FY 2023

CITY OF PORTLAND I BUREAU OF ENVIRONMENTAL SERVICES

Annual CSO and CMOM Report

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Annual CSO and CMOM Report - FY 2023

September 2023

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

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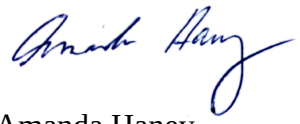

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NPDES Duly Authorized Representative
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AGCA. Accelerated Grease Cleaning Area

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

DWCL. Dry Weather Clarifier

EcoBiz. Eco-Logical Business Certification Program.

EMC. Event Mean Concentration

EWWPT. Enhanced Wet Weather Primary Treatment

FOG. Fats, Oils, and Grease

FSE. Food Service Establishment

FY. Fiscal Year (FY 2023 is July 1, 2022, through June 30, 2023)

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.

RAS. Return activated sludge, an important feature of CBWTP's secondary treatment process that returns a portion of the beneficial microorganisms used for treatment from where they settle in the secondary clarifiers back to the aeration basins to consume more organic matter.

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

STEP. Secondary Treatment Expansion Program

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

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Section 1 Introduction

The Annual CSO and CMOM Report for fiscal year 2023 (FY 2023: July 1, 2022, through June 30, 2023) provides a comprehensive review of Portland's integrated combined sewer overflow (CSO) system and the Capacity, Management, Operation, and Maintenance (CMOM) Program during FY 2023. This report provides updates to the previous report submitted for FY 2022. The report was developed to comply with National Pollutant Discharge Elimination System (NPDES) permit #101505, Schedule D, Condition 3.b.

1.1 Major Changes from FY 2022 Report

The report now includes Section 9 Pollution Prevention Programs to Reduce Contaminants in CSOs. There have been no other major changes from the FY 2022 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. 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 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 2,662 miles of collection system piping (1,011 miles of sanitary sewer including force mains, 914 miles of combined sewer, and 737 miles of sewer laterals) and 41,647 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 2023 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 2023 was a year with below average total rainfall. An average of 35.6 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. Four CSOs were recorded, all of which met the permit's requirements for storm return periods during CSO events.

The Wet Weather Treatment Facility (WWTF) with Chemically Enhanced Primary Treatment 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 biochemical oxygen demand and total suspended solids (BOD and TSS). BOD removal efficiencies were 88% in the summer and 79% in the winter, and TSS removal efficiencies were 89% in the summer and 80% in the winter.

Below average rainfall this fiscal year led to a lower volume of flow captured by the Willamette and Columbia Slough storage facilities of about 5.7 billion gallons. Operators managed the integrated collection system to treat 59% of this volume through the secondary system, with 41% treated through the WWTF. There were 33 events in which flows were sent through the WWTF. The average WWTF event

lasted 19.5 hours and discharged 71 million gallons from the WWTF. During the events, the average flow rate introduced into the secondary system was 109 million gallons per day (MGD). Despite a lower average flow into the secondary treatment system during EWWPT events, flows through the secondary system during EWWPT events met the 110 MGD requirement, maximizing secondary treatment capacity.

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 2023 include:

- Inspection of 0.61 million feet (116 miles) of sewer pipe, or about 6.0% of the mainline sewer system
- Cleaning of 1.15 million feet (217 miles) of sewer pipe, or about 11.3% of the mainline sewer system
- Completion of mainline sewer maintenance repairs on 8,147 feet of pipe; 51% of the repairs were in response to collection system problems
- Repair of 416 service laterals totaling about 5,210 feet of pipe; 63% of those repairs were in response to discovered problems
- Treatment of nearly 313,391 feet (59 miles) of sewer pipe for roots using chemical root foaming
- Completion of 18 inspections of maintenance holes considered to be at greatest risk of failure (Tier 2—see Section 3.1.5)
- Completion of six Capital Improvement Program (CIP) projects repairing and rehabilitating portions of the sanitary and combined collection system during the 2022 calendar year, resulting in an estimated risk reduction of $76.4 million. Maintenance activity on mainlines and service laterals also resulted in an estimated risk reduction of $2.4 million[1]

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

The number of sewer releases from the City-maintained sanitary and combined sewers increased slightly in FY 2023. The number of sewer releases per 100 miles of sewer was 5.1 in FY 2023, compared to 5.0 in FY 2022. This exceeded 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 95% of the time during FY 2023.

Section 2 Integrated CSO System Performance for FY 2023

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 2023.

2.1 Rainfall Patterns for the Past Fiscal Year

FY 2023 was a below average rainfall year for the City of Portland. The area weighted average rainfall for the Willamette CSO area measured 35.6 inches over the year, 96% of the average annual rainfall of 37 inches for Portland.

2.1.1 Summer Storms Review

During FY 2023, one summer storm was large enough to have caused a permittable CSO to the Willamette River, and the storm generated CSO discharge (Table 1).

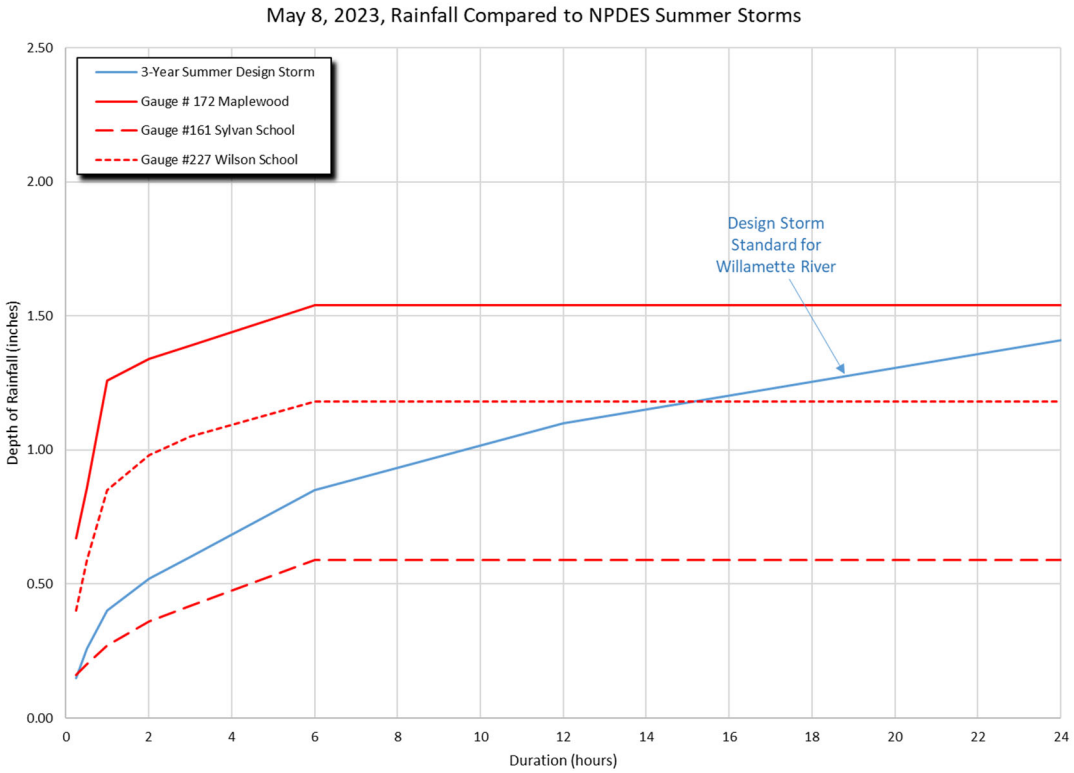
The summer storm of May 8, 2023, was caused by high intensity rainfall over the Carolina combined sewer basin in SW Portland and resulted in discharge from one Willamette River CSO outfall. The local rain gauges (#172, #161, and #227) recorded rainfall exceeding the 1-per-3-summer design storm for the 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 May 8, 2023 storm exceeded the 3-year summer NPDES Permit design depths at local rain gages, shown graphically in Figure 1, and resulted in a CSO. The 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 at each local gage. The observed rainfall event is compared to the 3-year NPDES Summer Design Storms shown with a blue-tinted line.

Table 1 FY 2023 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		
FY 2023 Summer Storms - Rainfall near Carolina Combined Sewer Basin (inches)											
May 8, 2023	**Yes**	0.67	0.86	1.26	1.39	1.54	1.54	1.54	1.54	Gauge # 172 Maplewood	Exceeds 3-year summer design storm for the 15 minute to 24 hour durations.
		0.16	0.20	0.27	0.42	0.59	0.59	0.59	0.59	Gauge #161 Sylvan School	Exceeds 3-year summer design storm for the 15 minute duration.
		0.40	0.59	0.85	1.05	1.18	1.18	1.18	1.18	Gauge #227 Wilson School	Exceeds 3-year summer design storm for the 15 minute to 12 hour durations.

Figure 1 FY 2023 CSO Summer Storms Compared to NPDES Summer Storms



2.1.2 Winter Storm Review

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

The winter storm of November 3-4, 2022, was a moderate atmospheric river event lasting 2 days and resulting in discharge from seven Willamette River CSO outfalls. Rainfall in the Willamette River CSO Area exceeded the 4-per-winter design storm for durations from 3-48 hours.

The winter storm of December 24-27, 2022, was a strong atmospheric river event lasting 3.5 days and resulting in discharge from eleven Willamette River CSO outfalls. The Willamette River CSO Area exceeded the 4-per-winter design storm for durations from 1-48 hours.

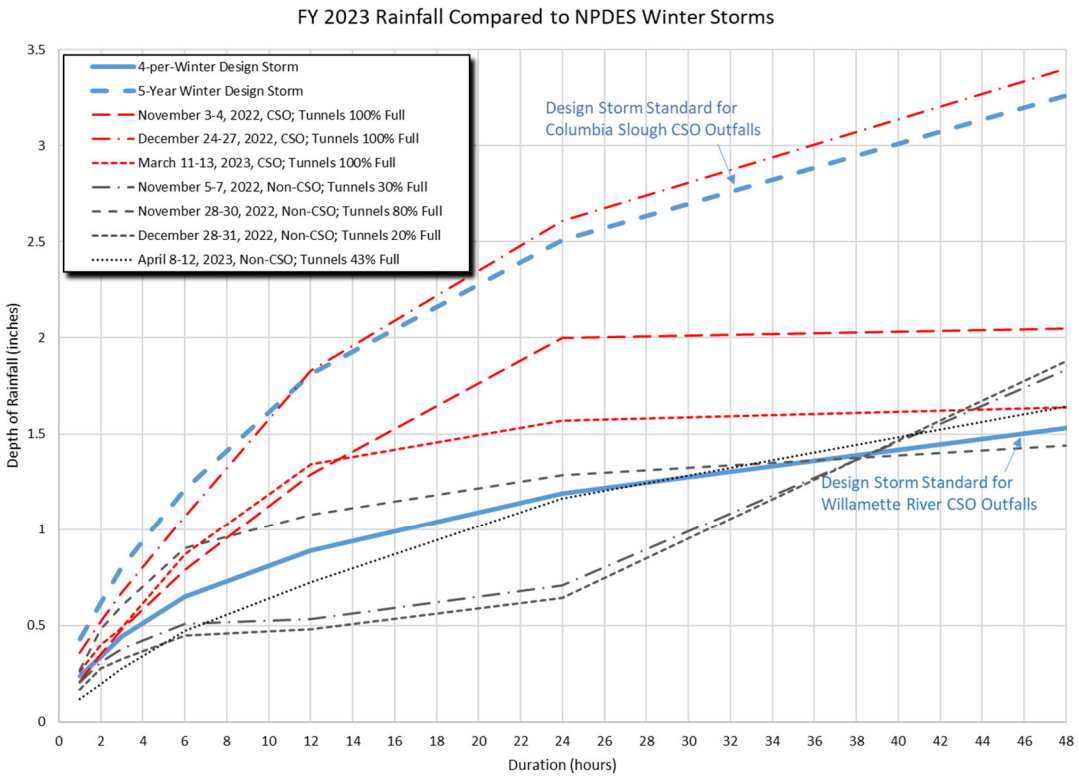
The winter storm of March 11-13, 2023, was an atmospheric river event lasting two days and resulting in discharge from six Willamette River CSO outfalls. The Willamette River CSO Area exceeded the 4-per-winter design storm for durations from 1-48 hours.

