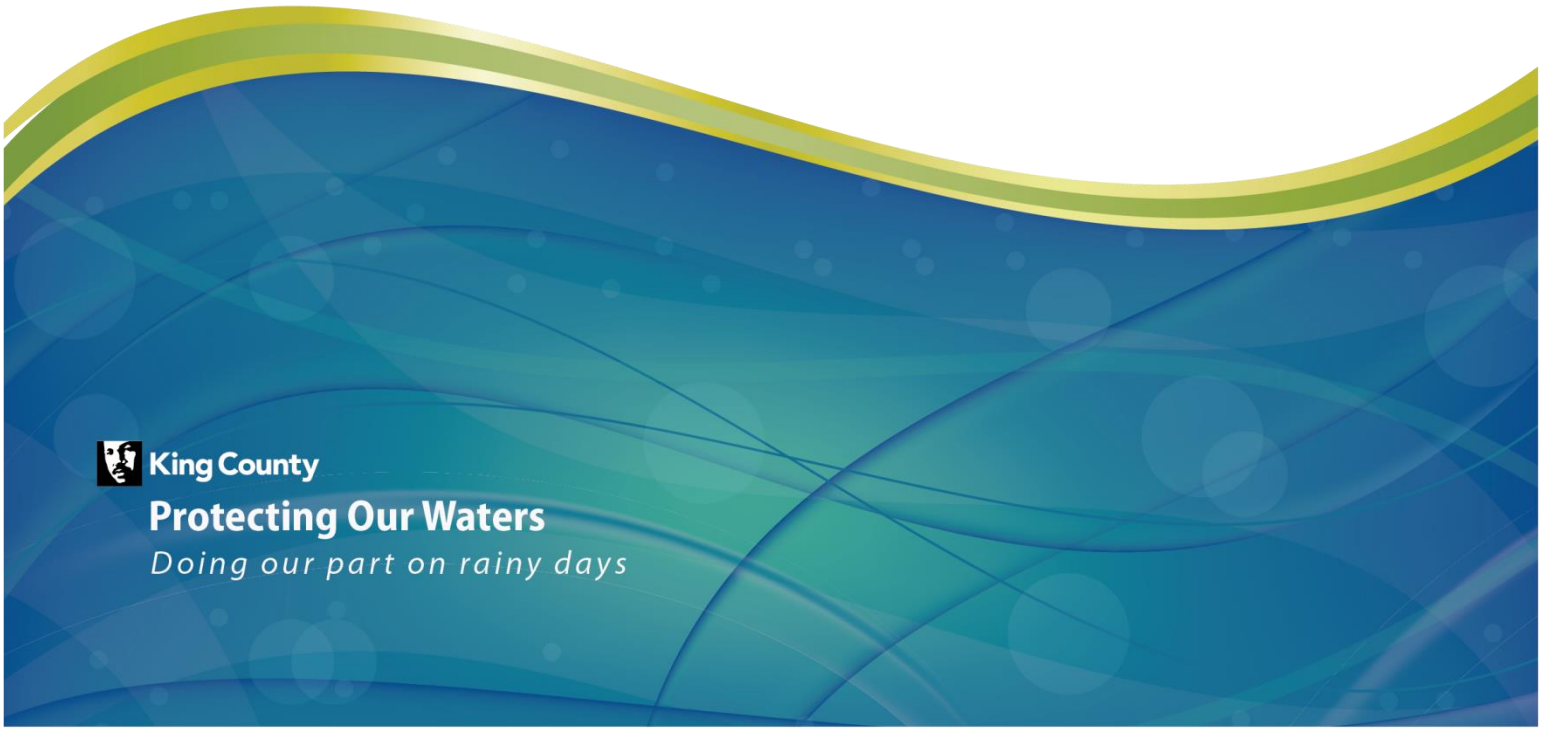
Combined Sewer Overflow Control Program

2017 Annual CSO and Consent Decree Report

July 2018



For comments or questions, contact:
John Phillips
King County Wastewater Treatment Division
CSO Control Program
201 S Jackson St.
KSC-NR-0503
Seattle, WA 98104-3855
206-477-5489
john.phillips@kingcounty.gov

Alternative Formats Available
206-684-1280 TTY Relay: 711

Table of Contents

Tables

Figures

List of Abbreviations and Acronyms

BMP	best management practices
CD	consent decree
Seattle	City of Seattle
County	King County
CSO	combined sewer overflow
DOJ	Department of Justice
DSN	discharge serial number
DWO	dry weather overflow
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ERTS	Environmental Report Tracking System
FOG	fats, oil, and grease
GSI	green stormwater infrastructure
HLKK	Hanford/Lander/King/Kingdome
hr	hour
Joint Plan	Joint Operations and System Optimization Plan
JOIST	Joint Operations Information Sharing Team
JPA	joint project agreement
KCIWP	King County Industrial Waste Program
L	liter
LHWMP	Local Hazardous Waste Management Program
LTCP	long-term control plan
Metro	Municipality of Metropolitan Seattle
µg/L	micrograms per liter
MG	million gallons

MGD	million gallons per day
ml	milliliter
MLK	Martin Luther King
MOA	memorandum of agreement
WQA/MS	water quality assessment/monitoring study
NPDES	National Pollutant Discharge Elimination System
NTP	notice to proceed
O&M	operation and maintenance
PCMP	Post-construction Monitoring Plan
PS	pump station
QAPP	quality assurance project plan
RS	regulator station
RWSP	Regional Wastewater Services Plan
SBS	sodium bisulfite
SCADA	supervisory control and data acquisition
SEPA	State Environmental Policy Act
SPU	Seattle Public Utilities
SS	settleable solids
SSO	sanitary sewer overflow
SSOP	Sewer System Operations Plan
SCIP	Source Control Implementation Plan
TRC	total residual chlorine
TSS	total suspended solids
TEPS	tunnel effluent pump station
UIC	underground injection control
WAC	Washington Administrative Code
WTD	Wastewater Treatment Division

WWTS	wet weather treatment station
VFD	variable frequency drive

1 Introduction

King County's (County) Wastewater Treatment Division (WTD) is responsible for managing the County's regional wastewater system, which consists of both separate and combined systems. WTD prepares annual reports for the combined portion of its system, which includes its combined sewer overflow (CSO) control program. This annual report fulfills requirements under the National Pollutant Discharge Elimination System (NPDES) permit for the County's West Point Treatment Plant (WA0029181) in Seattle and requirements in Washington Administrative Code (WAC) 173-245-090. King County submits these reports to the Washington State Department of Ecology (Ecology). The NPDES permit for West Point Treatment Plant (West Point) was renewed on December 19, 2014, and became effective on February 1, 2015.

On July 3, 2013, a consent decree (CD), Civil Action No. 2:13-cv-677, between the U.S. Department of Justice (DOJ), U.S. Environmental Protection Agency (EPA), Ecology, and King County was finalized. Section VIII of the CD requires submittal of an annual report detailing implementation of the CD. With agreement from EPA and Ecology, beginning with the 2014 annual report, the CSO and CD annual reports were consolidated into one report. This annual report meets the CD, WAC, and NPDES requirements.

CSO control is important to King County because CSOs are a recognized source of water pollution that can result in temporary increases in bacterial counts, aesthetic degradation of shorelines, long-term adverse impacts on sediment quality at discharge points, and raised public health concerns in areas where there is potential for human contact. Protection of water quality and compliance with environmental regulations are top priorities for King County.

In addition, the County is committed to meeting all the milestones and actions outlined in the CD. WTD staff are provided with ongoing trainings and briefings to ensure they are able to fully meet the required milestones and actions of the CD. WTD has a dedicated staff position to provide division-wide communication on the CD to ensure everyone works together to achieve these priorities.

This report documents King County CSO Control Program activities and information for the 2017 calendar year on the following topics:

- Implementation of early action and long-term CSO control plan measures
- CSO volumes and frequency of overflows (including overflow durations and associated rainfall data)

- Information on any CSO-related bypasses at West Point, including the incident that occurred on February 9, 2017 described in Section 4.2.1
- Information on any dry weather overflows (DWOs)
- Sewer System Operations Plan (SSOP) implementation
- Revision of the Joint Operations and System Optimization Plan (Joint Plan) between WTD and Seattle Public Utilities (SPU) based on comments from Ecology
- Implementation of the Joint Plan between WTD and SPU
- Coordination between WTD and SPU on CSO control projects
- NPDES permit compliance for the King County wet weather treatment stations (WWTSs)
- Stormwater best management practices (BMPs) in partnership with SPU for their NPDES municipal stormwater permit

The following sections provide background on King County's wastewater system, its CSO Control Program, and NPDES and CD requirements.

1.1 King County CSO System

King County provides wholesale wastewater conveyance and treatment of flows from 17 cities, 16 local sewer utilities, and one tribal government.

The City of Seattle's (Seattle) local wastewater collection system contains combined sewers that collect both wastewater and stormwater. The newer local systems in the other 33 agencies served by WTD use separated sewers to convey wastewater and stormwater within different pipelines. Seattle's combined sewers convey flows to King County trunks and interceptors, which convey the majority of flows to West Point in Seattle's Discovery Park. A small portion of flows from the combined system are treated at the County's South Treatment Plant (South Plant) in Renton. King County's responsibility for sewerage facilities begins at the point where 1,000 acres of drainage come together.

When large storms occur and flows exceed the capacity of the County conveyance system, CSOs may occur at any of the 39 County CSO locations that discharge to Lake Washington, Lake Union, the Lake Washington Ship Canal (Ship Canal), the Duwamish River, Elliott Bay, and Puget Sound (Figure 1). CSOs may also occur at Seattle's 85 CSO locations in their local sewer system. SPU is responsible for separately managing and reporting on those locations.

Figure 1. King County CSO Locations

1.2 CSO Control Plans, Amendments, and Updates

Since the 1970s, the Municipality of Metropolitan Seattle (Metro) and its successor, King County, have been implementing CSO control projects to improve water quality in the Seattle area. King County does this under a CSO Control Plan that is amended or updated with each renewal of West Point's NPDES permit. Prior to each CSO Control Plan update, the County reviews the plan and progress toward CSO control and compares its existing program against conditions that may have changed since the last update (e.g., flow patterns, scientific developments, changed regulations, new technologies, and public priorities). Significant changes may require adjustment of the CSO Control Plan and, potentially, the CD.

1.2.1 CSO Control Plans, 1979–2012

Metro first formalized CSO control with the development of the 1979 CSO Control Program, which was developed in cooperation with EPA and Seattle. The 1979 program identified nine Metro projects to reduce the number of CSO events into fresh water (Lake Washington, Lake Union, and the Ship Canal). In 1985, the Washington State Water Pollution Control Act (Chapter 90.48 RCW) introduced new regulations that required all municipalities with CSOs to develop plans for "the greatest reasonable reduction at the earliest possible date." Metro prepared the 1986 Final Supplemental Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control to meet this requirement.

Before the 1986 Plan could be implemented, Ecology promulgated new regulations (WAC 173-245-020) that defined "greatest reasonable reduction" to mean "control of each CSO such that an average of one untreated discharge may occur per year." Metro worked with Ecology to develop an interim goal of 75 percent reduction of CSO volumes system-wide by the end of 2005. Metro's Final 1988 Combined Sewer Overflow Control Plan identified 11 CSO control projects designed to meet this interim goal.

King County took over responsibility for operating and maintaining the regional wastewater system from Metro in 1994. As part of the 1995 NPDES permit renewal for West Point, King County prepared an update and amendment to the 1988 Plan. The 1995 CSO Control Plan Update assessed the effectiveness of CSO reduction efforts to date, reevaluated priorities for control of CSO sites, and identified three control projects for completion between 1995 and 2000.

In the late 1990s, King County developed a major update to its comprehensive sewerage plan, including both the combined and separated systems, called the 1999 Regional Wastewater Services Plan (RWSP). During that period, Ecology agreed to discontinue the 75 percent volume reduction interim target for County CSO control to allow prioritization of control projects according to public health and environmental

benefit rather than volume. The final RWSP adopted by the King County Council in 1999 included a revision to the 1995 Plan Update that consisted of 21 control projects to complete system control by 2030. The revision was included with the June 2000 submission of the West Point Treatment Plant NPDES permit renewal application as the Year 2000 CSO Control Plan Update. The 2000 Plan Update described King County's progress in CSO control, documented its compliance with CSO control requirements, and identified two large control projects—Denny Way/Lake Union and Henderson/Martin Luther King (MLK)/Norfolk CSO control projects—for completion in the next five-year NPDES permit cycle. The resulting Elliott West Wet Weather Treatment Station (Elliott West WWTS)/Mercer Street Treatment Tunnel (Mercer St. Treatment Tunnel) and Henderson/Martin Luther King Jr. Way Wet Weather Treatment Station (Henderson/MLK Jr. Way WWTS) came online in spring 2005.

In the RWSP, the King County Council called for a review of the County's CSO Control Program ahead of the NPDES permit renewal application and update to the 2000 Plan Update that was expected to be due in 2005. Issuance of the NPDES permit took longer than expected, pushing back the due date for the next application to 2008. King County completed the review in 2006 as the basis for the 2008 CSO Control Plan Update, which was then submitted as a part of the NPDES permit renewal application in 2008. The 2008 Plan Update described the County's wastewater system, control status of its CSOs, and overall progress toward CSO control; how the County met EPA's Nine Minimum Controls; and summarized the scientific studies that have shaped the control program over time. The 2008 Plan Update also described planned, in-progress, and completed CSO control projects. No changes to the 1999 RWSP CSO Control Plan were recommended and King County committed to implementing the first four of the RWSP CSO projects: Barton Street, Murray Street, South Magnolia, and North Beach, collectively known as the "Puget Sound Beach Projects."

In 2012, the County completed a three-year review of the CSO Control Program. The 2012 Long-term Control Plan Amendment (2012 LTCP) was approved by the King County Council in September 2012. The 2012 LTCP was submitted to Ecology and EPA on November 20, 2012, ahead of the June 2013 application date for the NPDES permit renewal and as part of the CD negotiations. The approved projects in the 2012 LTCP emerged from an evaluation of new conditions, opportunities, science, regulations, and community input since the last major CSO plan update in 1999. Project alternatives were developed for all uncontrolled CSOs to determine which were the most cost effective.

The approved 2012 LTCP is the County's current plan to construct nine projects to control 14 CSOs by the end of 2030. King County will conduct green stormwater infrastructure (GSI) early, ahead of traditional CSO control projects, for four projects, to reduce the size of the gray infrastructure needed to control CSOs.

The King County Council also approved a plan to complete a water quality assessment and monitoring study (WQA/MS) ahead of the next update of the LTCP. The purpose of the study was to ensure that future CSO projects to control pollution are well planned and timed to improve water quality in Elliott Bay, the Duwamish River, and the Ship Canal. The study was intended to confirm or identify possible adjustments in the sequence and schedule of future CSO projects, look at other planned water quality projects, and consider findings as part of a potential Integrated Plan proposal. The recommendation for this study emerged through conversations with stakeholders and the public asking that CSO control be evaluated more fully, along with other water quality improvement programs in the region. The WQA/MS is discussed further in Section 1.2.3 Water Quality Assessment/Monitoring Study.

1.2.2 2019 Long-term Control Plan Update

In 2015, King County began a comprehensive update of the CSO Control Program and the 2012 LTCP approved in 2013. Approximately every five years, updates are required by the WAC 173-245-090, West Point's NPDES permit, and King County Code 28.86.080. The resulting 2019 CSO Plan Update will be submitted to Ecology and EPA with the next West Point NPDES permit renewal application, due January 2019.

In the 2019 CSO Plan Update, WTD conducted analyses of the remaining uncontrolled CSO locations (Figure 1) where projects are not already being implemented, including an evaluation of the CSO control projects identified in the 2012 LTCP. New modeling and flow information has been obtained since the 2012 LTCP was completed. This information, along with additional options for collaboration with SPU, will inform the 2019 CSO Plan Update.

At this time, King County is not recommending any significant changes to the 2012 LTCP. Any updated information on the alternatives identified in the 2012 LTCP will be in the 2019 CSO Plan Update submitted to Ecology and EPA by January 31, 2019.

1.2.3 Water Quality Assessment/Monitoring Study

The WQA/MS was completed in October 2017. King County undertook the WQA/MS to inform the 2018 update to its CSO control plan as well as future activities undertaken by King County and other entities to improve water quality in the region. The study assessed past and present water quality conditions in the waterbodies where the County's remaining CSOs that overflow more than an average of once per year discharge: Lake Union/Ship Canal, Elliott Bay, and the Duwamish Estuary. The study also estimated annual contaminant loadings to these study areas from different pollutant pathways, reviewed planned projects to understand how contaminant loadings may change, and identified impairments that will remain in 2030. Twelve reports describe

different aspects of water quality in the study areas and include summary reports and a report from the peer review team that reviewed the science.

Actions over the past 50 years have improved water quality; nutrient and bacteria levels have decreased in surface waters and sediment cleanups have improved sediment quality. Despite improvements, some water quality is still impaired in the three study areas. Pathways contributing to impairments to receiving water bodies include CSO discharges, stormwater discharges, leaching from boat-bottom vessel paint, and leaching from creosote-treated wood pilings. Planned actions will reduce some contaminant loadings by 2030. Reduction in frequency of untreated CSO discharges will reduce bacteria loadings. Stormwater management and treatment will reduce loadings from stormwater. Laws limiting copper content in antifouling vessel bottom paint, and automobile brake pads will reduce copper. Creosote-treated wood piling removal will reduce organic chemical loading, and contaminated sediment cleanup will reduce sediment contamination levels. However, water quality challenges will remain in 2030 and beyond. Recommended next steps for the region include the following: reduce the frequency of untreated CSO discharges, implement planned water quality improvement projects and programs, monitor changes, and add to the body of knowledge over time.

Links to the 12 reports are available at:
https://www.kingcounty.gov/services/environment/wastewater/cso/projects/water-quality-study.aspx

1.3 Consent Decree

After King County Council approval of the 2012 LTCP, King County submitted the LTCP to Ecology and EPA for approval. EPA and Ecology approved the County's LTCP as meeting federal requirements on March 7, 2013. This approved version became the basis for settlement of ongoing negotiations with EPA, Ecology, and DOJ to finalize a negotiated CD between King County, EPA, and Ecology. The CD was formally filed in U.S. District Court on July 3, 2013.

The CD commits King County to implement the LTCP CSO capital projects specified in the 2012 LTCP within the timelines specified in the CD (and 2012 LTCP) as well as to complete several related plans. King County has made it a high priority to meet all CD milestones. To date, the County has met all past milestones, with one exception, and is currently on schedule to continue doing so with all future milestones. The exception is the South Magnolia Overflow Project (or South Magnolia Wet Weather Storage Project), which had completed construction and was operating correctly until an unexpected conveyance pipe break prevented flows from reaching the new facility. Details on this occurrence are provided in the South Magnolia project summary under Section 3.

Project summaries detailing 2017 progress, planned work in 2018, and their schedule of milestones can be found in Section 3 of this report.

In addition to specific CSO project implementation, the CD required several plans that are now completed or in progress. These plans include:

- Supplemental Compliance Plans submitted in August 2013 for Dexter Avenue Regulator Station Overflow (Dexter Ave. RS Overflow), Denny Way Regulator Station Overflow (Denny Way RS Overflow), and Harbor Avenue Regulator Station Overflow (Harbor Ave. RS Overflow) (with an amendment to the Harbor Ave. RS Overflow Supplemental Compliance Plan submitted September 2013). The aforementioned discovery of the conveyance pipe break triggered the preparation of a new Supplemental Compliance Plan for the South Magnolia Overflow project (submitted January 30, 2017, with an Addendum planned for submittal in April 2018 providing more detail on the corrective approach and schedule finalized with the contractor).
  - Dexter Ave. RS Overflow is controlled.
  - Denny Way RS Overflow and Harbor Ave. RS Overflow are not yet fully controlled as of December 31, 2017.
  - In addition, recent information suggesting the Barton Street Pump Station (Barton St. PS) is no longer in compliance will lead to a new Supplemental Compliance Plan submittal to correct the problem in 2018.
- The Sewer System Operations Plan was submitted in September 2013. A letter approving the SSOP was received from Ecology on May 30, 2014, and from EPA on July 29, 2014. The next review is in August 2018, which represents a relatively minor effort to ensure the information is current and any web links are correctly shown.
- The Joint Plan with SPU was initially submitted to EPA and Ecology on February 10, 2016. The Final Joint Plan was submitted and approved in February 2017. The CD requires the Joint Plan to be reviewed every three years and updated as necessary. Substantive changes that affect the operations of CSO facilities require submittal of the Joint Plan upon renewal of the County's NPDES permit. An updated plan is expected to be complete by March 2019.

An overview of these plans can be found in Sections 3.2 and 3.3 of this report.

1.4 Sediment Sampling and Analysis

In 1999, King County prepared a sediment management plan for addressing contaminated sediment at County CSO locations; the plan was updated in 2017. As part

of the update process, a predictive sediment contamination model for CSO discharges was developed. Two supplemental rounds of sampling at CSO locations were used to calibrate and verify model performance. Sediment sampling results of the first round covering the following locations were provided to Ecology at the end of 2012:

- Barton St. PS Overflow
- Murray Street Pump Station Overflow (Murray St. PS Overflow)
- North Beach Pump Station Inlet Overflow/North Beach Pump Station Wet Well Overflow (North Beach PS Inlet Overflow/North Beach PS Wet Well Overflow)
- South Magnolia Overflow (S Magnolia Overflow)
- Chelan Avenue Regulator Station Overflow (Chelan Ave. RS Overflow)
- 53rd Avenue Southwest Pump Station Overflow (53rd Ave. SW PS Overflow)
- Brandon Street Regulator Station Overflow (Brandon St. RS Overflow)
- Montlake Regulator Station Overflow (Montlake RS Overflow)
- University Regulator Station Overflow (University RS Overflow)
- 3rd Avenue West Overflow (3rd Ave. W Overflow)

Sediment results of the second set of sampling covering the following locations were submitted to Ecology in April 2014:

- Belvoir Pump Station Overflow (Belvoir PS Overflow)
- University RS Overflow (additional sampling)
- Chelan Ave. RS Overflow
- Murray St. PS Overflow
- North Beach PS Inlet Overflow/North Beach PS Wet Well Overflow
- S Magnolia Overflow

These two sampling events also collected baseline conditions at Barton St. PS Overflow, Murray St. PS Overflow, North Beach PS Inlet Overflow/North Beach PS Wet Well Overflow, and S Magnolia Overflow for the post-construction monitoring requirement. In December 2018, post-construction monitoring results for these sites will be provided to Ecology pursuant to the West Point NPDES permit (§S13.B, p. 41).

A draft sediment modeling quality assurance project plan (QAPP) was provided to Ecology in December 2016 pursuant to the West Point NPDES permit (§S13.B, p. 41) for specific Lake Washington CSO outfalls (i.e., 011, 012, 049, 013, 045, 018, and 033). Revisions to address Ecology comments were incorporated in 2017. The revised QAPP will be implemented in 2018. The NPDES permit required characterization at these sites and the County’s approved monitoring plan requires characterization by sampling or modeling.

1.5 Organization of this Report

Subsequent sections and appendices in this report present the following information:

- Report on implementation of EPA's Nine Minimum Controls (Section 2)
- Status of CSO control projects in design or construction (Section 3)
- Discussion of 2017 rainfall and untreated and treated CSO events (Section 4)
- Summary of CD violations in 2017 (Section 5)
- Table showing the 20-year average frequency of untreated CSO events (Section 6)
- Description of post-construction monitoring (Section 7)
- Detailed individual event-based tables for untreated CSOs in 2017 (Appendix A)
- Detailed individual event-based tables for treated CSOs in 2017 (Appendix B)
- Annual reports for the four satellite WWTSs: Alki Wet Weather Treatment Station (Alki WWTS), Carkeek Wet Weather Treatment Station (Carkeek WWTS), Elliott West WWTS, and Henderson/MLK Jr. Way WWTS (Appendices C through F)

This report meets the requirements of annual reporting as defined by the CD, WAC, and the NPDES permit. The crosswalks shown in Table 2 indicate where information meeting the requirements of each can be found in this report.

Table 1. Consent Decree, Washington Administrative Code, and National Pollutant Discharge Elimination System Permit Regulations Crosswalks

Consent Decree Section	Content	Annual Report Location
VIII.43.a	(i) the status of all Consent Decree compliance measures, including Currently Underway and Early Action CSO Control Measures, the implementation of all CSO Control Measures in Appendix B, Post-Construction Monitoring Plan, SSOP, and Information Sharing/Coordination Program Plan Between County and the City of Seattle. (ii) any problems anticipated or encountered, along with the proposed or implemented solutions. (iii) any anticipated or ongoing operation and maintenance activities relating to all CSO Control Measures. (iv) remedial activities that will be performed in the upcoming year to comply with the requirements of this Consent Decree.	(i) 3.1 Project Summaries 3.3.1 Sewer System Operations Plan 3.3.2 Information Sharing/Coordination Program Plan Between County and the City of Seattle (called Joint Operations and Optimization System Plan in the CD Appendix D) 7.0 Post-construction monitoring (ii) Included in sections above, 4.4, and Appendices C–F for WWTSs (iii) 2.1 Reducing CSOs Through Operations and Maintenance Appendices C–F for WWTSs (iv) All of the above
VIII.43.b	A description of any non-compliance with the requirements of this Consent Decree and an explanation of the likely cause and duration of the violation and any remedial steps taken, or to be taken, to prevent or minimize such violation.	5.0 Summary of Consent Decree Violations 2.1 Reducing CSOs Through Operations and Maintenance Appendices C–F for WWTSs

WAC Section	Content	Annual Report Location
WAC 173-245-090(1)(a)	Details the past year's frequency and volume of combined sewage discharged from each CSO site, or group of CSO sites in close proximity. The report shall indicate whether a CSO site or group of sites has increased over the baseline annual condition.	4.0 Summary of Rainfall and CSO Events 6.2 Changes to Control Status of CSO locations Appendix A Untreated CSO Events Appendix B Treated CSO Events Appendices C–F for WWTSs
WAC 173-245-090(1)(b)	Explains the previous year's CSO reduction accomplishments.	3.1 Project Summaries
WAC 173-245-090(1)(c)	Lists the projects planned for the next year.	3.1 Project Summaries

NPDES Permit WA0029181	Content	Annual Report Location
S11.C.2	The CSO Annual Report must include the following information: a. A summary of the number and volume of untreated discharge events per outfall for that year. b. A summary of the 20-year moving average number of untreated discharge events per outfall, calculated once annually. c. An event-based reporting form (provided by Ecology) for all CSO discharges for the reporting period, summarizing all data collected according to the monitoring schedule in Special Condition S11.B.9. d. An explanation of the previous year's CSO reduction accomplishments. e. A list of CSO reduction projects planned for the next year. f. A list of which permitted CSO outfalls can be categorized as meeting the one untreated discharge per year on a 20-year moving average performance standard. This annual assessment may be based on historical long-term discharge data, modeling, or other reasonable methods as approved by Ecology. The Permittee must submit paper and electronic copies of the report, and Excel spreadsheet copies of significant spreadsheets.	6.1 Twenty-Year Moving Average of Event Frequencies Electronic Template submitted electronically with annual report; hardcopy of content in Appendices A and B
S11.B	The Permittee must document compliance with the nine minimum controls in the annual CSO report as required in Special Condition S11.C.	2.0 Programs to Meet EPA's Nine Minimum Controls
S11.F.b	The Permittee must report the running 20-year average number of overflow events per year during this permit term from these existing controlled CSO outfalls in the CSO annual report required in Section S11.C.	6.1 Twenty-Year Moving Average of Event Frequencies

2 Programs to Meet EPA's Nine Minimum Controls

The EPA's Nine Minimum Controls are actions that can be taken to minimize CSO impacts while long-term capital projects are underway. King County has implemented a number of programs to satisfy the requirements of the Nine Minimum Controls, which are part of EPA's codified CSO Control Policy and included in the West Point NPDES permit. The following sections describe King County's programs and activities regarding each of the Nine Minimum Controls, with emphasis on activities undertaken in 2017.

2.1 Control 1—Reducing CSOs through Operation and Maintenance

Implement proper operation and maintenance programs for the sewer system and all CSO outfalls to reduce the magnitude, frequency, and duration of CSOs. The program must consider regular sewer inspections; sewer, catch basin, and regulator cleaning; equipment and sewer collection system repair or replacement, where necessary; and disconnection of illegal connections.

West Point and South Plant staff manage proper facility operation using King County's supervisory control and data acquisition (SCADA) system. The SCADA system provides monitoring and control capabilities for the treatment plant collection systems. See Control 2 (Section 2.2) for information on King County's transition to a new SCADA system.

Under the Asset Management Program, King County employs asset management tools, including a standardized inventory system and condition rating systems, and is developing long-range asset replacement and renewal forecasts, including action plans, to replace assets. The Asset Management Program, implemented by West Point, South Plant, and Conveyance Inspection staff, ensures regular maintenance of CSO outfalls, regulator stations, and pump stations. Conveyance inspection staff inspect sewers on a specified schedule and perform corrective actions when deficiencies are found. Maintenance schedules and records of visits are available for inspection on request.

In 2017, King County performed a review of the WTD Asset Management Program, including the Strategic Asset Management Plan (SAMP). The review identified strengths and opportunities for improvements to the SAMP and Asset Management Program. Recommendations from the review included updating the SAMP and asset management work plan in 2018 as well as early action recommendations to complete in 2018. By the end of 2017, work began to update the SAMP and implement the early action recommendations, many of which will further incorporate asset management into operation and maintenance (O&M) in the combined system.

2.2 Control 2—Storing CSOs in Collection System

Implement procedures that will maximize use of the collection system for wastewater storage that can be accommodated by the storage capacity of the collection system in order to reduce the magnitude, frequency, and duration of CSOs.

The West conveyance system is essentially a deep in-line tunnel system that conveys and stores a wide range of flows. The sizing of the largest in-line tunnels is shown in Figure 2. Maximizing storage in the conveyance system works in concert with maximizing conveyance to West Point to minimize overflows and obtain high quality treatment for service area flows. The system has been built to operate as much as possible based on gravity flow and levels in the interceptors and trunks, with little operator intervention.

When levels reach pre-determined set points, programmable logic controllers automatically adjust gates and pumps to manage the flows. These set points have been determined over the years by operational experience, hydraulic analysis, and modeling to balance conveyance to the treatment plant while maximizing storage in the pipelines and off-line storage facilities, and minimizing overflows and backups. Critical alarms and process data are communicated to the treatment plant operators using monitoring systems that report data in independent communication pathways from the control system. Operators at West Point's Main Control will remotely take control of certain facilities—primarily Interbay Pump Station to force storage in the Mercer St. Treatment Tunnel and the West Seattle Pump Station to force storage in the West Seattle Tunnel—to manage flows to and through West Point. The intent of this operations strategy is to avoid surges and oscillations in the plant, protect the biological system and avoid plant shutdown, optimize conveyance of flows to the plant for treatment, and maximize the use of system storage capacity.

