# Combined Sewer Overflow Control Program

## 2008 CSO Control Plan Update

June 2008

King County
Department of
Natural Resources and Parks
**Wastewater Treatment Division**

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**Combined Sewer Overflow Program**
King Street Center, KSC-NR-0512
201 South Jackson Street
Seattle, WA 98104
http://dnr.metrokc.gov/wtd/cso/

***For comments or questions, contact:***
Karen Huber, CSO Control Program Manager
King County Wastewater Treatment Division
201 South Jackson Street
KSC-NR-0512
Seattle, WA  98104-3856
206-264-1246
karen.huber@kingcounty.gov

This information is available in
alternative formats on request at
206-684-1242 (voice) or 711 (TTY).

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Chapter 1

# Introduction

This document updates King County's Combined Sewer Overflow (CSO) Control Plan. The Washington State Department of Ecology's CSO regulation (WAC 173-245) requires that the county submit CSO control plan updates about every five years to coincide with each National Pollutant Discharge Elimination System (NPDES) permit renewal for the West Point Treatment Plant. Updates are intended to document progress on implementing the county's CSO control program, identify its program for the next 5 years, and provide a vehicle for making changes in the overall long-term program. The last update was submitted to Ecology in 2000.[1]

This chapter describes the nature of CSOs, the reasons for controlling CSOs, and the county's CSO control strategies and accomplishments. It concludes with a description of the content of other chapters of the plan update.

## 1.1 What Are CSOs?

CSOs are discharges of wastewater and stormwater into water bodies during heavy rainstorms when sewers are full. Combined sewers, which carry both wastewater and clean stormwater, exist in many parts of older cities across the nation, including Seattle. To protect treatment plants and avoid sewer backups into homes, businesses, and streets, combined sewers in Seattle sometimes overflow into Puget Sound, the Duwamish Waterway, Elliott Bay, Lake Union, the Lake Washington Ship Canal, and Lake Washington. King County manages 38 CSO outfalls, and the City of Seattle manages about 90 CSO outfalls.

## 1.2 Why Reduce CSOs?

Although the wastewater in CSOs is greatly diluted by stormwater, CSOs may be harmful to public health and aquatic life because they can carry chemicals and disease-causing pathogens. Regulations, agreements, policies, and public expectations require, either directly or indirectly, the reduction of CSOs to protect public health, water quality, sediment quality, and aquatic species in our water bodies.

### 1.2.1 Technology and Water/Sediment Quality Regulations

In 1972, the federal Clean Water Act was adopted. The primary objective of the Clean Water Act (CWA) is to restore and maintain the integrity of the nation's waters. This objective translates into two national goals: to eliminate the discharge of pollutants into the nation's waters and to achieve and maintain fishable and swimmable waters. One way that the first goal is being

[1] The 2000 CSO control plan update can be found at http://dnr.metrokc.gov/wtd/cso/library.htm#plans

achieved is through the NPDES permit program. The second goal is being addressed by developing pollution control programs to meet specific water quality standards for water bodies.

The CWA requires all wastewater treatment facilities and industries that discharge effluent into surface waters to have an NPDES permit. In Washington State, NPDES permits are issued by the Washington State Department of Ecology (Ecology) and define appropriate technology controls and limits on the quality and quantity of effluent discharged from point sources such as treatment plants, CSOs, and industrial facilities. King County holds NPDES permits for its West Point, South, and Vashon Treatment Plants. Permits will be obtained for two new treatment plants before they come online—in 2008 for the Carnation plant and in 2010 for the Brightwater plant. The West Point NPDES permit includes the Alki and Carkeek CSO treatment plants, the CSO outfalls, and the newly constructed Mercer/Elliott West and Henderson/Norfolk CSO storage and treatment facilities. (See Chapter 2 for a description of King County's wastewater system.)

Both the CWA and Washington State regulations define minimum technologies to be used for different wastewater streams. The federal rules define "best conventional pollutant control technology" (BCT), "best available technology economically achievable" (BAT), and so forth, while Washington State defines technologies under "all known available and reasonable technologies" (AKART). For example, secondary treatment is defined as BCT and AKART for publicly owned treatment works. Effluent limits defined in NPDES permits reflect implementation of these technologies.

Effluent limits must also protect human health and the environment. To evaluate acceptable water quality and to set protective permit limits, Ecology has put into regulation use-based Water Quality Standards (WAC 173-201A)—aimed at keeping waters clean and safe for people, fish, and wildlife. The biological, chemical, and physical criteria used to assess a water body's health include fecal coliform bacteria, dissolved oxygen, temperature, pH, ammonia, turbidity, and a variety of other chemical compounds. These standards apply to the area in a water body that extends beyond a defined "mixing zone," where a discharge mixes with the ambient water.