The seven storms that exceeded the 4-per-winter NPDES Permit design depths over the CSO control area are shown graphically in Figure 2. 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.

Table 2 FY 2023 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	
FY 2023 Winter Storms - Average Rainfall over Willamette CSO Basin (inches)								
November 3-4, 2022	**Yes**	0.21	0.48	0.79	1.29	2.00	2.05	Exceeds 4-per-winter design storm for the 3 to 48 hour durations.
November 5-7, 2022	No	0.21	0.38	0.51	0.53	0.71	1.83	Exceeds 4-per-winter design storm for the 48 hour duration.
November 28-30, 2022	No	0.27	0.60	0.90	1.08	1.29	1.44	Exceeds 4-per-winter design storm for the 1 to 24 hour durations.
December 24-27, 2022	**Yes**	0.36	0.67	1.07	1.83	2.61	3.40	Exceeds 4-per-winter design storm for the 1 to 48 hour durations.
December 28-31, 2022	No	0.17	0.33	0.45	0.48	0.64	1.88	Exceeds 4-per-winter design storm for the 48 hour duration.
March 11-13, 2023	**Yes**	0.26	0.49	0.87	1.34	1.57	1.64	Exceeds 4-per-winter design storm for the 1 to 48 hour durations.
April 8-12, 2023	No	0.12	0.28	0.47	0.72	1.16	1.64	Exceeds 4-per-winter design storm for the 48 hour duration.

Figure 2 FY 2023 CSO Winter Storms Compared to NPDES Winter Storms



2.2 CSO Discharges into the Willamette River and Columbia Slough

2.2.1 Discharge Events

In FY 2023, there were one summer and three 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.

- **November 4, 2022.** 35.2 million gallons (MG) discharged over 4 hours from seven outfalls to the Willamette River. An atmospheric river with peak intensities surpassing the 1-per-winter level throughout the city caused the overflow.
- **December 26, 2022.** 286 MG discharged over 16 hours from eleven Willamette River outfalls. A Level 4 (Extreme)[2] atmospheric river that

[2] Based on the Center for Western Weather and Water Extremes (www.cw3e.ucsd.edu) criteria for assessing atmospheric river events.

produced rainfall depths surpassing the 1-per-5 winters level passed through the entire City of Portland.

- **March 13, 2023.** 18 MG discharged over 3.5 hours from six outfalls to the Willamette. An atmospheric river with peak intensities surpassing the 1-per-winter level in the SE/SW portion of Portland's combined sewer area caused the overflow.
- **May 8, 2023.** 80,000 gallons discharged over 25 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-10 summers level for the 1, 2, and 3-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 below average during the reporting period. The system experienced one summer and three winter overflows out of a total 54 distinct storm events. Approximately 2,104 MG were stored in the CSO tunnels during these events.

Total CSO discharge for the year was 339 MG from the Willamette CSO system, which was less than 5.6% of the wet weather volume handled by the combined and sanitary collection systems. This equates to 94.4% 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 than 4-per-winter and 1-per-3 summers), tunnel storage levels did not exceed more than 35% capacity. For the CSO-sized events that the system managed without overflow, tunnel storage peaked at 80% capacity.

2.2.2 Dry Weather Overflow Events

No dry weather overflow events from the combined system outfalls were recorded in FY 2023.

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 2023.

Table 3 CSO events with floatables control activity

CSO Event Date(s)	Maint. Date	Location	Description of Maintenance
November 4, 2022	11/17/22.	Sheridan Bar Screen (ANS918)	Cleaned screen of 10 gallons of organic material with some trash/rags mixed in.
December 26, 2022	1/25/2023	Sheridan Bar Screen (ANS918)	Cleaned screen of 20 gallons of organic material with some trash mixed in.
March 13, 2023	3/17/2023	Sheridan Bar Screen (ANS918)	Cleaned screen of 0.5 cubic yards of sticks, leaves, and other organic material.
May 8, 2023	n/a	Carolina OF03 Bar Screen	Outfall was designed with higher expected storm performance. No floatable control system required.

2.3 Wet Weather Treatment Performance and Effluent Quality

2.3.1 CSO Facilities Operations

The CSO System configuration experienced no major changes for most of FY 2023. The system experienced a below average year of rainfall, receiving 35.6 inches of total rainfall following an above average year of rainfall in FY 2022 where the City of Portland received 50.4 inches of rainfall. Influent volumes to CBWTP decreased by 5.6% from FY 2022 totaling over 25 billion gallons as shown in Table 6. The percentage treated by the secondary system increased from 86% to 91%. The percentage of captured CSO treated via secondary also increased from 57% in FY 2022 to 59% in FY 2023. The average percentage of captured CSO treated via secondary is 61% since tracking began in 2012. Winter season removal efficiency for BOD and TSS are 90% and 89% respectively. Summer season removal efficiency for BOD and TSS are 93% and 95% respectively. Total BOD removal efficiency dropped

marginally from last year's 92% to 91% while total TSS removal efficiency increased marginally from 91% to 92%. These numbers indicate that the plant reliably exhibits satisfactory performance year over year.

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 5,700 MG of captured CSO reached the plant (Table 6). About 4,600 MG of tunnel flow was pumped, representing 81% 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)	1,753
Force main 2 (Peninsular Wet Weather)	492
Force main 3 (Portsmouth Wet Weather)	1,397
Swan Island CSO Pump Station Subtotal	3,641
Influent Pump Station Total	985
Total Volume Pumped to CBWTP from Tunnels	4,626

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. Annual percent removal efficiencies for the wet weather system were based on Portland's 2009 No Feasible Alternative Analysis (NFAA) report. Table 5 summarizes this aspect, the minimum efficiency limits for BOD and TSS were met for the winter and summer season (May 1 – October 31).

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	88%	89%
	Winter	65% or more	79%	80%

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. Key parameters are in blue text for FY 2023.

- Average flow introduced to secondary treatment during EWWPT events was maintained at 109 MGD, although the operating setpoint was established at 110 MGD. Secondary effluent flows during EWWPT events met the 110 MGD required by the permit after FY 2014. This is discussed further in Section 2.4.
- Percent of wet weather volume treated through secondary exceeded the model target level at 59% compared to 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 88% and 89%, respectively, in May-June of FY 2023 (with expected efficiencies of both being at least 85%), and 79% and 80%, respectively, during the winter season (November 1 – April 30; with expected efficiencies of both being at least 65%).
- **Were flows to secondary treatment maximized?** Yes, flows were maximized according to regular protocol and established setpoints. Secondary effluent flowsmet the 110 MGD requirement during EWWPT events even though average flow introduced to secondary treatment was measured at 109 MGD. Measures are being taken to ensure that the minimum flow requirement is met. See Section 2.2.1.2 and Section 2.4.
- **Were effluent limits for BOD and TSS achieved at OF001 and OF003?** Effluent limits were not achieved during two excursions. During October 2022 the monthly average BOD reached 32 mg/L, as documented in a warning letter from DEQ. During the calendar week of January 14, 2023, the weekly average for BOD (46 mg/L) and TSS (47 mg/L) exceeded limits. For all other months and weeks BOD and TSS effluent limits were achieved as described in the permit. It is important to note however that TSS effluent concentration was exceeded for the maximum 30-day performance (36 mg/L achieved with a 30 mg/L limit) while BOD effluent concentration was exceeded for the peak 7-day performance (52 mg/L achieved with a 45 mg/L limit) when calculated using a moving average that does not consider the end of the month or week.

Table 6 CBWTP annual treatment performance data[3]

CBTWP Annual Treatment Performance and Characteristics Summary FY2022-2023	CEPT (yes/no)	Annual Rainfall Depth (inches/year)	Flows to CBWTP	Influent Volume (MG/Year)	Dry Weather Sanitary Volume (MG/Year)	Captured CSO Flow - Volume (MG/Year)	Total Volume Treated Through Secondary (MG)	% of Plant Flow Treated Through Secondary System	WWTF (EWWPT) Events	Flow Rate to DW/Secondary Durring EWWPT (MGD)	Number of Events/Year	WWTF Volume/Year	Amount of Captured CSO Treated via Secondary (%)	Duration of WWTF Events (hours)	Calendar Days of WWTF Discharges (days)	Blended Effluent (OF001 & OF003) Treatment	BOD Loading (lbs/year)	BOD Average Concentration (mg/L)	Total Plant BOD Removal Efficiency (%)	TSS Loading (lbs/year)	TSS Average Concentration (mg/L)	Total Plant TSS Removal Efficiency (%)
Trend Line																						
Average Year Model/Permit	-	-		28,300	22,100	6,200	25,443	90%		100	32	2857	54%	919	-		2,510,000	27.0	-	2,440,000	27.0	-
FY2012	no	46.8		28,800	20,200	8,600	25,662	89%		120	29	3,138	64%	706	66		4,000,000	16.6	93%	5,050,000	21.0	92%
FY2013	yes	40.2		26,625	19,496	7,129	24,197	91%		126	22	2,429	66%	668	50		2,957,783	13.3	95%	3,585,748	16.1	94%
FY2014	yes	40.0		26,549	19,471	7,078	24,002	90%		112	27	2,546	64%	904	65		3,472,307	15.7	94%	4,055,479	18.3	93%
FY2015	yes	33.9		25,760	19,609	6,151	23,221	90%		112	27	2,540	59%	591	51		4,176,834	19.4	93%	4,413,412	20.5	92%
FY2016	yes	53.4		30,665	20,179	10,485	26,301	86%		117	39	4,363	58%	1,241	92		3,871,106	15.1	93%	4,910,264	19.2	92%
FY2017	yes	59.5		33,544	22,358	11,187	28,765	86%		119	41	4,779	57%	1,333	99		4,554,872	16.3	92%	5,248,619	18.8	92%
FY2018	yes	37.6		26,844	21,635	5,209	24,947	93%		117	37	1,897	64%	602	65		3,046,966	13.6	95%	3,738,873	16.7	94%
FY2019	yes	30.5		23,763	20,037	3,726	22,173	93%		118	35	1,590	57%	387	52		2,786,772	14.1	95%	3,237,714	16.3	95%
FY2020	yes	33.2		22,528	18,624	3,904	21,176	94%		111	37	1,352	65%	338	53		2,925,285	15.6	94%	2,962,541	15.8	94%
FY2021	yes	35.4		23,305	17,657	5,648	21,129	91%		111	35	2,175	61%	556	59		3,014,266	15.5	93%	3,276,139	16.9	93%
FY2022	yes	50.4		27,026	18,632	8,523	23,345	86%		110	44	3,681	57%	860	82		3,907,860	17.3	92%	4,493,102	19.9	91%
FY2023	yes	35.6		25,505	19,818	5,687	23,159	91%		109	33	2,346	59%	645	65		4,251,889	20.0	91%	4,306,550	20.2	92%

[3]* 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. Operations also initiated a pilot last year 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 and excessive filamentous bacteria growth as witnessed in the July 2021 event detailed in last year's report. One such effort is to take a closer look at the residence time of combined flow throughout the collection system which can be used to identify potential nutrient load monitoring locations. This could provide a better understanding of the relationship between the collection system and filamentous bacteria outbreaks.