Senior operators assess a range of system factors in making decisions to begin manual control. Which factors are most important depends on the direction storms come from, how fast flows are changing, and antecedent conditions. Decisions require extensive senior operator experience, a sense for antecedent conditions, and the ability to anticipate changing flows.

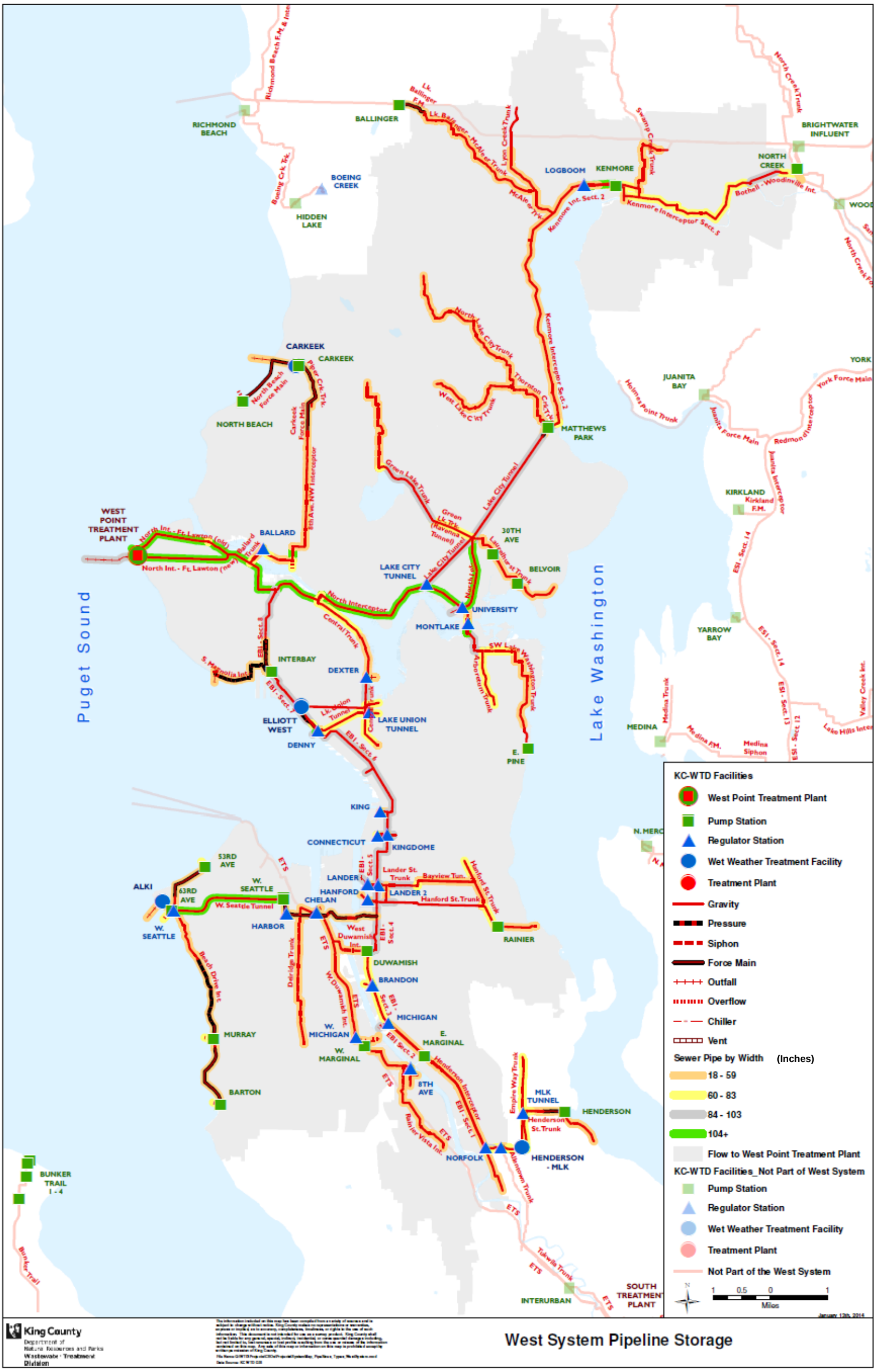


Figure 2. King County Wastewater West System Pipeline Storage

This page intentionally left blank.

2.3 Control 3—Optimizing Pretreatment Program

Review and modify, as appropriate, existing pretreatment program to minimize CSO impacts from discharges due to nondomestic users.

King County's Industrial Waste Program (KCIWP) issues approvals that set limits on the chemical contents of industrial discharges. The program includes monitoring and permit enforcement, education, and technical assistance to businesses on appropriate waste pretreatment and disposal techniques. King County works with the local sewer agencies during the permit approval and renewal process. Local discharge limits are reviewed on a regular basis according to Ecology requirements. The County submits an annual pretreatment report to Ecology detailing permitting, monitoring and inspections, and enforcement actions taken during the year, as well as an evaluation of influent, effluent, and biosolids, focusing on loading and removal rates. King County also administers and helps fund the Local Hazardous Waste Management Program.

Influent and effluent quality at West Point are assessed for trends that would suggest concurrent changes in CSO discharges. In addition, biosolids quality data from West Point are tracked as an indicator of changed loading to the system that could influence CSO quality. No specific new trends were observed in 2017 in pollutant concentrations. Biosolids concentrations are relatively stable and well below EPA's standards.

Beginning in 2016, WTD began to include the downstream CSO to which each permitted industrial discharger contributes in the annual pretreatment report submitted to Ecology.

King County is currently working with Ecology on the County's Source Control Implementation Plan (SCIP) for the Lower Duwamish Waterway. The first draft was submitted in June 2014. King County revised its SCIP based on comments received from Ecology on April 3, 2015. The revised plan was submitted to Ecology in March 2016. King County is currently implementing the plan, which covers 2014 to 2018. Another five-year SCIP will be developed to cover the next five years (2019 to 2023). Per the SCIP, King County submitted a Source Control Annual Report for years 2014 to 2015, documenting source control activities for that period. Source control annual reports will continue to be produced each year.

2.4 Control 4—Maximizing Flow to Treatment Plant

Operate the POTW [publicly owned treatment works] at maximum treatable flow during all wet weather flow conditions to reduce the magnitude, frequency, and duration of CSOs. The Permittee must deliver all flows to the treatment plant within the constraints of the treatment capacity of the POTW.

The 2014 SSOP describes how maximizing storage in the conveyance system works in concert with maximizing conveyance to the treatment plant to minimize CSOs and obtain high quality treatment for service area flows. As described in Control 2 (Section 2.2) and shown in Figure 2, the West conveyance system is essentially a deep in-line tunnel system that can convey a wide range of flows to West Point. SCADA is used to maximize flow to the secondary treatment plant while protecting the biological treatment system via operation of regulators and pump stations. The parallel Fort Lawton Tunnel was built in 1992 to convey up to 440 million gallons per day (MGD) to West Point. West Point provides secondary treatment for all base flows (defined by Ecology as 2.25 times the average wet weather flow) up to 300 MGD and primary treatment for all flows between 300 MGD and the designed instantaneous peak hydraulic capacity of 440 MGD. CSO/primary treated flows are mixed with secondary effluent for disinfection, dechlorination, and discharge from the deep marine outfall. The resulting effluent must meet secondary effluent quality limits, with a small reduction (i.e., 80 percent instead of 85 percent removal during the wet season months of November through April) in total suspended solids (TSS) percent removal requirements.

Up to 24 MGD of combined flows are conveyed to South Plant from southeast Seattle to receive full secondary treatment. This conveyance minimizes CSOs to the Duwamish River along the Elliott Bay Interceptor.

Where captured CSOs cannot be conveyed to secondary treatment plants because of conveyance system limitations, flows are conveyed to WWTSs. King County currently operates four WWTSs: Alki WWTS, Carkeek WWTS, Elliott West WWTS, and Henderson/MLK Jr. Way WWTS.

Treatment process stability is monitored and optimized to manage flows based on information from automatic sensors and an array of analytical tests. Process control laboratories at each plant conduct testing and analysis, and then recommend adjustments to the processes, if necessary, to ensure that quality treatment is provided.

2.5 Control 5—Preventing Dry Weather Overflows

Dry weather overflows from CSO outfalls are prohibited. The Permittee must report each dry weather overflow to the permitting authority as soon as it becomes aware of the overflow. When it detects a dry weather overflow, the Permittee must begin corrective action immediately and inspect the dry weather overflow each subsequent day until it has eliminated the overflow.

The County provides enough capacity in the combined sewer system to transfer 2.25 times the average wet weather flow to secondary treatment, as negotiated with Ecology. As a result, overflows during the dry season are not the result of a lack of capacity. During dry weather, the County only experiences overflows in the combined system

when problems such as power outages, mechanical failures, or human error occur. Similarly, during wet weather, CSOs occurring as a result of precipitation may be exacerbated by power outages, mechanical failures, or human error. While these events are rare and are immediately corrected and reported to Ecology (see Section 4.2), King County's ongoing Asset Management Program reduces the likelihood of these kinds of failures.

To minimize the risk of a DWO due to power loss at a pump station, generators and automatic power transfer systems were installed at pump stations throughout the system, greatly reducing the risk of overflows associated with a loss of power.

To minimize the risk of mechanical failure, the King County Asset Management Program includes an assessment to determine the criticality of pump station equipment. This assessment identifies assets essential to pumping sewage, and inspection and maintenance routines have been developed to increase service time and reduce failures for these assets. These efforts contribute to reducing overflows by decreasing the probability of mechanical failures.

O&M programs, as described for Control 1 (Section 2.1), focus on DWOs and exacerbated CSOs. The conveyance system is monitored through SCADA and direct inspection, and corrective action is taken immediately if a problem occurs. Equipment problems are immediately reviewed and repair or replacement is undertaken in a timely manner.

2.6 Control 6—Controlling Solids and Floatables

Implement measures to control solid and floatable materials in CSOs.

The majority of floatables in the King County system are captured in the large volume of wastewater transferred to the treatment plants before overflows occur.

The County routinely engages in the following practices to control floatables:

- Capturing the "first flush" (maximizing flow to treatment plants) so that most solids and floatables that do enter the sewer are conveyed to the secondary treatment plants for removal and disposal before pipelines reach overflow conditions.
- Constructing facilities with gates and weirs that retain and minimize the release of solid and floatable materials. Gates are set to maximize flow containment. Baffles are used in front of weirs to help hold back all but the smallest items in the flow that passes over them.
- Coordinating with SPU on measures to reduce the washing of street solids and trash into sewers via stormwater and to promote proper disposal of trash so that

it is not flushed down toilets. SPU's catch basin maintenance program limits the introduction of floatable materials to sewers.

- Educating the public on keeping trash and grease out of the sewers (http://www.kingcounty.gov/services/environment/wastewater/education/protect-environment/flush-trouble.aspx).
- Encouraging less water use to reduce unnecessary flows in the sewer that contribute to overflows (http://www.kingcounty.gov/services/environment/wastewater/education/protect-environment/less-water.aspx).

2.7 Control 7—Preventing Pollution

Implement a pollution prevention program focused on reducing the impact of CSOs on receiving waters.

The following section describes the programs that comprise King County's pollution prevention program to reduce sources of flows and contaminant loading within the combined basins. It also describes ongoing efforts in 2017 to coordinate with SPU programs to ensure pollution prevention programs align, cover the geographic area fully, and are comprehensive in addressing all pollution types (solid waste, wastewater, stormwater, etc.). This section is divided into subsections that describe existing industrial and commercial programs, community programs, and stormwater programs.

Programs to Support Pollution Prevention with Industrial and Commercial Discharges

KCIW, along with the County's Local Hazardous Waste Management Program (LHWMP), contributes to source control within the combined sewer system. Industrial facilities throughout Seattle that are permitted through the KCIW program are required to limit the discharge of chemicals and other substances to sanitary sewers that might adversely impact the environment and the wastewater treatment process. KCIW also manages construction dewatering permits within Seattle that propose to discharge wastewater to the sanitary sewer system.

KCIW limits the discharge of fats, oil, and grease (FOG) from a petroleum or mineral origin (nonpolar FOG) to 100 milligrams per liter. Industries must use oil/water separators to pretreat oily wastewater to prevent harm to the biological phase of wastewater treatment and must submit plans for the separators to the local sewer utility or to KCIW for review and approval before installing the separators. FOG from an animal or a vegetable origin (polar FOG) can block sewer lines. Although polar FOG has no numerical limit, dischargers are required to minimize free-floating polar FOG and may be required to complete a FOG control plan for KCIW's review and approval.

King County also prohibits discharge to the sewer of materials such as ashes, sand, grass, and gravel. Industrial wastewater must contain less than 7 milliliters per liter of solids capable of settling. Food waste, including food-grinder waste, must be capable of passing through a 0.25-inch sieve. Discharge rates and maximum volumes are also set for construction dewatering projects, with strict restrictions during the wet season.

In addition, since 2014, King County has continued to implement the SCIP for the Lower Duwamish Waterway. The Plan includes working with Lower Duwamish businesses and residents on pollution prevention as well as County-performed studies and activities. The 2014 to 2015 report on SCIP activities and data collected was delivered to Ecology in 2017. The 2016 report was prepared in 2017 to be delivered in early 2018.

The LHWMP is a multi-jurisdictional effort of King County, SPU, two tribal governments, and 37 local towns and cities that is implemented through a "Management Coordination Committee" and enabled by the King County Board of Health. The LHWMP provides outreach to smaller facilities through a non-regulatory business inspection program, which includes partial-reimbursement vouchers for purchase of source control equipment or services. The LHWMP creates plans to manage hazardous wastes produced by households and in small quantities by businesses and other organizations. The LHWMP is funded by local hazardous waste fees on solid waste (garbage) and sewer accounts.

Programs to Support Community Pollution Prevention

King County and Seattle manage a number of general public education and outreach efforts and specific waste collection/reduction programs for the purpose of reducing contaminant discharges to the sanitary sewer and stormwater systems in combined basins (e.g., water conservation programs, Adopt-a-Road, Adopt-a-Street, recycling resources). Both KCIW and LHWMP maintain extensive online program information and availability of resources and events. The County's LHWMP manages free hazardous waste collection services for household and business wastes (e.g., mobile collection, hazardous waste collection/drop-off sites). The King County Board of Health passed the Secure Medicine Return Regulation in 2013 (also known as the "Drug Take Back" Program) that generates tax revenues from pharmaceutical sales for the LHWMP to facilitate the collection and disposal of prescription and over-the-counter medicines at pharmacies and law enforcement offices at no cost to residents. King County and Seattle also collaborate on various campaigns, including "Puget Sound Starts Here" and "Don't Drip and Drive," that provide free clinics to educate owners on how to inspect and repair automotive fluid leaks (e.g., oil and antifreeze). The agencies also promote proper pest waste disposal and Seattle maintains "Mutt Mitt" plastic bag stations throughout the city. Seattle also stencils facilities or posts other signs to prevent dumping or discharge of wastes in the storm drainage systems. Educational materials

on controlling trash disposal to sewers are also addressed as part of the larger public information programs described in Control 6 (Section 2.6).

In partnership with SPU, WTD has administered the RainWise Program since 2010. This program provides rebates to homeowners living in specific combined sewer areas for installing rain gardens and cisterns on their own property. RainWise helps to slow, detain, or retain stormwater, which reduces both the volume and timing of combined sewer flows and reduces sources of pollution into the combined system.

WTD manages grant programs to help residents and small businesses implement small-scale projects to improve air and water quality and to support the success of King County's CSO projects by controlling new and ongoing sources of pollution that could harm the environment or re-contaminate cleaned-up areas in the waterway. The grants also help promote partnerships around source control, develop local expertise in water quality protection, and enhance small-scale environmental and economic opportunities in the community. The grants help King County residents protect their long-term investment in water quality projects.

In 2017, the following grants were awarded through King County WaterWorks competitive grant funding, funded and administered by WTD. Funding for these 12 projects totaled $850,000, not including administration, all of which will have water quality benefits.

1. *City of Bellevue: Kelsey Creek Stormwater Quality Retrofit ($100,000).* Retrofit a portion of the existing stormwater system within the City of Bellevue to reduce the loading of contaminants from stormwater runoff into Kelsey Creek. A community educational component consists of a Coho pre-spawn mortality curriculum for local high school students.
2. *City of Redmond: Street Sweeping for Water Quality ($64,000).* Measure and study the in-stream benefits of street sweeping to see how effective this action is at improving creek health. This is part of a larger monitoring program to measure in-stream responses to a variety of restoration efforts.
3. *Seattle Public Utilities: Bioretention to Underground Injection Control Well Water Quality Monitoring ($94,200).* Monitor water quality of the effluent from two bioretention systems that discharge to underground injection control wells. These data will help to inform design and maintenance requirements of these new systems.
4. *Environmental Coalition of South Seattle: Environmental Stewards Program ($55,000).* Build on the success of completed raingarden and green stormwater infrastructure demonstration sites at multicultural gathering spaces and use those sites and community connections to facilitate workshops for multilingual community members about CSOs, nonpoint source pollution, and water quality.

5. *Environmental Science Center: Salmon Heroes: Watershed Education and Water Quality Training for Underserved Students ($50,000).* Train the next generation of environmental leaders on water quality issues through Salmon Heroes, a three-part, five-hour education and stewardship project.
6. *Island Wood: Community Waters: Connecting Stormwater Curriculum to Local Watersheds ($200,000).* Integrate localized Puget Sound water quality education into a district-wide 4th-grade science curriculum for the Seattle school district and educate students about pollution prevention in collaboration with Seattle Public Schools and other partners.
7. *Mountains to Sound Greenway Trust: Greenway Education Project ($25,000).* Provide hands-on science education to nearly 4,000 students through classroom sessions, field investigations, and service learning stewardship events. Students learn how their actions can contribute to the health of local waterways.
8. *Salmon-Safe: Salmon-Safe Sammamish ($42,728).* Promote a certification program that accelerates private-sector conservation actions. Salmon-Safe will co-lead workshops and events to reach and engage key decision makers involved with development to promote water quality, conservation, and best practices along the Sammamish and neighboring sites.
9. *Sustainability Ambassadors (Sustainable Seattle): Green/Duwamish Project Design Lab ($89,969).* Engage middle and high school teachers in four Green-Duwamish school districts (Seattle, Tukwila, Kent, and Auburn) to design and test a curriculum on local water quality. Teachers will also facilitate student-led community impact projects and advocate for district-wide adoption of the best models.
10. *Tilth Alliance: The Watershed Stewards Project ($50,000).* Create a Sustainable Stewards program that will provide extensive training in watershed stewardship and outreach to volunteers from communities east and south of Lake Washington. Once trained, these volunteers will provide over 1,000 hours of community service, reaching over 2,500 people.
11. *University of Washington Bothell*: *Investigation on Use of Mycoremediation to Reduce Loading of Pathogenic Bacteria to North Creek ($45,903).* Conduct field and laboratory experiments to test reductions in pathogens by using wattles inoculated with mushroom mycelium. A large crow roost in the wetlands on campus is the primary source of very high levels of fecal coliform bacteria in the wetlands leading into North Creek.
12. *YMCA of Greater Seattle - Earth Service Corps: Youth in Action: Stewardship, Education & Leadership ($33,200).* Educate diverse youth in after-school programs on watersheds and water quality issues, and empower them to address issues in their communities through environmental service projects.

Programs to Support Municipal Stormwater Management

In 2017, WTD worked with SPU staff to develop a coordinated approach to the mutual tracking and sharing of information on stormwater pollution prevention BMPs that are implemented within combined basins consistent with the provisions of each agency's NPDES permit. Because all of King County's CSOs serve areas within the City's boundaries, the City's management and maintenance activities under their Stormwater Code and Side Sewer Code provide many of the source control actions commonly recognized as most effective for reducing contaminant discharges in CSO systems. Seattle provides area-wide services for solid waste collection, street sweeping, spill response, water quality complaint investigations, stormwater system maintenance, and catch basin cleaning. At WTD-owned facilities within Seattle, operations and maintenance staff also perform spill response, drainage facility maintenance, and catch basin cleaning. Both King County and SPU maintain hotlines for reporting of illegal dumping; the County routes reports to the appropriate jurisdictional entity for cleanup of sites.

Seattle Municipal Code Chapters 22.800 through 22.808 contains the City's Stormwater Code, which is the City's primary means of implementing the following requirements: (1) to practice stormwater pollution prevention during construction; (2) to reduce the introduction of pollutants into stormwater runoff as close to the source as possible; and (3) to install flow control, stormwater treatment facilities, or both depending on the size and nature of a project. The Stormwater Code is implemented through the Directors' Rule, promulgated jointly by the Director of SPU and the Director of the Seattle Department of Construction and Inspections. "The Code and Manual establish SPU's authority to implement mandatory City-wide BMP requirements as follows:

- Illicit Connection Identification and Elimination: Under this provision, sanitary side sewer systems must be inspected for illicit connections of sanitary or process wastewater flows. In addition, SPU and WTD also conduct inspections for illicit connections when they are suspected or determined to exist within a basin.
- Routine Maintenance: This program requires property owners to inspect, maintain, and periodically clean approved stormwater facilities such as collection, conveyance, catch basins, and treatment systems (e.g., oil/water separator), and properly dispose of wastes.
- Proper Disposal of Fluids and Wastes: Seattle requires all real property to implement proper liquid waste storage, disposal, and runoff prevention measures.
- Proper Storage of Solid Wastes: Seattle requires all real property to implement proper solid waste storage and disposal practices.

- Spill Prevention and Cleanup: This provision requires businesses and real properties that load, unload, store, or manage liquids or erodible materials (e.g., stockpiles) to maintain spill plans, equipment, and practices to prevent and clean spills as well as notification procedures for spills to the drainage and sewer systems.
- Provide Oversight and Training for Staff: Businesses and public entities that have activities requiring BMPs are required to have trained personnel for their implementation.
- Site Maintenance: Businesses and public entities that involve materials or wastes that may come into contact with stormwater are required to implement proper housekeeping practices to minimize discharge of contaminants such as inspections, avoidance measures (containment, covering, or locating activities away from drainage systems), and sweeping and cleaning procedures.

Ecology has determined that the City's Stormwater Code and Manual are equivalent to Ecology's Surface Water Design Manual for Western Washington. This equivalency establishes the City's authority to conduct business inspections for stormwater code compliance purposes in both separated and combined basins, and to conduct catch basin inspection and cleaning. SPU conducts these inspections in combined sewer basins as resources allow. Finally, both WTD and SPU conduct stormwater drainage and mapping programs to document the boundaries of separated, partially separated, and combined basins.

In reviewing the pollution prevention programs in combined basins described above, both WTD and SPU have determined that existing legal authorities are sufficient to effectively administer and implement these programs. WTD and SPU will continue to implement the pollution prevention program that is consistent with each agency's NPDES permits and that benefits each agency's combined sewer system.

To meet NPDES permit obligations, the King County Department of Natural Resources and Parks (DNRP) relies on SPU to implement pollution prevention actions (e.g., spill response, water quality complaint response, and street sweeping) in areas of the City served by DNRP CSO facilities. SPU currently provides these pollution prevention actions, but is not responsible for DNRP's NPDES permit compliance. At DRNP's request, SPU tracks and reports to DNRP on the limited set of BMPs identified above. SPU and DNRP will explore whether to continue this arrangement and, if so, how to document costs and responsibilities.

During 2017, SPU tracked the following pollution prevention BMPs in areas served by King County CSOs:

- Water Quality Complaints: SPU inspectors respond to complaints as they are received through the water quality hotline, web page, or agency referrals. In 2017, 186 water quality complaints were reported in these basins.
- Spill Response: Spills are dispatched through the SPU Operations Response Center to on-call spill coordinators as they are received. In 2017, SPU responded to 268 spills within these basins.
- Street Sweeping*:* SPU coordinates with the Seattle Department of Transportation (SDOT) to conduct street sweeping on arterials in Seattle using high-efficiency regenerative air street sweepers. In 2017, SPU and SDOT swept 10,128 lane miles in these basins.

2.8 Control 8—Notifying the Public

Implement a public notification process to inform the citizens of when and where CSOs occur. The process must include (a) a mechanism to alert persons of the occurrence of CSOs and (b) a system to determine the nature and duration of conditions that are potentially harmful for users of receiving waters due to CSOs.

King County operates a CSO Notification and Posting Program as a joint project with the City of Seattle and Public Health–Seattle & King County. This program includes signs at publicly accessible CSO locations, an information phone line, websites, a brochure, and other public outreach activities. In 2017 SPU and DNRP developed a new CSO outfall sign design with more languages, a link to the CSO overflow website, and a new phone number that is staffed 24 hours a day. SPU and DNRP intend to fabricate and install the new signs beginning in 2018.

A website providing real-time notification of recent and current CSO discharges went live in December 2007 (http://www.kingcounty.gov/environment/wastewater/CSOstatus.aspx). In April 2011, King County completed the process to incorporate City of Seattle near real-time overflow information on this website. The website presents overflow status for the majority of Seattle and County CSOs with links to and from each agency's independent website. The community has access to consolidated information to assist in making choices about use of local waters. In late 2015, the website was upgraded to be more usable on mobile devices and allows users to zoom in and out to get more details. This upgrade "redesigned" the site from a set of five pages (an overview map and four submaps) to a single-page map.

In 2017, the CSO Status Web pages had 8,774 page views (representing 7,583 unique page views, with 86 percent of users viewing and then leaving the page [bounce rate]).

This represented a 6.05 percent decrease in page views from 2016, during which there were 9,342 page views.

2.9 Control 9—Monitoring CSO Outfalls

Monitor CSO outfalls to characterize CSO impacts and the efficacy of CSO controls. This must include collection of data that will be used to document the existing baseline conditions, evaluate the efficacy of the technology-based controls, and determine the baseline conditions upon which to base the long-term control plan. This data must include:

A. Characteristics of the combined sewer system, including the population served by the combined portion of the system and locations of all CSO outfalls in the combined sewer system.
B. Total number of CSO events and the frequency and duration of CSOs for a representative number of events.
C. Locations and designated uses of receiving waterbodies.
D. Water quality data for receiving waterbodies.
E. Water quality impacts directly related to CSOs (e.g., beach closing, floatables, wash-up episodes, fish kills).

In 1986, Metro began a sampling program to characterize each CSO and identify high-priority sites for early control. The program included collecting overflow quality data for five CSO sites per year and collecting sediment samples at each site. In the 1990s, sampling was expanded to assess compliance with Washington State Sediment Management Standards. The County's extensive monitoring for its 1999 CSO Water Quality Assessment of the Duwamish River and Elliott Bay found that the majority of risks to people, wildlife, and aquatic life would not be reduced by removal of CSOs because most risk-related chemicals come from sources other than CSOs.

Under the previous NPDES permit for West Point effective July 1, 2009, King County developed a comprehensive sediment quality summary report for all CSO discharge locations (submitted December 2009 and to be updated in 2018). The report can be found at: http://your.kingcounty.gov/dnrp/library/wastewater/cso/docs/SedQuality/0912_CompSedQualSumRptCSODischargeLoc.pdf.

King County's Post-construction Monitoring Plan (PCMP) is designed to assess, document, and report on the effectiveness of its CSO Control Program in achieving performance requirements and complying with state water and sediment quality standards. (See also Chapter 7 for additional information.) The King County PCMP was submitted to Ecology in July 2010 and was approved on September 28, 2012. It can be found at:

http://your.kingcounty.gov/dnrp/library/wastewater/cso/docs/ProgramReview/2012/AppH_CSO_PostConstructionMonitoringPlan,Sept2012.pdf.

King County published a comprehensive look at water quality in Elliott Bay, Lake Union, the Ship Canal, and the Duwamish Estuary in 2017. The study's Synthesis Report presents many of the findings from the more detailed documents, including the following:

- Some long-term water quality trends show improvements—even as the Puget Sound region has grown. The region's water quality investments over the last 40 years have paid off.
    - Less bacteria that can make people sick
    - Fewer nutrients that can cause toxic algae blooms
    - More dissolved oxygen for fish to breath
- There is more to do to achieve water quality goals.
    - Water temperature is getting warmer, which is worse for fish
    - Even with the long-term improvements, water does not always meet state water quality standards for bacteria, dissolved oxygen, temperature, or human health standards for banned industrial chemicals called polychlorinated biphenyls or PCBs
    - Historically, contaminated sediments need to be cleaned up or contained
- Completing the CSO program will protect water quality.
    - By 2030, King County and the City of Seattle are scheduled to finish CSO projects to meet state standards
    - This will reduce the amount of fecal coliform bacteria entering the waterbodies by 80 percent
    - It will take more than CSO control to achieve water quality goals
- Stormwater runoff and upstream watersheds carry many pollutants to waterbodies.
    - Many jurisdictions are developing new stormwater rules and regulations. A regional commitment and investment to address stormwater runoff, similar to wastewater treatment, will be needed

(https://www.kingcounty.gov/services/environment/wastewater/cso/projects/water-quality-study.aspx).

3 CSO Control Measures Currently Underway

This section describes the progress made implementing current CSO control projects and other projects that affect CSO control. It includes project-specific summaries of progress made in 2017, planned activities for 2018, and where each project is in relation to its schedule of milestones.

The CD requires the County to report on projects underway and early action CSO control measures. The CD milestone statuses through 2017 are summarized in Table 3. The locations of the CSOs and the status of the related project(s) are included in Figure 3.

