December 2011

Table 22 presents the CSO events to the Willamette River since the Willamette River CSO Tunnel system became fully operational in December 2011. FY 2022's events are listed in the bold box below. Winter events are shaded in green, and summer events are shaded in yellow. All events were permitted under the NPDES permit at the time.

Table 22 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	-	-	-	14.89[4]	0.42	-	-	14.89[4]	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	39.19[4]	3.00	14.30	3.00	24.85[4]	2.42[4]

[4] Corrected from previous reports.

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)
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
13	October 30-November 2, 2015	50-year, 2-hour storm	1.94	1.98	2.55	190.5	6.35	30.24	4.88	160.05	6.35
14	November 16-17, 2015	1-per Winter, 1-hour storm	0.80	0.85	1.37	0.03	0.17	-	-	0.03	0.17
15	December 5-13, 2015	25-year, 3-6 hour storm	2.04	2.61	3.19	638.7	15.60	134.86	13.33	503.83	15.60
16	December 16-19, 2015	1-per Winter, 3-48 hour storm	1.11	1.56	2.37	145.8	11.00	26.79	9.70	118.99	10.30
17	May 19, 2016	3-year, 30-minute Summer Storm	-	-	-	0.02	0.18	-	-	0.02	0.18
18	October 13-17, 2016	> 100-year, 1-2 hour storm	1.56	1.81	2.09	0.92	0.63	0.89	0.63	0.03	0.33
19	November 22-25, 2016	5-year winter, 3-hour storm	1.20	1.81	2.47	210.5	17.00	49.36	16.10	161.15	16.60
20	January 17-18, 2017	2-per-winter, 1-day storm	0.61	1.03	1.78	93.5	8.90	20.82	7.50	72.70	8.90
21	February 3-6, 2017	5-year winter, 1-day storm	0.81	1.48	2.53	206.0	12.10	53.07	11.5	152.95	12.1

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)
22	February 7-10, 2017	4-per-winter, 1-day storm	0.51	0.82	1.36	0.0035	0.17	0.0035	0.17	-	-
23	February 15-16, 2017	1-per-winter, 1-2 day storm	0.80	1.25	1.98	89.6	6.4	25.61	5.8	63.98	5.8
24	May 12-14, 2017	>10-year summer, 15 minute storm	0.43	0.68	0.75	0.0051	0.20	0.0051	0.20	-	-
25	September 17-20, 2017	10-year summer, 15-minute - 2-hour storm	0.76	1.18	1.58	0.097	0.63	-	-	0.097	0.063
26	October 19-22, 2017	10-year summer, 24-hour storm	0.96	1.64	2.29	70.5	6.17	19.82	4.92	50.68	6.00
27	April 6-8, 2018	1-per-winter, 12-48 hour storm	0.74	1.29	1.94	24.7	2.55	4.71	2.32	19.95	2.52
28	October 25-29, 2018	25-year, 10-minute - 2-hour storm	1.46	2.06	2.12	0.0037	0.17	-	-	0.0037	0.17
29	August 10, 2019	100-year: 5-minute - 3-hour storm	1.93	1.93	1.93	0.060	0.38	0.060	0.38	-	-
30	December 18-22, 2020	1-per-winter, 12-24 hour storm	0.85	1.44	1.93	12.3	3.42	1.2	1.40	11.1	3.42
31	January 11-12, 2021	5-year winter, 3-6 hour storm	1.24	1.37	2.30	138.6	5.85	39.9	4.82	98.7	5.85
32	September 17-19, 2021	1-per-10 summer, 3-24 hour storm	0.87	1.28	1.34	0.06	0.23	-	-	-	-
33	September 26-28, 2021	1-per-10 summer, 15-min to 24-hour storm	0.65	1.07	1.40	0.03	0.35	0.03	0.35	-	-
34	November 10-12, 2021	1-per-5 winter storm	0.93	1.61	2.49	127.43	10.58	28.64	8.65	98.79	10.58

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)
35	December 16-20, 2021	2-per-winter 6-24 hour storm	0.89	1.30	1.79	2.05	1.97	0.03	0.43	2.02	1.97
36	January 2-7, 2022	1-per-5 winter storm	1.42	1.77	2.08	103.48	9.4	18.8	7.38	84.68	9.4
37	April 28-30, 2022	25-year 15-30 minute storm	0.87	1.50	1.63	0.004	0.08	-	-	-	-
38	June 9-12, 2022	1-per-3 summer 6-48 hour storm	0.81	1.24	1.53	0.0003	0.05	0.0003	0.05	-	-

ENVIRONMENTAL SERVICES
CITY OF PORTLAND

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