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 2022-April 2023). Table 8 summarizes the results for the summer season (July – October 2022 and May – June 2023). While the permit requires reporting of maximums on a calendar month basis, this evaluation uses a more stringent moving 30-day window analysis. Exceedances shown in the tables below do not reflect the concentrations shown in the monthly DMRs where two excursions have been reported. The maximum monthly average concentrations of BOD and TSS allowed by the permit are 30 mg/L for both summer and winter seasons.

For the winter season, maximum 30-day concentrations and loadings at both outfalls were below the permitted monthly limits for BOD but not TSS. The TSS concentration for the maximum 30-day period for the winter season is 36 mg/L. The maximum 30-day period for the winter season ended on January 22, 2023, for both BOD and TSS.

For the summer season, monthly limits were exceeded for BOD producing a maximum concentration of 33 mg/L. The TSS concentrations for the maximum 30-day period in the summer season is 22 mg/L well below the monthly limit. The maximum 30-day period ended on October 31, 2022, for BOD and May 9, 2023, for TSS for the summer season. This is consistent with the excursion that occurred in October of 2022 as documented by DEQ. The monthly average BOD measured was 32 mg/L (Section 2.3.2.1).

Table 7 FY 2023 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 (m^3/s)	30-Day Avg Flow (MGD)	Permit Monthly (Megagrams /day)	Permit Monthly (lbs/day)	Max 30-Day (lbs/day)	Max 30-Day (Megagrams /day)	Date of 30th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality										
BOD5	30	30	9.0	116	20.4	45,000	29,099	9.4	22-Jan-23	9.12 inches of rain in 30d
TSS	30	**36**	9.0	116	20.4	45,000	34,908	10.6	22-Jan-23	

Table 8 FY 2023 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 (m^3/s)	30-Day Avg Flow (MGD)	Permit Monthly (Megagrams /day)	Permit Monthly (lbs/day)	Max 30-Day (lbs/day)	Max 30-Day (Megagrams /day)	Date of 30th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality										
BOD5	30	**33**	4.7	61	20.4	45,000	16,631	9.4	31-Oct-22	3.28 inches in 30d (BOD), 2.87 inches in 30d (TSS)
TSS	30	22	4.7	91	20.4	45,000	16,357	10.6	9-May-23	

Table 9 FY 2023 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 Weekly (mg/l)	Max 7-Day (mg/l)	7-Day Avg Flow (m^3/s)	7-Day Avg Flow (MG)	Permit Weekly (Megagrams /day)	Permit Weekly (lbs/day)	Max 7-Day (lbs/day)	Max 7-Day (Megagrams /day)	Date of 7th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality										
BOD5	45	**52**	8.9	115	53.5	118,800	13,528	6.1	14-Jan-23	1.37 inches in 7d (BOD, TSS)
TSS	45	**55**	8.9	115	53.5	118,800	52,446	23.6	14-Jan-23	

Table 10 FY 2023 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 (m^3/s)	7-Day Avg Flow (MG)	Permit Weekly (Megagrams /day)	Permit Weekly (lbs/day)	Max 7-Day (lbs/day)	Max 7-Day (Megagrams /day)	Date of 7th Day	Notes
Columbia Boulevard WWTP - Outfalls 001 and 003 Effluent Quality										
BOD5	45	**55**	8.9	45	53.5	118,800	20,464	9.2	16-Oct-22	0.0 inches in 7d (BOD), 1.03 inches in 7d (TSS)
TSS	45	29	8.9	79	53.5	118,800	19,216	8.7	9-May-23	

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.

During the winter, concentration and loading for BOD and TSS for the maximum 7-day period were above the permit's maximum weekly limit of 45 mg/L for both. Rolling average calculations for the maximum 7-day period, ending on January 14, 2023, showed BOD concentrations of 52 mg/L and TSS concentrations of 55 mg/L. During the calendar week of January 14, 2023, DEQ documented this excursion when the weekly average BOD (46 mg/L) and TSS (47 mg/L) exceeded limits.

During the summer, concentration and loading for TSS for the maximum 7-day period, ending May 9, 2023, was below the permit's weekly limit of 45 mg/L. Rolling average calculations for the maximum 7-day period, ending on Oct 16, 2022, showed BOD concentrations of 55 mg/L, exceeding the permit's weekly limit of 45 mg/L. The rolling 7-day BOD excursion in October 2022 is consistent with the average monthly excursion documented by DEQ (Section 2.3.2.1).

Filamentous bacteria outbreaks continue to be the cause of these exceedances which is inhibiting the ability to achieve proper settling. The Secondary Treatment Expansion Program (STEP) projects currently in motion are aimed at improving the plant's response to these outbreaks. Management at the treatment plant are evaluating potential indicators of filamentous bacteria outbreak as well as alternative strategies to prevent such outbreaks like beginning Return Activated Sludge (RAS) chlorination earlier. Data is still being collected on these initiatives to assess their reliability and effectiveness.

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.

Table 11 summarizes the WWTF events for FY 2023 (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	**33**				**2,346**	**645**	**65**	**739,032**	**755,517**		
Average/Event		**192**	**109**	**70**	**71**	**19.5**	**2.0**	**22,395**	**22,894**	**50**	**36**

Key aspects WWTF performance for FY 2023 include:

- Volume of EWWPT events was around 2.35 billion gallons. This is about 9.2% of the total volume received at the CBWTP for the year (25 billion gallons; see Table 6). This marks a decrease from FY 2022 (13.6% of total CBWTP influent volume, 3.7 billion gallons). This is expected for drier years.
- An EWWPT event was in progress during 7.4% of the year for a total of 645 hours. WWTF discharge occurred on 65 calendar days (just over 1.25 days per week). This is a decrease from FY 2022 which experienced 860 hours (9.8% of the year) and 82 calendar days (1.5 days per week). This is expected for drier years.
- 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 149 MGD on 2/26/23, which meets the permit requirement.
- The average event mean concentrations (EMC) for BOD was 50 mg/L and 36 mg/L for TSS. This is an increase to the performance achieved in FY 2022 (BOD – 54 mg/L, TSS – 42 mg/L).
- Operators maintained an average of 109 MGD into the dry weather clarifier (DWCL)system during EWWPT events. This rate is 57% of the average flow rate reaching the plant during an EWWPT event (192 MGD).

- BES has noted a slight decline in the average flow introduced into the secondary treatment during EWWPT events, despite maintaining a setpoint of 110 MGD as a minimum.
- It is important to note that the average calculated flow into secondary treatment system and secondary effluent flows during EWWPT events routinely meet the minimum 110 MGD indicating that secondary treatment continues to be maximized per Section 2 of Schedule A of the NPDES permit.
- Assets associated with this system, as well as programming, are being inspected as a result. In the meantime, a temporary fix would be to increase the minimum setpoint to secondary treatment slightly above the normal setpoint of 110 MGD. As documented in a notification sent to DEQ on July 21, 2023 the setpoint is currently established at 80 MGD to accommodate aeration basin rehabilitation that is scheduled to be completed in October 2023. Any temporary increases to the setpoint will be determined following completion of the rehabilitation.
- EWWPT events lasted 20 hours on average and typically occurred across 2 days. This is similar to last year (FY 2022) where the average event lasted 20 hours and typically occurred across 1.9 days.

BOD and TSS removal efficiencies compared to event volume are shown in Figure 3 (BOD) and Figure 4 (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, as seen in Figure 3 and Figure 4.