Table 2. Summary of King County Consent Decree Milestones through 2017

CSO Name (Project Name)	DSN	Current CD Milestone and Required Date	Actual Milestone Completion Date
Barton St. Pump Station (Barton Street Roadside Raingardens)	057	CSO controlled by December 31, 2017	Recent data show it is not controlled; corrective plan to be submitted 1st Qtr. 2018
Ballard Siphon Regulator (Ballard Siphon Project)	003	CSO outfall controlled by December 31, 2014	Outfall Controlled December 2014
Chelan Ave. Regulator Station (Chelan Ave. CSO Project)	036	Submit Facility Plan by December 31, 2018	N/A
Brandon St. Regulator Station/S. Michigan St. Regulator Station (Georgetown Wet Weather Treatment Station)	039, 041	Completion of Bidding by December 31, 2017	Bidding Completed Notice to proceed (NTP) November 30, 2017
Hanford #2 Regulator Station/Lander St. Regulator Station/King St. Regulator Station/ Kingdome Regulator Station (Project Name TBD)	032 030 028 029	Submit Facility Plan by December 31, 2024	N/A

CSO Name (Project Name)	DSN	Current CD Milestone and Required Date	Actual Milestone Completion Date
Montlake RS (Project Name TBD)	014	Submit Facility Plan by December 31, 2023	N/A
Murray Street PS (Murray St. Wet Weather Storage Project)	056	CSO controlled by December 31, 2017	Outfall Controlled December 2017
North Beach PS (North Beach Wet Weather Storage Project)	048a, 048b	CSO outfall controlled by December 31, 2016	Outfall Controlled December 2016
Hanford #1 (Rainier Valley Wet Weather Storage Project)	031	Construction Completion by December 31, 2019	Construction Completion expected in 2018
11th Ave. NW/3rd Ave W (Ship Canal Water Quality Project)[1]	004, 008	Submit Final Facilities Plan/Engineering Report by December 31, 2017	Final Facilities Plan submitted March 28, 2017
South Magnolia (S Magnolia Wet Weather Storage Project)[2]	006	CSO controlled by December 31, 2016 Supplemental Compliance Plan due January 30, 2017	Supplemental Compliance Plan submitted January 27, 2017
University RS (Project Name TBD)	015	Submit Facility Plan by December 31, 2023	N/A
West Michigan St. Regulator/Terminal 115 (West Duwamish CSO Control Project)	038, 042	Submit Facility Plan by December 31, 2020	N/A
Dexter Ave. RS (Dexter Ave. Supplemental Compliance Plan)	009	Submit to Ecology & EPA within 30 days of CD (July 3, 2013)	Supplemental Compliance Plan submitted August 2013; Compliance achieved July 2016
Denny Way RS (Denny Way Supplemental Compliance Plan)	027a	Submit to Ecology & EPA within 30 days of CD (July 3, 2013) Revised Plan submitted to Ecology August 31, 2016 Completion of modification by December 2018	Supplemental Compliance Plan submitted August 2013; Revised Plan submitted August 2016

CSO Name (Project Name)	DSN	Current CD Milestone and Required Date	Actual Milestone Completion Date
Harbor Ave. RS (Harbor Ave. Supplemental Compliance Plan)	037	Submit to Ecology & EPA within 30 days of CD (July 3, 2013) Revised Plan submitted to Ecology August 31, 2016 Completion of modification by December 2018	Supplemental Compliance Plan submitted August 2013; Revised Plan submitted August 2016

Notes:

[1] Per October 25, 2016, Non-Material CD Modification. CD Appendix A refers to two stand-alone CSO outfalls, East Ballard (a.k.a. 11th Ave. NW) and 3rd Ave. W and Ewing St. (a.k.a. 3rd Ave. NW). The referenced CD modification allows these two outfalls to be controlled as part of the Ship Canal Water Quality Project in collaboration with the City of Seattle. SPU CD milestones will be used to measure progress because SPU is the project lead and their dates are earlier than the County's SCWQP dates for a joint project in the nonmaterial CD modification.

[2] CD Appendix A refers to this as Magnolia Overflow. Because this project did not meet its performance standard due to a pipeline break, the CD-required Supplemental Compliance Plan was submitted. See project-specific update on page 48.

Figure 3. King County CSO Control Projects

3.1 Project Summaries

A summary project status page for 2017 for each active project follows. These project summaries do not include past completed projects or upcoming projects.

Projects in progress include:

- Barton Roadside Raingardens
- Murray Wet Weather Storage
- Georgetown Wet Weather Treatment Station
- Rainier Valley Wet Weather Storage
- Ship Canal Water Quality Project
- West Duwamish
- University GSI
- Chelan Ave. CSO Project

CD/CSO Report Project Status
Barton St. Roadside Raingardens

CSO(s): DSN 057 (Barton St. PS Overflow)
Project Description: Construct GSI (bioretention swales and associated drainage structures) and underground injection control (UIC) wells for CSO control. For more information see:
http://www.kingcounty.gov/environment/wtd/Construction/Seattle/BartonCSO-GSI.aspx.

Milestones	CD Milestone Date (Actual Date)	2010	2011	2012	2013	2014	2015	2016	2017
Submission of Facilities Plan	N/A (final 9/20/2011)								
Submission of Final Plans & Specifications	12/31/2012 (6/13/2013)								
Start of Construction	12/31/2013 (10/21/2013)								
Construction Completion	12/31/2016 (3/22/2016)								
Achievement of Performance Standard	12/31/2017								

2017 Accomplishments:

- King County staff fully took over monitoring compliance with the UIC well inspections from the contractor.

2017 Challenges and Corrections:

- Some of the plants grew more vigorously than expected and outgrew the allotted space. Landscape and maintenance staff worked out the issues as they arose through trimming, changing the plant type, or removing the plant.
- Pump station was upgraded in 2016. Operational controls were not optimizing full capacity of pump station and causing small overflow events. The controls are optimized, but monitoring performance over two more wet seasons.

2018 Activities in Progress or Expected:

- Continue project performance monitoring for compliance.

CD/CSO Report Project Status
Georgetown Wet Weather Treatment Station

CSO(s): DSN 041 (Brandon St. RS Overflow) and DSN 039 (S. Michigan St. Overflow)
Project Description: Construct a WWTS, associated conveyance, and marine outfall. For more information see: http://www.kingcounty.gov/environment/wtd/Construction/Seattle/BrandonMichiganCSO.aspx.

Milestones	CD Milestone Date (Actual Date)	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Submission of Facilities Plan	12/31/2015 (draft submitted 11/2/2015)											
Completion of Bidding	12/31/2017 (11/30/2017)											
Construction Completion	12/31/2022 (N/A)											
Achievement of Performance Standard	12/31/2024 (N/A)											

2017 Accomplishments:

- Acquired final property required for the treatment station site and relocated remaining business.
- Completed the acquisition of permanent and temporary construction easements for the new pipelines.
- Completed geotechnical investigations and survey work.
- Completed demolition, remediation, and site preparation of the treatment station site; substantial completion of the construction contract is expected first quarter 2018.
- Completed utility retirements on the treatment station site and began relocation work for Seattle City Light overhead power facilities.
- Completed design and bidding of the “Georgetown Wet Weather Treatment Station” construction contract and issued Notice-to-Proceed to Flatiron West, Inc. on November 30.
- Completed design and bidding of the “Georgetown Wet Weather Treatment Station - Outfall” construction contract; Notice-to-Proceed expected first quarter 2018. Contract awarded to Pacific Pile & Marine.

- Design for the pipeline construction contract, “Georgetown Wet Weather Treatment Station - Conveyance”, reached 100 percent design. It is anticipated that the construction contract will be advertised at the end of the first quarter of 2018.
- Completed permitting processes for major permits, including the construction and United States Army Corp Section 404/10 permits.
- Obtained a Water Infrastructure Finance and Innovation Act (WIFIA) loan for up to $128.5 million and applied for a State-Revolving Fund (SRF) loan.
- Continued community briefings.

2017 Challenges and Corrections:

- Conveyance construction contract – Union Pacific Railroad would not allow a spur track located at East Marginal Way South and South Brandon Street to be removed from service for any period of time. The pipeline alignment was adjusted to avoid the spur track.
- Outfall construction contract – Washington State Department of Transportation (WSDOT) modified the requirements for restoring a drainage swale that the new outfall crosses. Design is currently being modified to meet WSDOT requirements.

2018 Activities in Progress or Expected:

- Issue substantial completion to the demolition, remediation, and site preparation contractor, first quarter 2018.
- Begin construction of the treatment station, complete the regulator structure and rigid inclusion ground improvements, begin the equalization basin structure, and begin yard piping.
- Negotiate agreement and complete the relocation of a Puget Sound Energy medium pressure gas line in East Marginal Way South.
- Notice-to-Proceed issued to Pacific Pile & Marine on January 17, 2018, to begin construction of the outfall.
- Advertise the conveyance construction contract late first quarter and begin construction by the end of 2018.
- Negotiate WIFIA and SRF loan agreements.

CD/CSO Report Project Status
Murray Street Wet Weather Storage

CSO(s): DSN 056 (Murray St. PS Overflow)
Project Description: Construct wet weather storage. For more information see: http://www.kingcounty.gov/environment/wtd/Construction/Seattle/MurrayCSOStorage.aspx.

Milestones	CD Milestone Date (Actual Date)	2010	2011	2012	2013	2014	2015	2016	2017
Submission of Facilities Plan	N/A (final 9/30/2011)								
Submission of Final Plans & Specifications	12/31/2012 (12/31/2012)								
Start of Construction	12/31/2013 (10/16/2013)								
Construction Completion	12/31/2016 (11/14/2016)								
Achievement of Performance Standard	12/31/2017 (N/A)								

2017 Accomplishments:

- Substantial completion of construction achieved, November 2016.
- Compliance was achieved, December 2017.

2017 Challenges and Corrections:

- Substantial completion was delayed from original contract finish, but CD milestone was still met.
- Weather caused 11 working days of delays.

2018 Activities in Progress or Expected:

- Landscape and restoration activities to be completed.
- Project performance monitoring for compliance and achievement of performance standard.
- Record drawing creation, ongoing.

CD/CSO Report Project Status
Rainier Valley Wet Weather Storage

CSO(s): DSN 031 (Hanford #1 Overflow - Hanford @ Rainier Overflow, Bayview North Overflow, and Bayview South Overflow)
Project Description: Construct CSO Storage Tank and Conveyance Improvements. For more information see:
http://www.kingcounty.gov/environment/wtd/Construction/Seattle/HanfordCSO.aspx.

Milestones	CD Milestone Date (Actual Date)	2013	2014	2015	2016	2017	2018	2019	2020
Submission of Facilities Plan	12/31/2014 (draft 2/28/2014)								
Completion of Bidding	12/31/2016 (5/16/2016)								
Construction Completion	12/31/2019 (N/A)								
Achievement of Performance Standard	12/31/2020 (N/A)								

2017 Accomplishments:

- Completed the Bayview Siphon.
- Finished concrete on the CSO tank.
- Successfully completed conveyance pipe from the Hanford Tunnel to the CSO tank.
- Masonry work completed on the CSO tank building.

2017 Challenges and Corrections:

- Initial tunneling method (for the conveyance pipe to the CSO tank) failed due to a differing site condition. This caused an approximate two-month delay and a $1.2 million change order.
- The project is on track to meet the CD schedule.

2018 Activities in Progress or Expected:

- Substantial completion in June 2018.
- Turnover of the facility to King County operations.
- CD milestone met.

CD/CSO Report Project Status
Ship Canal Water Quality Project

CSO(s): DSN 004 (3rd Ave. W Overflow) and DSN 008 (11th Ave. NW Overflow)
Project Description: The Ship Canal Water Quality Project (Ship Canal Project) is a joint SPU-WTD project that will control CSOs from SPU's Wallingford, Fremont and Ballard areas (Outfalls 147, 150, 151, 152, and 174) and WTD's 3rd Avenue West (DSN 008) and 11th Avenue Northwest (DSN 004) outfalls.

SPU is the lead agency for design and construction, and will own, operate, and maintain the tunnel and its related structures. (WTD will continue to own its two outfall structures.) WTD is coordinating with SPU on the project through a Joint Project Agreement (JPA) approved by the Seattle and County Councils in July 2016. The JPA guides implementation, operation, and cost-sharing of the Ship Canal Project. The County is providing funding and technical expertise, and participates in the Joint Oversight and Project Review and Change Management Committees. This project is in both King County and the City of Seattle's CDs. For more information see: http://www.seattle.gov/util/EnvironmentConservation/Projects/ShipCanalWaterQuality/index.htm

As project lead, more detail is also provided in SPU's Annual CD/CSO Report.

Milestones	CD Milestone Date (Actual Date)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Submission of Draft Facilities Plan	3/31/2017 (1/15/2016)[1]												
Completion of Bidding	7/1/2021 (expected 2019)[2]												
Construction Completion	12/31/2025 [3] (N/A)												
Achievement of Performance Standard	12/31/2026 (N/A)												

Note: CD Milestones and Actual Dates are SPU's except for Construction Completion, which is the same for both agencies. WTD's CD does not have interim milestones for a joint city–county storage tunnel.
[1] The formal County submittal date was 1/22/2016.
[2] The completion of bidding for the tunnel portion is expected to take place in 2019. Bidding for the pump station will take place in 2021, with NTP in 2022.

[3] Date represents completion of both the tunnel construction contract and the pump station construction contract.

2017 Accomplishments

- Completed the State Environmental Policy Act (SEPA) process for the Ship Canal Project after issuing the Final Supplemental Environmental Impact Statement (EIS) in January 2017 with responses to all comments received on the Draft Supplemental EIS and concluding the appeal period on February 9, 2017, with no appeals.
- The storage tunnel and the conveyance packages (for 3rd Ave W, 11th Ave NW and Fremont) completed 60 percent design in 2017.
- The Ballard Early Work Package completed 100 percent design. This construction package includes site remediation near the western tunnel portal, replacement of the pedestrian pier and CSO Outfall 151 at the 24th Ave NW street end, and temporary power and utility relocations at the Ballard site. Reconstruction of the 24th Ave NW pier will enable barging of tunneling spoils.
- Submitted Final Facility Plan in March 2017.
- Completed an Integrated Model for evaluating design performance, which includes the tunnel system, the County's North Interceptor, upstream flows from University and Montlake basins, and West Point treatment plant. SPU and DNRP worked together to develop and calibrate common standardized models for both agencies' CSO Basins and facilities tributary to the Ship Canal Water Quality Project and the West Point Treatment Plant. The component models were integrated into a single model used to simulate the North Interceptor, define operational strategies, and evaluate the predicted performance of the Ship Canal Project.
- Drafted an addendum to the Final Facility Plan to include an updated Hydraulic Modeling Report and associated design revisions.
- Developed 30 percent design of the Tunnel Effluent Pump Station (TEPS).
- Continued with developing a joint Tunnel Effluent Pump Station (TEPS) operational strategy to coordinate effective communications and operations between agencies once the project is completed.
- Advertised and selected a Construction Management consultant for the project.
- Coordinated the design of the Shilshole (effluent) pipeline design with Seattle Department of Transportation's Burke-Gilman trail "missing link" project in Ballard to minimize public disruption from multiple construction activities.
- Submitted mitigation plan for in-water work portion of the Ballard Early Works Package to federal, state, and local agencies, as well as the Muckleshoot Indian Tribe.
- Continued with community outreach.

2017 Challenges and Corrections:

- Revising required control volumes for each basin to reflect updated information in light of the completed Integrated Tunnel Model was a significant effort, including quality assurance and control, from both agencies. Revised control volumes will be included in an Addendum to the Final Facility Plan in early 2018.
- The complexity and costs associated with different work packages required careful integration and review, including extensive value engineering to limit cost increases.

2018 Activities in progress or expected:

- Submit Addendum to the Final Facility Plan reflecting updated modeling results.
- Issue Notice to Proceed on the Ballard Early Works Package.
- Issue a Notice to Proceed for contracted Construction Management and Program Support Services to integrate with the design team and ensure proper oversight and quality management of all future construction activity.
- Develop 90 percent design of the Storage Tunnel, Fremont, 3rd Ave. W, and 11th Ave. NW Conveyance package.
- Obtain the remaining necessary property easements along the tunnel alignment. Properties are being appraised and easements are expected to be finalized in 2018.

CD/CSO Report Project Status
West Duwamish CSO Control

CSO(s): DSN 038 (Terminal 115 Overflow) and DSN 042 (West Michigan Regulator Overflow)
Project Description: Construct a storage tank. For more information see: https://www.kingcounty.gov/depts/dnrp/wtd/capital-projects/active/west-duwamish-cso-control.aspx.

Milestones	CD Milestone Date (Actual Date)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Submission of Facilities Plan	12/31/2020 (N/A)											
Completion of Bidding	12/31/2022 (N/A)											
Construction Completion	12/31/2025 (N/A)											
Achievement of Performance Standard	(N/A)											

2017 Accomplishments:

- Completed Preliminary Design - Alternatives Analysis process and began Preliminary Design - Baseline Design process.
- Pursued acquisition of proposed storage tank property.
- Conducted geotechnical, cultural resource, and hazardous material field investigations on proposed storage tank property.
- Continued community briefings through project website and mailings.

2017 Challenges and Corrections:

- None.

2018 Activities in Progress or Expected:

- Complete acquisition of proposed storage tank property.
- Continue community briefings through project website and mailings.
- Continue Preliminary Design - Baseline Design process.

CD/CSO Report Project Status
University Green Stormwater Infrastructure

CSO(s): DSN 015 (University RS Overflow)
Project Description: Construct GSI to minimize the gray infrastructure demands needed to achieve full CSO control. The timeline below corresponds to the CD's timeline for complete control of the University RS Overflow. For more information see: https://www.kingcounty.gov/depts/dnrp/wtd/capital-projects/active/university-gsi.aspx.

Milestones	CD Milestone Date (Actual Date)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Submission of Facilities Plan	12/31/2023 (N/A)												
Submission of Final Plans & Specifications	12/31/2025 (N/A)												
Start of Construction	N/A												
Construction Completion	12/31/2028 (N/A)												
Achievement of Performance Standard	N/A												

2017 Accomplishments:
- The Preliminary Design - Alternatives Analysis process was initiated in Q3 2017.

2017 Challenges and Corrections:
- None.

2018 Activities in Progress or Expected:
- Completion of the Preliminary Design - Alternatives Analysis process is expected in Q4 2018.

CD/CSO Report Project Status
Chelan Avenue CSO Control Project

CSO(s): DSN 036 (Chelan Ave. RS Overflow)
Project Description: This project will control the Chelan Avenue combined sewer overflow to one event per year on a 20-year rolling average. It includes the siting, design, and construction of a buried storage tank or tunnel to hold approximately 4.3 MG of combined waste and rainwater; a pump station of approximately 7.7 MGD; and above-grade support facilities likely to include a facilities building, odor control, emergency generation, flow diversion, and discharge.
For more information see: https://www.kingcounty.gov/depts/dnrp/wtd/capital-projects/active/chelan-cso-control.aspx.

Milestones	CD Milestone Date (Actual Date)	2017	2018	2019	2020	2021	2022	2023	2024	2025
Submission of Facilities Plan	12/31/2018 (N/A)									
Submission of Final Plans & Specifications	N/A									
Start of Construction	12/31/2020 (N/A)									
Construction Completion	12/31/2023 (N/A)									
Achievement of Performance Standard	N/A									

2017 Accomplishments:

- Investigated four project alternatives to determine which best addressed the improvements required by the CSO Long Term Control Plan.
- Further investigated two of the original four alternatives and selected a WTD management-approved preferred alternative.
- Began working with community stakeholders to share project information and solicit concerns and interests.
- SPU and WTD have identified a potential partnering opportunity to control both WTD's Chelan Avenue CSO and SPU's Delridge 99 CSO. Negotiations will continue as the project progresses.

2017 Challenges and Corrections:

- No challenges were identified and no corrections were required.

2018 Activities in Progress or Expected:

- Begin detailed design of management-approved alternative.

3.2 Supplemental Compliance Plan Summaries

A status page for each project under a Supplemental Compliance Plan follows.

Projects with active Supplemental Compliance Plans include:

- Denny Way RS Overflow
- Harbor Avenue RS Overflow
- South Magnolia Wet Weather Storage and Pipeline

CD/CSO Report Supplemental Compliance Plan Status
Denny Way Regulator Station Overflow

CSO(s): DSN 027a (Denny Way RS Overflow)
Project Description: Adjust facilities built in 2005 to achieve final control per the Supplemental Compliance Plan included in the 2011 TM 970, and updated to Ecology and EPA in 2012. Investigation suggested that two of the inputs—Denny Local and Denny Lake Union—were overflowing more than intended. The investigation recommended removal of the lower Denny local weir and modification of the Elliott West pump ramp-up strategy to drop the lead pump start set point by 2.25 feet and improve flow into the Elliott West facility. The weir modifications were completed in July 2011 and pumping strategy modifications were completed on November 17, 2011. Additional work on the pumping strategy was completed in the fall of 2015. Monitoring in 2016 still showed control issues with Denny Way and additional adjustments to pumping strategy were made in December 2016.

2017 Activities:

- Continued modeling of the pumping system at Elliott West.

2017 Challenges and Corrections:

- Consultant work to model pump strategy will take time.
- Operational fixes are implemented and up to an additional year is needed to monitor results. King County needs to monitor operations during major winter storms.

2018 Activities in Progress or Expected:

- Complete the model and begin to make operational adjustments.
- Monitor compliance at Denny Way RS.

CD/CSO Report Supplemental Compliance Plan Status
Harbor Avenue Regulator Station Overflow

CSO(s): DSN 037 (Harbor Ave. RS Overflow)
Project Description: Adjust facilities built in 1998 to achieve final control per the Supplemental Compliance Plan submitted to Ecology and EPA in August 2012 and amended in September 2012. It was determined that failed modulation of the Alki Gate to the West Seattle Tunnel resulted in less tunnel storage capacity being available to store Harbor flows; half of the tunnel capacity was still available. Locking the gate partly open (51 percent) was recommended. The regulator station did not meet compliance in 2016. Revised modeling of the station found that if the CSO gate could open within one minute, the station would likely achieve compliance. A project was initiated to install a new actuator on the CSO gate. A Supplemental Compliance Plan was submitted to Ecology and EPA on August 31, 2016.

2017 Activities:

- Project manager assigned (June 9).
- Assembled project team and held kickoff meeting.
- Completed two site visits to assess power and space availability.
- Began pre-design.

2018 Activities in Progress or Expected

- Ensure availability of adequate power to the regulator station to power new actuator.
- Complete design.
- Procure contractor and begin construction.
- Achieve substantial completion and final acceptance.

CD/CSO Report Supplemental Compliance Plan Status
South Magnolia Wet Weather Storage and Pipeline

CSO(s): DSN 006 (S. Magnolia Overflow)
Project Description: Investigate solution to pipe break in the CSO conveyance pipe that was first discovered in fall 2016. A Supplemental Compliance Plan was submitted in January 2017 to comply with the CD deadline for notifications.
For more information see:
http://www.kingcounty.gov/environment/wtd/Construction/Seattle/SMagnoliaCSOStorage.aspx.

2017 Accomplishments:

- Submitted Supplemental Compliance Plan (January).
- Located approximate vicinity of pipe break.
- Required contractor to submit a Corrective Action Plan (CAP) to restore project to controlled status.
-

2017 Challenges and Corrections:

- The total conveyance pipe blockage required significant investigation, including debris removal and void grouting.
- The location of the conveyance pipe break 150 feet underground, consideration of potential resolutions, the contractor's submittal of the CAP, and obtaining permits required to implement the CAP resulted in a start date of summer 2017 for the remedial construction phase.
- Prepared for the administration of the remedial construction phase.
- Because of the conveyance pipe blockage, CSO Outfall 006 did not achieve performance standard compliance in 2017.

2018 Activities in Progress or Expected:

- Continue implementation of the CAP, using pipe bursting technology to break up the damaged pipe and replace it with a new pipe.
- Complete pipe repair in fall 2018, restarting the facility's full operation and bringing South Magnolia CSO Control Facility back online.
- An addendum to the Supplemental Compliance Plan will be submitted separately from this CD/CSO annual report.
- Completed as-built drawings for the constructed storage facility. Submit remaining State Revolving Fund documents to Ecology for the project.
- Resume a period of overflow performance monitoring to verify that the facilities are achieving CSO performance standards as intended.

3.3 Program Plan Summaries

The CD required development and implementation of two plans: the SSOP and the Joint Plan with the City of Seattle.

3.3.1 Sewer System Operations Plan

WTD submitted the SSOP on September 27, 2013. Ecology and EPA approved the SSOP on May 29, 2014 and July 29, 2014, respectively. The SSOP is an electronic, interactive document with imbedded links to the most current base documents, such as O&M manuals, plant manuals, safety plans, and maps. King County staff typically access the SSOP from the County's intranet site. Portable storage device (thumb drive) versions are also provided at each facility and to key staff for access in the field or from home. Once a year in August, the team representatives of Operations, Offsite, and CSO control planning go over the plan to ensure that the electronic links still work. Every third year (beginning in 2017), the team will review the SSOP to ensure that base documents are being updated as needed, and that any new or changed information is reflected in the SSOP. Thumb drives are replaced as needed.

3.3.2 Joint Operations and System Optimization Plan

The City of Seattle's and King County's CDs direct both agencies to work together to develop a single Joint Plan. Staff from King County's DNRP and SPU focused on areas in the system that have the greatest potential for operational optimization and developed a set of multi-basin joint commitments. These commitments were approved by the Director of SPU's Drainage and Wastewater Line of Business and the Director of DNRP's WTD and were included in the Joint Plan submitted to EPA and Ecology on February 10, 2016. Comments were received from EPA and Ecology and a revised plan was submitted on February 23, 2017. The following describes each commitment and the progress SPU and DNRP made in 2017:

- The Joint System Debrief Committee commitment is to evaluate performance of the SPU and DNRP systems, identify interconnections to improve operations, and share information after major storm events. SPU and DNRP conducted a post-storm debrief meeting in March 2017 to review the operation of each agency's system during the February 9 storm event, during which flooding occurred at West Point and sewer backups in homes occurred in the South Park Neighborhood as a result of a failure of a backup controller at WTD's 8th Ave. S Regulator Station (RS). Subsequently, WTD provided regular updates to SPU on the progress of restoring West Point, and WTD and SPU coordinated a response to flooded customers in South Park. To coordinate for the 2017 and 2018 wet season, a meeting was held in September 2017 to discuss maintenance activities, system changes, meteorological information, and inter-agency

communications. SPU also provided regular updates to DNRP on the Pump Station 43 bypass, installed after a leak in the force main was detected.

- The Data Sharing commitment is supported by four activities: the formation of the Joint Operations Information Sharing Team (JOIST), implementation of a pilot project for sharing real-time SCADA data, development of data sharing protocols, and the improvement of regional ability to forecast storms and rainfall intensities.
    - JOIST held four meetings during which SPU and DNRP staff conducted tours of both SPU and DNRP facilities and shared information on the operation of existing facilities, progress of capital projects, and coordination of Joint Plan commitments. Additionally, a meeting was arranged with the City of Portland operations staff to tour their CSO tunnel system and learn from their CSO program.
    - A Real-Time Data Sharing Pilot established a framework for real-time data sharing and resulted in development of a secure connection between DNRP's and SPU's SCADA systems for the Windermere/University basin where both DNRP and SPU have pump stations and CSO control facilities. SPU and DNRP signed an extension allowing the pilot project to continue for three more years, and the agencies started working on an options analysis for a permanent solution. A joint project team held regular workshops throughout the year, and a recommendation on a data sharing platform will be made to both agencies in 2018. The recommended platform will replace the pilot project.
    - The SPU and DNRP data sharing committee established standard operating procedures for sharing information and to facilitate data transfer as requested. An annual data review workshop was held in June to review flow monitoring data collected by each agency and provide recommendations for future monitoring.
    - Improved Rainfall Data for Forecasting with additional gauges. DNRP and SPU have started to share historical and real-time rain gauge data and have continued to exchange internal operational weather forecasts and impacts information for the past few years. Staff shared post-storm analyses, which are currently being incorporated into weather modeling and forecasting. Both agencies are working together to incorporate a climate change model output to better understand future impacts of intense rainfall on the wastewater systems. Through a developing partnership with the Center for Western Water and Weather Extremes, SPU and DNRP are co-developing forecast alerts that will enable advance operational adjustments to mitigate CSO and flooding events.
- The Joint Modeling Coordination Committee commitment is to share tools and modeled information to improve operational strategies. Members of the Joint

Modeling Coordination Committee held several meetings in 2017 to review modeling results and coordinate model developments between each agency. A major work activity was the completion of an integrated MIKE URBAN model of the North Interceptor system that combined elements of SPU's system with DNRP's regional system. The committee also developed a model of the joint Ship Canal Water Quality Project facility to support design and operation.

- The Coordination during start-up and commissioning of CSO Control Facilities commitment is to conduct document review, attend commissioning meetings, and implement data sharing for SPU and DNRP CSO control facilities. In 2017, DNRP reviewed the construction plans for the Henderson North CSO improvements. SPU also hosted facility tours during construction for DNRP staff.
- The Real-Time CSO Notification commitment is to improve both on-site signs and website information to improve notification of CSO events and communication with customers. In 2017, SPU and DNRP worked on an updated design for signs identifying CSO outfalls. The design includes the website address to obtain CSO status, multiple languages, a larger size for visibility, and a new phone number directed to SPU's Operations Response Center, which will serve as a single point of contact for both SPU and DNRP CSO outfalls located in the City of Seattle. Sign fabrication and installation is expected to begin in 2018.
- The Reduce Saltwater Intrusion commitment is continuing to work together on studies, data and solutions for reducing intrusion. In 2017, DNRP conducted saltwater monitoring in their system during King Tide events and is planning to share that data with SPU. In November, saltwater intrusion was detected in the system. SPU and DNRP worked together to quickly identify the source originating from a failed flap gate that was repaired. DNRP will continue to monitor saltwater in the conveyance system during King Tides to monitor progress and identify any new issues.

In addition to the above commitments, SPU and DNRP created the Wastewater System Operations Oversight Committee in 2017 to meet regularly to resolve issues and make recommendations and/or decisions about operational coordination and system operations. The committee is authorized to make operational decisions and recommendations for capital or O&M projects that result in a change in operations of existing SPU and DNRP facilities or facilities under construction or upgrade.

In 2017, SPU and DNRP coordinated to initiate review of the Joint Plan. The Consent Decree requires that the Joint Plan is reviewed every three years and updated as necessary to ensure the optimal level of coordination and information sharing between SPU and DNRP. The review will continue in 2018.

3.3.3 WTD Coordination with SPU on CSO Control Projects

Similar to WTD, SPU is implementing CSO control projects under their NPDES permit and CD. Unless these projects involve separation or GSI, Seattle projects will send captured CSO flows to the King County regional system for treatment at West Point or WWTSs. The two agencies have been working together for many years to identify joint project and operational opportunities to improve each agency's efforts and better protect public health and the environment. King County and Seattle have agreed to guiding principles to ensure that neither agency will adversely impact the compliance of the other.

Given that SPU's combined sewers are upstream of King County's system, new or improved SPU CSO control facilities have the potential to affect flows in King County's regional system. For this reason, SPU and WTD coordinate before and after construction of capital projects. Below is a list of projects constructed by SPU in recent years:

- Delridge – NPDES 168 and 169: construction completed in October 2015 with flows to the regional system in November 2015.
- Genesee – NPDES 40/41 and 43: construction complete in October 2015 with flows to the regional system in January 2015 (flows started during commissioning).
- South Henderson – NPDES 46: construction completed in December 2015 with flows to the regional system in December 2015.
- South Henderson – NPDES 47B/171: construction completed August 2015 with flows to the regional system in August 2015.
- South Henderson – NPDES 47C: construction completed November 2013 with flows to the regional system in December 2013.
- Windermere – NPDES 13 and 15: construction completed in July 2015 with flows to the regional system in March 2015 (flows started during commissioning).
- Leschi – NPDES 26 through 36: Phase 2 construction completed in November 2016 with flows to the regional system in 2016.
- North Union Bay – NPDES 18: physical completion in July 2016 with flows to the regional system in 2016.
- South Park (14th and Concord): construction completed in August 2016 with flows to the regional system in 2016.
- Henderson North CSO Reduction Project – NPDES 44 and 45: physical completion in May 2017 with flows to the regional system in 2017 (flows started during commissioning).