**Regulations that Affect CSO Control Planning**

**Clean Water Act (CWA)—**Adopted in 1972 to eliminate the discharge of pollutants into the nation's waters and to achieve and maintain fishable and swimmable waters.

**National Pollutant Discharge Elimination System (NPDES)—**The Washington State Department of Ecology (Ecology) implements the CWA by issuing NPDES permits to wastewater agencies and industries that discharge effluent (including CSOs) to water bodies.

**Water Quality Standards—**To implement CWA, Ecology has developed biological, chemical, and physical criteria to assess a water body's health and to impose NPDES permit limits accordingly.

**State CSO Control Regulations—**Ecology requires agencies to develop plans for controlling CSOs at the earliest possible date so that an average of one untreated discharge per year occurs at each location.

**Wet Weather Water Quality Act of 2000 (based on the CSO Control Policy)—**The U.S. Environmental Protection Agency (EPA) requires agencies to implement Nine Minimum Controls and to develop long-term CSO control plans.

**Sediment Quality Standards—**Ecology developed chemical criteria to characterize healthy sediment quality and identified a threshold for sediment cleanup. King County has participated in sediment cleanup at some of its CSO locations.

**Endangered Species Act (ESA)—**Three fish species that use local water bodies where CSOs occur have been listed as threatened under ESA.

When a water body does not meet these Water Quality Standards, Section 303(d) of the CWA requires that the water body be added to a list of impaired waters called the "303(d) list." The 303(d) list is published every four years. Once listed, the water body must be studied and controls must be put into place that will correct conditions so that it meets standards. Controls often involve allocating the pollutant load to its sources, such as stormwater runoff and municipal or industrial discharges, that the water body can assimilate and still meet the standards. This process is called a Total Maximum Daily Load (TMDL). Most of the water bodies where King County CSOs occur are on the 303(d) list and will require TMDLs.

Chemical contamination of aquatic sediments can adversely impact benthic organisms and can enter the food chain as species feed on each other. Each species, in turn, can suffer adverse impacts. Humans can be affected via direct contact with the chemicals in the sediments through activities such as beach play or hauling fishing nets or via consumption of chemically laden fish and wildlife.

Ecology is granted legal authority under WAC 173-204, Sediment Management Standards, to direct the identification, screening, ranking, prioritization, and cleanup of contaminated sediment sites in the state. The standards include the Sediment Quality Standards (SQS), which are chemical-specific criteria that designate what is considered healthy sediment quality, and a threshold called the Cleanup Screening Level (CSL) for sediment cleanup efforts ("remediations"). When these chemical criteria are exceeded, toxicity testing may be used to verify the adverse impact. Once a site is ranked and placed on the contaminated sites list, it may then be considered for cleanup. WAC 173-204 provides for the voluntary cleanup of contaminated sediments with oversight and guidance by Ecology. Alternatively, Ecology or EPA may initiate enforcement actions (including cost recovery) under the Washington Model Toxics Control Act (MTCA) or the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund.

### 1.2.2 CSO Control Regulations

CSOs were recognized as a unique category of discharge that was not adequately covered by the existing federal or state regulations.

In 1984, Ecology introduced legislation requiring agencies with CSOs to develop plans for "the greatest reasonable reduction [of CSOs] at the earliest possible date." In January 1987, Ecology published a new regulation (WAC 173-245) that defined the greatest reasonable reduction in CSOs as "control of each CSO such that an average of one untreated discharge may occur per year." The new regulation also defined standards for treated CSOs, which were essentially technology standards. Water Quality Standards allow a once-per-year exemption from the mixing zone standards for "one untreated discharge" from CSO treatment facilities. Water quality–based effluent limits also apply to treated CSO discharges where determined needed.

The U.S. Environmental Protection Agency's (EPA's) 1994 CSO Control Policy was codified as the Wet Weather Water Quality Act of 2000 (H.R. 4577, 33 U.D.C. 1342(q)). This act requires implementation of Nine Minimum Controls for CSOs and the development of long-term CSO control plans. The purpose of the Nine Minimum Controls is to implement early actions that can improve water quality before the protracted and more expensive capital projects in the control plan are built. EPA has determined that the Nine Minimum Controls are equal to BAT. Agencies must show that water quality standards are met after implementation of their CSO control plan. The requirements of this act are incorporated in the NPDES permit for the West Point plant.

### 1.2.3 Endangered Species Act

The Endangered Species Act (ESA) was promulgated to provide extra protections and support to species and populations so greatly impacted that other regulatory control programs, such as the CWA, were not sufficient to rescue or restore them. The act was part of a suite of environmental regulations in the 1970s. It provides for the protection of species that are becoming extinct and the habitat that they need. All federal agencies, including EPA, have to consider endangered species when undertaking any actions.