Figure 3 WWTF BOD removal efficiency vs. event volume

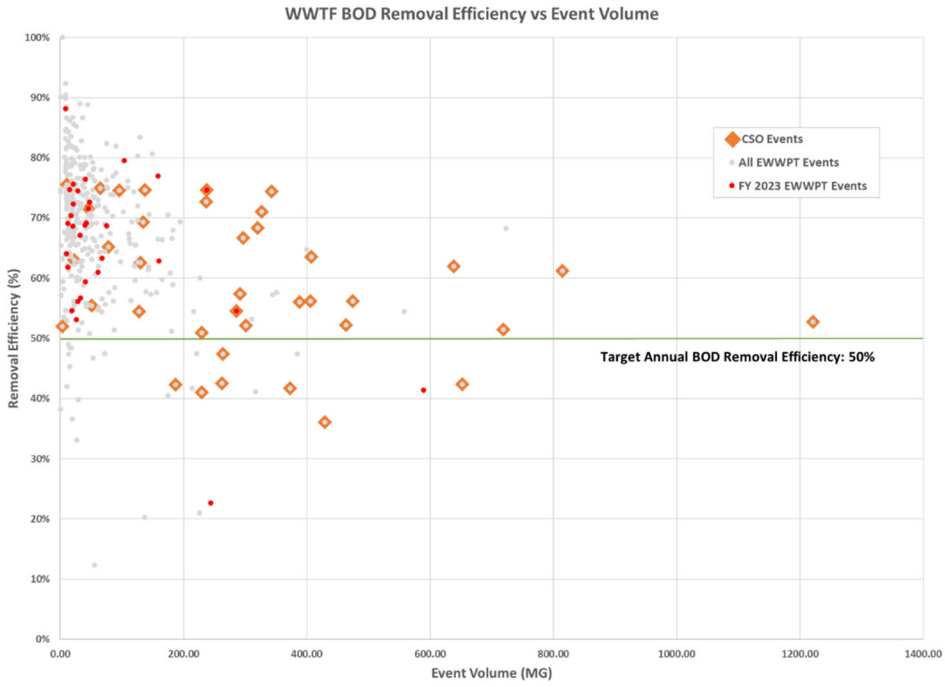


Figure 4 WWTF TSS removal efficiency vs. event volume

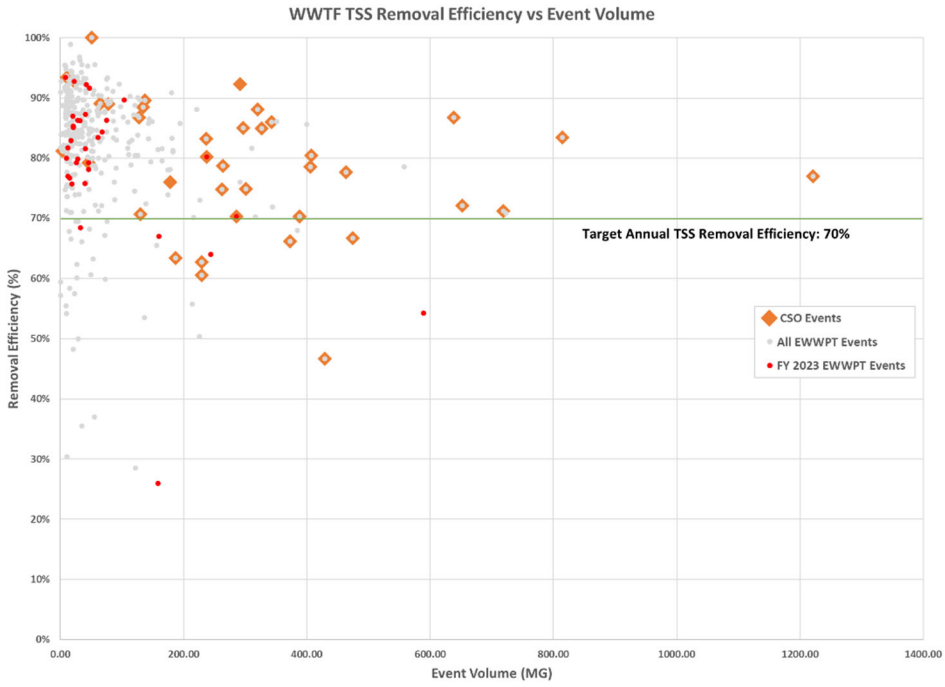


Table 12 Enhanced wet weather primary treatment events - detailed information

		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)
10/21/22 17:45	1	206	109	89	25	6.8	2	21,320	18,247	103	88
10/25/22 20:00	2	191	110	70	38	13.0	2	4,187	3,111	13	10
10/28/22 13:00	3	184	109	61	32	12.8	2	15,868	9,916	59	37
10/31/22 12:30	4	236	115	112	95	20.5	2	28,016	18,710	35	24
11/4/22 8:15	5	196	109	81	278	82.5	4	77,089	69,123	33	30
11/25/22 19:15	6	188	110	69	14	5.0	2	4	3	0.04	0.02
11/27/22 11:45	7	147	110	25	7	7.0	1	2,985	2,692	50	45
11/30/22 3:00	8	267	114	142	151	25.5	2	71,923	93,974	57	75
12/8/22 10:30	9	179	109	55	13	5.5	1	5,329	4,050	51	39
12/9/22 17:00	10	260	111	139	152	26.3	2	50,866	51,329	40	40
12/24/22 14:15	11	261	110	143	581	97.3	5	144,800	238,403	30	49
12/29/22 10:45	12	185	111	67	60	21.5	2	27,998	21,258	56	43
1/4/23 17:15	13	168	109	36	4	2.8	1	2,195	1,857	63	53
1/8/23 3:15	14	175	107	61	53	21.0	2	20,948	14,712	47	33
1/9/23 14:30	15	134	109	13	4	7.3	1	1,841	937	57	29
1/12/23 0:30	16	240	110	115	32	6.8	1	7,945	6,027	29	22
1/14/23 13:00	17	241	109	113	32	6.8	1	11,450	12,248	43	46
1/18/23 13:15	18	185	109	57	12	5.0	1	5,321	2,945	53	29
2/26/23 13:30	19	163	110	42	20	11.5	2	14,873	9,098	89	54
2/27/23 16:45	20	146	109	25	11	10.3	2	12,494	7,970	140	89
3/7/23 22:30	21	226	109	97	13	3.3	2	5,751	3,081	52	28
3/9/23 22:15	22	153	104	40	24	14.3	2	11,051	4,529	56	23
3/13/23 2:45	23	278	110	158	229	34.8	2	30,316	40,355	16	21
3/28/23 21:30	24	151	110	20	2	2.8	1	1,158	630	62	34
3/31/23 22:45	25	178	109	43	9	5.3	2	3,857	2,672	49	34
4/6/23 17:45	26	172	109	56	67	28.5	2	20,931	11,725	38	21
4/9/23 17:45	27	200	108	84	236	67.8	4	72,308	66,959	37	34
4/16/23 18:15	28	130	111	4	0	1.5	1	54	30	29	17
4/17/23 23:00	29	121	105	9	18	48.0	3	9,438	4,717	62	31
4/20/23 17:00	30	205	110	83	34	9.8	2	13,381	5,262	47	19
5/4/23 14:45	31	158	113	38	21	13.0	2	9,200	5,949	54	35
5/8/23 20:15	32	193	106	82	38	11.0	2	18,179	12,593	58	40
6/18/23 18:45	33	214	110	93	40	10.3	2	15,955	10,406	48	32
Total	**33**				**2,346**	**645**	**65**	**739,032**	**755,517**		
Avg/Event		**192**	**109**	**70**	**71**	**20**	**2.0**	**22,395**	**22,894**	**50**	**36**

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 fourth sample for the current NPDES permit, of which five are required for the current cycle, per Schedule A, Condition 5.b.iii.(A). Figure 5 shows the laboratory analysis report for the March 11-23, 2023, 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 in Figure 5. For the March 11-13, 2023, event the CSO sample of 3.01 µg/L exceeded the IWQC for criterion continuous concentration (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. An ambient comparison sample was not collected for the March 11-13, 2023, CSO event. Ambient comparison samples were collected seven days before the event on March 6, 2023, and ten days after the event on March 23, 2023, at the Morrison Bridge, close to Outfall 36. Applying the dilution, the March 11-13, 2023, 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?
3/6/2023	10.86	5.43	3.37	1.4	0.26	3.01	No
3/23/2023	8.78	4.39	2.72	0.78	0.18	3.01	Yes

Figure 5 March 13, 2023, 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:	**W23C141**	Project Mgr:	Amanda Haney
Received:	3/13/23 15:55		
Submitted By:	Field Operations		

Sample	Laboratory ID	Matrix	Type	Sample Collection Date Start	End	Qualifier
CSO36	W23C141-01	Stormwater	Grab	03/13/23 15:12	03/13/23 15:12	

Analyte	Result	Units	MRL	Dil.	Batch	Prepared	Analyzed	Method	Qualifier
CSO36 : W23C141-01									
Field Parameters									
pH*	7.3	pH Units		1	B23C213	03/13/23 15:12	03/13/23	FO SOP 1.01a	
Temperature*	10.6	°C		1	B23C213	03/13/23 15:12	03/13/23	FO SOP 1.05a	
Microbiology									
E. coli	20000	MPN/100 mL	100	1	B23C200	03/13/23 16:36	03/14/23	Colilert QT	
General Chemistry									
Dissolved organic carbon	9.85	mg/L	1.00		B23C498	04/01/23	04/01/23	SM 5310B	
Alkalinity	17.6	mg CaCO3/L	1.0		B23C355	03/21/23	03/21/23	SM 2320B	
Total suspended solids	104	mg/L	3		B23C275	03/17/23	03/18/23	SM 2540D	
Nutrients									
Chloride	4.42	mg/L	1.00	1	B23C223	03/15/23	03/15/23	EPA 300.0	
Sulfate	4.96	mg/L	1.00	1	B23C223	03/15/23	03/15/23	EPA 300.0	
Total Metals									
Total Metals by ICPMS									
Aluminum	2.05	mg/L	0.050	1	B23C280	03/17/23	03/22/23	EPA 200.8	
Copper	13.0	ug/L	0.222	1	B23C280	03/17/23	03/22/23	EPA 200.8	
Lead	8.69	ug/L	0.111	1	B23C280	03/17/23	03/22/23	EPA 200.8	
Hardness by calculation									
Hardness	20.8	mg CaCO3/L	0.253	1	[CALC]	03/17/23	03/22/23	SM 2340B	
Calcium	5.43	mg/L	0.056	1	B23C280	03/17/23	03/22/23	EPA 200.8	
Magnesium	1.76	mg/L	0.028	1	B23C280	03/17/23	03/22/23	EPA 200.8	
Dissolved Metals									
Dissolved Metals by ICPMS									
Copper, dissolved	3.01	ug/L	0.212	1	B23C317	03/20/23	03/21/23	EPA 200.8	
Calcium, dissolved	4.22	mg/L	0.053	1	B23C317	03/20/23	03/21/23	EPA 200.8	
Magnesium, dissolved	1.11	mg/L	0.026	1	B23C317	03/20/23	03/21/23	EPA 200.8	
Potassium, dissolved	1.96	mg/L	0.106	1	B23C317	03/20/23	03/21/23	EPA 200.8	
Sodium, dissolved	6.00	mg/L	0.106	1	B23C317	03/20/23	03/21/23	EPA 200.8	

2.5.2 Willamette River Instream Water Quality Sampling

Figure 6 through Figure 10 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 6 Willamette River monitoring results for zinc