In addition to the SPU projects listed above, WTD and SPU are working together to optimize operation of WTD's 8th Ave. S RS to reduce the possibility of sewer backups in the South Park Basin. Sewer backups have the potential to occur when the level of flow in pipes upstream of the 8th Ave. S RS is higher than the overflow elevation at the regulator station, such as what occurred on February 9, 2017. WTD and SPU have taken action to protect high-risk properties by identifying those properties that have connections or fixtures that are below the elevation of the 8th Ave. S RS outfall weir and installing back-flow preventers at those properties. Monitoring and modeling efforts to characterize and optimize operation of the 8th Ave. S RS are ongoing.

WTD and the City of Seattle have monitoring in place for those Seattle projects with the potential to impact flows in the regional system. WTD will continue working with SPU on control and operational strategies as SPU starts up and continues operating Genesee, Delridge, North Union Bay, Leschi, South Park, Windermere, and the remaining components of the Henderson projects.

SPU and WTD continue to work together to ensure GSI projects in the City of Seattle use a consistent approach, per the GSI Memorandum of Agreement signed by the two agencies in 2013. The term *GSI* describes a variety of measures that use soil to absorb stormwater or slow the rate of stormwater entering the combined sewer system. GSI solutions control the sources of pollution by slowing, detaining, or retaining stormwater so that it does not carry runoff into nearby waterways. GSI projects reduce the volume and timing of flows into the combined sewer system. GSI facilities also are referred to as "natural drainage systems" and can be a component of low impact development. Collaborative work between WTD and SPU in 2017 included:

- Maintaining and updating multiple web resources in a jointly managed internet site: http://www.700milliongallons.org/
- Incorporating lessons learned from SPU and WTD projects to improve future projects

Lastly, SPU and WTD are working closely on the Ship Canal Water Quality Project, a joint project that will control WTD's 11th Ave. NW and 3rd Ave. W. CSOs and SPU Basins 147, 150/151, 152, and 174. Coordination for this project is ongoing, and the status of this joint project is described in Section 3.1 of this report.

4 Summary of Rainfall and CSO Events

King County measures rainfall in the Seattle area at many of its regulator stations, pump stations, overflow locations, and at West Point. It also monitors the frequencies and volumes of both untreated and treated CSOs at all of its permitted CSO locations.

This section describes rainfall data and reports on unpermitted overflows and summarizes frequency and volume for all untreated and treated CSO discharges in 2017. Additional information can be found in the appendices.

4.1 Annual Rainfall

Rainfall data are reported for each CSO event as measured by the nearest King County-owned rain gauge. Rainfall data for 2017 are included in Appendices A and B. The annual rainfall for 2017, as an average over local rain gauges, was 42.20 inches. The annual rainfall at Sea-Tac Airport was 47.86 inches, which is higher than the 20-year Sea-Tac Airport annual average of 37.49 inches. This was the fourth year in a row that was wetter than average. Long-term, WTD needs to look at how storms over the last 20 years may compare to storms of the next 60 years. Ecology and WTD are funding work at the University of Washington Climate Impacts Group to examine precipitation over the next century.

4.2 Unpermitted Overflows

Overflows can occur from CSO structures, broken pipelines, and maintenance holes. Unpermitted overflows can be of three types: DWOs, exacerbated CSOs, or sanitary sewer overflows (SSOs).

Overflows in the combined system to CSO outfalls that occur beyond 24 hours after rainfall has ceased are called DWOs. In King County's system, when DWOs occur, they are usually a result of mechanical failures, power outages, or human error. Under EPA's Nine Minimum Controls, DWOs are to be prevented.

Overflows in controlled or uncontrolled basins to CSO outfalls that are increased or extended in duration as a result of mechanical failures, power outages, or human error, are referred to as "exacerbated CSOs."

The release of sanitary or combined flows at any location in the conveyance system other than the designated CSO outfalls, regardless of the basin's "control" status, presence/absence of precipitation or existing high flow events, or causes due to mechanical failures, power outages, or human error, are referred to as *SSOs*. Additionally, the CD defines an SSO as "any overflow, spill, diversion, or release of

wastewater from or caused by the Sanitary Sewer System or the Combined Sewer System" to surface waters of the state or United States, or to land. However, it is not considered an SSO when a wastewater release occurs on land where the overflow is completely contained in a system designed for the purpose of wastewater containment during construction activity.

On February 9, 2017, West Point experienced flooding that caused extensive damage to equipment and treatment processes. This section summarizes the February 9 incident at West Point, then describes other unpermitted overflows not directly related to the February 9 flooding incident.

4.2.1 Incident at West Point Treatment Plant on February 9

On February 9, 2017, West Point experienced a major equipment failure, resulting in serious flooding at the plant and bypasses of untreated stormwater and wastewater into Puget Sound. During a heavy rainstorm, while the treatment plant was operating as designed at maximum influent flows of 440 MGD, an instantaneous fault in the electrical systems to the effluent pumping station led to the pumps shutting down. As operators worked to restart the pumps, the plant operators were trying to hold flows inside the treatment process tanks to avoid a bypass of the influent flows.

Operators rely on an automated system that measures the level of the water in the tanks and automatically shuts down the influent pumps and opens the emergency bypass gates to stop flow into the plant and protect personnel and the facility. However, on February 9, these level sensors (also called float switches) did not work correctly and the primary treatment tanks overflowed, flooding the treatment plant. The flooding caused serious damage to below-ground motors, pumps, and electrical systems. When operators realized flooding was occurring, they manually shut off the influent pumps and opened the emergency bypass gates, allowing untreated stormwater and wastewater to flow through the emergency marine outfall to Puget Sound.

An estimated 200 MG of approximately 90 percent stormwater and 10 percent wastewater discharged to Puget Sound during the 19 hours the plant was offline. In the days after partial wastewater treatment resumed, heavy rains prompted an additional emergency bypass on February 15 and 16 that discharged about 58 MG over the course of 20 hours.

Although the weather did not cause the bypass and flooding, it did contribute to the situation by reducing the time available to respond to the problem. The time between the electrical failure at the effluent pumps and when the primary tanks first started to overflow was only 12 minutes. Because of the equipment damage caused by the flooding, from February 10 to May 10, West Point operated at a reduced treatment capacity. Start-up of secondary treatment began on March 27 at a limited capacity,

reaching full capacity by April 27. By May 10, 2017, the plant was operating with fully restored capacity and meeting pollutant removal requirements under state and federal permits. Although some areas of the plant relied on temporary equipment while longer-term repair and replacement was being performed, by the end of 2017 the plant was fully restored and operating at full capacity.

Over the course of the period of restoration activities at West Point, maximum wastewater inflows during storm events had to be managed carefully to prevent additional bypasses. Considerably higher-than-normal rainfall occurred in the service area during the months of February through April, which contributed to elevated stormwater flows in the combined system. To control flows conveyed to West Point, system flows during storm events were diverted to several of the County's CSO treatment facilities (Alki, Carkeek, and Elliott West). System flows also were routed to King County's Brightwater and the City of Edmonds' wastewater treatment plants. Additionally, untreated discharges from selected King County and SPU CSO outfalls located upstream of the Interbay Pump Station were exacerbated to some extent during the emergency bypass events, as well as periodically during storm events occurring through April when flow shedding occurred.

However, CSO flows depend on many site-specific characteristics, such as background flow in the system, rainfall intensity, and other facility operations. Therefore, it was not possible to estimate the additional quantities of exacerbated CSO discharges during the period of West Point repairs compared to discharges that would have occurred had the plant been fully operational. The CSO Control Program will consider and account for the exacerbated flows that occurred during the flooding and recovery period when conducting hydraulic and system compliance modeling and planning studies in the future to ensure that the properly functioning system conditions are accurately characterized.

Between February 9 and April 27, 2017, West Point was discharging primary treated sewage. The flow during this time period was not above 300 MGD; therefore, the discharge is not considered treated CSO flow. The Alki, Carkeek, Elliott West, and MLK WWTSs experienced increased flows and events from flow shedding because of West Point's limited capacity. This flow shedding led to increased influent and effluent volumes at the WWTSs. Refer to Appendices C through F for more information on flow shedding from the West Point.

Because of the equipment failure and flooding at West Point, several studies were performed to investigate the causes of the incident and to look forward to ensuring the reliability of the entire regional system. The results of these studies that most directly impact the combined sewer system and the CSO Control Program, in particular, are the recommendations that address the ability of West Point to continue to reliably

accommodate combined stormwater and wastewater flows, including stored CSO flows, into the future. These recommendations include having adequate redundancy and reliability at West Point to accommodate peak flows and flexibility to treat peak flows, potentially for longer periods of time or more often; addressing the maintenance, rehabilitation, and replacement of aging infrastructure; and continuing to improve WTD's ability to make risk-based asset management decisions. WTD is addressing these issues through ongoing evaluations and capital project implementation.

4.2.2 Additional Unpermitted Overflows

There were several other exacerbated flow events associated with Elliott West WWTS operations or at CSO outfalls, and other DWOs and SSOs that occurred in 2017 as a result of equipment malfunctions. Table 3 provides a tabular summary of the exacerbated CSOs, DWOs, and SSO.

Table 3. Summary of Unpermitted Overflows in 2017

Date of Event	Facility	Description of Violation(s)
1/18/17	Alki WWTS	SSO: failure to control/reduce inflow pumping from 63rd pump station during high water level event; 256,000 gallons to stormwater system and Puget Sound
2/9/17	8th Ave. Regulator	SSO: regulator gate malfunction resulting in sewer backup into the basements of 27 residential customers
2/16/17	63rd Pump Station	Exacerbated CSO, wet weather: line power outage; 860,000 gallons to Puget Sound
2/9/17 (through April)	Elliott West, Alki, and Carkeek CSO WWTSs and other CSO outfalls	Exacerbated CSO WWTS treated and CSO outfall discharges resulting from West Point flow shedding (volumes of additional discharges undetermined)
10/22/17 through 11/22/17	Elliott West WWTS	Exacerbated Elliott West WWTS treated discharges: failure of outfall tidal flap gate allowed sea water intrusion (additional discharge volumes undetermined)
10/22/17 through 12/31/17	Elliott West WWTS	Exacerbated Elliott West WWTS discharges: faulty wet well drain gate resulted in circulation of additional flow and treated discharges (volumes undetermined)
12/29/17 through 1/1/18	Hanford #2 Regulator Station	Exacerbated CSO, wet weather: faulty gate closure relay; 5.5 MG of non-CSO flow to East Waterway

4.3 Annual Untreated CSO Events

West Point's SCADA system monitors the volume and frequency of CSOs at regulator and pump stations. Portable flow meters are deployed at 11 CSO locations not currently monitored by SCADA or to supplement SCADA monitoring: 11th Ave. NW Overflow, 30th Ave. NE Overflow, Southwest Alaska Street Overflow (SW Alaska St. Overflow), Bayview North Overflow (Bayview N Overflow), Bayview South Overflow (Bayview S Overflow), East Duwamish Pump Station Overflow (E Duwamish PS Overflow), W Duwamish Overflow, Hanford @ Rainier Overflow, S Magnolia Overflow, North Beach PS Inlet Overflow, and Terminal 115 Overflow.

Hydraulic modeling predicts that King County CSOs will discharge 800 MG of untreated CSO in an average year of rainfall. In 2017, there were 34 storm events resulting in untreated CSO discharges. Some storm events spanned multiple days and, at times, there were multiple discharges on the same day. Conditions in 2017 resulted in 206 untreated CSO events discharging 1,707 MG and 54 treated CSO events discharging 1,454 MG, including West Point CSO events. This volume is about double the predicted volume during a normal rainfall year. The highest precipitation occurred in February (8.85 inches) and resulted in 45 untreated events and 749 MG. The second highest precipitation occurred in November (8.63 inches), resulting in 37 untreated events and an overflow volume of 202 MG.

The incident on February 9, 2017, at West Point impacted the collection system upstream and exacerbated overflows at selected King County and SPU CSO outfalls located upstream of the Interbay Pump station. This may be why CSO volumes were much higher in February despite similar rainfall totals in February and November. These impacts upstream of West Point continued until West Point returned to full capacity on April 27, 2017. Section 4.2.1 describes the impact to untreated CSO overflows during the February 9th incident in more detail.

Appendix A lists the untreated events from County CSOs during 2017. These data are also provided in electronic form to Ecology with this report.

4.4 CSO Treatment

King County provides CSO treatment, defined in Chapter 173-245 WAC as "equivalent to primary" treatment and disinfection, at West Point for flows above its secondary capacity of 300 MGD and at four satellite facilities: Alki, Carkeek, Elliott West, and Henderson/MLK Jr. Way WWTSs.

The following sections summarize performance and compliance at each facility during 2017. Appendix B of this report provides more detail on volumes and events. Appendices C through F contain the annual reports for each WWTS.

4.4.1 West Point Treatment Plant CSO-related Events

In addition to secondary treatment of up to 300 MGD of base wastewater flows (defined as 2.25 times the average wet weather flow of 133 MGD), West Point provides CSO treatment for flows above 300 MGD and up to a designed instantaneous peak of 440 MGD. Where captured CSOs cannot be conveyed to secondary treatment plants because of conveyance system limitations, flows are conveyed to WWTSs or are discharged untreated. CSO treatment at West Point consists of blending primary treated flows (between 300 and 440 MGD) with full secondary treated flows (up to 300 MGD), followed by disinfection, dechlorination, and discharge of the final effluent from the deep marine outfall. The resulting effluent must meet secondary effluent quality limits, with a small reduction (i.e., 80 percent instead of 85 percent) in the monthly removal requirements of TSS during the typical wet season months of November through April. This practice is accepted by Ecology, provides a high level of treatment to CSO flows, and reduces program costs and impact to local waterbodies. West Point had 13 CSO-related events during 2017. The total volume was 212 MG. All occurrences are listed in Appendix B.

In the event of power and equipment failures, dry weather secondary diversions can occur via CSO gates at West Point when necessary to prevent exposure of workers to safety hazards and facility damage. These secondary diversions receive primary treatment and disinfection (including dechlorination). In 2017, there were two dry weather secondary diversions, both as a result of the February 9 incident. These incidences are noted in Table 3.

4.4.2 Alki Wet Weather Treatment Station

The transfer of Alki area base flows to West Point was completed in 1998, and conversion of the Alki Treatment Plant from a continuously operating primary plant to a WWTS was completed in 2001. In 2017, there were 13 filling events and 11 discharge events. The Alki WWTS received 247.6 MG and discharged 227.1 MG. The high inflow and discharge volumes compared to past years have been attributed to flow shedding from West Point because of the February 9 incident described in Section 4.2.1.

Overall, TSS removal was 24.5 percent for 2017, which did not meet the annual 50 percent TSS removal limit. The annual average settleable solids (SS) was 0.14 milliliter per liter per hour (ml/L/hr), which met the SS limit of 0.3 ml/L/hr. The Alki WWTS did not meet the instantaneous minimum pH less than 6.0 for one discharge day out of 18 days of discharges. In addition, Alki's effluent had four days out of 18 discharge days exceeding the daily maximum average total residual chlorine (TRC) permit limit of 234 micrograms per liter (µg/L). Alki WWTS met the monthly fecal coliform geomean permit

limit of 400 counts/ 100 ml during each month of discharge at Alki WWTS. More detail is available in Appendix C.

4.4.3 Carkeek Wet Weather Treatment Station

The transfer of Carkeek area base flows to West Point and the conversion of the Carkeek Treatment Plant from a continuously operating primary plant to a WWTS was completed in 1994. In 2017, Carkeek WWTS had 22 filling events and 10 discharge events. The Carkeek WWTS received 86.9 MG and discharged 79.6 MG. The high inflow and discharge volumes compared to past years have been attributed to flow shedding from West Point due to the February 9 incident described in Section 4.2.1.

Overall, TSS percent removal was 28.2 percent in 2017, thereby not meeting the NPDES permit limit of 50 percent for annual removal. Carkeek WWTS met its annual average SS limit with the average measured as 0.16 ml/L/hr, with the NPDES permit limit being 0.3 ml/L/hr. All remaining NPDES permit limits were met except for one exceedance of the monthly fecal coliform geomean limit. More detail is available in Appendix D.

4.4.4 Elliott West Wet Weather Treatment Station

The Elliott West WWTS was brought online in May 2005 as a joint project with Seattle's East Lake Union CSO control projects. In 2017, there were 35 inflow events totaling 1332.7 MG and 17 discharge events totaling 917.4 MG, treated and discharged through the Elliott West Outfall at the Denny Way RS. The high inflow and discharge volumes compared to past years have been attributed to flow shedding from West Point due to the February 9 incident described in Section 4.2.1. Almost 75 percent of 2017 discharged CSO volume occurred during the flow shedding events in the months of February, March, and April 2017.

Additional flow shedding from West Point into the Mercer Tunnel and Elliott West WWTS occurred during November and December rain events in order to minimize the flow of seawater into the conveyance system and into West Point. The seawater intrusion into the conveyance system and West Point was caused by the failure of a marine flap gate at the Denny Regulator in late October. The marine flap gate was replaced in late December 2017.

Overall, TSS removal was 21.4 percent for the year, thereby not meeting the NPDES 50 percent annual average TSS removal limit. Elliott West WWTS also did not meet the SS annual event average limit, with the average measured as 4.04 ml/L/hr and the NPDES permit limit being 0.3 ml/L/hr. Elliott West WWTS performance limitations are being addressed through an assessment report (to be completed in 2019) and a resulting

improvement project (to be completed by 2027). More detail can be found in Appendix E.

4.4.5 Henderson/MLK Jr. Way Wet Weather Treatment Station

The Henderson/MLK Jr. Way WWTS was brought online in May 2005. The Henderson/MLK Jr. Way WWTS had seven filling events and three discharge events during 2017. The Henderson/MLK Jr. Way WWTS received a total inflow of 34.7 MG and discharged 18.6 MG of treated water through the Norfolk Street Overflow to the Duwamish Waterway.

Overall, TSS removal was 46 percent for the year, thereby not meeting the NPDES 50 percent annual average TSS removal limit. The primary reason that the annual average TSS removal was not met was the compromised treatment capacity of West Point after it suffered damage on February 9, 2017. The annual average effluent settleable solids was below 0.1 ml/L/hr, which met West Point's permit limit of 0.3 ml/L/hr.

There was one exception to the minimum pH limit on January 18, 2017. There were two exceptions to the maximum daily TRC limit. Both occurred during the February 9 event. Improvement projects have been in progress to increase the consistency in meeting NPDES permit requirements. More detail is available in Appendix F.

5 Summary of Consent Decree and NPDES Violations in 2017

Section VIII. 43 of the CD requires the listing of any violations of the CD in the annual report. Table 4 identifies CD violations in 2017 and related exceedances of NPDES wet-weather permit requirements for the CSO system.

Following the February 9 flooding event, West Point provided limited treatment while efforts were underway to restore secondary treatment processes. This included some settling of solids, screening, disinfection, and dechlorination. The event severely damaged mechanical and electrical systems needed to provide heat to the secondary system biology, which essentially crippled the plant's solids handling capabilities. Restoration of West Point's primary and secondary treatment processes was completed by the end of April 2017. However, the recovery of solids handling processes was still ongoing until May 9, which resulted in discharge of higher suspended solids than normal. The reduced treatment at West Point during the restoration process affected the ability of the plant to consistently meet its NPDES permit limits for TSS, carbonaceous biochemical oxygen demand (CBOD), and residual chlorine. In turn, the limited solids removal at West Point during the restoration affected the calculated solids removal efficiency of the CSO treatment facilities (Alki, Carkeek, Elliott West, and Henderson/Martin Luther King), which is based on the daily solids removal at West Point.

Details on causes and corrective actions are provided in Appendices C through F. All notifications to Ecology were made in a timely manner.

Table 4. Summary of Effluent Limitation* and Consent Decree Violations in 2017

Date of Event	Facility	Description of Violation(s)
1/17/17	Elliott West WWTS	Total chlorine residual
1/17/17	Elliott West WWTS	pH
1/18/17	Elliott West WWTS	Total chlorine residual
1/18/17	Alki WWTS	Total chlorine residual
1/18/17	Alki WWTS	SSO (overland): failure to control/reduce inflow pumping from 63rd pump station
1/17/17	H/MLK WWTS	pH
1/18/17	H/MLK WWTS	pH
January 2017	Elliott West WWTS	Monthly fecal coliform
2/8/17	Elliott West WWTS	Total chlorine residual

Date of Event	Facility	Description of Violation(s)
2/8/17	Alki WWTS	Total chlorine residual
2/8/17	Alki WWTS	pH
2/8/17	H/MLK WWTS	Total chlorine residual
2/9/17	Elliott West WWTS	pH
2/9/17	H/MLK WWTS	Total chlorine residual
2/9/17	8th Ave Regulator	SSO (sewer backup into residences); regulator gate malfunction
2/10/17	Alki WWTS	Total chlorine residual
2/14/17	Elliott West WWTS	Total chlorine residual
2/15/17	Elliott West WWTS	pH
2/16/17	63rd Pump Station	Exacerbated CSO: line power outage
3/3/17	Elliott West WWTS	Total chlorine residual
3/7/17	Elliott West WWTS	Total chlorine residual
3/15/17	Elliott West WWTS	Total chlorine residual
3/18/17	Alki WWTS	Total chlorine residual
March 2017	Elliott West WWTS	Monthly fecal coliform
4/11/17	Elliott West WWTS	Total chlorine residual
4/12/17	Elliott West WWTS	pH
10/18/17	Elliott West WWTS	Total chlorine residual
10/21/17	Elliott West WWTS	Total chlorine residual
11/3/17	Elliott West WWTS	Total chlorine residual
11/4/17	Elliott West WWTS	Total chlorine residual
11/5/17	Elliott West WWTS	Total chlorine residual
11/21/17	Elliott West WWTS	Total chlorine residual
11/21/17	Elliott West WWTS	pH
11/22/17	Elliott West WWTS	pH
12/19/17	Elliott West WWTS	pH
12/29/17	Hanford #2 Regulator Station	Exacerbated CSO: faulty gate closure relay
December 2017	Elliott West WWTS	Monthly fecal coliform
December 2017	Carkeek WWTS	Monthly fecal coliform
2017 annual	Alki WWTS	Annual average TSS removal
2017 annual	Carkeek WWTS	Annual average TSS removal
2017 annual	Elliott West WWTS	Annual average TSS removal

Date of Event	Facility	Description of Violation(s)
2017 annual	Elliott West WWTS	Annual average SS
2017 annual	H/MLK WWTS	Annual average TSS removal

* pH effluent limits are specified in the NPDES permit, but are not specified as violations subject to stipulated penalties under the CD.

6 Control Status of CSO Locations

6.1 Twenty-year Moving Average of Event Frequencies

The NPDES permit for West Point, effective July 1, 2009, implemented a new interpretation of the performance standard for CSO control, which is derived from the Washington state regulatory requirements for "greatest reasonable reduction" as specified in WAC 173-245-022(22). The CD recognizes this performance level. This standard of "not more than one untreated discharge event per year per outfall on average" is based on a 20-year moving average. The number of untreated discharges that occurred over each of the previous 20 years is reported for each CSO site and then averaged (Table 5). This moving average is used each year to assess compliance with the performance standard. However, since the upgraded SCADA system was fully brought online in 2005, and began to report data for all sites over time, a full 20 years of data are not available for all sites. Locations lacking the full 20 years of measured data are noted. For sites where new control facilities have been built and, thus, lack the 20 years of measured data, modeled data of how the new facilities would have performed with the historic rainfall over those years have been substituted for the unavailable measured data. For sites not identified as controlled, only available measured data are reported.

The following 19 CSOs were identified as controlled through the monitoring and modeling data:

1. 30th Ave. NE Overflow
2. 53rd Avenue Southwest Pump Station Overflow (53rd Ave. SW PS Overflow)
3. 8th Avenue South Overflow (8th Ave. S Overflow)
4. Ballard Siphon Overflow
5. Canal Street Overflow (Canal St. Overflow)
6. Dexter Ave. RS Overflow
7. E Duwamish PS Overflow
8. East Marginal Way Pump Station Overflow (E Marginal Way PS Overflow)
9. East Pine Street Pump Station Overflow (E Pine St. PS Overflow)
10. Henderson Street Pump Station Overflow (Henderson St. PS Overflow)
11. Martin Luther King Junior Way Overflow (MLK Jr. Way Overflow)
12. Matthews Park Pump Station Overflow (Matthews Park PS Overflow)
13. Murray Avenue Pump Station Overflow
14. Norfolk Street Overflow (Norfolk St. Overflow)
15. North Beach Inlet
16. North Beach Wet Well
17. Rainier Avenue Pump Station Overflow (Rainier Ave. PS Overflow)

18. SW Alaska St. Overflow
19. W Duwamish Overflow.

6.2 Changes to Control Status of CSO Locations

Projects previously completed at two CSO sites, Denny Way RS Overflow and Harbor Ave. RS, have not fully achieved control to the Washington state standard. Work completed, or currently underway to complete control at these two locations, is described in Section 3.1 of this report.

In a letter submitted to DOE in December 2017, WTD outlined the status of compliance for the Belvoir PS Overflow. Belvoir PS Overflow, which is within King County's CSO system, has historically been reported as controlled. However, updated modeling indicates that the CSO frequency has increased due to hydraulic and hydrologic changes. As of 2016, Belvoir PS Overflow (No. 012) does not meet the CSO control performance standard.

WTD and SPU recognize that hydraulic and hydrologic changes have affected compliance at the Belvoir PS Overflow. WTD is committed to coordinating and developing mutually beneficial solutions with SPU. This includes working with SPU to meet the approach and schedule included in SPU's approved Windermere Basins 13 and 15 Supplemental Compliance Plans, dated December 7, 2016 and April 18, 2018, respectively.

The 63rd Avenue Southwest Pump Station (63rd Ave. SW PS) Outfall, which is within King County's CSO system, has historically been reported as controlled. However, monitoring data indicate that the CSO frequency has increased because of hydraulic changes. As of 2017, the 63rd Ave. SW PS Outfall (No. 054) does not meet the CSO control performance standard.

WTD is currently optimizing the West Seattle portion of its CSO system, which includes operating the Alki WWTS more frequently. Recent improvements have also been made to the 63rd Ave. SW PS, including changing two constant speed pumps to variable speed pumps as well as electrical and control upgrades. These upgrades will increase operating flexibility and improve performance of the 63rd Ave. SW PS and the Alki WWTS when optimization is complete. A comprehensive computer model of the West Seattle System will be completed by the end of 2018, and it will be used to optimize operations by 2020. Operations staff will work to maintain control of the 63rd Ave. SW PS during the optimization period.

This page intentionally left blank.

Table 5. King County Untreated CSO Events, Averages, and Baselines, 1998–2017

Overflow Name	Discharge Serial Number (DSN)	1998[a]	1999	2000[b]	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	20-Year Average[c]	1983 Baseline (24-hr inter-event)
11th Ave. NW[d]	004	10	12	14	14	8	8	6	11	22	10	7	16	19	16	20	12	25	17	22	21	**14.5**	16
30th Ave. NE	049	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	5	0	3	1	1	2	3	1	0	**0.8**	1
3rd Ave. W[e]	008	8	4	1	11	4	6	4	5	13	6	3	9	8	7	13	5	12	7	5	6	**6.9**	17
53rd Ave. SW PS[f]	052	NM	NM	0	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0	0	1	**0.3**	<1
63rd Ave. SW	054	NM	NM	0	0	0	2	0	1	0	0	0	0	1	1	3	2	2	4	5	4	**1.4**	2
8th Ave. S	040	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	**0.1**	6
Ballard Siphon[g]	003	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	2	0	0	0	**0.2**	13
Barton St. PS[f]	057	2	2	0	3	0	2	1	2	2	1	1	3	1	0	2	3	0	2	2	2	**1.6**	9
Belvoir PS	012	1	0	0	0	0	4	0	0	1	1	0	5	1	2	2	2	2	5	2	2	**1.5**	1
Brandon St. RS[h]	041	31	32	30	30	21	28	21	27	11	NM	3	16	11	7	12	7	16	14	12	6	**17.6**	36
Canal St.	007	2	0	1	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	0	0	**0.5**	1
Chelan Ave. RS	036	5	5	2	7	2	3	1	2	5	2	0	0	3	4	13	4	13	13	9	10	**5.2**	7
Denny Way RS	027a	23	23	25	26	15	25	20	11	9	1	2	4	2	2	1	2	1	5	1	3	**10.1**	32
Dexter Ave. RS	009	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	1	1	0	0	**0.3**	15
E Duwamish PS[d]	034	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	**0.2**	1
E Marginal Way PS	043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.0**	1
E Pine St.	011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.0**	1
Hanford #1[d,l,j]	031a	17	5	0	0	3	6	8	NM	16	4	6	14	13	13	18	10	26	16	22	13	**11.1**	30
Hanford #2 RS	032	17	18	17	13	10	12	16	15	26	12	8	17	17	15	23	9	27	16	24	18	**16.5**	28
Harbor Ave. RS[k]	037	1	0	0	2	0	2	0	3	5	2	0	0	1	1	3	2	1	4	2	3	**1.6**	30
Henderson St. PS[l]	045	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0	**0.0**	12
King St. RS	028	11	14	10	14	12	16	15	20	27	7	3	15	18	15	13	2	23	19	14	3	**13.6**	16
Kingdome RS	029	3	0	1	0	0	0	2	5	4	5	1	8	6	2	11	6	22	17	12	16	**6.1**	29

Overflow Name	Discharge Serial Number (DSN)	1998[a]	1999	2000[b]	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	20-Year Average[c]	1983 Baseline (24-hr inter-event)
Lander St. RS	030	10	15	11	10	10	12	9	8	28	8	6	19	17	15	25	8	29	17	25	21	**15.2**	26
Matthews Park PS	018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.0**	1
MLK Jr. Way[j]	013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.0**	16
Montlake RS	014	7	0	2	0	5	11	5	6	NM	0	1	3	10	8	18	7	20	15	16	12	**7.7**	6
Murray St. PS[f]	056	0	0	1	2	0	2	1	0	1	2	1	0	1	0	1	2	1	2	0	1	**0.9**	5
Norfolk St.[l]	044a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**0.1**	20
North Beach PS Inlet[d]	048b	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	1	**0.1**	18
North Beach PS Wet Well[m]	048a	0	0	0	1	0	2	0	0	0	1	0	0	1	2	1	1	1	2	1	3	**0.8**	18
Rainier Ave. PS	033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.0**	1
S Magnolia[d]	006	19	5	0	0	5	18	17	26	30	21	26	25	38	22	36	16	38	23	15	30	**20.5**	25
S Michigan St. RS	042	0	10	8	12	8	9	6	5	13	5	3	10	12	14	16	8	26	17	16	13	**10.6**	5
SW Alaska St.[d]	055	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	0	0	0	0	0	**0.3**	1
Terminal 115[d,n]	038	NM	NM	NM	NM	NM	2	0	2	7	4	0	3	3	0	1	1	0	1	1	2	**1.8**	4
University RS	015	10	4	3	5	4	4	4	3	12	5	3	9	8	6	13	4	14	11	9	7	**6.9**	13
W Duwamish[d]	035	NM	NM	NM	NM	NM	NM	NM	1	0	1	0	0	1	0	0	1	0	0	0	1	**0.4**	1
W Michigan St.[o]	039	3	3	2	7	5	4	1	3	8	4	0	8	9	3	5	2	3	6	9	6	**4.6**	34

Notes: Modeled numbers are shown in *italics*.
[a] CSO "event" definition changed to be based on a 48-hour dry period.
[b] CSO "event" definition changed to be based on a 24-hour dry period.
[c] Blue 20-year averages are those that meet the no more than one event per year on a 20-year average and therefore are in control. Black 20-year averages are for uncontrolled basins.
[d] Portable monitors are used at 11th Ave. NW, 30th Ave NE, SW Alaska St., Bayview North and South, E Duwamish, W Duwamish, Hanford @ Rainier, S Magnolia, North Beach PS Inlet, and Terminal 115. The Bayview North monitor was installed in 2010; the Bayview South monitor was installed in 2011.
[e] The 3rd Ave. W monitor was down June 2006 through November 2006.
[f] Monitoring began in June 2000 at 53rd Ave. SW PS, 63rd Ave. SW, Barton St., and Murray St.
[g] Years 1997–2013 are modeled data and numbers may be updated in future reports as new information is gathered. Modeled data have been substituted to simulate how current facilities would have performed under rain patterns during that time.
[h] The monitor at Brandon St. RS was down June 2006 to March 2008. A portable monitor was installed in March 2008. Monitoring by SCADA was restored beginning with the 2009 period.
[i] Monitoring began at Hanford #1 (Hanford @ Rainier) in January 1996.
[j] The monitor at Hanford #1 was down June 2000 through May 2001 and was not operating properly June 2007 to December 2007. From June 2005 to May 2006 the portable meter provided questionable data.
[k] No data were recorded at Harbor Ave. in April and May 2004.
[l] Henderson, MLK Jr. Way, and Norfolk St. were controlled as of 2006. Modeled data through 2005 (in italics) have been substituted to simulate how current facilities would have performed under rain patterns during that time.
[m] Monitoring began in June 2005 at North Beach wet well.
[n] Monitoring began in June 2003 at Terminal 115.
[o] Monitoring began at W Duwamish in June 2005.

7 Post-construction Monitoring

King County's PCMP was approved by Ecology on September 28, 2012. Monitoring volume and frequency of overflows at the controlled untreated discharge locations listed above is ongoing, reported monthly to Ecology, and summarized in each CSO Annual Report (Appendix A and B). Volume, frequency, and NPDES permit effluent monitoring and effluent compliance for the wet weather treatment stations are reported monthly and summarized in Appendix B.

King County's ongoing ambient monitoring program provides data for post-construction monitoring as described in the PCMP. Additional details can be found in the PCMP's Appendix D (Receiving Water Characterization Study Sampling and Analysis Plan and Quality Assurance Project Plan), Appendix E (Major Lakes Sampling and Analysis Plan), and Appendix F (Freshwater Swimming Beach Monitoring Sampling and Quality Assurance Project Plan).

Sediment monitoring for controlled sites is being performed as described in the PCMP. Details can be found in the PCMP's Appendix C (Sampling and Analyses Plan). Sediment characterization data completed by 2012 were submitted to Ecology in two submittals, both completed by April 2014.

Design of a sampling plan specific to the Ballard Siphon site was completed in October 2015, in accordance with the PCMP. Data sampling collection was completed on October 15, 2015. The Ballard Outfall Sediment Quality Data Report was sent to Ecology December 1, 2016.

Appendices

Appendix A. Untreated CSO Events, January–December 2017

Appendix B. Treated CSO Events, January–December 2017

Appendix C. Alki Wet Weather Treatment Station 2017 Annual Report

Appendix D. Carkeek Wet Weather Treatment Station 2017 Annual Report

Appendix E. Elliott West Wet Weather Treatment Station 2017 Annual Report

Appendix F. Henderson/MLK Jr. Way Wet Weather Treatment Station 2017 Annual Report

Appendix A
Untreated CSO Events

January–December 2017

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
003	Ballard Siphon Regulator via Seattle Storm Drain	Lake Washington Ship Canal	N/A	N/A	N/A	N/A	N/A	N/A	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	1/17/17 3:15 PM	1/18/17 9:23 AM	18.13	1,206,614	2.19	27.95	
004	East Ballard (a.k.a. 11th Ave NW)[2]	Lake Washington Ship Canal	2/9/17 12:21 AM	2/9/17 9:48 AM	9.45	1,751,560	2.02	24.33	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	2/15/17 3:00 AM	2/16/17 4:10 AM	25.17	492,016	2.46	30.37	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	3/3/17 4:32 PM	3/3/17 5:01 PM	0.48	48,358	0.37	22.07	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	3/14/17 11:55 AM	3/14/17 12:15 PM	0.33	14,818	0.99	46.82	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	3/18/17 9:58 AM	3/18/17 10:19 AM	0.35	6,079	1.12	21.05	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	4/12/17 4:48 AM	4/12/17 5:25 AM	0.62	38,046	0.43	4.18	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	4/23/17 4:30 PM	4/23/17 4:49 PM	0.32	37,815	0.28	5.48	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	4/26/17 1:34 PM	4/26/17 1:51 PM	0.28	40,840	0.07	0.30	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	5/4/17 6:19 PM	5/4/17 6:45 PM	0.43	274,432	0.37	2.02	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	5/16/17 5:40 AM	5/16/17 11:10 AM	5.50	98,567	0.74	40.72	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	10/13/17 12:20 AM	10/13/17 1:01 AM	0.68	319,600	0.33	13.17	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	10/18/17 5:59 PM	10/19/17 4:29 PM	22.50	394,925	1.60	30.47	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	11/15/17 4:35 AM	11/15/17 5:50 AM	1.25	70,310	0.52	7.53	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	11/20/17 7:12 AM	11/20/17 8:45 AM	1.55	177,126	0.68	16.55	

Appendix A Untreated CSO Events

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
004	East Ballard (a.k.a. 11th Ave NW)[1]	Lake Washington Ship Canal	11/21/17 11:54 AM	11/22/17 11:18 PM	35.40	749,435	2.80	78.83	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	11/26/17 12:54 PM	11/26/17 1:39 PM	0.75	402,200	0.54	20.62	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	11/28/17 1:39 PM	11/28/17 1:50 PM	0.18	1,184	0.33	7.50	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	12/2/17 4:15 PM	12/2/17 5:46 PM	1.52	10,303	0.83	27.95	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	12/19/17 5:03 AM	12/19/17 11:12 AM	6.15	141,446	1.77	29.35	
004	East Ballard (a.k.a. 11th Ave NW)	Lake Washington Ship Canal	12/29/17 10:39 AM	12/29/17 1:33 PM	2.90	138,897	1.02	17.88	
006	Magnolia Overflow	Elliott Bay/Puget Sound	1/8/17 1:48 PM	1/8/17 2:26 PM	0.63	11,951	0.32	3.30	
006	Magnolia Overflow	Elliott Bay/Puget Sound	1/17/17 2:34 PM	1/18/17 10:42 AM	20.13	534,532	2.32	30.30	
006	Magnolia Overflow	Elliott Bay/Puget Sound	2/4/17 1:34 PM	2/4/17 2:22 PM	0.80	115	1.04	39.50	
006	Magnolia Overflow[2]	Elliott Bay/Puget Sound	2/8/17 10:20 PM	2/9/17 10:20 AM	12.00	625,286	1.95	25.53	
006	Magnolia Overflow	Elliott Bay/Puget Sound	2/14/17 10:50 PM	2/15/17 10:20 AM	11.50	178,052	2.13	30.35	
006	Magnolia Overflow	Elliott Bay/Puget Sound	3/3/17 3:46 PM	3/3/17 4:56 PM	1.17	15,754	0.33	23.28	
006	Magnolia Overflow	Elliott Bay/Puget Sound	3/9/17 3:26 PM	3/9/17 6:50 PM	3.40	1,452	0.53	26.02	
006	Magnolia Overflow	Elliott Bay/Puget Sound	3/11/17 12:30 PM	3/11/17 12:50 PM	0.33	309	0.24	3.38	
006	Magnolia Overflow	Elliott Bay/Puget Sound	3/13/17 2:56 PM	3/15/17 10:16 AM	43.33	13,126	1.42	68.43	
006	Magnolia Overflow	Elliott Bay/Puget Sound	3/17/17 3:14 PM	3/18/17 10:34 AM	19.33	24,295	1.10	21.42	
006	Magnolia Overflow	Elliott Bay/Puget Sound	4/2/17 2:48 AM	4/2/17 3:08 AM	0.33	2,581	0.16	1.52	
006	Magnolia Overflow	Elliott Bay/Puget Sound	4/12/17 4:10 AM	4/12/17 11:06 AM	6.93	28,029	0.69	10.03	
006	Magnolia Overflow	Elliott Bay/Puget Sound	4/23/17 4:10 PM	4/23/17 4:36 PM	0.43	10,665	0.22	28.43	
006	Magnolia Overflow	Elliott Bay/Puget Sound	5/4/17 6:06 PM	5/4/17 10:02 PM	3.93	16,103	0.32	5.60	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
006	Magnolia Overflow	Elliott Bay/Puget Sound	5/16/17 5:46 AM	5/16/17 10:38 AM	4.87	307	0.58	21.43	
006	Magnolia Overflow	Elliott Bay/Puget Sound	6/15/17 6:57 PM	6/15/17 7:15 PM	0.30	1,247	0.55	12.58	
006	Magnolia Overflow	Elliott Bay/Puget Sound	9/19/17 1:40 PM	9/19/17 1:51 PM	0.18	4,064	0.38	21.62	
006	Magnolia Overflow	Elliott Bay/Puget Sound	10/13/17 12:04 AM	10/13/17 12:34 AM	0.50	3,575	0.24	12.95	
006	Magnolia Overflow	Elliott Bay/Puget Sound	10/18/17 5:46 PM	10/19/17 4:44 PM	22.97	218,061	1.31	56.90	
006	Magnolia Overflow	Elliott Bay/Puget Sound	10/21/17 4:40 PM	10/21/17 10:26 PM	5.77	1,785	0.77	18.15	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/4/17 11:08 PM	11/5/17 6:56 AM	7.80	10,029	0.77	13.83	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/12/17 6:26 AM	11/13/17 4:02 PM	33.60	16,472	0.88	55.42	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/15/17 3:58 AM	11/15/17 8:50 AM	4.87	104,433	0.59	10.65	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/20/17 6:56 AM	11/22/17 11:10 PM	64.23	488,029	2.43	78.55	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/25/17 8:16 PM	11/26/17 6:46 AM	10.50	3,564	0.41	14.32	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/28/17 11:12 AM	11/28/17 1:46 PM	2.57	5	0.40	8.13	
006	Magnolia Overflow	Elliott Bay/Puget Sound	11/30/17 9:24 AM	11/30/17 9:56 AM	0.53	2,693	0.24	3.07	
006	Magnolia Overflow	Elliott Bay/Puget Sound	12/2/17 2:06 PM	12/2/17 5:28 PM	3.37	28,821	0.49	28.00	
006	Magnolia Overflow	Elliott Bay/Puget Sound	12/18/17 11:50 PM	12/19/17 11:06 AM	11.27	110,885	1.61	28.63	
006	Magnolia Overflow	Elliott Bay/Puget Sound	12/29/17 8:12 AM	12/29/17 1:30 PM	5.30	58,141	1.20	17.62	
007	Canal Street Overflow	Lake Washington Ship Canal	N/A	N/A	N/A	N/A	N/A	N/A	
008	3rd Ave W and Ewing St	Lake Washington Ship Canal	1/17/17 4:10 PM	1/18/17 9:32 AM	17.37	1,601,631	2.19	27.95	
008	3rd Ave W and Ewing St[2]	Lake Washington Ship Canal	2/9/17 12:14 AM	2/9/17 9:21 AM	9.12	1,866,007	2.01	24.22	
008	3rd Ave W and Ewing St	Lake Washington Ship Canal	10/18/17 8:33 PM	10/18/17 9:57 PM	1.40	317,788	0.92	11.95	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
008	3rd Ave. W and Ewing St	Lake Washington Ship Canal	11/21/17 12:41 PM	11/22/17 12:02 AM	11.35	1,364,835	2.30	55.87	
008	3rd Ave. W and Ewing St	Lake Washington Ship Canal	12/19/17 6:36 AM	12/19/17 12:06 PM	5.50	1,603,784	1.81	30.13	
008	3rd Ave. W and Ewing St	Lake Washington Ship Canal	12/29/17 10:33 AM	12/29/17 1:48 PM	3.25	1,040,365	1.03	18.17	
009	Dexter Ave. Regulator	Lake Union	N/A	N/A	N/A	N/A	N/A	N/A	
011	E Pine St. Pump Station Emergency Overflow	Lake Washington	N/A	N/A	N/A	N/A	N/A	N/A	
012	Belvoir Pump Station Emergency Overflow	Lake Washington	1/18/17 8:19 AM	1/18/17 9:36 AM	1.28	73,634	2.42	29.63	
012	Belvoir Pump Station Emergency Overflow[2]	Lake Washington	2/9/17 7:40 AM	2/9/17 10:48 AM	3.13	458,304	2.14	25.68	
013	Martin Luther King Way Trunkline Overflow	Lake Washington via storm drain	N/A	N/A	N/A	N/A	N/A	N/A	
014	Montlake Overflow	Lake Washington Ship Canal	1/17/17 3:31 PM	1/18/17 9:40 AM	18.15	10,463,215	2.42	29.63	
014	Montlake Overflow[2]	Lake Washington Ship Canal	2/8/17 10:51 PM	2/9/17 1:38 PM	14.78	19,215,838	2.35	28.02	
014	Montlake Overflow	Lake Washington Ship Canal	2/15/17 2:47 AM	2/16/17 4:48 AM	26.02	8,926,558	2.28	30.48	
014	Montlake Overflow	Lake Washington Ship Canal	3/17/17 10:48 PM	3/18/17 10:49 AM	12.02	509,488	1.20	21.58	
014	Montlake Overflow	Lake Washington Ship Canal	4/12/17 5:08 AM	4/12/17 5:19 AM	0.18	183,825	0.44	4.27	
014	Montlake Overflow	Lake Washington Ship Canal	4/26/17 1:53 PM	4/26/17 2:17 PM	0.40	836,619	0.21	0.33	
014	Montlake Overflow	Lake Washington Ship Canal	5/5/17 4:21 AM	5/5/17 4:33 AM	0.20	284,028	0.56	12.32	
014	Montlake Overflow	Lake Washington Ship Canal	10/18/17 9:02 PM	10/18/17 9:23 PM	0.35	389,822	0.77	11.38	
014	Montlake Overflow	Lake Washington Ship Canal	11/20/17 8:02 AM	11/20/17 8:44 AM	0.70	660,701	0.74	17.87	
014	Montlake Overflow[1]	Lake Washington Ship Canal	11/21/17 9:23 PM	11/22/17 12:04 AM	2.68	4,960,429	2.36	57.30	
014	Montlake Overflow	Lake Washington Ship Canal	12/19/17 5:18 AM	12/19/17 12:04 PM	6.77	4,566,417	1.78	30.07	

Appendix A Untreated CSO Events

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
014	Montlake Overflow	Lake Washington Ship Canal	12/29/17 8:44 AM	12/29/17 1:37 PM	4.88	3,080,120	1.21	17.75	
015	University Regulator	Lake Washington Ship Canal	1/17/17 4:17 PM	1/18/17 11:13 AM	18.93	16,294,062	2.47	30.47	
015	University Regulator[2]	Lake Washington Ship Canal	2/9/17 12:53 AM	2/9/17 11:23 AM	10.50	24,971,186	2.16	25.98	
015	University Regulator	Lake Washington Ship Canal	2/15/17 3:24 AM	2/16/17 4:31 AM	25.12	9,185,838	2.28	30.48	
015	University Regulator	Lake Washington Ship Canal	11/21/17 9:39 PM	11/22/17 12:17 AM	2.63	8,008,583	2.37	57.57	
015	University Regulator	Lake Washington Ship Canal	11/26/17 1:36 PM	11/26/17 1:49 PM	0.22	256,610	0.59	21.55	
015	University Regulator	Lake Washington Ship Canal	12/19/17 8:08 AM	12/19/17 11:41 AM	3.55	2,970,063	1.75	29.65	
015	University Regulator	Lake Washington Ship Canal	12/29/17 12:40 PM	12/29/17 1:46 PM	1.10	2,789,407	1.22	18.22	
018	Matthews Park Pump Station Emergency Overflows	Lake Washington	N/A	N/A	N/A	N/A	N/A	N/A	
027a	Denny Way Regulator[2]	Elliott Bay	2/9/17 7:19 AM	2/9/17 9:46 AM	2.44	11,228,437	1.95	25.53	
027a	Denny Way Regulator	Elliott Bay	2/15/17 2:34 AM	2/15/17 4:47 PM	14.23	3,975,521	1.68	19.17	
027a	Denny Way Regulator	Elliott Bay	11/3/17 4:16 PM	11/3/17 4:39 PM	0.38	2,185,635	0.56	29.18	
028	King Street Regulator	Elliott Bay	1/18/17 7:44 AM	1/18/17 8:30 AM	0.77	65,141	1.98	28.05	
028	King Street Regulator[2]	Elliott Bay	2/9/17 7:10 AM	2/9/17 9:30 AM	2.33	1,164,295	1.80	24.28	
028	King Street Regulator	Elliott Bay	2/15/17 3:01 AM	2/16/17 3:56 AM	24.92	180,780	1.90	30.07	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	1/17/17 6:37 PM	1/18/17 8:28 AM	13.85	466,431	1.98	28.05	
029	Connecticut St. Regulator (a.k.a. Kingdome)[2]	t Bay	2/9/17 12:42 AM	2/9/17 9:44 AM	9.03	4,131,587	1.80	24.28	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	2/15/17 2:48 AM	2/16/17 4:00 AM	25.20	532,699	1.90	30.07	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	3/15/17 12:00 PM	3/15/17 1:33 PM	1.55	59,880	1.23	71.60	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	3/17/17 6:49 PM	3/18/17 12:10 PM	17.35	2,178,276	0.99	22.72	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	3/29/17 8:40 AM	3/29/17 10:02 AM	1.37	68,173	0.44	32.67	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	4/12/17 5:14 AM	4/12/17 11:19 AM	6.08	460,933	0.56	9.88	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	6/15/17 9:00 PM	6/15/17 10:49 PM	1.82	1,401,319	0.55	12.17	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	10/18/17 8:23 PM	10/19/17 12:45 AM	4.37	1,197,390	0.81	14.45	
029	Connecticut St. Regulator (a.k.a. Kingdome)[1]	Elliott Bay	10/21/17 6:34 PM	10/21/17 9:12 PM	2.63	326,316	1.91	82.70	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	11/5/17 5:20 AM	11/5/17 7:21 AM	2.02	633,685	0.68	13.80	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	11/15/17 5:36 AM	11/15/17 7:02 AM	1.43	229,152	0.48	8.93	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	11/20/17 8:30 AM	11/20/17 9:04 AM	0.57	94,156	0.62	17.70	
029	Connecticut St. Regulator (a.k.a. Kingdome)[1]	Elliott Bay	11/21/17 10:22 AM	11/23/17 12:59 AM	38.62	3,771,583	2.62	81.75	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	12/18/17 11:30 PM	12/19/17 12:49 PM	13.32	4,954,802	1.48	29.63	
029	Connecticut St. Regulator (a.k.a. Kingdome)	Elliott Bay	12/29/17 6:08 AM	12/29/17 3:12 PM	9.07	4,068,935	1.10	12.72	
030	Lander St. Regulator	Elliott Bay	1/17/17 3:47 PM	1/19/17 4:32 AM	36.75	112,372,783	2.70	44.90	
030	Lander St. Regulator	Elliott Bay	2/3/17 5:30 PM	2/6/17 2:13 AM	56.72	12,393,804	2.10	71.70	
030	Lander St. Regulator[2]	Elliott Bay	2/8/17 4:39 PM	2/10/17 7:40 AM	39.02	145,702,564	2.41	46.65	
030	Lander St. Regulator	Elliott Bay	2/15/17 1:37 AM	2/16/17 5:02 PM	39.42	134,808,171	2.10	34.42	
030	Lander St. Regulator	Elliott Bay	3/3/17 5:13 PM	3/3/17 8:54 PM	3.68	1,284,499	0.50	39.23	
030	Lander St. Regulator	Elliott Bay	3/7/17 2:31 PM	3/7/17 3:01 PM	0.50	93,016	0.38	13.65	
030	Lander St. Regulator	Elliott Bay	3/9/17 4:41 PM	3/9/17 9:37 PM	4.93	7,306,490	0.54	27.13	
030	Lander St. Regulator	Elliott Bay	3/13/17 3:16 PM	3/15/17 2:41 PM	47.42	36,321,833	1.61	71.40	
030	Lander St. Regulator	Elliott Bay	3/17/17 6:42 PM	3/18/17 3:22 PM	20.67	13,213,656	1.04	22.27	
030	Lander St. Regulator	Elliott Bay	4/12/17 5:24 AM	4/12/17 7:48 AM	2.40	3,568,854	0.54	18.03	
030	Lander St. Regulator	Elliott Bay	6/15/17 9:37 PM	6/15/17 11:20 PM	1.72	2,273,240	0.90	16.47	
030	Lander St. Regulator	Elliott Bay	10/18/17 8:28 PM	10/19/17 1:15 AM	4.78	6,710,615	1.15	15.32	
030	Lander St. Regulator	Elliott Bay	10/21/17 6:43 PM	10/22/17 12:57 AM	6.23	23,273,432	0.96	20.68	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
030	Lander St. Regulator	Elliott Bay	11/5/17 12:11 AM	11/5/17 9:08 AM	8.95	13,480,183	0.68	15.52	
030	Lander St. Regulator	Elliott Bay	11/13/17 5:59 PM	11/13/17 8:36 PM	2.62	6,349,997	1.05	57.27	
030	Lander St. Regulator	Elliott Bay	11/15/17 5:45 AM	11/15/17 10:29 AM	4.73	15,975,384	0.62	11.93	
030	Lander St. Regulator	Elliott Bay	11/20/17 8:33 AM	11/23/17 4:03 AM	67.50	121,518,537	2.61	81.70	
030	Lander St. Regulator	Elliott Bay	11/28/17 1:15 PM	11/28/17 5:43 PM	4.47	11,623,002	0.48	10.13	
030	Lander St. Regulator	Elliott Bay	12/2/17 9:25 PM	12/2/17 9:50 PM	0.42	36,653	0.64	32.18	
030	Lander St. Regulator	Elliott Bay	12/19/17 12:33 AM	12/19/17 1:48 PM	13.25	27,088,274	1.78	29.20	
030	Lander St. Regulator	Elliott Bay	12/29/17 6:41 AM	12/29/17 3:20 PM	8.65	28,313,491	1.34	20.02	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	1/17/17 3:23 PM	1/18/17 9:13 PM	29.83	14,667,834	2.58	41.07	
031	Hanford #1[2]	Duwamish River via Diagonal Storm Drain	2/8/17 8:48 PM	2/9/17 9:04 PM	24.27	34,463,200	2.37	35.77	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	2/15/17 2:22 AM	2/16/17 10:22 AM	32.00	12,499,310	2.10	34.42	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	3/15/17 7:41 AM	3/15/17 11:16 AM	3.58	296,242	1.54	69.33	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	3/17/17 10:11 PM	3/18/17 11:30 AM	13.32	995,323	1.04	22.27	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	4/12/17 4:43 AM	4/12/17 5:27 AM	0.73	170,925	0.42	15.63	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	5/4/17 6:24 PM	5/5/17 4:27 AM	10.05	55,612	0.43	12.28	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	6/15/17 7:05 PM	6/15/17 7:45 PM	0.67	17,781	0.61	12.90	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	11/13/17 5:17 PM	11/13/17 5:38 PM	0.35	36,636	1.04	56.85	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	11/20/17 7:33 AM	11/20/17 8:58 AM	1.42	663,979	0.7	17.57	

Appendix A Untreated CSO Events

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
031	Hanford #1[1]	Duwamish River via Diagonal Storm Drain	11/21/17 9:11 PM	11/23/17 12:52 AM	27.68	3,682,192	2.61	81.70	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	12/19/17 5:10 AM	12/19/17 1:28 PM	8.30	3,919,331	1.78	29.20	
031	Hanford #1	Duwamish River via Diagonal Storm Drain	12/29/17 8:21 AM	12/29/17 4:06 PM	7.75	3,922,877	1.36	20.83	
032	Hanford #2 Regulator	Duwamish River - East Waterway	1/8/17 4:53 PM	1/8/17 8:47 PM	3.90	1,734,995	0.59	10.00	
032	Hanford #2 Regulator	Duwamish River - East Waterway	1/17/17 3:46 PM	1/19/17 5:19 PM	49.55	30,634,454	2.82	59.80	
032	Hanford #2 Regulator	Duwamish River - East Waterway	2/3/17 5:29 PM	2/6/17 7:50 PM	74.35	10,010,977	2.53	88.87	
032	Hanford #2 Regulator[2]	Duwamish River - East Waterway	2/8/17 4:34 PM	2/10/17 10:21 AM	41.78	25,845,836	2.41	46.65	
032	Hanford #2 Regulator	Duwamish River - East Waterway	2/15/17 1:59 AM	2/16/17 5:57 PM	39.97	14,608,752	2.10	34.42	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/3/17 5:17 PM	3/3/17 9:36 PM	4.32	7,934,676	0.50	39.23	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/7/17 2:27 PM	3/7/17 4:28 PM	2.02	3,103,596	0.44	14.60	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/9/17 4:42 PM	3/9/17 8:21 PM	3.65	3,521,137	0.54	27.13	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/13/17 3:19 PM	3/15/17 6:19 PM	51.00	10,700,054	1.62	73.33	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/17/17 6:40 PM	3/18/17 5:31 PM	22.85	24,987,573	1.04	22.27	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/24/17 8:36 PM	3/24/17 9:45 PM	1.15	671,130	0.56	24.88	
032	Hanford #2 Regulator	Duwamish River - East Waterway	3/29/17 8:14 AM	3/29/17 10:15 AM	2.02	2,044,085	0.51	32.88	
032	Hanford #2 Regulator	Duwamish River - East Waterway	4/12/17 5:33 AM	4/12/17 9:48 AM	4.25	2,473,521	0.57	19.40	
032	Hanford #2 Regulator	Duwamish River - East Waterway	6/15/17 7:57 PM	6/15/17 10:53 PM	2.93	906,267	0.89	15.23	
032	Hanford #2 Regulator	Duwamish River - East Waterway	10/18/17 8:32 PM	10/19/17 4:07 AM	7.58	17,909,211	1.26	17.72	
032	Hanford #2 Regulator	Duwamish River - East Waterway	12/2/17 4:28 PM	12/2/17 10:40 PM	6.20	3,820,258	0.66	33.13	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
032	Hanford #2 Regulator	Duwamish River - East Waterway	12/19/17 12:29 AM	12/19/17 6:02 PM	17.55	46,422,806	1.79	33.38	
032	Hanford #2 Regulator	Duwamish River - East Waterway	12/29/17 6:45 AM	12/30/17 4:10 PM	33.42	57,300,000	1.44	26.10	
032	Hanford #2 Regulator[4]	Duwamish River - East Waterway	12/30/17 4:55 PM	1/1/18 12:55 AM	15.90	5,500,000	0	0	Exacerbated CSO
033	Rainier Ave. Pump Station	Lake Washington	N/A	N/A	N/A	N/A	N/A	N/A	
034	East Duwamish	Duwamish River	N/A	N/A	N/A	N/A	N/A	N/A	
035	West Duwamish	Duwamish River	2/9/17 7:49 AM	2/9/17 10:15 AM	2.43	202,782	2.10	25.80	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	1/17/17 3:48 PM	1/19/17 12:13 AM	32.42	20,268,192	2.68	43.57	
036	Chelan Ave. Regulator[2]	Duwamish River - West Waterway	2/8/17 8:22 PM	2/9/17 8:16 PM	23.90	26,367,800	2.37	35.77	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	2/15/17 3:20 AM	2/16/17 9:06 AM	29.77	6,212,638	2.10	34.42	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	3/15/17 11:05 AM	3/15/17 11:25 AM	0.33	33,869	1.55	69.67	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	3/18/17 12:16 AM	3/18/17 12:29 AM	0.22	11,437	0.74	10.95	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	10/18/17 8:43 PM	10/18/17 8:47 PM	0.07	1,289	0.73	10.82	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	11/20/17 8:32 AM	11/20/17 9:17 AM	0.75	45,098	0.70	17.57	
036	Chelan Ave. Regulator[1]	Duwamish River - West Waterway	11/21/17 11:28 AM	11/23/17 12:18 AM	36.83	1,415,670	2.59	81.35	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	12/19/17 5:04 AM	12/19/17 2:23 PM	9.32	2,312,387	1.78	29.20	
036	Chelan Ave. Regulator	Duwamish River - West Waterway	12/29/17 8:28 AM	12/29/17 4:10 PM	7.70	2,099,175	1.36	20.83	
037	Harbor Avenue Regulator[2]	Duwamish River into Elliott Bay	2/9/17 7:52 AM	2/9/17 9:15 AM	1.38	213,903	2.06	25.32	
037	Harbor Avenue Regulator	Duwamish River into Elliott Bay	2/16/17 3:42 AM	2/16/17 3:47 AM	0.08	14,280	2.07	30.20	
037	Harbor Avenue Regulator	Duwamish River into Elliott Bay	11/20/17 6:52 AM	11/20/17 6:53 AM	0.02	167	0.48	16.10	
038	Terminal 115 Overflow	Duwamish River	1/18/17 8:55 AM	1/18/17 10:25 AM	1.50	16,594	2.39	30.15	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
038	Terminal 115 Overflow[2]	Duwamish River	2/9/17 7:30 AM	2/9/17 1:50 PM	6.33	407,660	2.20	29.25	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	1/17/17 3:04 PM	1/18/17 11:45 AM	20.68	15,769,001	2.40	30.77	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)[2]	Duwamish River	2/8/17 8:39 PM	2/9/17 6:23 PM	21.73	35,360,772	2.27	33.18	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	2/15/17 1:58 AM	2/16/17 5:26 AM	27.47	6,950,957	2.39	32.27	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	3/3/17 4:10 PM	3/3/17 5:29 PM	1.32	185,806	0.52	36.48	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	3/15/17 10:30 AM	3/15/17 11:10 AM	0.67	15,786	1.82	97.43	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	3/17/17 10:09 PM	3/18/17 12:18 PM	14.15	1,965,122	1.28	22.58	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	3/24/17 6:54 PM	3/24/17 7:15 PM	0.35	12,633	0.63	22.42	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	4/12/17 4:35 AM	4/12/17 5:30 AM	0.92	276,157	0.45	14.68	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	5/6/17 3:27 AM	5/6/17 4:13 AM	0.77	50,803	0.85	35.02	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	11/20/17 7:49 AM	11/20/17 9:00 AM	1.18	1,170,329	0.88	17.15	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	11/21/17 1:09 PM	11/23/17 12:58 AM	35.82	1,805,050	2.86	81.37	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	12/19/17 12:42 AM	12/19/17 12:50 PM	12.13	47,495,181	1.83	28.98	
039	Michigan Regulator (a.k.a. S. Michigan Regulator)	Duwamish River	12/29/17 5:00 AM	12/29/17 3:06 PM	10.10	45,182,858	1.46	26.13	
040	8th Ave. South Regulator (a.k.a. W. Marginal Way Pump Station)[2]	Duwamish River	2/9/17 8:15 AM	2/9/17 1:37 PM	5.37	676,493	2.19	28.77	
041	Brandon Street Regulator	Duwamish River	1/17/17 3:50 PM	1/18/17 12:10 PM	20.33	14,850,609	2.36	30.27	
041	Brandon Street Regulator	Duwamish River	2/8/17 10:02 PM	2/9/17 7:46 PM	21.73	16,140,143	2.37	35.77	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
041	Brandon Street Regulator	Duwamish River	2/15/17 3:07 AM	2/16/17 6:56 AM	27.82	8,059,906	2.09	30.33	
041	Brandon Street Regulator	Duwamish River	3/15/17 1:13 PM	3/15/17 1:44 PM	0.52	572	1.61	71.40	
041	Brandon Street Regulator	Duwamish River	3/17/17 10:20 PM	3/18/17 1:15 PM	14.92	1,290,628	1.04	22.27	
041	Brandon Street Regulator	Duwamish River	11/21/17 9:14 PM	11/21/17 9:35 PM	0.35	169,826	1.85	54.77	
042	West Michigan (a.k.a. SW Michigan St. regulator)	Duwamish River	1/17/17 8:39 PM	1/18/17 11:22 AM	14.72	586,981	2.40	30.77	
042	West Michigan (a.k.a. SW Michigan St. Regulator)[2]	Duwamish River	2/9/17 1:39 AM	2/9/17 8:04 PM	18.42	2,750,271	2.27	33.18	
042	West Michigan (a.k.a. SW Michigan St. Regulator)	Duwamish River	2/15/17 3:56 AM	2/16/17 6:04 AM	26.13	536,706	2.40	32.27	
042	West Michigan (a.k.a. SW Michigan St. Regulator)	Duwamish River	11/21/17 9:46 PM	11/21/17 10:45 PM	0.98	71,385	2.13	55.17	
042	West Michigan (a.k.a. SW Michigan St. Regulator)	Duwamish River	12/19/17 11:17 AM	12/19/17 12:47 PM	1.50	174,572	1.83	28.98	
042	West Michigan (a.k.a. SW Michigan St. Regulator)	Duwamish River	12/29/17 1:29 PM	12/29/17 2:21 PM	0.87	76,681	1.43	25.27	
043	East Marginal Pump Station	Duwamish River	N/A	N/A	N/A	N/A	N/A		
044a	Norfolk local drainage	Duwamish River	N/A	N/A	N/A	N/A	N/A		
045	Henderson Pump Station	Lake Washington	N/A	N/A	N/A	N/A	N/A		
048a	North Beach Pump Station (wet well)	Puget Sound	1/18/17 7:56 AM	1/18/17 8:37 PM	12.69	1,656,994	2.90	40.61	
048a	North Beach Pump Station (wet well)[2]	Puget Sound	2/9/17 2:58 AM	2/9/17 1:59 PM	11.02	1,212,485	2.19	28.54	
048a	North Beach Pump Station (wet well)	Puget Sound	2/15/17 5:12 PM	2/16/17 8:27 AM	15.24	1,294,557	2.73	33.24	
048b	North Beach Pump Station (inlet structure)	Puget Sound	1/18/17 8:15 AM	1/18/17 8:37 AM	0.36	73,351	2.52	28.67	
049	30th Avenue NE Pump Station	Lake Washington	N/A	N/A	N/A	N/A	N/A	N/A	
052	53rd Avenue SW Pump Station[2]	Puget Sound	2/9/17 8:20 AM	2/9/17 9:44 AM	1.40	37,393	2.10	25.80	
054	63rd Avenue SW Pump Station	Puget Sound	1/17/17 8:00 PM	1/18/17 12:51 PM	16.85	34,436,086	2.36	30.27	