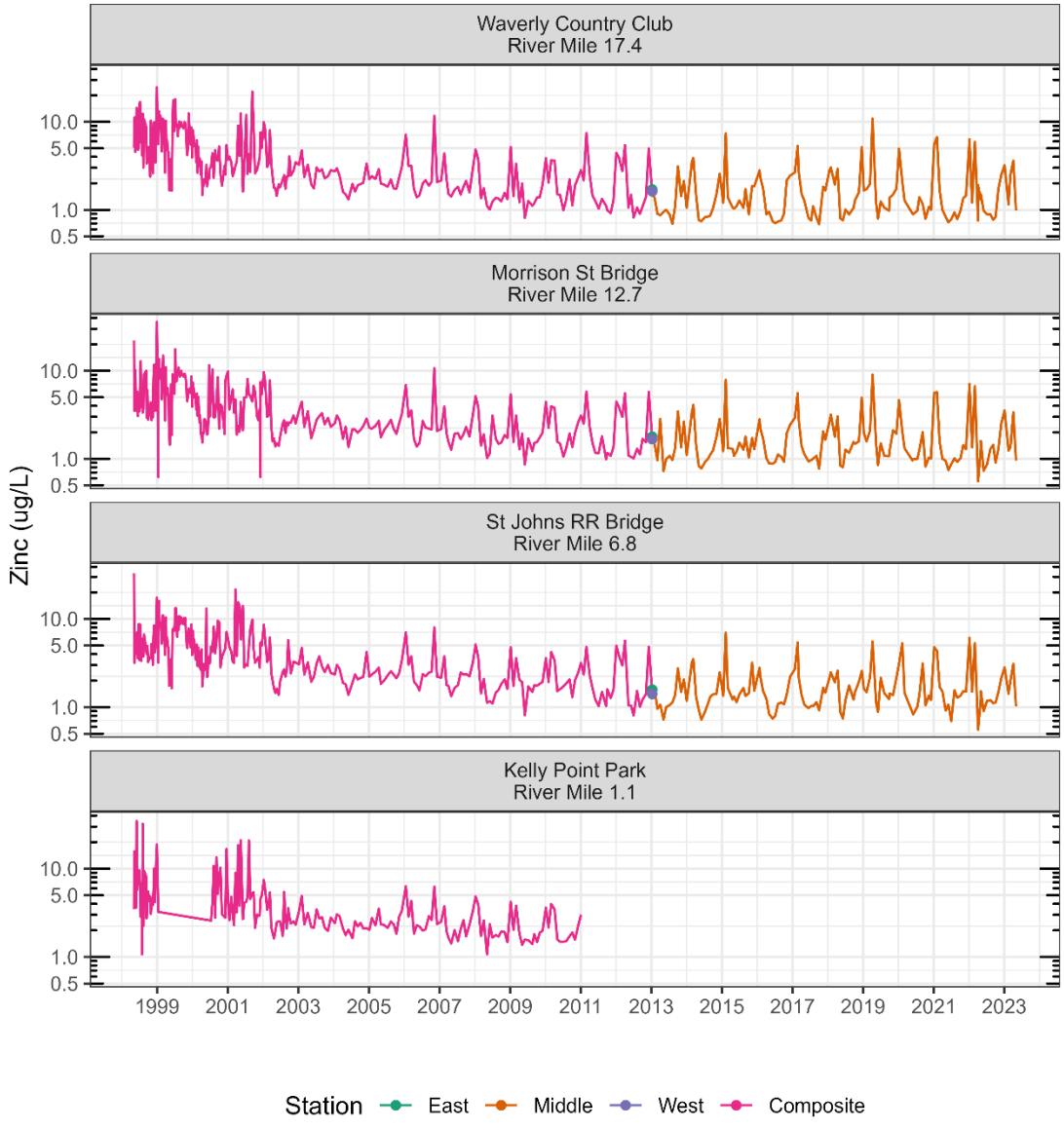


Figure 7 Willamette River monitoring results for lead

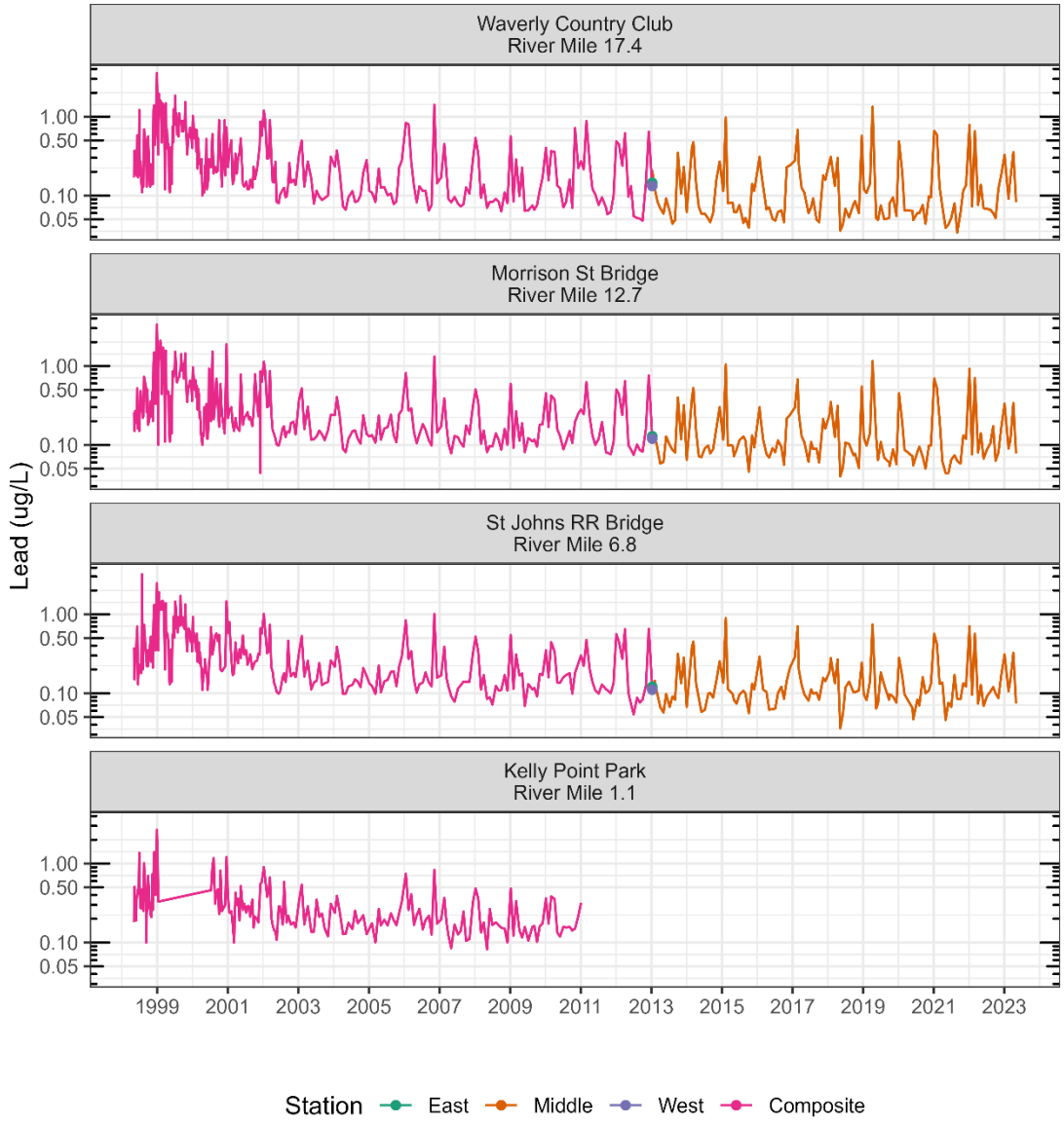


Figure 8 Willamette River monitoring results for copper

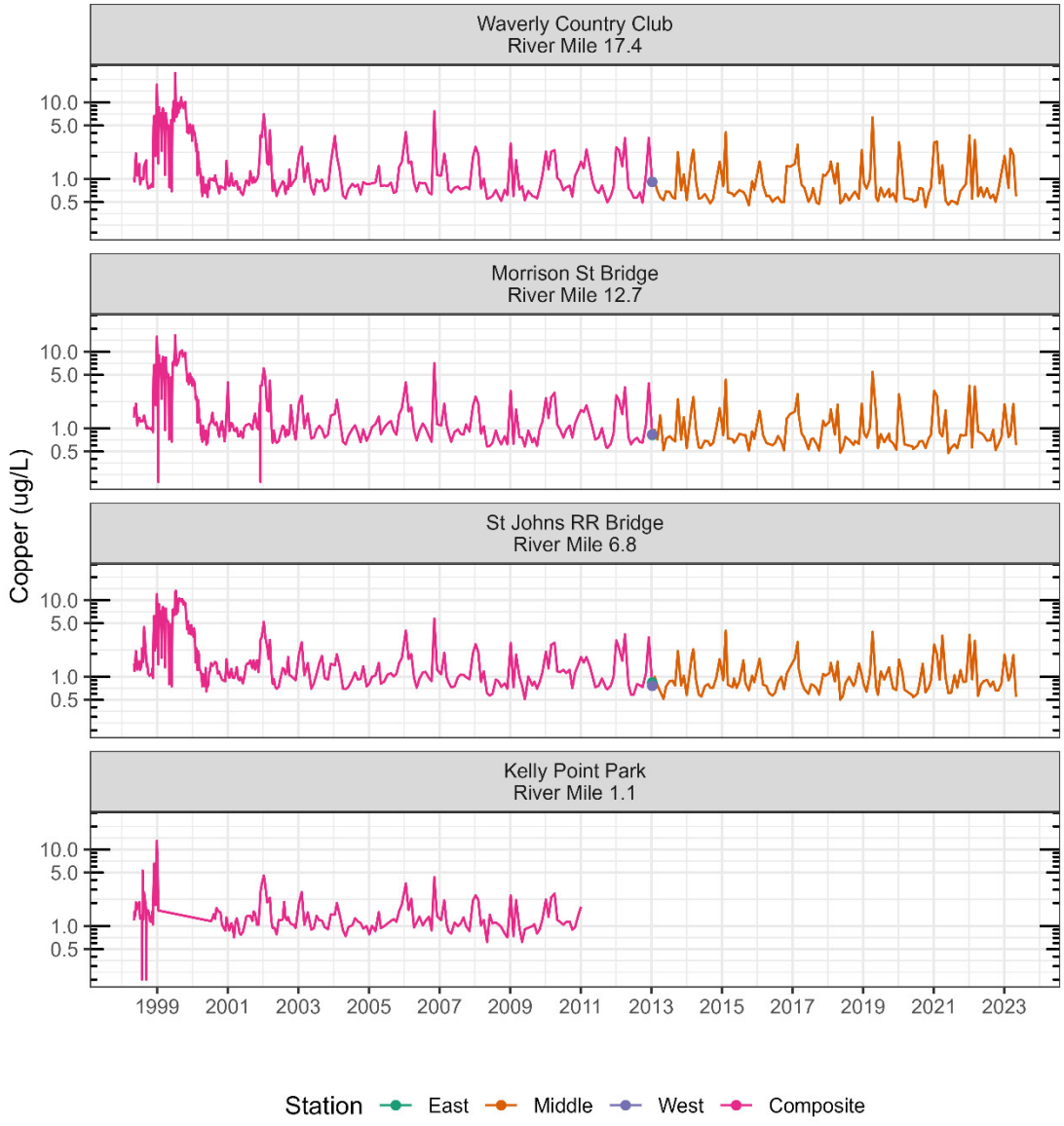


Figure 9 Willamette River monitoring results for TSS

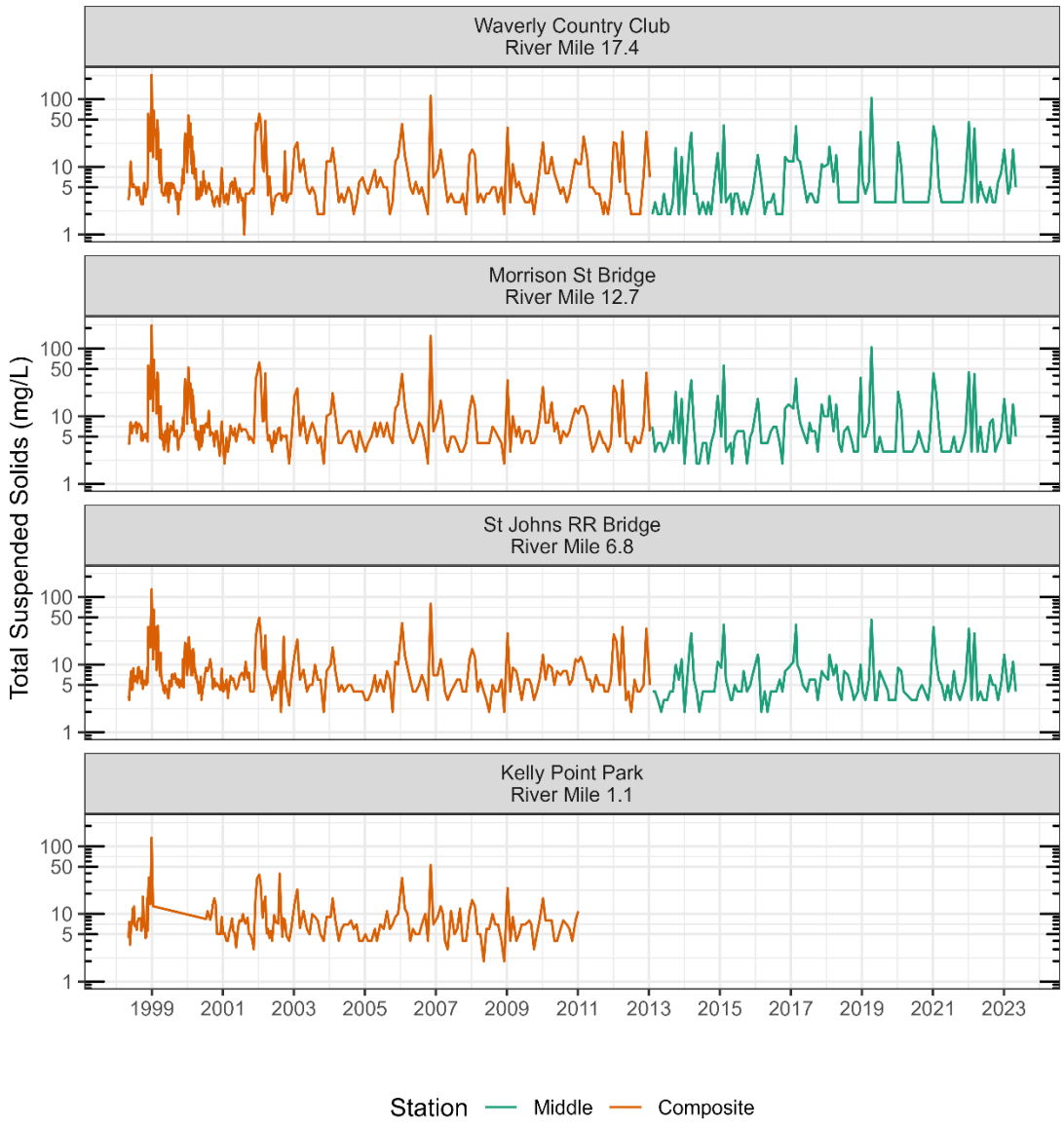
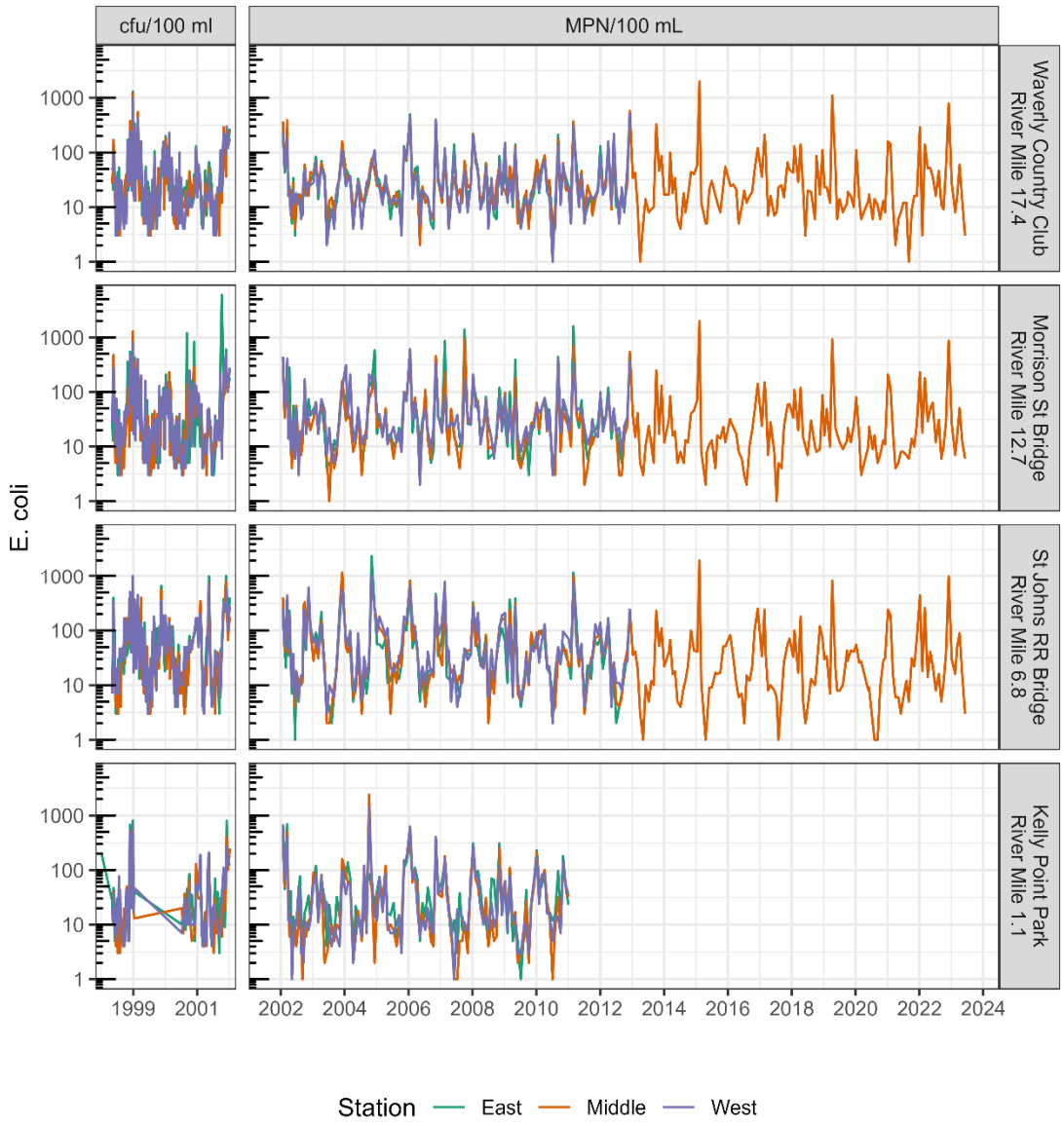


Figure 10 Willamette River monitoring results for *E. coli*



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 2023 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 2023, the sewer inspection program inspected 610,409 linear feet (116 miles) of mainline sewer pipe, which corresponds to approximately 6.0% 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 2023, approximately 92% 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 462 assets in FY 2023.

In FY 2023, the sewer cleaning program cleaned 1,146,785 feet (217 miles) of sewer pipe, which corresponds to approximately 11.3% 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 2023, 97% 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 typically conducts stream walks and data analysis to assess external factors that might affect sewer pipes near streams. Because of reduced staffing, no stream walks were conducted in FY 2023.

BES is planning on resuming stream walks in FY 2024 and 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 and to develop a standardized, repeatable condition assessment approach for this type of inspection moving forward.

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[4] 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

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

to sanitary sewer releases and hazard-related repairs). The *CMOM Program Report* includes descriptions of sewer repair maintenance activities and equipment.

During FY 2023, 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. There was one emergency repair project which repaired 65 feet of pipe and installed a new maintenance hole after a failure caused a significant sinkhole.

City maintenance crews completed mainline sewer repairs totaling 8,147 linear feet. Approximately 51% 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 416 service lateral repairs totaling approximately 5,210 linear feet. Approximately 63% 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 2023, BES Maintenance Engineering continued to manage the chemical root control program using third-party service providers who apply dense herbicidal foam that kills roots on contact without harming trees or surface vegetation. The City's Root Control Program uses a priority ranking system so that sewers with the greatest need for chemical root treatment are addressed first. During FY 2023, 313,391 linear feet (59 miles) of mainline sewer were chemically treated for roots. In addition to chemical root foaming, City crews cleaned approximately 5,100 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 2023, four sewer releases from the City-maintained sewer system were 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 2023, there were 18,935 linear feet (3.6 miles) of Accelerated FOG-related sewer lines in the program. This is a reduction from 23,398 feet in FY 2022. Each year lines are removed because sources of FOG have been addressed and accelerated cleaning is no longer need. Also, some AGCA lines may be re-assigned to a non-FOG accelerated cleaning list when baseline levels of FOG are exacerbated by sewer main deficiencies (i.e., sags, roots, running more than half full, and flat slopes). 