DSN #	Overflow Name	Receiving Water	Event Starting Date & Time	Event Ending Date & Time	Duration (hours)	Volume (gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO or SSO
054	63rd Avenue SW Pump Station[2]	Puget Sound	2/9/17 7:30 AM	2/9/17 8:50 PM	13.33	66,216,487	2.37	35.77	
054	63rd Avenue SW Pump Station	Puget Sound	2/15/17 3:27 AM	2/16/17 5:31 AM	26.07	95,726,032	2.09	30.33	
054	63rd Avenue SW Pump Station[5]	Puget Sound	2/16/17 4:16 PM	2/16/17 5:05 PM	0.82	830,000	0	0	Exacerbated CSO
054	63rd Avenue SW Pump Station	Puget Sound	12/19/17 10:50 AM	12/19/17 11:07 AM	0.28	783,819	1.74	28.40	
055	SW Alaska Street Overflow	Puget Sound	N/A	N/A	N/A	N/A	N/A	N/A	
056	Murray Street Pump Station[2]	Puget Sound	2/9/17 8:57 AM	2/9/17 10:13 AM	1.27	1,356,738	2.34	26.37	
057	Barton Street Pump Station[2]	Puget Sound	2/9/17 7:44 AM	2/9/17 9:33 AM	1.82	231,660	2.22	25.98	
057	Barton Street Pump Station	Puget Sound	5/4/17 5:56 PM	5/4/17 6:10 PM	0.23	49,015	0.37	2.00	
Total Volume (does not include any DWO, SSO, or exacerbated CSO volumes)						**1,707,235,049**			

Notes:

[1] This storm event includes the previous storm event.

[2] West Point experienced a major emergency on February 9, 2017, after it was overwhelmed by intense flows from record rains combined with a critical equipment malfunction. Some of these overflows were likely exacerbated because of West Point operation.

[3] The portable flow meter at Bayview South was not working properly from 1/1/17 to 1/25/17.

[4] See letter for Environmental Report Tracking System (ERTS) #678207 for event details.

[5] See letter for ERTS #670814 for event details.

Appendix B
Treated CSO Events

January–December 2017

DSN #	Overflow Name	Receiving Water	Event Ending Date/Time	Event Starting Date/Time	Event Duration (hours)	Volume (million gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO
051b	Alki WWTS	Puget Sound	1/19/17 1:10 AM	1/17/17 7:22 PM	26.73	30.07	2.70	44.90	
051b	Alki WWTS[1]	Puget Sound	2/11/17 3:01 AM	2/9/17 1:00 AM	49.49	61.29	2.41	51.31	
051b	Alki WWTS[1]	Puget Sound	2/16/17 11:13 PM	2/15/17 3:51 AM	42.03	60.00	2.10	34.42	
051b	Alki WWTS[1]	Puget Sound	3/10/17 12:09 AM	3/9/17 9:06 PM	3.05	1.86	0.55	27.13	
051b	Alki WWTS[1]	Puget Sound	3/15/17 9:30 PM	3/14/17 10:16 AM	23.58	27.27	1.61	73.33	
051b	Alki WWTS[1]	Puget Sound	3/18/17 7:58 PM	3/17/18 12:00 AM	21.47	26.12	1.03	22.27	
051b	Alki WWTS[1]	Puget Sound	3/29/17 4:46 PM	3/29/17 2:27 PM	2.32	1.33	0.54	37.77	
051b	Alki WWTS[1]	Puget Sound	4/13/17 5:02 AM	4/12/17 11:55 AM	7.72	4.79	0.88	36.58	
051b	Alki WWTS	Puget Sound	11/22/17 3:26 AM	11/21/17 11:10 PM	4.27	3.20	2.2	60.36	
051b	Alki WWTS	Puget Sound	12/19/17 2:45 PM	12/19/17 8:33 AM	6.17	7.51	2.31	29.2	
051b	Alki WWTS	Puget Sound	12/29/17 6:37 PM	12/29/17 1:21 PM	5.17	3.66	1.44	22.48	
046b	Carkeek WWTS	Puget Sound	1/20/17 6:34 AM	1/17/17 7:41 PM	58.89	12.42	2.66	59.57	
046b	Carkeek WWTS[1]	Puget Sound	2/11/17 11:55 PM	2/9/17 12:43 AM	69.18	25.62	2.12	52.13	
046b	Carkeek WWTS[1]	Puget Sound	2/17/17 11:22 AM	2/15/17 1:33 AM	56.45	25.22	2.46	32.24	
046b	Carkeek WWTS[1]	Puget Sound	3/3/17 11:03 PM	3/3/17 5:30 PM	5.52	0.70	0.40	24.95	
046b	Carkeek WWTS[1]	Puget Sound	3/9/17 10:48 PM	3/9/17 4:20 PM	6.4	1.73	0.62	27.98	

Appendix B Treated CSO Events

DSN #	Overflow Name	Receiving Water	Event Ending Date/Time	Event Starting Date/Time	Event Duration (hours)	Volume (million gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO
046b	Carkeek WWTS[1]	Puget Sound	3/16/17 3:34 AM	3/14/17 6:33 AM	29.46	4.58	1.60	77.78	
046b	Carkeek WWTS[1]	Puget Sound	3/19/17 12:45 AM	3/17/17 5:32 PM	30.9	7.23	1.19	22.5	
046b	Carkeek WWTS[1]	Puget Sound	4/12/17 11:44 AM	4/12/17 6:07 AM	5.61	1.64	0.93	10.08	
046b	Carkeek WWTS	Puget Sound	11/22/17 1:31 AM	11/21/17 11:00 PM	2.53	0.16	2.50	57.47	
046b	Carkeek WWTS	Puget Sound	12/19/17 1:08 PM	12/19/17 9:49 AM	3.32	0.30	1.89	30.13	
027b	Elliott West WWTS	Puget Sound	1/19/17 1:47 AM	1/17/17 5:07 PM	23.60	61.42	2.62	44.98	
027b	Elliott West WWTS[1]	Puget Sound	2/10/17 6:03 PM	2/8/17 10:48 PM	43.30	192.48	2.23	47.25	
027b	Elliott West WWTS[1]	Puget Sound	2/16/17 6:39 PM	2/15/17 1:20 AM	41.40	214.13	2.13	30.35	
027b	Elliott West WWTS[1]	Puget Sound	3/3/17 5:54 AM	3/3/17 6:01 PM	11.90	22.35	0.36	25.88	
027b	Elliott West WWTS[1]	Puget Sound	3/7/17 4:44 PM	3/7/2017 14:41 AM	2.10	5.15	0.46	28.48	
027b	Elliott West WWTS[1]	Puget Sound	3/9/17 11:44 PM	3/9/17 5:29 PM	6.30	21.91	0.53	15.37	
027b	Elliott West WWTS[1]	Puget Sound	3/15/17 3:48 PM	3/13/17 4:14 PM	24.60	94.53	1.53	71.3	
027b	Elliott West WWTS[1]	Puget Sound	3/18/17 6:23 PM	3/17/17 6:57 PM	23.50	91.65	1.14	24.45	
027b	Elliott West WWTS[1]	Puget Sound	3/24/17 5:21 AM	3/24/17 3:57 AM	1.40	0.85	0.26	5.4	
027b	Elliott West WWTS[1]	Puget Sound	3/29/17 2:32 PM	3/29/17 8:46 AM	5.80	13.85	0.51	31.45	
027b	Elliott West WWTS[1]	Puget Sound	4/12/17 3:53 PM	4/12/17 6:00 AM	9.90	29.51	0.91	10.54	
027b	Elliott West WWTS	Puget Sound	10/18/17 1:13 AM	10/18/17 10:39 PM	2.30	5.16	1.03	41.3	
027b	Elliott West WWTS[2]	Puget Sound	10/22/17 12:00 AM	10/21/17 12:00 AM	4.02	11.73	1.15	22.17	
027b	Elliott West WWTS[3]	Puget Sound	11/5/17 9:57 AM	11/3/17 4:28 PM	16.00	86.14	1.24	44.55	

Appendix B Treated CSO Events

DSN #	Overflow Name	Receiving Water	Event Ending Date/Time	Event Starting Date/Time	Event Duration (hours)	Volume (million gallons)	Precipitation (inches)	Storm Duration (hours)	Note if DWO
027b	Elliott West WWTS	Puget Sound	11/22/17 9:53 AM	11/21/17 1:14 PM	18.40	30.36	2.21	61.8	
027b	Elliott West WWTS	Puget Sound	12/19/17 7:45 PM	12/19/17 7:14 AM	12.52	21.20	1.68	29.48	
027b	Elliott West WWTS	Puget Sound	12/29/17 5:42 PM	12/29/17 11:05 AM	6.62	15.02	1.28	21.17	
044b	MLK/Henderson CSO Treatment Facility Outfall	Duwamish River	1/18/17 2:58 PM	1/18/17 6:48 AM	8.17	4.08	2.34	32.95	
044b	MLK/Henderson CSO Treatment Facility Outfall[1]	Duwamish River	2/9/17 9:50 PM	2/9/17 6:30 AM	15.33	12.28	4.73	163.00	
044b	MLK/Henderson CSO Treatment Facility Outfall	Duwamish River	2/16/17 10:21 AM	2/17/17 4:18 AM	6.03	2.3	2.47	32.95	
1	West Point[4]	Puget Sound	1/8/17 5:24 PM	1/8/17 7:50 PM	2.43	5.50	0.55	8.80	
1	West Point[4]	Puget Sound	1/17/17 3:36 PM	1/19/17 1:20 AM	26.78	94.44	2.56	42.12	
1	West Point[4]	Puget Sound	2/3/17 4:38 PM	2/4/17 5:07 PM	4.53	11.28	1.12	38.47	
1	West Point[4]	Puget Sound	2/8/17 9:36 PM	2/9/17 12:00 AM	2.40	2.47	0.74	14.87	
1	West Point[4]	Puget Sound	10/18/17 7:47 PM	10/19/17 2:23 AM	6.60	12.57	1.29	16.40	
1	West Point[4]	Puget Sound	10/21/17 6:32 PM	10/21/17 11:58 PM	5.43	2.55	0.74	18.18	
1	West Point[4]	Puget Sound	11/4/17 11:49 PM	11/5/17 1:09 AM	1.33	.02	0.42	8.15	
1	West Point[4]	Puget Sound	11/15/17 5:24 AM	11/15/17 9:44 AM	4.33	5.5	0.78	10.73	
1	West Point[4]	Puget Sound	11/20/17 8:39 AM	11/23/17 2:15 AM	20.43	30.97	2.86	80.33	
1	West Point[4]	Puget Sound	11/28/17 1:44 PM	11/28/17 4:40 PM	2.93	2.61	0.37	9.20	
1	West Point[4]	Puget Sound	12/2/17 5:35 PM	12/2/17 7:53 PM	2.30	1.05	0.87	30.32	
1	West Point[4]	Puget Sound	12/19/17 1:02 AM	12/19/17 3:15 PM	14.22	25.65	1.81	30.13	
1	West Point[4]	Puget Sound	12/29/17 7:35 AM	12/29/17 5:09 PM	9.57	17.55	1.10	21.43	
Total Volume						**1,454.66**			

Notes:

[1] West Point experienced a major emergency on February 9, 2017, after it was overwhelmed by intense flows from record rains combined with a critical equipment malfunction. Part of this event was result of flow shedding from West Point Treatment Plant's limited capacity due to the West Point flood.
[2] The last day of this discharge event has been attributed to salt water intrusion into the collection system from a broken marine outfall gate at Denny regulator. A letter to DOE, dated November 8, 2017, has been submitted which provides details regarding this issue.
[3] Part of this event was the result of flow shedding of West Point flows to mitigate impacts of saltwater intrusion on the West Point Treatment Plant.
[4] Flow at West Point exceeded 300 MGD

Appendix C
Alki Wet Weather Treatment Station
Annual Report

January–December 2017

Executive Summary

This 2017 annual report summarizes the performance of King County's Alki Wet Weather Treatment Station (Alki WWTS). The Alki WWTS came online for combined sewer overflow (CSO) treatment in 1998; it operates under the National Pollutant Discharge Elimination System (NPDES) permit for the West Point Treatment Plant (West Point) (WA-0029181-1).

A total of 42.45 inches of rain fell in calendar year 2017, as measured at the rain gauge located at the Chelan Avenue Pump Station, the nearest gauge to the Alki WWTS. The 2017 annual rainfall recorded at Sea-Tac is 47.9 inches. The 20-year average at Sea-Tac is 39.9 inches.

There were 13 filling events and 11 discharge events during 2017. The Alki WWTS received 247.6 million gallons (MG) and discharged 227.1 MG. The high inflow and discharge volumes compared to past years have been attributed to flow shedding from West Point. The plant had reduced capacity while it recovered from a flood on February 9, 2017. The reduced plant capacity has resulted in excess flows being discharged upstream in the collection system, including Alki WWTS and the other CSO plants, during wet weather conditions. Flow shedding was implemented by reducing or shutting down West Seattle Pump Station, thereby limiting flows up to 19.8 million gallons per day (MGD) into the Elliott Bay Interceptor and to West Point.

Alki's performance in 2017 is summarized in Table C-1. Total suspended solids (TSS) removal average was 24.5 percent in 2017, thereby not meeting the NPDES permit limit of 50 percent for annual removal. Alki WWTS met its annual average settleable solids (SS) limit with the average measured as 0.14 milliliters/liter/hour (ml/L/hr.); the NPDES permit limit is 0.3 mL/L/hr. The Alki WWTS did not meet the instantaneous minimum pH less than 6.0 for one discharge day out of 18 days of discharges. In addition, Alki's effluent had four days out of 18 discharge days, exceeding the daily maximum average total residual chlorine (TRC) permit limit of 234 micrograms per liter (µg/L). Alki WWTS met the monthly fecal coliform geomean permit limit of 400 counts/100 ml during each month of discharge at Alki WWTS. The performance for 2017 is summarized in Table C-1.

Table C-1. Alki WWTS Permit Performance in 2017

Parameter	Performance	Permit Conditions
Discharge events (number)[a]	**11**	**29**
Discharge volume MG[a]	**227.1**	**108**
Annual average SS (ml/L/hr)	**0.14**	**0.3**
Annual average TSS removal, including all discharge events (%)	**24.5**	**50**
Instantaneous minimum effluent pH, frequency of discharge days with pH < 6.0	**1 out of 18 discharge days**	**≥ 6.0**
Instantaneous maximum effluent pH, frequency of discharge days with pH > 9.0	**0 out of 10 discharge days**	**≤ 9.0**
TRC, maximum of daily averages (µg/L), frequency of discharge days with TRC > 234 µg/L	**4 out of 18 discharge days**	**≤234 µg/L**
Monthly fecal coliform geomean, frequency of months with monthly geomean > 400/100mL	**0 out of 6 discharge months**	**400/mL**

[a] Compliance assessed over a 5-year average.
Numbers in red indicate a permit exceedance.

Suspended and Settleable Solids

The annual TSS removal was calculated to be 24.5 percent, which did not meet its annual average TSS removal permit level of 50 percent. The annual event average SS was 0.14 ml/L/hr.; therefore, meeting the annual average NPDES permit level of 0.3 ml/L/hr.

Solids removal at Alki WWTS has not met the 50 percent limit in the past, and past operational changes to improve the removal were not effective. These changes included changing the set point to start the solids flights in the sedimentation tanks earlier as the sedimentation tanks fill, so that as solids settle, the flights will move the solids to the sump to be removed sooner and avoid any potential solid wash out or carryover to the effluent flow. In addition, King County operators cleaned out and removed accumulated solids and debris from the effluent channel as part of the summer dry-weather work. The challenges to meet the solids removal requirements were made more difficult in 2017 because of the flow shedding during the West Point recovery period (February 9, 2017, through April 21, 2017) from the February West Point flood. Flow shedding was

achieved by throttling down, or shutting down, conveyance pump stations that would normally allow flows to West Point. It should be noted that the three lowest solids removal performances occurred during those months of flow shedding.

High rates of flow and swings of inflows from the 63rd Avenue pump station can also impact solids removal at Alki WWTS. Recently, variable frequency drives (VFDs) were added to all three CSO pumps at the 63rd Avenue pump station as part of the capital project to improve flow control into Alki. Programming the VFD to control pumping, and fine-tuning of the program, were delayed due to the West Section's Offsite Instrumentation and Electrical Workgroup's priority schedule; however, fine-tuning of the VFD pump control has started in late 2017 and is currently ongoing in 2018. Tuning and optimization is in progress. Pump station performance is evaluated after each CSO event for any additional changes.

As part of the CSO Control Program, King County will bring in consultants in early 2018 to evaluate plant performance and make recommendations on how to improve solids removal. The consultant review and recommendations should be available in 2018.

Fecal Coliform Bacteria

There were six months with treated discharges in 2017 at Alki WWTS, and each of the six monthly geomean values for fecal coliform were below the NPDES permit monthly geomean limit of 400 counts/100 ml. The maximum fecal coliform geomean was 41 counts/100 ml, which occurred in January. The annual average of the monthly fecal coliform geomean was 14 counts /100 ml.

Total Residual Chlorine

The Alki WWTS was in compliance with the daily average TRC permit limit of 234 μg/L on 14 of 18 discharge days in 2017. The highest daily average TRC in 2017 was 659 μg/L on March 18. A temporary interruption of the dechlorination feed resulted in a high residual chlorine in the effluent. The sodium bisulfite (SBS) feed stopped as part of a low-level inter-lock on the SBS storage tank. Alki WWTS was impacted by the damage caused to West Point on February 9; the reduced West Point plant capacity has resulted in excess flows being discharged upstream in the collection system, including the CSO plants, during wet weather conditions. High inflows into Alki, and subsequent high consumption of treatment chemicals including SBS, resulted in the SBS storage level dropping below the interlock trigger that shuts down the SBS feed pumps to prevent pump damage. Once the operator switched to another tank, the SBS feed was re-established and the dechlorination system worked to keep the effluent TRC level to near zero. The 2017 annual TRC average was 115.5 μg/L.

Instantaneous Minimum and Maximum Effluent pH

For the daily instantaneous minimum pH below 6.0, the permit limit occurred once out of the 18 discharge days in 2017. The minimum pH occurred on February 8th discharge event (a three-day discharge event) and it appears that the drop in pH may be related to issues with the SBS feed. The SBS feed pump 1 was not feeding properly. Once pump 1, which was the lead pump, was switched to pump 2, the dechlorination system began to work properly. This event was initiated when the region experienced heavy rainfall with over 2.4 inches of rain in a two-day period (February 8 to 9), resulting in high CSO flows. The Alki WWTS was impacted by the damage caused to West Point on February 9; the reduced West Point plant capacity has resulted in excess flows to be discharged upstream in the collection system, including the CSO plants, during wet weather conditions. There were no discharge events with a maximum pH above 9.0, which is the permit limit. The minimum and maximum pH values for all 2017 discharge events were 4.8 and 7.1, respectively

Operation and Maintenance

Major upgrades to the Alki WWTS were completed in recent years. Staff evaluated and made adjustments, as needed, in 2017. Highlights of operation and maintenance (O&M) activities during 2017 include:

- Conducted annual CSO refresher training for the operators in October 2017.
- Quarterly/monthly testing of hypochlorite and bisulfite solution strength; set point changes made to chemical feed pumps based on solution strength; shipments of full-strength solutions ordered as necessary.
- Continued to conduct debriefings with O&M staff after discharge events to review and discuss the discharge and treatment performance and make any needed operational adjustments for subsequent events.
- Periodic cleaning of the effluent channel of accumulated solids and debris to improve treatment, including solids removal.
- Ongoing, routine preventive maintenance practice to exercise the chemical feed pumps on a monthly basis.
- Offsite Instrumentation and Electrical staff will continue to fine-tune and monitor the 63rd Avenue Pump Station pump VFD controls.

Hypochlorite Feed System Improvement Project

A project was initiated in 2016 to improve the hypochlorite feed system at Alki. This project design was completed in 2017, and construction and installation work is scheduled to begin in spring/summer 2018. The project is necessary to replace the aging pumps and chemical piping. The project includes replacement of the old,

oversized hypochlorite feed pumps with three new magnetic drive metering pumps—one feed metering pump with a chemical flow meter per influent force main and one standby pump, along with associated VFDs. New hypochlorite feed piping and venting is included in the project. In a separate project also initiated in 2016, the chemical offloading station at Alki was upgraded in summer 2017. This project constructed an improved chemical containment area for bulk hypochlorite offloading at Alki.

Near Future Operation

As with all wet weather treatment stations, opportunities to operate and then to optimize are very limited. Challenges may be identified during an event in the wet season, but any major projects to address the challenge would likely have to occur during the following dry season. Then, after the completion of these projects, the opportunities to test the improvements would likely occur in the following wet season. King County Wastewater Treatment Division (WTD) staff will continue to investigate and make any necessary adjustments in O&M. In addition, WTD staff responding to Alki WWTS will:

- Continue with the evaluation, testing, and adjustments of the new VFDs for the 63rd Avenue pumps.
- Provide ongoing support of the project design for a hypochlorite feed system, including three new feed pumps, chemical diffuser, and flow meters.
- Follow up and review consultant recommendations to improve Alki CSO treatment performance.

Table C-2. Alki WWTS Annual Event Data Summary

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Alki + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Avg (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (µg/l)	Daily Min/Max pH
January	17	1	19.3	1	17.2	8,370	5,658		0.1		300/230	21	6.5/6.6
	18	1	12.8	1	12.8	6,746	4,624		0.1	0.1	1	298	6.4/6.8
	Instant. Min/Max pH												**6.45/6.8**
	Event/Daily Max									**0.10**		**298**	
	Monthly Total/Avg/GeoMean	**1**	**32.1**	**1**	**30.1**	**15,116**	**10,282**	**32.0%**			**41**		
February	8	1	11.2	1	9.7	5,040	3,042		0.1		1/1	446	4.8/6.0
	9	1	34.7	1	34.7	27,196	15,003		0.1		1	5	6.5/6.8
	10	1	16.9	1	16.9	16,096	16,096		0.1	0.1	1	478	6.7/7.1
	14	2	6.1	2	4.6	3,021	1,807		0.1		230	4	6.1/6.5
	15	2	41.1	2	41.1	11,657	11,655		0.1		20/1	41	6.4/6.8
	16	2	14.3	2	14.3	2,501	2,270		0.1	0.1	1	6	6.6/6.8
	Instant. Min/Max pH												**4.8/7.1**
	Event/Daily Max									**0.10**		**478**	
	Monthly Total/Avg/GeoMean	**2**	**124.3**	**2**	**121.3**	**65,511**	**49,872**	**23.9%**			**2.9**		
March	9	1	3.32	1	1.86	1,551	1,361		0.2	0.2	130 /20	20	6.7/6.9
	14	2	14.15	2	12.51	22,894	15,924		0.1		1300 /1	3	6.5/6.9
	15	2	14.76	2	14.76	6,524	7,396		0.1	0.1	1 /1	3	6.6/6.7
	17	3	14.12	3	12.6	6,006	5,223		0.1		1 /270	7	6.2/6.6
	18	3	13.52	3	13.52	23,115	18,630		0.1	0.1	1	659	6.6/6.9
	29	4	3.20	4	1.33	2,002	1,378		0.3	0.3	500	3	6.4/6.8
	Instant. Min/Max pH												**6.2/ 6.9**
	Event/Daily Max									**0.18**		**659**	
	Monthly Total/Avg/GeoMean	**4**	**63.1**	**4**	**56.58**	**62,091**	**49,912**	**19.6%**			**14.7**		
April	12	1	6.5	1	4.79	3,740	3,499		0.1	0.10	40/1	10	6.4/6.9

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Alki + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Avg (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (µg/l)	Daily Min/Max pH
	Instant. Min/Max pH												**6.4/6.9**
	Event/Daily Max									**0.10**		**10**	
	Monthly Total/Avg/GeoMean	**1**	**6.5**	**1**	**4.79**	**3,740**	**3,499**	**6.5%**			**6.3**		
May	4	1	0.33	ND	ND	1858	340		ND		ND	ND	ND
	5	1	0.47	ND	ND	682	59		ND		ND	ND	ND
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**1**	**0.8**	**0**	**ND**	**2,540**	**399**	**84.3%**			**ND**		
June	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**0**	**ND**	**ND**	**ND**	**ND**			**ND**		
July	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**0**	**ND**	**ND**	**ND**	**ND**			**ND**		
August	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**0**	**ND**	**ND**	**ND**	**ND**			**ND**		
September	No Inflow/No Disch.												

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Alki + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Avg (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (µg/l)	Daily Min/Max pH
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**0**	**ND**	**ND**	**ND**	**ND**			**ND**		
October	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**0**	**ND**	**ND**	**ND**	**ND**			**ND**		
November	13	1	0.31	ND	ND	271	22		ND		ND	ND	
	14	1	0.44	ND	ND	312	27		ND		ND	ND	
	20	2	0.57	ND	ND	989	180		ND		ND	ND	
	21	2	4.82	1	3.20	2,573	1,677		0.10	0.1	1/1	66	6.2/6.6
	22	2	0.29	ND	ND	51	10		ND		ND	ND	
	Instant. Min/Max pH												**6.2/6.6**
	Event/Daily Max									**0.10**		**66**	
	Monthly Total/Avg/GeoMean	**2**	**6.4**	**1**	**3.2**	**4,196**	**1,916**	**54.3%**			**1**		
December	19	1	8.8	1	7.51	5,504	5,504		0.20	0.2	40/20	3	6.2/7.0
	29	2	5.48	2	3.66	4,662	1,902		0.30	0.3	140/1	6	6.6/7.0
	Instant. Min/Max pH												**6.2/7.0**
	Event/Daily Max									**0.3**		**6**	
	Monthly Total/Avg/GeoMean	**2**	**14.3**	**2**	**11.2**	**10,166.00**	**7,406**	**27.1%**			**18.3**		
Total		**13**	**247.6**	**11**	**227.1**	**163,361**	**123,286**						

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Alki + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Avg (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (µg/l)	Daily Min/Max pH
Inst. pH Min/Max													4.8/7.1
Max (GEM, SS, TRC)										0.30	41	659	
Annual Average							by mass:	24.5%		0.14	14	115.50	

Notes:
ND= No discharge.
Red= NPDES permit exceedance.

	Inflow Volume (MG)	Discharge Volume (MG)	Total Alki CSO TSS lbs-in	Total Alki CSOTSS lbs Discharged	Annual Average Alki CSO %TSS Removal	Maximum of Event Averages Settleable Solids (ml/l/hr)	Annual Average Settleable Solids Concentration (ml/l/hr)	Maximum of Monthly Geomean Alki CSO Effl. Fecal Coliforms (#/100 ml)	Annual Average of Monthly Geomean Alki CSO Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of Alki CSO Effl. Res. Cl2 (ug/l)	Instant. Min/Max pH
Includes all events	247.6	227.1	163,361	123,286	24.5%	0.30	0.14	41	14	659	4.8/7.1

Appendix D
Carkeek Wet Weather Treatment Station
Annual Report

January–December 2017

Executive Summary

This 2017 report summarizes the performance of Carkeek Wet Weather Treatment Station (Carkeek WWTS). The Carkeek WWTS began to operate as a combined sewer overflow (CSO) treatment facility on November 1, 1994. The Carkeek WWTS operates under the National Pollutant Discharge Elimination System (NPDES) permit for the West Point Treatment Plant (West Point), Washington State Department of Ecology (Ecology) permit number WA-0029181-1.

The total rainfall for the reporting period was 43.07 inches, as measured by the Ballard Station rain gauge. The 2017 annual rainfall recorded at Sea-Tac is 47.9 inches. The 20-year average at Sea-Tac is 39.9 inches.

There were 22 filling events and 10 discharge events during 2017. The Carkeek WWTS received 86.9 million gallons (MG) and discharged 79.6 MG. The high inflow and discharge volumes compared to past years have been attributed to flow shedding from the West Point. The plant had reduced capacity while it recovered from a flood on February 9, 2017. The reduced West Point plant capacity has resulted in excess flows being discharged upstream in the collection system, including Carkeek WWTS, and the other CSO plants, during wet weather conditions. Flow shedding was implemented by reducing or shutting down Carkeek Pump Station, thereby limiting flows to West Point.

The annual average total suspended solids (TSS) removal was 28.2 percent for the year, thereby not meeting the NPDES permit limit of 50 percent for annual removal. Carkeek WWTS met its annual average settleable solids (SS) limit, with the average measured as 0.16 milliliters/liter/hour (ml/L/hr); the NPDES permit limit is 0.3 mL/L/hr. The Carkeek WWTS met all remaining NPDES permit limits except for one exceedance of the monthly fecal coliform geomean limit. The performance for 2017 is summarized in Table D-1.

Table D-1. Carkeek WWTS Permit Performance in 2017

Parameter	Performance	Permit Conditions
Discharge events (number)[a]	**10**	**10**
Discharge volume MG[a]	**79.6**	**46**
Annual average SS (mL/L/hr)	**0.16**	**0.3**
Annual average TSS removal, including all discharge events (%)	**28.2**	**50**
Instantaneous minimum effluent pH, frequency of discharge days with pH <6.0	**0 out of 21 discharge days**	**≥ 6.0**
Instantaneous maximum effluent pH, frequency of discharge days with pH> 9.0	**0 out of 21 discharge days**	**≤ 9.0**
Total residual chlorine (TRC), maximum of daily averages (µg/L), frequency of discharge days with TRC > 490 µg/L	**0 out of 21 discharge days**	**≤490 µg/L**
Monthly fecal coliform geomean, frequency of months with monthly geomean > 400/100 mL	**1 out of 6 discharge months**	**400/mL**

[a] Compliance assessed over a five-year average.
Numbers in red indicate a permit exceedance.

Suspended and Settleable Solids

TSS removal averaged 28.2 percent, thereby not meeting the annual TSS removal NPDES permit limit of 50 percent. The challenges to meet the solids removal requirements were made more difficult in 2017 because of the flow shedding during the West Point recovery period (February 9, 2017, through April 21, 2017) from the February West Point flood. Flow shedding was achieved by throttling down, or shutting down, conveyance pump stations that would normally allow flows to West Point. At Carkeek WWTS, flow shedding was accomplished by shutting down the Carkeek Pump Station, thus allowing flows that would have been pumped to West Point to enter the Carkeek WWTS treatment plant sooner. The annual SS for the year averaged 0.16 ml/L/hr, thereby meeting the NPDES permit limit annual average of 0.3 ml/L/hr.

Fecal Coliform Bacteria

One month out of six discharge months exceeded the monthly fecal coliform geomean permit limit. The maximum monthly geomean during the 2017 reporting period occurred in December and was 1871 counts/100 ml, thereby not meeting the monthly NPDES permit limit of 400 counts/100 ml. The cause of high fecal coliform level was initially suspected to be that the hypochlorite dosing set point appeared to have been inadequate, or that the hypochlorite feed pump was gas-bound. However, in the following month during the subsequent treatment event at Carkeek WWTS, the hypochlorite feed was very low, and King County staff found that the backpressure valve on the hypochlorite feed line was clogged. Once the valve was cleared of the

obstruction, the hypochlorite feed was re-established to the appropriate levels. A new backpressure valve will be installed in 2018 that allows the operator to bypass the valve so unrestricted hypochlorite feed can occur during maintenance or cleaning of the valve. The 2017 annual average of the monthly geomeans was 325 counts/100 ml.

Instantaneous Minimum/Maximum pH

The instantaneous minimum and maximum pH during the 2017 reporting period was 6.7 and 8.4, respectively, thereby meeting the NPDES permit limits for instantaneous minimum pH equal to or greater than 6.0 and for the maximum pH permit limit of equal to or less than 9.0. During the second day of the March 17 to 18, 2017, event, the final effluent sample pump failed, and staff were unable to restart or install a backup sample pump before the end of the event. As a result, the final effluent online pH meter and chlorine analyzer readings were not reported because those online measurements were not considered representative of the treated effluent. In the March discharge monthly report (DMR) sent to Ecology, a “no sample/not reported” designation was reported for the March 18, 2017, daily online pH value. A backup final effluent sample pump was installed, and a system to switch sample pumps on-the-fly during an event is currently being reviewed.

Total Residual Chlorine

Carkeek met the daily maximum average total residual chlorine (TRC) on all 21 discharge days in 2017. The annual average of the TRC was 94 µg/L. The maximum daily average effluent TRC during the 2017 reporting year was 483 µg/L, thereby meeting the NPDES permit limit of 490 µg/L. As mentioned above, during the second day of the March 17 to 18, 2017, event, the final effluent sample pump failed, and staff were unable to restart or install a backup sample pump before the end of the event. As a result, the final effluent online pH meter and chlorine analyzer readings were not reported because those online measurements were considered not representative of the treated effluent. In the March DMR sent to Ecology, a “no sample/not reported” designation was reported for the March 18, 2017, daily online average TRC value. A backup final effluent sample pump was installed, and a system to switch sample pumps on-the-fly during an event is currently being reviewed.

Operation and Maintenance

In the interim, two of the three pumps’ aging variable frequency drives (VFDs) for the raw sewage pump sets at Carkeek Pump Station were replaced, and the third VFD is scheduled for replacement. Highlights of operation and maintenance (O&M) activities during 2017 include:

- Conducted annual CSO refresher training for the operators in October 2017.

- Received shipments of both sodium hypochlorite and sodium bisulfite treatment chemicals.
- Continued to conduct debriefings with O&M staff after discharge events to review and discuss the discharge and treatment performance and make any needed operational adjustments for subsequent events.
- Conducted periodic cleaning of the sedimentation tanks and effluent channel of accumulated solids and debris to improve solids removal.
- Continued quarterly or monthly testing of the treatment chemicals' concentrations (sodium hypochlorite and sodium bisulfite solutions), and made necessary changes to the feed programs or ordered fresh chemicals.
- Continued a preventive maintenance practice to exercise the chemical feed pumps on a monthly basis.
- Installed a backup final effluent sample pump and evaluated a system modification that could allow the operators to switch sample pumps on-the-fly.
- Carkeek Pump Station evaluation and adjustments of the VFD are ongoing.

Near Future Operation

As with all wet weather treatment stations, opportunities to operate and then to optimize are very limited. Challenges may be identified during an event in the wet season, but any major projects to address the challenge would likely have to occur during the following dry season. Then, after the completion of these projects, the opportunities to test the improvements would likely occur in the following wet season. Given the "normal" challenges of an intermittently operated facility, WTD has essentially had to make improvements continuously, and a number of improvements have been identified to be addressed during subsequent dry seasons.

- Continued to conduct debriefings with O&M staff after discharge events to review and discuss the discharge and treatment performance and make any needed operational adjustments for subsequent events.
- Continued monthly or quarterly testing of the treatment chemicals' concentrations (sodium hypochlorite and sodium bisulfite solutions) and made necessary changes to the feed programs or ordered fresh chemicals.
- Continued a preventive maintenance practice to exercise the chemical feed pumps on a monthly basis.
- Continued to monitor and evaluate the completed flow measurement improvements.
- Follow up with VFD replacement project for the remaining raw sewage pump set at Carkeek Pump Station.

Table D-2. Carkeek WWTS Annual Plant Performance 2017

Month	Day	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. SS Event avg (ml/l/hr)	Avg daily Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (ug/l)	Daily Min/Max pH
January	8	1	0.03	ND	ND	120	12		ND		ND	ND	ND
	17	2	2.78	1	2.28	1,463	667		0.1		50000 /1	131	6.8 /7.3
	18	2	8.32	1	8.32	1,248	1,106		0.1		1	115	6.8 /7.3
	19	2	1.43	1	1.82	454	316		0.1	0.1	1	7	6.9 /7.2
	22	3	0.07	ND	ND	107	5		ND		ND	ND	ND
	Instant. Min/Max pH												**6.8 / 7.3**
	Event/Daily Max									**0.10**		**131**	
	Monthly Total/Avg/GeoMean	**3**	**12.6**	**1**	**12.42**	**3,391**	**2,107**	**37.9%**			**15**		
February	4	1	0.06	ND	ND	61	34		ND		ND	ND	ND
	8	2	4.20	1	3.93	2,590	780		0.1		80 /20	438	6.8 /8.4
	9	2	17.94	1	17.49	1,646	1,491		0.1		80	100	6.7 /7.5
	10	2	2.95	1	2.91	2,633	2,633		0.1		3000	21	7.0 /7.3
	11	2	1.28	1	1.30	1,025	497		0.1	0.1	1	59	7.2 /7.4
	14	3	3.19	2	2.43	1,089	678		0.1		1/1	103	6.7 /8.3
	15	3	17.91	2	17.41	8,664	7,298		0.1		80	76	6.7 /7.2
	16	3	4.94	2	5.31	1,153	1,081		0.1		1	24	6.7 /7.0
	17	3	0.05	2	0.07	25	21		0.1	0.1	1	6	6.6 /6.8
	Instant. Min/Max pH												**6.6 /8.4**
	Event/Daily Max									**0.10**		**438**	
	Monthly Total/Avg/GeoMean	**3**	**52.5**	**2**	**50.8**	**18,886**	**14,512**	**23.2%**			**11**		
March	3	1	1.18	1	0.70	1,638	1,033		0.1	0.1	1 /1	85	7.0 /8.2
	9	2	2.30	2	1.73	2,376	1,366		0.1	0.1	130 /40	110	7.0 /8.2
	13	3	0.62	ND	ND	186	144		ND		ND	ND	ND
	14	3	3.57	3	3.24	1,072	859		0.1		300 /0 /40	76	7.0 /8.0
	15	3	1.34	3	1.34	692	798		0.1	0.1	1	7	7.1 /7.2

Month	Day	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. SS Event avg (ml/l/hr)	Avg daily Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (ug/l)	Daily Min/Max pH
	17	4	6.10	4	5.26	1,220	971		0.1		20 /1	483	6.8 /8.1
	18	4	1.92	4	1.97	690	544		0.1	0.1	1	NR	NR
	24	5	0.04	ND	ND	46	20		ND		ND	ND	ND
	Instant. Min/Max pH												**6.8 /8.2**
	Event/Daily Max									**0.10**		**483**	
	Monthly Total/Avg/GeoMean	**5**	**17.07**	**4**	**14.24**	**7,921**	**5,735**	**27.6%**			**7**		
April	11	1	0.73	1	0.31	728	370		0.8		1	6	6.8 /7.0
	12	1	1.49	1	1.33	3,405	2,812		0.6	0.70	40	19	7.0 /7.3
	26	2	0.06	ND	ND	129	22		ND		ND	ND	
	Instant. Min/Max pH												**6.8 /7.3**
	Event/Daily Max									**0.70**		**19**	
	Monthly Total/Avg/GeoMean	**2**	**2.28**	**1**	**1.64**	**4,263**	**3,204**	**24.8%**			**6.3**		
May	4	1	0.113	ND	ND	288	53		ND		ND	ND	ND
	15	2	0.166	ND	ND	228	12		ND		ND	ND	ND
	16	2	0.041	ND	ND	52	4		ND		ND	ND	ND
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**2**	**0.32**	**ND**	**ND**	**569**	**69**	**87.9%**			**ND**		
June	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**ND**	**ND**	**ND**	**ND**	**ND**			**ND**		
July	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**

Month	Day	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. SS Event avg (ml/l/hr)	Avg daily Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (ug/l)	Daily Min/Max pH
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**ND**	**ND**	**ND**	**ND**	**ND**			**ND**		
August	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**ND**	**ND**	**ND**	**ND**	**ND**			**ND**		
September	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0.0**	**ND**	**ND**	**ND**	**ND**				**ND**		
October	12	1	0.11	ND	ND	191	5		ND		ND	ND	ND
	18	2	0.16	ND	ND	484	91		ND		ND	ND	ND
	19	2	0.03	ND	ND	27	12		ND		ND	ND	ND
	21	3	0.05	ND	ND	35	6		ND		ND	ND	ND
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**3**	**0.35**	**ND**	**ND**	**736**	**114**	**84.5%**			**ND**		
November	20	1	0.03	ND	ND	29	5		ND		ND	ND	
	21	1	0.63	1	0.16	164	87		0.10	0.1	40	0	6.9/7.0
	22	1	0.08	ND	ND	29	6		ND		ND	ND	
	26	2	0.10	ND	ND	83	15		ND		ND	ND	
	Instant. Min/Max pH												**6.9/7.0**
	Event/Daily Max											**0**	

Month	Day	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. SS Event avg (ml/l/hr)	Avg daily Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (ug/l)	Daily Min/Max pH
	Monthly Total/Avg/GeoMean	**2**	**0.85**	**1**	**0.16**	**305**	**113**	**63.1%**			**40**		
December	19	1	0.71	1	0.30	1311	1311		0.10	0.1	50000/70	7	6.7/6.8
	29	2	0.20	ND	ND	517	62		ND		ND	ND	
	Instant. Min/Max pH												**6.7/6.8**
	Event/Daily Max									**0.1**		**7**	
	Monthly Total/Avg/GeoMean	**2**	**0.91**	**1**	**0.30**	**1,828**	**1,373**	**24.9%**			**1871**		
Total		**22**	**86.9**	**10**	**79.59**	**37,900**	**27,227**						
Inst. pH Min/Max													**6.7/8.4**
Max (GEM, SS, TRC)										**0.70**	**1871**	**483**	
Annual Average								**28.2%**		**0.16**	**325**	**94**	

Notes:
ND= No discharge.
^ED= End of discharge; fecal coliform samples were collected for 0-3 and 4-8 hour grabs then discharge ended before next grab sample was required.
Red= NPDES permit exceedance.
%NS= No sample collected; No online instrumentation values to report
* NR= Not Reported due to lab error.

	Inflow Volume (MG)	Discharge Volume (MG)	Total TSS Infl. (lbs)	Total TSS Effl. (lbs)	Annual Average TSS Removal (%)	Maximum of Event Averages SS (ml/l/hr)	Annual Average SS Concentration (ml/l/hr)	Maximum of Monthly Geomean Effl. Fecal Coliforms (#/100 ml)	Annual Average of Monthly Geomean Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of Effl. TRC (µg/l)	Instant. Min/Max pH
Includes all events	86.9	79.59	37,900	27,227	28.2%	0.70	0.16	1871	325	483	6.7/8.4

Appendix E
Elliott West Wet Weather Treatment Station
Annual Report

January–December 2017

Executive Summary

This 2017 annual report summarizes the performance of the Elliott West Wet Weather Treatment Station (Elliott West WWTS). Elliott West WWTS began operating in July 2005. The facility operates under the National Pollutant Discharge Elimination System (NPDES) permit for the West Point Treatment Plant (West Point), Washington State Department of Ecology (Ecology) permit number WA-0029181-1. The current permit went into effect on February 1, 2015.

Total rainfall recorded in 2017 was 41.75 inches as measured at the Denny Way rain gauge station, which is located at 3165 Alaskan Way in Seattle. The 2017 annual rainfall recorded at Sea-Tac is 47.9 inches. The 20-year average at Sea-Tac is 39.9 inches.

There were 35 inflow events and 17 discharge events in 2017. Elliott West WWTS received a total of 1332.7 million gallons (MG), out of which 917.4 MG were treated and discharged through the Elliott West Outfall at the Denny Way Regulator Station located in Myrtle Edwards Park. The high inflow and discharge volumes compared to past years have been attributed to flow shedding from West Point. The plant had reduced capacity while it recovered from a flood on February 9, 2017. The reduced West Point plant capacity has resulted in excess flows being discharged upstream in the collection system, limiting flows into the Elliott Bay Interceptor and to West Point. Flow shedding was implemented by reducing or shutting down Interbay Pump Station, thereby limiting flows into the Elliott Bay Interceptor and to West Point. Almost 75 percent of 2017 discharged combined sewer overflow (CSO) volume occurred during the flow shedding events in the months of February, March, and April 2017. Additional flow shedding from West Point into the Mercer Tunnel and Elliott West WWTS occurred during November and December rain events in order to minimize the flow of seawater into the conveyance system and into West Point. The seawater intrusion into the conveyance system and West Point was caused by the failure of a marine flap gate at the Denny Regulator in late October. The marine flap gate was replaced in late December 2017.

In late October 2017, it was discovered that the Elliott West WWTS wet well drain gate failed to close. This drain gate is normally closed during discharge events, but will open after events to allow the facility to drain the treated flow in the effluent pipeline that was not discharged, back into the facility where it can be transferred to West Point for treatment. The partially open gate allowed recycling of disinfected and dechlorinated during treatment events, so proper dosing becomes more of a challenge. Repair of the failed drain gate requires dry weather and is anticipated to be completed in July 2018.

The average total suspended solids (TSS) removal for all events during the year was 21.4 percent, thereby not meeting the NPDES 50 percent annual average TSS removal limit. Elliott West WWTS also did not meet the settleable solids (SS) annual event average limit, with the average measured as 4.04 milliliters/liter/hour (ml/L/hr); the NPDES permit limit is 0.3 ml/L/hr. The performance for 2017 has been summarized below in Table E-1.

Performance in 2017

Table E-1 summarizes NPDES permit performance in 2017.

Table E-1. Elliott West WWTS Permit Performance in 2017

Parameter	Performance	Permit Conditions
Discharge events (number)	**17**	**NA**
Discharge volume MG	**917.4**	**NA**
Annual average SS (ml/L/hr)	**4.04**	**0.3**
Annual average TSS removal, including all discharge events (%)	**21.4**	**50**
Instantaneous minimum effluent pH, frequency of discharge days with pH < 6.0	**5 out of 30 discharge days**	**≥ 6.0**
Instantaneous maximum effluent pH, frequency of discharge days with pH > 9.0	**2 out of 30 discharge days**	**≤ 9.0**
Total residual chlorine (TRC), maximum of daily averages (µg/L), frequency of discharge days with TRC > 109 µg/L	**14 out of 30 discharge days**	**≤109 µg/L**
Monthly fecal coliform geomean, frequency of months with monthly geomean > 400/100 mL	**3 out of 7 discharge months**	**400/mL**

Numbers in red indicate a permit exceedance.

Suspended and Settleable Solids

In 2017, the annual TSS removal was calculated to be 21.4 percent; therefore, Elliott West WWTS did not meet the NPDES permit limit of 50 percent. The challenges to meet the solids removal requirements were made more difficult in 2017 because of the

flow shedding during the West Point recovery period (February 9, 2017, through April 21, 2017) from the February West Point flood. Flow shedding was achieved by throttling down, or shutting down, conveyance pump stations that would normally allow flows to West Point. At Elliott West WWTS, flow shedding was accomplished by shutting down the Interbay Pump Station, thus allowing flows that would have been pumped to West Point to enter Elliott West WWTS treatment plant sooner. Additional flow shedding occurred in November and December rain events to minimize the impact of seawater intrusion to West Point caused by a failed marine flap gate at the Denny Regulator Station.

The renewed NPDES permit effective February 1, 2015, removed the SS event maximum limit and kept the annual average of 0.3 ml/L/hr. Meeting the SS NPDES permit limit continues to be a challenge. The annual SS concentration for the 2017 discharge events averaged 4.04 m/L/hr, exceeding the NPDES permit limit of 0.3 ml/L/hr. The event maximum in 2017 was 30.0 ml/L/hr, occurring on March 7, 2017. With the ongoing challenges of meeting the NPDES permit limits, King County has started a project with consultant engineers to help further evaluate the issues with solids removal and SS compliance. An extensive sampling plan has been established to monitor flows and solids entering the Mercer Street Treatment Tunnel and Elliott West WWTS pipeline (which are the wet well flows from the west). The solids sampling and monitoring project started in late 2015 and continued through 2016. In 2018, the consultants will submit recommendations to King County on treatment alternatives to improve solids removal and overall treatment performance at Elliott West WWTS

Fecal Coliform Bacteria

In 2017, Elliott West WWTS did not meet the fecal coliform NPDES permit limit of 400/100 ml monthly geomean three out of the seven discharge months. The maximum monthly geomean for fecal coliform bacteria occurred in January, and was calculated as 1054 counts/100 ml. The annual average of the monthly geomeans was 492 counts/100 ml. Actions taken throughout the year to address the high fecal coliform levels included cleaning and shock dosing the final effluent sample line and stilling well and increasing the hypochlorite dose. Further increases in hypochlorite dose set point will be applied for future events. However, the increased hypochlorite dose will require additional diligence to ensure compliance with the effluent chlorine (Cl_2) and/or pH limits. Additional steps to improve fecal coliform inactivation include review of the hypochlorite and dechlorination chemical feed system pumps and program controls as part of the 2016 Elliott West WWTS assessment and improvement project by King County.

Total Residual Chlorine

During 2017, there were 14 discharge days out of 30 that exceeded the maximum daily average total residual chlorine (TRC) NPDES permit level of 109 micrograms per liter (µg/L). Please refer to Table E-2 for the discharge events that exceeded the TRC limits. The annual average of all daily TRC values was 296 µg/L, and the maximum value of 3412 µg/L was measured by the online effluent chlorine analyzer.

There are several potential causes for the TRC permit limit exceedances. Several of the discharge events had intermittent flows, and many events had wide pumping fluctuations by the main pumps, causing challenges to the chemical systems to respond quickly enough to the changes in the discharge flows. In addition, the TRC exceedances may have been caused by inadequate sodium bisulfite (SBS) feed and mixing, and the continuous adjustments made to the SBS feed in direct response to the minimum pH excursions. It is possible that SBS underfeeding contributed to the TRC exceedances.

From examining event data trends, it is possible the SBS mixing may be inadequate. The current SBS mixing is accomplished by using carrier water and two induction mixers located at the base of the 96-inch diameter effluent pipe. During most events, one or both of the SBS induction mixers tend to trip out and require manual reset due to motor overload caused by heavy debris and floatables fouling the mixer propeller. With limited mixing by the induction mixers, the effectiveness of the dechlorination system is impacted, resulting in higher chlorine residual in the effluent, and at times exceeding the daily average TRC limits. King County Wastewater Treatment Division (WTD) staff are continuing to adjust the chemical feed controls and monitoring equipment (i.e., the online chlorine analyzers and pH meter).

In 2016, a capital project was initiated to build a separate dedicated sampling and instrumentation room at Denny Way Regulator Station for the final effluent compliance sampling and monitoring and pre-dechlorination sample delivery improvements. This project included increasing the water system capacity to provide higher flows for the SBS carrier water. A modified dechlorination control program was added in 2016 to allow operators to switch between automatic SBS feed control to “semi-auto” feed control. In semi-auto feed control, the inputs from the pre-dechlorination chlorine analyzer are disengaged, which will allow the operator to enter a pre-dechlorination chlorine residual value. The pre-dechlorination chlorine analyzer provides a control input for the automatic dechlorination feed program that frequently becomes clogged, thus generating false chlorine residual inputs to the SBS feed program and resulting in incorrect dosing of SBS. Furthermore, design of a diffuser for SBS application was submitted, and because of scheduling delays, the installation is now scheduled for summer 2018. Evaluation of the diffuser will start shortly after installation.

Along with work on the SBS diffuser, King County has implemented a project to design, install, and operate an in-line SBS dilution system at Elliott West WWTS to dilute the 38 percent SBS to 20 percent solution when SBS is transferred to the day tank at Denny Way Regulator Station. Using a more dilute SBS along with additional carrier water will aid in chemical dispersion and improved mixing. The SBS post-dilution system will be implemented by summer 2018.

Instantaneous Minimum and Maximum Effluent pH

Instantaneous minimum and maximum effluent pH in 2017 was measured as 5.3 and 9.7, respectively. There was a total of 30 discharge days in 2017, and five of those discharge days had the instantaneous minimum effluent pH measured below the NPDES permit level of 6.0. There were two events exceeding the maximum pH limit of 9.0. During February, there were two separate discharge events that had an instantaneous maximum pH greater than 9.0. Those two events occurred during the West Point flow shedding; the maximum pH peaked at 9.2 and 9.7. Further investigation of these two events did not find a cause in these high pH excursions.

A low effluent pH tends to occur during extreme storm flows when the alkalinity of the CSO flows can be quite low, and higher hypochlorite doses may be needed because of shorter detention times. The alkalinities of the inflow and final effluents have been in the range 10 to 50 milligrams per liter (mg/L) as calcium carbonate ($CaCO_3$). Though the influent pH tends to be above pH 6.5 even with low influent alkalinity, the low alkalinity will provide little buffer to the acidic compounds that can be introduced during the dechlorination process. SBS is not only acidic in nature, it will also react with dissolved oxygen in the effluent to form sulfate, or sulfuric acid ($H2SO_4$), which will then consume alkalinity and drop the effluent pH. Thus, the key to complying with the minimum pH limit is the ability to vary or control the SBS dose so it just neutralizes the pre-SBS chlorine residual. In fact, staff have been fine-tuning the SBS feed control program as well as trying to reduce the hypochlorite dose so the necessary SBS dose to meet the coliform limits is also reduced. Nonetheless, these actions did not prevent all exceedances in 2017. WTD staff will continue to respond to Elliott West WWTS discharges in order to adjust the chlorination and dechlorination controls. Some projects to improve treatment chemical feed controls and SBS mixing, mentioned in the previous section on final chlorine residual permit performance, will also benefit in meeting the pH permit limits of the discharge effluents. Further analysis of the data trends of discharge events is ongoing.

Operation and Maintenance

Highlights of operation and maintenance (O&M) activities at the Elliott West CSO during 2017 include:

- Conducted annual CSO refresher training for the operators in September 2017.
- Provided remote monitoring support team in anticipation of a treatment and discharge event and during the event.
- Received shipments of both sodium hypochlorite and sodium bisulfite treatment chemicals as needed.
- Continued the automated Mercer Tunnel flushing program at the East Portal flushing gate in an attempt to flush and capture the solids settled in the Mercer Tunnel.
- Continued to monitor the effectiveness of the automated Mercer Tunnel flushing by taking additional samples from the return flows and running laboratory solids analyses on those samples.
- Continued to run the dewatering pumps during discharges in order to remove additional solids, which takes advantage of the turbulence and re-suspension of solids in the wet well caused by the larger main pumps and increases the amount of solids in the return flows to West Point.
- Continued to conduct debriefings with O&M staff after discharge events to review and discuss the discharge and treatment performance and make any needed operational adjustments for subsequent events.
- Continued with additional procedures to the post-discharge event routines, including equipment testing, cleaning, and de-ragging within the dechlorination and final effluent vaults/structures. Equipment includes both pre-dechlorination and final effluent sample pumps and sample intakes and SBS mixers.
- Continued to exercise the chemical feed pumps on a monthly basis as a preventive maintenance measure.
- Continued quarterly or monthly testing of the treatment chemicals' concentrations (sodium hypochlorite and sodium bisulfite solutions) and made necessary changes to the feed programs or ordered fresh chemicals.
- Made changes to the main pump control program with the goal of minimizing large pump flow swings impacting treatment and impacts to upstream conveyance.
- A design of a diffuser for SBS application has been submitted and will be installed in summer 2018. Evaluation of the diffuser will start shortly after installation.
- In 2016, King County implemented a project to design, install, and operate a post- in-line SBS dilution system at Elliott West WWTS to dilute the 38 percent SBS to 20 percent solution. The SBS post-dilution system will be implemented by summer 2018.
- Implemented a "semi-auto" mode for SBS feed control that would disable the input from the pre-dechlorination chlorine analyzer to the SBS feed program during times when the analyzer is not working properly.

Chlorination-Dechlorination System Improvements Project

2017 marks the sixth year of operation for the chlorination-dechlorination system controls, which were part of the Chlorination-Dechlorination System Improvement Project. This project was completed in November 2011. The response team was tasked with troubleshooting and adjusting the feed controls, so they responded to each treatment and discharge event when the wet well was filling, prior to the start of the main discharge pumps. Control adjustments were made to the hypochlorite system that should allow for better hypochlorite feed control, which, in turn, should reduce the potential of overfeeding of hypochlorite, and, therefore, could also reduce the overfeeding of SBS.

To continuously improve the new system, station performance has been evaluated during the operations debriefings held after each discharge event. An example of evaluation and continuous improvement is the modification to the SBS feed control, which was implemented in early 2016 as the “semi-auto” mode. When the mode is employed by the operator, the program disengages inputs from the pre-dechlorination chlorine analyzer to the feed program and the operator inputs value for the pre-dechlorination chlorine residual, thus removing inaccurate inputs to the dechlorination program. The inaccurate inputs have occurred because the pre-dechlorination chlorine analyzer becomes clogged. This modification was implemented to minimize underfeeding of SBS and subsequent high effluent chlorine residual. This continuous improvement process is ongoing with staff, who are evaluating alternatives to prevent this clogging. When the clogging issue is resolved, staff will evaluate a return to the auto mode for SBS feed control.