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 FY 2023, 13,188 linear feet of cleaning was completed, and 16,254 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, 798 grease interceptor cleaning inspections, and 79 CCTV inspections of food service establishment (FSE) sewer laterals in FY 2023. FOG enforcement actions in FY 2023 are summarized in Table 14.

Table 14 FOG Enforcement Activities in FY 2023

Description	Number	Requirement
Warning Notice	113	Increase grease removal device cleaning frequency
	29	Repair or replace grease removal devices
Notice of Violation (NOV) with Civil Penalties/ Cost Recovery	7	Plumb all fixtures to a grease interceptor
	1	Service grease interceptor at prescribed cleaning frequency
	0	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.

3.1.5 Maintenance Hole Inspection

During FY 2022, BES made the decision to temporarily suspend the risk-based Tier 2 maintenance hole inspections. A higher priority was placed on completing routine mainline sewer cleaning and CCTV inspections instead. Since the limited staffing issues continued in FY 2023, the decision was made to do these types of inspections at a reduced rate. In FY 2024, the City plans on increasing the Tier 2 maintenance hole inspection program and additional equipment has been purchased to help pursue this goal.

In FY 2023, 18 Tier 2 maintenance hole inspections were completed. Of the Tier 2 maintenance holes inspected in FY 2023, none needed total replacement or repairs.

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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 Sewer Releases per Hundred Miles of Pipe

Sewer releases 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 sewer releases per 100 miles of sewer, BES has a succinct metric for gauging overall success toward minimizing sewer releases.

As of the end of FY 2023, BES owned and maintained approximately 1,925 miles of mainline sanitary and combined sewers, and 737 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 2023, the City experienced 136 sewer releases over the 2,662 miles of collection system, which is approximately 5.1 releases per 100 miles of sewer.

There were also 12 weather-related release events in FY 2023 that exceeded the design capacity of the collection system (referred to as *force majeure*) and were intentionally excluded for the purposes of analyses and tracking trends, although these releases were included in reporting to DEQ. If those 12 *force majeure* releases were to be included, then there would have been approximately 5.6 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 11.

4.2.2 Response to Urgent Health and Safety-Related Service Requests

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

Response time performance for FY 2023 is shown in Table 17. A comparison with previous fiscal years is shown in Figure 12. Sewer emergency response crews arrived on site within the City's 2-hour response time target 95% of the time during FY 2023.

Figure 11 Sewer releases per 100 miles of sewer (lower numbers are better)

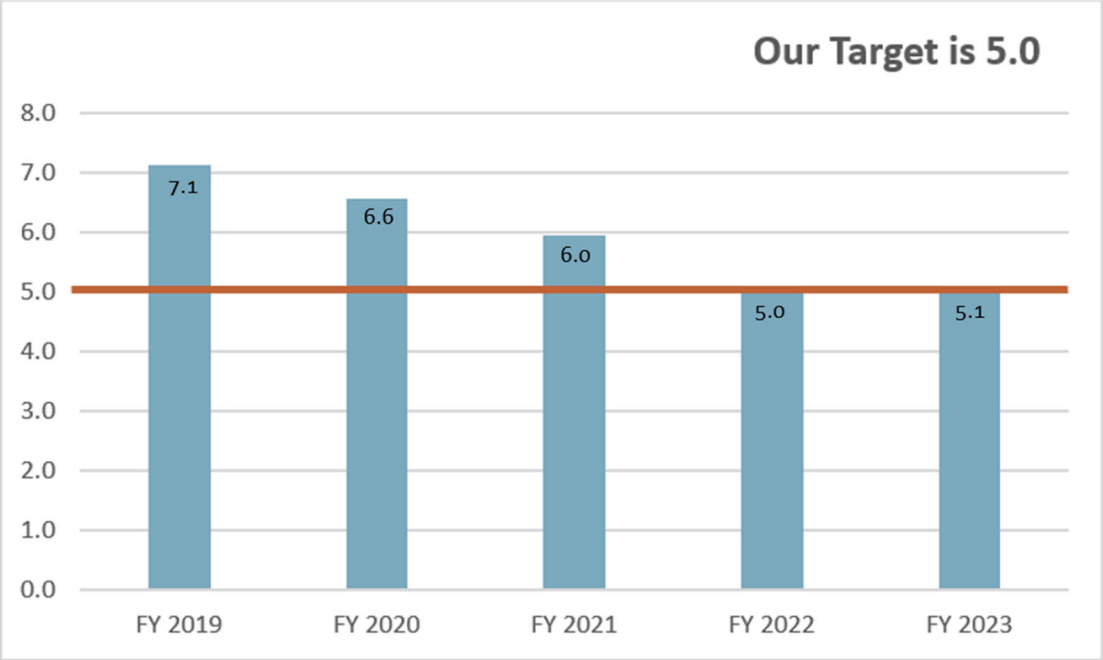


Figure 12 Sewer release response time comparison

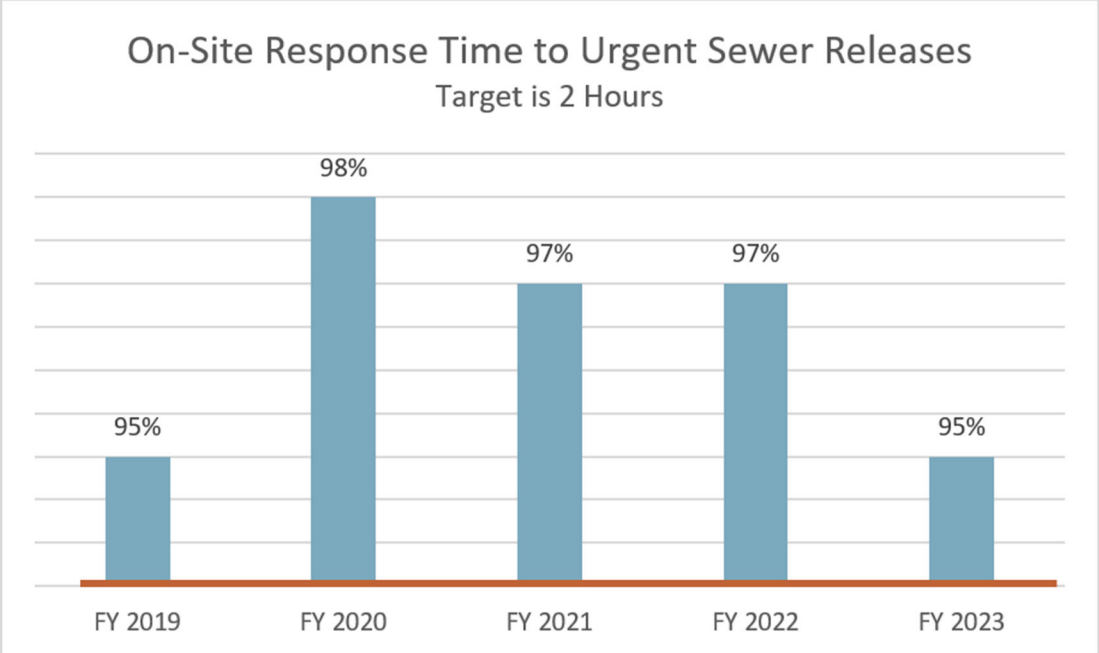


Table 17 Sewer Release Response Time and Counts for FY 2023

FY 2023 Urgent Sewer Release Calls	Number of Calls	Percent of Total
Urgent Calls with Response Time Less Than 2 Hours	395	95%
Urgent Calls with Response Time 2 Hours or More	22	5%
Total	417	100%

4.3 Analysis of Causes and Locations of Sewer Releases

During FY 2023, the City experienced 136 releases from the sanitary and combined sewer systems.

There were also 12 weather-related release events in FY 2023 that exceeded the design capacity of the collection system (referred to as *force majeure*) which were excluded from that total. That total of 136 does include eight releases related to weather issues (ones from large storm events that were not large enough to reach *force majeure* status).

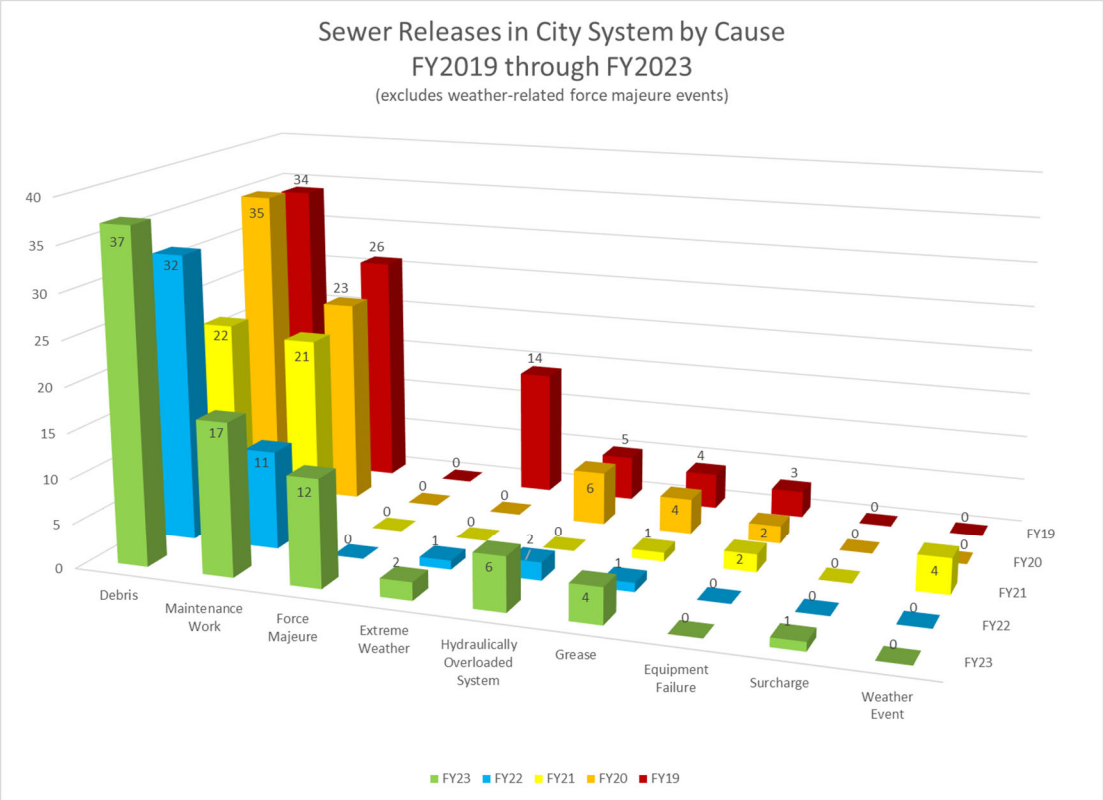
There were 50 sewer releases associated with mainlines, maintenance holes, and pump stations, which equates to 2.6 releases per 100 miles of mainline sewer. If the 12 *force majeure* releases were to be included in this total, then there would have been 3.2 releases per 100 miles of mainline sewer. There were also 86 sewer releases caused by issues in the sewer laterals, which is approximately 11.7 releases per 100 miles of sewer lateral pipe.

A chart comparing the causes of releases in FY 2019 through FY 2023 is shown in Figure 13. 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 2023 are shown on the map in Figure 14.

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 13 Comparison of causes of sewer releases in FY 2019 through FY 2023



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 17 releases caused by structural defects in FY 2023: 15 were associated with defective laterals, one with a mainline sewer, and one with a maintenance hole. 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. This total of 17 is a sharp decline from recent years and may in part reflect the success of sewer repair, rehabilitation, and replacement CIP projects that have been completed in recent years.

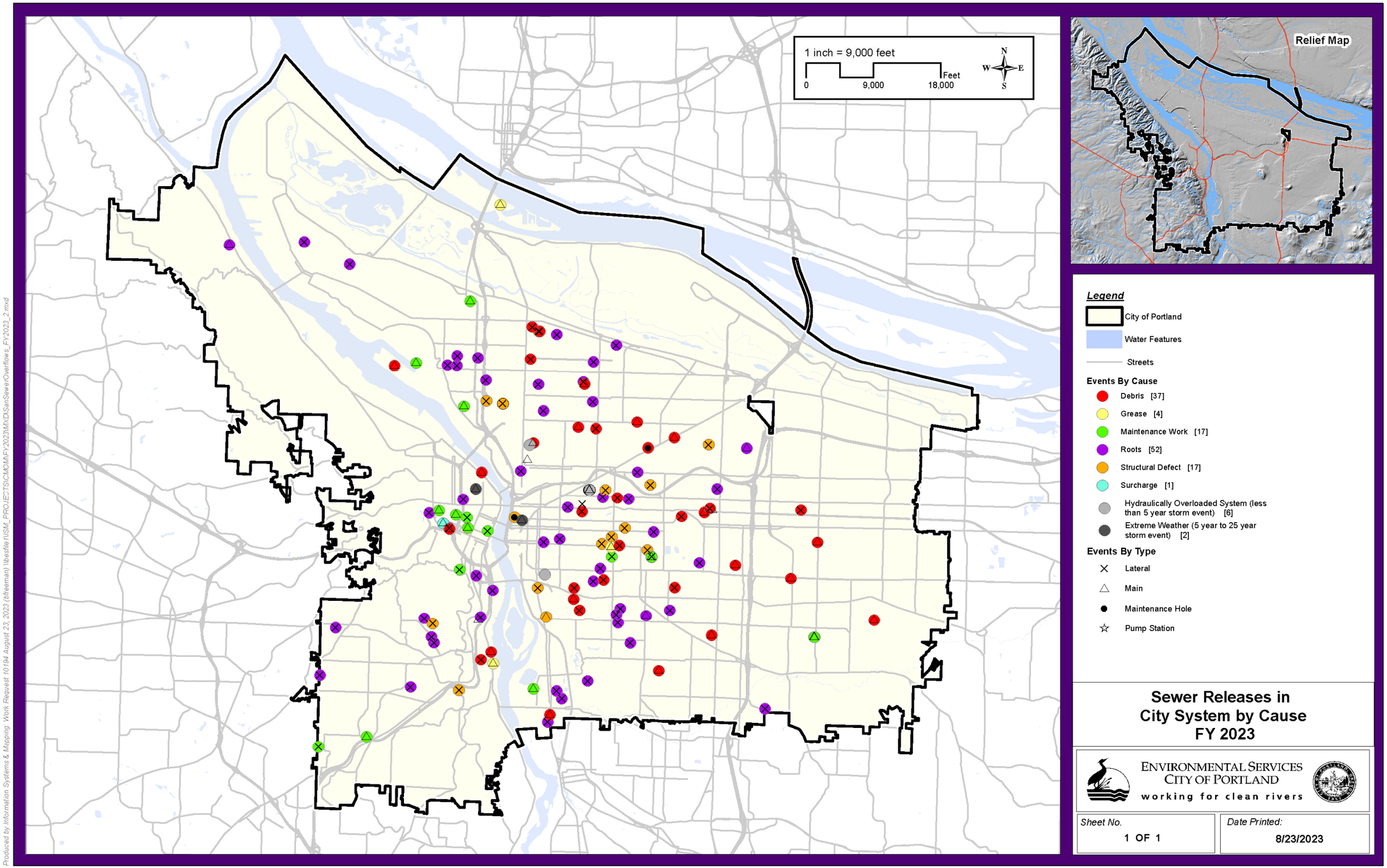
Roots. During FY 2023, 52 releases were caused by roots. Of those, only three were in sewer mainlines while 49 were in service laterals. To reduce the risk of future root intrusion, City crews installed CIPP liners or excavated and replaced the overwhelming majority of laterals where releases occurred in FY 2023.