Other Improvement Projects at Elliott West Wet Weather Station

The Instrumentation and Sampling Equipment Relocation Project was completed in September 2017. The work on the project, including the design phase and necessary construction permitting, was carried out by the King County Capital Projects team in 2015. This project aimed to improve sample delivery and to relocate the process instrumentation and monitoring equipment at Denny Way Regulator Station (the location of Elliott West WWTS dechlorination and final effluent monitoring). The instrumentation and sampling equipment was relocated to a separate dedicated room out of the SBS day tank room. In addition to relocating the instrumentation, the pre-dechlorination and final effluent amperometric chlorine residual analyzers were updated with newer models that have been programed to enter a “sleep mode” during non-discharge days, thus preventing instrument wear and reducing city water and reagent chemical use. As part of this project, the sample lines and copper flushing water lines were replaced with non-metal materials that will meet the standards for priority pollutant sampling and eliminate the non-compatible material contamination of samples. Monitoring of the new sampling and instrumentation system performance, and any necessary modifications, are

currently being made. One of these modifications is the discovery of the need to increase sample flow velocities through the cyclonic separator to achieve particle separation needed for the chlorine residual analyzers.

In a separate project, the SBS post-dilution system was started in 2016 and will be completed in 2018. This project will dilute the SBS from the stored concentration of 38 percent to 20 percent solution during the transfer of SBS from storage tanks at Elliott West facility to the day tank at Denny Way Regulator Station. Use of a more dilute SBS will minimize freezing and crystallization of SBS in the transfer line and will aid in SBS dispersion at the dechlorination vault, located at Denny Way Regulator Station. It is anticipated that the SBS feed pumps will perform better when pumping at higher speeds to adjust for a more dilute SBS chemical.

Near Future Operation

During the 12 years of operation, opportunities to operate and then to optimize have been very limited. Challenges may be identified during an event in the wet season, but any major projects to address the challenge would likely have to occur during the following dry season. Then, after completion of these projects, the opportunities to test the improvements would likely occur in the following wet season. Given the complexity of Elliott West WWTS's design and operation, and the “normal” challenges of an intermittently operated facility, WTD has essentially had to make improvements continuously, and a number of improvements have been identified to be addressed during subsequent dry seasons. WTD staff will continue to fine-tune the chlorination-dechlorination controls and assess and improve the facility performance using these additional tools.

In addition, WTD staff will:

- Continue to investigate and, if possible, correct the cause(s) of the instantaneous minimum pH exceedances.
- Continue to implement the remote monitoring response team to Elliott West WWTS as the wet well fills and in anticipation of a discharge.
- Continue evaluation and fine-tuning of the chlorination and dechlorination controls.
- Continue evaluation and fine-tuning of systems after completing the sample and instrumentation relocation project.
- Continue to sample and monitor copper and dissolved oxygen of Elliott West WWTS flow per NPDES permit requirement.
- Continue with laboratory solids analyses on all flows sampled at Elliott West WWTS as part of monitoring of the automated Mercer Tunnel flushing program.

- Continue evaluation and fine-tuning of changes in the main pump control program.

Table E-2. Elliott West WWTS Annual Plant Performance 2017

Month	Day	Inflow Event Number	Inflow Volume (MGD)	Discharge Event Number	Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EW + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Average (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (ug/l)	Daily Min/Max pH
January	8	1	7.68	ND	ND	2,884	293		ND		ND	ND	ND
	9	1	1.11	ND	ND	471	25		ND		ND	ND	ND
	17	2	42.66	1	40.57	36,205	17,739		0.1		130/30,000	811	5.7/7.6
	18	2	30.88	1	20.85	6,193	3,981		0.1	0.1	300	191	6.0/6.9
	19	2	3.11	ND	ND	1,114	92		ND		ND	ND	ND
	20	2	0.05	ND	ND	224	10		ND		ND	ND	ND
	22	3	0.35	ND	ND	103	5		ND		ND	ND	ND
	Instant. Min/Max pH												**5.7/7.6**
	Event/Daily Max									**0.1**		**811**	
	Monthly Total/Avg/GeoMean	**3**	**85.83**	**1**	**61.42**	**47,193**	**22,145**	**53.08%**			**1054**		
February	3	1	5.78	ND	ND	2299	311		ND		ND	ND	ND
	4	1	8.07	ND	ND	3903	2164		ND		ND	ND	ND
	5	1	4.89	ND	ND	6681	2010		ND		ND	ND	ND
	6	1	2.01	ND	ND	552	131		ND		ND	ND	ND
	8	2	47.06	1	45.42	67478	57835		3.0		170/230	147	6.2/6.8
	9	2	127.45	1	124.70	32118	31360		3.0		300	76	6.3/9.7
	10	2	32.43	1	22.36	20864	20864		0.1	2.0	20	1	6.7/8.1
	11	2	5.41	ND	ND	3299	775		ND		ND	ND	ND
	12	2	4.93	ND	ND	2074	608		ND		ND	ND	ND
	13	2	4.98	ND	ND	1662	487		ND		ND	ND	ND
	14	2	52.30	2	46.59	38191	35468		1.9		1,100/1,400	278	6.1/7.7
	15	2	147.46	2	144.57	98578	98297		4.0		3,000	91	6.0/9.2
	16	2	34.45	2	22.97	11755	10122		0.1	2.0	170	4	6.3/6.7
	17	2	5.60	ND	ND	2596	1786		ND		ND	ND	ND
	18	2	5.89	ND	ND	2857	1524		ND		ND	ND	ND
	19	2	5.94	ND	ND	2606	1014		ND		ND	ND	ND
	20	2	7.28	ND	ND	3232	1457		ND		ND	ND	ND
	21	2	2.34	ND	ND	3519	1562		ND		ND	ND	ND
	23	3	0.45	ND	ND	2416	563		ND		ND	ND	ND
	27	4	3.15	ND	ND	1630	434		ND		ND	ND	ND

Month	Day	Inflow Event Number	Inflow Volume (MGD)	Discharge Event Number	Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EW + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Average (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (ug/l)	Daily Min/Max pH
	28	4	0.80	ND	ND	7112	2106		ND		ND	ND	ND
	Instant. Min/Max pH												**6.0/9.7**
	Event/Daily Max									**2.0**		**278**	
	Monthly Total/Avg/GeoMean	**4**	**508.69**	**2**	**406.61**	**315,422**	**270,880**	**14.12%**			**341**		
March	3	1	25.02	1	22.35	52946	50800		8.0	8.0	230/800	210	6.1/8.1
	4	1	4.27	ND	ND	2743	1593		ND		ND	ND	
	5	1	0.42	ND	ND	859	436		ND		ND	ND	
	7	2	13.66	2	5.15	24220	26011		30.0	30.0	3,000	383	6.4/7.0
	8	2	1.37	ND	ND	664	366		ND		ND	ND	
	9	2	29.68	3	21.91	24672	22124		6.0	6.0	800/230	109	6.5/7.8
	10	2	1.37	ND	ND	274	132		ND		ND	ND	
	11	2	5.76	ND	ND	607	382		ND		ND	ND	
	12	2	0.60	ND	ND	2622	1143		ND		ND	ND	
	13	2	20.73	4	12.83	19641	18760		7.5		20/1100	77	6.4/7.5
	14	2	47.46	4	37.32	26289	24876		2.2		500	64	6.3/7.1
	15	2	53.16	4	44.38	19363	19915		0.1	3.3	170	136	6.3/7.1
	16	2	1.94	ND	ND	2336	1577		ND		ND	ND	
	17	2	57.63	5	55.85	19582	19192		0.1		30000/9000	56	6.5/6.9
	18	2	44.47	5	35.80	8767	8279		0.1	0.1	40	16	6.5/6.8
	19	2	1.54	ND	ND	8390	5914		ND		ND	ND	
	23	3	3.48	6	0.85	4115	1472		0.1	0.1	1,300,000	0	6.4/7.0
	24	3	6.51	ND	ND	5765	2489		ND		ND	ND	
	27	4	0.27	ND	ND	356	120		ND		ND	ND	
	28	4	0.14	ND	ND	37	12		ND		ND	ND	
	29	4	22.00	7	13.85	19244	16431		7.0	7.0	2050/130	47	6.3/7.5
	30	4	0.95	ND	ND	1302	631		ND		ND	ND	
	Instant. Min/Max pH												**6.1/8.1**
	Event/Daily Max									**7.8**		**383**	
	Monthly Total/Avg/GeoMean	**4**	**342.43**	**7**	**250.29**	**244,792**	**222,653**	**9.04%**			**977**		
April	1	1	0.20	ND	ND	114	37		ND		ND	ND	

Month	Day	Inflow Event Number	Inflow Volume (MGD)	Discharge Event Number	Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EW + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Average (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (ug/l)	Daily Min/Max pH
	5	2	6.94	ND	ND	4,117	2,546		ND		ND	ND	
	6	2	3.15	ND	ND	2,985	1,557		ND		ND	ND	
	7	2	1.65	ND	ND	3,650	2,304		ND		ND	ND	
	8	2	1.01	ND	ND	828	578		ND		ND	ND	
	10	3	0.56	ND	ND	238	342		ND		ND	ND	
	11	3	6.27	1	6.19	34	12		NS		-	3,412	6.4/6.8
	12	3	31.64	1	23.32	14,405	13,827		1.0	1.0	500/230	98	5.8/6.8
	13	3	1.52	ND	ND	4,648	3,333		ND		ND	ND	
	19	4	1.18	ND	ND	453	239		ND		ND	ND	
	20	4	0.65	ND	ND	349	258		ND		ND	ND	
	26	5	3.56	ND	ND	2,119	356		ND		ND	ND	
	Instant. Min/Max pH												**5.8/6.8**
	Event/Daily Max									**1.0**		**3412**	
	Monthly Total/Avg/GeoMean	**5**	**58.34**	**1**	**29.51**	**33,940**	**25,390**	**25.19%**			**339**		
May	2	1	0.34	ND	ND	2287	502		ND		ND	ND	
	3	1	0.88	ND	ND	2290	528		ND		ND	ND	
	4	1	4.76	ND	ND	7604	1392		ND		ND	ND	
	5	1	3.01	ND	ND	1504	131		ND		ND	ND	
	6	1	0.79	ND	ND	569	56		ND		ND	ND	
	11	2	0.39	ND	ND	315	13		ND		ND	ND	
	16	3	1.15	ND	ND	325	22		ND		ND	ND	
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**3**	**11.31**	**ND**	**ND**	**14,893**	**2,644**	**82.25%**			**ND**		
June	8	1	0.53	ND	ND	388	18						**ND**
	15	2	3.47	ND	ND	2094	145			**ND**		**ND**	

Month	Day	Inflow Event Number	Inflow Volume (MGD)	Discharge Event Number	Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EW + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Average (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (ug/l)	Daily Min/Max pH
	16	2	1.49	ND	ND	2000	150				**ND**		
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**2**	**5.49**	**ND**	**ND**	4482.13	313.30	**93.0%**			**ND**		
July	No Inflow/No Disch.												
	Instant. Min/Max pH												
	Event/Daily Max												
	Monthly Total/Avg/GeoMean		**ND**	**ND**	**ND**	**ND**	**ND**	**ND**					
August	No Inflow/No Disch.												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean		**ND**	**ND**	**ND**	**ND**	**ND**	**ND**			**ND**		
September	19	1	1.73	ND	ND	6,048	379		ND		ND	ND	
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**1**	**1.73**	**ND**	**ND**	**6,048**	**379**	**93.7%**			**ND**		
October	12	1	0.65	ND	ND	312	8		ND		ND	ND	
	13	1	0.91	ND	ND	576	32		ND		ND	ND	
	18	2	13.28	1	5.16	12715	8403		1.30	1.3	1	540	6.1/7.2
	19	2	6.71	ND	ND	840	366		ND		ND	ND	
	20	2	0.62	ND	ND	212	10		ND		ND	ND	
	21	2	18.83	2	8.58	12408	7818		1.50		230	658	6.3/7.5
	22	2	11.51	2	3.15	4203	3233		NS	1.5	130	2	6.7/8.6
	23	2	0.90	ND	ND	90	34		ND		ND	ND	
	25	3	0.30	ND	ND	854	182		ND		ND	ND	
	28	4	0.50	ND	ND	434	68		ND		ND	ND	
	29	4	0.40	ND	ND	275	43		ND		ND	ND	

Month	Day	Inflow Event Number	Inflow Volume (MGD)	Discharge Event Number	Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EW + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Average (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (ug/l)	Daily Min/Max pH
	31	5	0.58	ND	ND	887	132		ND		ND	ND	
	Instant. Min/Max pH												**6.1/8.6**
	Event/Daily Max									**1.4**		**658**	
	Monthly Total/Avg/GeoMean	**5**	**55.19**	**2**	**16.89**	**33,806**	**20,330**	**39.9%**			**31**		
November	1	1	2.44	ND	ND	2032	385		ND		ND	ND	
	2	1	11.99	ND	ND	8456	3476		ND		ND	ND	
	3	1	32.42	1	22.94	18880	16305		0.30		230/1	239	6.3/8.5
	4	1	60.81	1	46.88	20295	13420		0.30		360	710	6.3/7.6
	5	1	24.24	1	16.32	5342	3801		0.30	0.3	20	243	6.7/7.3
	6	1	1.26	ND	ND	157	10		ND		ND	ND	
	9	2	0.87	ND	ND	269	23		ND		ND	ND	
	10	2	0.56	ND	ND	141	6		ND		ND	ND	
	12	3	1.33	ND	ND	221	15		ND		ND	ND	
	13	3	2.08	ND	ND	404	33		ND		ND	ND	
	14	3	1.94	ND	ND	547	47		ND		ND	ND	
	15	3	6.47	ND	ND	7284	1214		ND		ND	ND	
	16	3	0.68	ND	ND	272	11		ND		ND	ND	
	19	4	0.41	ND	ND	739	37		ND		ND	ND	
	20	4	5.89	ND	ND	2510	458		ND		ND	ND	
	21	4	34.27	2	28.99	12671	9861		0.10		1,700/40	225	**5.5**/8.5
	22	4	9.87	2	1.37	2154	771		0.10	0.1	220	0	**5.3**/5.5
	23	4	1.95	ND	ND	324	48		ND		ND	ND	
	24	4	0.96	ND	ND	543	42		ND		ND	ND	
	25	4	0.54	ND	ND	67	8		ND		ND	ND	
	26	4	0.71	ND	ND	101	18		ND		ND	ND	
	28	5	2.74	ND	ND	1270	138		ND		ND	ND	
	29	5	1.08	ND	ND	314	18		ND		ND	ND	
	30	5	1.19	ND	ND	376	20		ND		ND	ND	
	Instant. Min/Max pH												**5.3/8.5**
	Event/Daily Max									**0.3**		**710**	

Month	Day	Inflow Event Number	Inflow Volume (MGD)	Discharge Event Number	Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EW + WP (lbs)	% removal	Effl. Daily Settl Solids (ml/l/hr)	Effl. Settl Solids Event Average (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. Residual Chlorine Daily Average (ug/l)	Daily Min/Max pH
	Monthly Total/Avg/GeoMean	**5**	**206.69**	**2**	**116.50**	**85,372**	**50,165**	**41.2%**			**81.9**		
December	2	1	1.05	ND	ND	253	23		ND		ND	ND	ND
	3	1	0.85	ND	ND	420	31		ND		ND	ND	ND
	18	2	0.66	ND	ND	199	12		ND		ND	ND	ND
	19	2	28.59	1	21.20	11712	11712		1.0	1.0	700/1400	47	5.9/7.0
	20	2	1.28	ND	ND	351	28		ND		ND	ND	ND
	21	2	0.61	ND	ND	116	3		ND		ND	ND	ND
	29	3	22.06	2	15.02	23612	20691		4.9	4.9	500/300	4	6.0/7.9
	30	3	1.32	ND	ND	254	24		ND		ND	ND	ND
	31	3	0.60	ND	ND	1032	50		ND		ND	ND	ND
	Instant. Min/Max pH												**5.9/7.9**
	Event/Daily Max									**3.0**		**47**	
	Monthly Total/Avg/GeoMean	**3**	**57.02**	**2**	**36.22**	**37,949**	**32,574**	**14.2%**			**619**		
Total		**35**	**1332.7**	**17**	**917.4**	**823,897**	**647,473**						
Inst. pH Min/Max													**5.3/9.7**
Max (GEM, SS, TRC)										**30.00**	**1054**	**3412**	
Annual Average							by mass:	**21.4%**		**4.04**	**492.0**	**296**	

Notes:
ND= No Discharge.
ED= End of discharge; fecal coliform samples were collected for 0-3 and 3-8 hour grabs then discharge ended before next grab sample was required.
* NM= Not measured due to the FE sample pump failed to collect sample.
%NR= Not Reported due to lab error
Red= NPDES permit exceedance

	Inflow Volume (MGD)	Discharge Volume (MGD)	Total TSS Infl. (lbs)	Total TSS Effl. (lbs)	Annual Average TSS Removal (%)	Maximum of Event Averages SS (ml/l/lhr)	Annual Average SS Concentration (ml/l/hr)	Maximum of Monthly Geomean Effl. Fecal Coliforms (#/100 ml)	Annual Average of Monthly Geomean Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of Effl. TRC (µg/l)	Instant. Min/Max pH
Includes all events	1332.7	917.4	823,897	647,473	21.4%	30.00	4.04	1054	492	3412	5.3/9.7

Appendix F
Henderson/MLK Jr. Way Wet Weather Treatment Station Annual Report

January–December 2017

Executive Summary

This 2017 annual report summarizes the performance of King County's Henderson/Martin Luther King Junior Way Wet Weather Treatment Station (Henderson/MLK Jr. Way WWTS). The Henderson/MLK Jr. Way WWTS came online in 2005 and operates under the National Pollutant Discharge Elimination System (NPDES) permit for the West Point Treatment Plant (West Point) (WA-0029181-1).

A total of 44.5 inches of rain fell in 2017, as measured at Henderson Street Pump Station. SeaTac Airport recorded 47.86 inches for 2017, compared to the historical annual average measured at Sea-Tac of 39.8 inches (20-year average).

There were seven filling events and three discharge events during 2017. The three discharge events resulted in five discharge days for determining compliance (a "compliance" day is based on a 7:00 a.m. to 7:00 a.m. clock). The Henderson/MLK Jr. Way WWTS received a total inflow of 34.7 million gallons (MG) and discharged 18.6 MG of treated water through the Norfolk Street Overflow to the Duwamish Waterway.

Performance in 2017

Table F-1 summarizes NPDES permit performance in 2017. The numbers in red indicate a permit exception.

Table F-1. Henderson/MLK Jr. Way WWTS Permit Performance in 2017

Parameter	Performance	Permit Conditions
Annual average effluent settleable solids (ml/L/hr)	<0.1	**0.3**
Annual average total suspended solids removal - based all discharge events (%)	46%	**50**
Instantaneous minimum effluent pH: number of discharge days with pH < 6.0	1 out of 5 discharge days	**≥ 6.0**
Instantaneous maximum effluent pH: number of discharge days with pH > 9.0	0 out of 5 discharge days	**≤ 9.0**
Total residual chlorine (TRC), daily average (µg/L): number of discharge days with TRC > 39 µg/L	2 out of 5 discharge days	**39**
Monthly fecal coliform geomean (cfu/100 ml): number of months with monthly geomean > 400	0 out of 2 discharge months	**400**

Note: Numbers in red indicate a permit exceedance.

Annual Suspended Solids Removal and Settleable Solids

The annual average total suspended solids (TSS) removal was 46 percent; the minimum permit limit is 50 percent. The challenges to meet the solids removal requirements were made more difficult in 2017 because of the flow shedding during the West Point recovery period (February 9, 2017, through April 21, 2017) from the February West Point flood. Flow shedding was achieved by throttling down, or shutting down, conveyance pump stations that would normally allow flows to West Point. All annual average effluent settleable solids were below 0.3 milliliters/liter/hour (ml/L/hr).

Monthly Fecal Coliform Bacteria

All monthly fecal coliform results were below the 400 colony forming units (cfu)/100 ml.

Instantaneous Minimum/Maximum pH

There was one exception to the minimum pH limit. An estimated 0.18 MG of treated effluent with a pH below pH 6.0 was discharged for 30 minutes on January 18, 2017. The lowest effluent pH recorded during the 30-minute period was pH 4.1. The low effluent pH was caused by an oversupply of sodium bisulfite.

Daily Total Residual Chlorine

There were two exceptions to the maximum daily total residual chlorine (TRC) limit. Both occurred during the February 9 event. Though the event occurred on one calendar day, compliance days are based on a 7:00 a.m. to 7:00 a.m. clock. Because this discharge event started at 6:30 a.m. and lasted 15 hours, this event had two compliance days. Effluent TRC averaged 799 parts per billion (ppb) and 152 ppb for the two days. Hypochlorite application was quite high during the initial stages of the tunnel inflow, resulting in high effluent TRC levels for the first 1.7 hours of discharge. Effluent TRC was below 39 ppb for the remaining 13.3 hours of discharge.

Operation and Maintenance

The equipment and facilities of the Henderson/MLK Jr. Way WWTS were fully functioning and available during 2017. Preventive maintenance was performed routinely. Routine operation and maintenance (O&M) activities not directly associated with an event included weekly operator inspections, checklists, equipment and sampler testing, alarm checks, weekly analyzer preventive maintenance and calibrations, quarterly lubrication and preventive maintenance of mechanical equipment, annual training and preparation for winter wet weather operation, post-event cleaning of the combined sewer overflow facilities, and post-event debriefs and corrective work orders,

as appropriate. All samples and analyses listed in West Point's monitoring schedule were collected and measured during each event. Priority pollutant samples were collected and measured for each discharge event. More details are available in the monthly discharge monitoring reports.

Henderson/MLK Jr. Way WWTS Improvements Project

In 2015, a consultant study recommended improvements to address challenges with consistently meeting NPDES permit requirements for disinfection and dechlorination. In 2016, a capital project was funded to complete improvements based on the consultant's recommendations. Project tasks were separated into two phases. Phase-1 improvements, which were completed in late 2017, are intended to enhance the flow-pacing accuracy of the existing hypochlorite and SBS pumps. Phase 1 improvements included:

- Re-level the existing inlet and outlet rectangular weirs to provide a more accurate inlet and outlet flow calculation over these very long weirs, which, in turn, will provide better control of chemical dosing.
- Install new fine-range bubbler sensors directly upstream of the tunnel's inlet and outlet weirs to provide greater accuracy at the small incremental level changes that occur over these very long weirs. A more accurate flow reading will provide better control of chemical dosing. The existing level sensors will be retained for redundancy and full-depth readings.
- Install flow meters on the hypochlorite and SBS chemical dosing lines to verify that the actual applied chemical dose is equal to the dose set point (e.g., lbs/MG) in the control system. The chemical flow meters will also be used in the control systems for feed control after the new chemical feed pumps and pre-dechlorination analyzer are installed.
- Improve venting of the chemical supply lines by removing and relocating pressure-relief valves at various locations on the hypochlorite supply lines.

Phase 2 improvements are based on "right-sizing" the chemical dosing pumps to better match actual flows and doses and installing tools to improve control of the dechlorination process. Right-sizing the chemical pumps was very important given that actual flows have been far lower than the 146 million gallons per day (MGD) peak design flow. The largest inflow recorded at the facility thus far is only 55 MGD; current modeling suggests that peak flows will only reach about 75 MGD in the foreseeable future. Right-sizing the chemical pumps was also important because actual doses have been much lower than the dose assumed during initial design. Hypochlorite doses required to meet the 400 cfu/100 ml have usually been near 3 to 4 milligrams per liter (mg/L) as chlorine (Cl_2), while the initial design assumed 10 mg/L. Thus, the current hypochlorite pump capacity is nearly five times the demand required during most events. The new chemical pumps, while providing the lower doses with more accuracy,

will still provide a sufficient dose if a 146-MGD peak flow occurs. Thus, the new equipment will maintain Henderson/MLK Jr. Way WWTS's rated capacity of 146 MGD.

Phase 2 improvements are currently at 90 percent design. Construction will begin in 2018 and is scheduled to be completed in 2019. Phase 2 improvements include the following tasks:

- Replace the three existing hypochlorite chemical feed pumps. The existing hypochlorite pumps are as much as five times larger than necessary, based on historic operating conditions. The prior plan had been to modify the existing pumps; however, during design it was decided that new pumps will better match the range of actual and expected doses.
- Replace the two existing SBS chemical feed pumps. The two existing SBS chemical feed pumps are as much as two times larger than necessary, based on historic operating conditions. The prior plan had been to modify the existing pumps; however, during design, it was decided that new pumps will better match the range of actual and expected doses.
- Install a chlorine residual analyzer before the tunnel outlet weir (referred to as *pre-dechlorination analyzer*). This chlorine residual signal will be used for feed-forward control of the SBS dose along with outlet flow; the SBS pumps are currently only controlled by outlet flow rate.
- Install a strainer on the SBS pump suction lines to remove impurities, debris, and chemical residues to avoid interference with the metering pumps.
- Modify the exhaust ventilation intake duct in the SBS Chemical Room to improve building ventilation.

As with all wet weather treatment stations, and especially the Henderson/MLK Jr. Way WWTS, opportunities to optimize operations are limited because of the infrequent number of events. Challenges may be identified during one wet season, and design and implementation of major improvements may not be completed until the next wet season, with opportunities to test and monitor the improvements subsequently dependent on following storm events. Given the complexity and "normal" challenges of an intermittently operated WWTS facility, King County Wastewater Treatment Division staff will continue to monitor, evaluate, and make necessary adjustments in the station's operation and maintenance. Similarly, equipment improvements will follow a design-construct-operate-monitor-adjust cycle. Additional improvements will be made as necessary.

Table F-2. Henderson/MLK Jr. Way WWTS Annual Plant Performance 2017

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Effl. TSS @ MLK + WP (lbs)	TSS Removal (%)	Effl. Daily SS (ml/l/hr)	Effl. SS Event Max (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (µg/l)	Daily Min/Max pH
January	17	1	3.68	ND	0.00	3898	234		ND	ND	ND	ND	ND
	18	1	4.08	1	4.08	4219	1213		0.1	0.1	1	13.8	4.1/7.2
	Instant. Min/Max pH												**4.1/7.2**
	Event/Daily Max									**0.1**		**13.8**	
	Monthly Total/Avg/GeoMean	**1**	**7.76**	**1**	**4.08**	**8117**	**1447**	**82.2%**			**1**		
February	8	2	4.13	2	0.45	2067	2067		<0.1	<0.1	1.7	799	6.3/6.4
	9	2	11.83	2	11.83	3749	3749		<0.1	<0.1	1.7	152	6.4/6.6
	17	3	5.37	3	1.69	1791	1345		<0.1	<0.1	13	0	6.5/6.6
	18	3	0.56	3	0.56	168	130		<0.1	<0.1	13	29	6.4/7.9
	Instant. Min/Max pH												**6.3/7.9**
	Event/Daily Max									**<0.1**		**799**	
	Monthly Total/Avg/GeoMean	**2**	**21.89**	**2**	**14.51**	**5708**	**5224**	**8.5%**			**4.7**		
March	18	4	0.18	ND	0	86	67		ND	ND	ND	ND	ND
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**1**	**0.18**	**ND**	**ND**	**86**	**67**	**22.1%**			**ND**		
April	No Inflow/ No Discharge												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0**	**ND**	**ND**	**0**	**0**				**ND**		
May	No Inflow/ No Discharge												
	Instant. Min/Max pH												**ND**
	Event/Daily Max									**ND**		**ND**	
	Monthly Total/Avg/GeoMean	**0**	**0**	**ND**	**ND**	**0**	**0**				**ND**		
June	No Inflow/ No Discharge												
	Instant. Min/Max pH												**ND**

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Effl. TSS @ MLK + WP (lbs)	TSS Removal (%)	Effl. Daily SS (ml/l/hr)	Effl. SS Event Max (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (µg/l)	Daily Min/Max pH
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	0	0	ND	ND	0	0				ND		
July	No Inflow/ No Discharge												
	Instant. Min/Max pH												ND
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	0	0	ND	ND	0	0				ND		
August	No Inflow/ No Discharge												
	Instant. Min/Max pH												ND
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	0	0	ND	ND	0	0				ND		
September	No Inflow/ No Discharge												
	Instant. Min/Max pH												ND
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	0	0	ND	ND	0	0				ND		
October	18	5	1.23	ND	ND	718	136		ND	ND	ND	ND	ND
	Instant. Min/Max pH												ND
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	1	1.23	ND	ND	718	136	81.0%			ND		
November	No Inflow/ No Discharge												
	Instant. Min/Max pH												ND
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	0	0	ND	ND	0	0				ND		
December	19	6	1.86	ND	ND	1334	1334		ND	ND	ND	ND	ND
	29	7	1.76	ND	ND	895	45		ND	ND	ND	ND	ND
	Instant. Min/Max pH												ND
	Event/Daily Max									ND		ND	
	Monthly Total/Avg/GeoMean	2	3.62	ND	ND	2229	1379	38.1%			ND		

Month	Day/Parameter	Inflow Event Number	Inflow Volume (MG)	Discharge Event Number	Discharge Volume (MG)	Total Influent TSS (lbs)	Effl. TSS @ MLK + WP (lbs)	TSS Removal (%)	Effl. Daily SS (ml/l/hr)	Effl. SS Event Max (ml/l/hr)	Effl. Fecal Coliforms (#/100 ml)	Effl. TRC Daily Average (µg/l)	Daily Min/Max pH
Annual Total		7	34.7	3	18.6	18,924	10,320						
Inst. pH Min/Max													4.1/7.9
Max (GEM, SS, TRC)										0.1	4.7	799	
Annual Average								45.5%		<0.1	2.9		

Notes:
N/A= Not applicable
ND= No discharge
Red= NPDES permit exceedance

	Inflow Volume (MG)	Discharge Volume (MG)	Total TSS Infl (lbs)	Total TSS Effl. (lbs)	Annual Average TSS Removal (%)	Maximum of Event Averages SS (ml/l/lhr)	Annual Average SS Concentration (ml/l/hr)	Maximum of Monthly Geomean Effl. Fecal Coliform (#/100 ml)	Annual Average of Monthly Geomean Effl. Fecal Coliform (#/100 ml)	Maximum of Daily Averages of Effl. TRC (µg/l)	Instant. Min/Max pH
Includes all events	34.7	18.6	18,924	10,320	45.5	0.1	<0.1	4.7	2.9	799	4.1/7.9