Maintenance. In FY 2023, there were 17 releases associated with maintenance activities: 11 of the occurrences were associated with mainlines, and six were associated with laterals. Five of the 17 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.

Four maintenance-related releases were associated with City sewer construction projects. Six releases were related to either open cut repairs or installation of CIPP liners by City crews. The other two releases were related to work done by other City bureaus.

Debris. There were 37 releases caused by debris in FY 2023, 20 of which were associated with mainlines, one from a maintenance hole, and 16 from service laterals. Since debris in our sewer system continues to be an issue, BES continues to conduct "what not to flush" public outreach. Also, BES is looking at ideas for accelerated cleaning with regards to sewer mains where pipe sags and debris have been found to be an issue in past CCTV inspections with the intent of reducing the likelihood of this type of release in the future.

Figure 14 FY 2023 sewer release map



4.3.1 Sewer Releases to Surface Water in FY 2023

A sewer release to surface water occurred at just one location in FY 2023 and that occurred during what was determined to be a *force majeure* event for that location. The circumstances of that release are described below.

12750 S Fielding Road (release to the Willamette River). On March 27, 2023, a resident at this address mentioned to a city employee that a sewage release on their property occurred on or around December 27, 2022. Based on information provided by the resident, the volume has been estimated to be approximately 42,000 gallons.

The release occurred from a cleanout on private property and spilled across the ground surface. That released material made its way to a ditch in that area. That ditch leads to the Willamette River. The release occurred during heavy rain and then stopped when the rain abated.

As mentioned, the city was notified of the release on March 27, 2023. DEQ was notified that same day. Since this release had occurred three months prior, no public notification was issued.

An *E.coli* sample was collected from the water in the ditch near the cleanout. The result of that sample was 0 MPN/100mL. No potential debris from the release was observed in the area and therefore no cleanup was performed.

The cause of the sewage release was determined to be heavy rainfall that occurred on December 27, 2023. The nearest rain gauge reported a rainfall amount of 1.67" on that day. An analysis of the rainfall amount determined that this was a *force majeure* storm event. Since this storm was greater than the design capacity of the sewer mains, no changes are planned for the sewer system in this area.

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. This may have been a contributing factor to the reduced number of releases in the last couple of years.

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 just 28 or 1.45 per 100 miles of mainline for FY 2023.

There was just one mainline sewer release associated with a structural defect in FY 2023. This very 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 2023 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.

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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. City staff continue to implement the requirements in the 2020 SWMM.

In FY 2023, implementation of the SWMM in combined sewer basins led to construction of stormwater facilities at 242 properties, managing 19 acres of private impervious area onsite, thereby reducing stormwater volume into the combined system.

5.2 Private Property Retrofit Program

The Private Property Retrofit Program (PPRP) continues installation of stormwater facilities on private property in support of larger Bureau CIP capacity and sewer improvement projects. 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. In turn,

participating properties agree to keep and maintain the new stormwater systems via an operations and maintenance agreement that is recorded with Multnomah County. 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).

FY 2023 project installation season started in October of 2022 and lasted through the end of June 2023. PPRP partnered with property owners in three CSO target program areas located in the Laurelhurst, Boise Eliot and Richmond neighborhoods. The program installed 32 rain gardens, 30 hybrid drywell/rain gardens, 1 downspout disconnection and seven drywell-only projects for a grand total of 70 projects during the FY 2023 season. Most of these projects (61) were implemented in the Richmond neighborhood to help alleviate flows and surcharging to the Taggart D trunk sewer. PPRP will continue to implement and target projects in the Taggart D sewer basin in FY2024. In total, the program controlled 1.7 acres of impervious surfaces in CSO areas during fiscal year 23. Examples of FY 2023 retrofit projects are shown in Figure 15 through Figure 17.

Figure 15 PPRP Example Project #1, two mini drywells installed in series

Figure 16 PPRP Example Project #2, constructed rain garden, SE 43 Ave

Figure 17 PPRP Example Project #3, FY 2022 rain garden after a year of establishment

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 2023, Portland has 563 ecoroofs installed throughout the city, managing over 39.9 acres of roof. Approximately 444 of those ecoroofs are in the combined sewer area. An estimated nine new ecoroofs were installed in the combined sewer area, although the date of some ecoroof installations is uncertain. Newly installed ecoroofs manage approximately 1.14 acres of roof. This roof area represents 1.15 million gallons of rainfall to the combined system annually, and Portland's monitoring data indicate that approximately 573,000 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 2023, Portland has implemented over 2,600 green streets in the right-of-way, with approximately 1,155 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 2023, four new green street facilities were installed in the combined sewer area. The facilities were implemented in two private development projects. Collectively, these facilities manage approximately 0.2 acres of impervious area that generate 200,000 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 140,000 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 2023 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 this section.

The City of Portland has been working diligently over the past fiscal year on developing a risk reporting methodology for pipe rehabilitation. The methodology relies on existing internally-developed asset management and project tracking systems. These systems underwent significant changes and upgrades over the past year, but they need to be further adjusted to enhance risk reduction reporting.

The City is in the process of improving risk calculations for large diameter (36-inch or larger vertical and/or horizontal dimension) pipe assets. The risks for large diameter assets assume different failure scenarios and rehabilitation methods, compared to smaller diameter pipes. Results presented in this report apply to smaller diameter pipes (less than 36-inch diameter).

The City has also completed a Pump Station System Plan in 2020. The plan developed a process to implement a data-driven risk analysis process for determining necessary pump station investment. To promote consistency in decision making, the asset management approach developed for the pipe collection system was tailored for use in evaluating pump station assets. Characterization to identify condition, capacity, and level of service deficiencies among pump station assets is used to quantify risk with the goal of identifying corrective actions. These actions meet the BES core mission by protecting public health, water quality, and the

environment in a manner that optimizes the return on investment for the rate paying customer.

6.2 FY 2023 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	$76,442,000

The Capital Improvement Program completed six projects in the sanitary and combined collection system during the 2022 calendar year. These projects repaired and rehabilitated 138 sanitary and combined sewer gravity mains. A significant portion of the capital project risk reduction ($60.7 million) was accomplished by rehabilitation of the Taggart combined sewer outfall. The project entailed lining approximately 3,240 linear feet of a 120 inch diameter brick sewer at depths of 40 to 60 feet.

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 2,888 linear feet of repair and lining work on sewer main assets and 135 laterals which were replaced or lined. The total risk reduction due to maintenance activity during the 2022 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	$2,448,000

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 2023 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. Temporary flow monitors were installed throughout the Fanno and Burlingame sanitary sewer systems for the 2022-2023 season in order to gather information to assist with evaluating the effectiveness of this Hillsdale Crest RDII reduction project. This analysis will include an overall evaluation of I&I in the Fanno and Burlingame basins, including evaluating proposed RDII reduction projects along the Beaverton Hillsdale Highway and Vermont Street. These RDII reduction projects have been approved and added to the capital improvement program, but they have been delayed due to funding issues resulting from the CBWTP Secondary Treatment Expansion program's budgetary requirements.

The Council Crest sewer basin is currently undergoing a wider, integrated planning effort to eliminate sanitary sewer overflow risk in the local sanitary sewer system that includes addressing I&I issues. Progress made in the past year included refining planning alternatives using hydrologic and hydraulic models of the sanitary sewer system, the downstream combined sewer system, and the local stormwater and surface water systems. Alternatives being considered include upsizing the collection system, disconnecting and reconnecting roof downspouts in the upper area of the basin by Council Crest Park from the sanitary system to an improved stormwater system, and a combination of those two approaches.

7.2 Planned FY 2024 Activities

The outcome of RDII analysis for the Fanno and Burlingame systems will have a direct impact on determining the fate of the Cambridge Village Pump Station, which is a small wet weather diversion pump station located on the upper Fanno Creek Interceptor. This pump station has been identified as requiring investment in the near-term time frame in order to continue operating reliably. Depending on the results of the RDII analysis, this pump station could be abandoned, upgraded, or left in service as is.

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. Work will continue on the Council Crest Integrated RDII project to identify a suitable recommended alternative for eliminating the sanitary sewer overflow risk. Once that has been done the project will proceed through design and to construction.

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 a public information tool in the fall of 2021 that is a valuable resource for the public and media. The online Big Pipe Tracker allows the public to see a visualization of how the Big Pipe system 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.

From November 2021 through June 2023, the Big Pipe Tracker has received more than 19,500 pageviews, with spikes in viewing occurring during storms, as expected and intended.

Section 9 Pollution Prevention Programs to Reduce Contaminants in CSOs

The City has recently developed a Toxics Reduction Program that is specifically focused on reducing pollutants in wastewater and stormwater to protect human health and the environment. The Toxics Reduction Program supports longstanding City education programs in meeting the Nine Minimum Control, Pollution Prevention Programs to Reduce Contaminants in CSOs.

9.1 Pollution Prevention Program Activity

Activities for FY 2023 include:

- Coordination with Clean Rivers Education Program to initiate updates to curricula related to toxics, with an initial emphasis on mercury minimization
- With Environmental Education Program, began development of resources for teachers and classrooms related to the science and best management practices for household/residential toxics reduction and source control, with a focus on toxics with potential to impact wastewater.
- Regular coordination between wastewater treatment plant compliance and Pretreatment programs to address anomalies in toxics concentrations within sanitary system
- Incorporating EPA direction regarding emerging contaminants into BES work and strategies, prioritizing PFAS. Conducted industrial outreach and initiated PFAS source control work through pretreatment program, with the goal of educating industrial users and reducing PFAS in industrial discharges to sanitary system.

Additionally, in FY 2023 BES administered the Eco-Logical Business (EcoBiz) Certification Program in its service area. EcoBiz is a state-wide, voluntary, DEQ-backed pollution prevention program for automotive and landscaping businesses. EcoBiz provides free technical assistance, tools, and training resources to Oregon's automotive and landscaping businesses to encourage responsible stormwater and wastewater management and pollution prevention practices. These services are provided regardless of whether a business completes all steps for EcoBiz certification.

For the FY 2022-23 reporting year:

- 335 business received EcoBiz outreach;
- 37 spill kits were distributed, with an estimated 111 employees trained on spill control and prevention;
- 30 businesses received resources;
- Eight business received technical assistance;
- One new business completed all steps for certification, and five businesses completed all steps for recertification;
- Seven businesses started the certification process, which is on-going.

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 42 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 2023. 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 2023'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[5]	0.42	-	-	14.89[5]	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[5]	3.00	14.30	3.00	24.85[5]	2.42[5]

[5] 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	-	-
39	November 3-4, 2022	1-per-winter 24 hour storm	0.79	1.29	2.00	35.23	4.15	4.51	3.17	30.72	4.15
40	December 24-27, 2022	5-year 12-48 hour storm	1.07	1.83	2.61	286.26	16.18	122.84	14.35	163.42	16.18
41	March 11-13, 2023	2-per-winter 6-12 hour storm	0.87	1.34	1.57	17.94	3.35	1.93	2.20	16.01	3.35
42	May 8, 2023	10-year 1-3 hour summer storm	1.21	1.21	1.21	0.08	0.42	0.08	0.42	-	-

ENVIRONMENTAL SERVICES
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