In 1999, chinook salmon and bull trout were listed species under ESA. In 2000, NOAA Fisheries adopted a draft protective rule under Section 4(d) of ESA prohibiting the "take" of the listed species.[2,3] Following the adoption of the rule, King County's Wastewater Treatment Division (WTD) began a review of its activities to determine how it should modify its practices, including construction practices and uses of property near water bodies, to stay within the parameters set out in the 4(d) rule.

NOAA stated in the 4(d) rule that it would work with permitting authorities (Ecology) to ensure that permitted treatment plant discharges do not violate ESA. NOAA Fisheries, the U.S. Fish and Wildlife Service (USFWS), and EPA have signed a Memorandum of Agreement to work together on integrating CWA standards and ESA requirements. Both NOAA Fisheries and USFWS have the opportunity to review NPDES permits.

Killer whales were listed in February 2006 and steelhead were listed in May 2007 under ESA.

### 1.2.4 Public Perception and Preferences

Since the 1950s when a regional wastewater management system was formed, public opinion has been sought on priorities and plans. In recent times, King County's 1999 *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* included valuable input from regional stakeholders. The message heard during this process and during formation of the Regional Wastewater Services Plan (see "Policies" below)—that water quality is a priority to the citizens of King County, that the county has a mandate to protect and enhance water quality, and that the citizens believe CSOs should be controlled—has been continually reaffirmed through all WTD public involvement activities since the plan was adopted in 1999. In a recent survey, 75 percent of respondents said that CSOs should be prevented even if the effort increases sewer rates.

[2] NOAA = National Oceanic and Atmospheric Administration.
[3] "Take" under ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct [ESA §3(19)].

### 1.2.5 Policies

In 1999, King County adopted the Regional Wastewater Services Plan (RWSP), a 30-year wastewater comprehensive plan. RWSP CSO policies are intended to guide King County in controlling CSO discharges so that all CSO locations meet state and federal regulations (Appendix A). In setting schedules for implementing CSO control projects, the RWSP gives highest priority to locations with the greatest potential to impact human health, bathing beaches, and ESA-listed species. The policies call for regular assessment of CSO projects, priorities, and opportunities using the most current studies. Another CSO control policy addresses the cleanup of contaminated sediments near county CSOs. The policy directs the county to implement its long-range sediment management strategy and, where applicable, to participate with partners in sharing responsibilities and costs of cleaning up sites such as the Superfund sites in the Lower Duwamish Waterway.

## 1.3 How Is King County Controlling CSOs?

In 1958, the Municipality of Metropolitan Seattle (Metro) was formed to clean up the waters of Lake Washington and the Seattle waterfront. In the 1960s, Metro assumed ownership of the City of Seattle's wastewater treatment plants and portions of its sewer system and then built large pipes, called interceptors, to carry regional wastewater from local systems to the treatment plants. In 1994, King County assumed Metro's responsibilities for regional wastewater management. Regional improvements in collecting, conveying, and treating wastewater that were made after the formation of Metro continue to be effective despite decades of population growth and development.

In response to the Clean Water Act of 1972, Metro adopted the *Combined Sewer Overflow Control Program* in 1979. Since adoption of this first program, Metro and then King County have modified plans to respond to evolving CSO regulations, including Ecology's control standard of no more than an average of one untreated discharge per year at each CSO location.

The most recent CSO control plan was adopted in 1999 as part of the RWSP and was updated in 2000 as a part of the West Point plant's NPDES permit renewal. No changes to the RWSP CSO control plan were recommended in the 2000 update. The NPDES permit is due for renewal in 2008. In anticipation of this renewal and to comply with RWSP policy, WTD performed a review to evaluate the continuing benefits of the CSO control

**A History of CSO Plans**

1979—Metro adopted its first *Combined Sewer Overflow Control Program.*

1985 and 1986—The *Plan for Combined Sewer Overflow Control* and the *Supplemental Plan for Combined Sewer Overflow Control* were prepared as part of a system-wide planning effort

1988—The *1988 Combined Sewer Overflow Control Plan* was prepared in response to Ecology's 1987 definition of control as one untreated discharge per year.

1995—As part of the 1995 West Point NPDES permit renewal, King County prepared an update and amendment to the 1988 plan.

1999—A CSO control plan was adopted as part of the RWSP. The plan lists 21 control projects to bring all CSOs into control by 2030.

2000—The RWSP CSO control plan was updated as part of the West Point NPDES permit renewal. No changes to the RWSP CSO control plan were recommended.

2006—The first CSO control program review was completed.

program identified in the RWSP.[4] Information from the program review informs this 2008 CSO control plan update. Subsequent plan updates will be preceded by a program review.

Strategies for reducing or mitigating the effects of CSOs include pollution prevention through source control, stormwater management, and operational controls to transfer as much CSO flow as possible to regional treatment plants; upgrades of existing facilities; and construction of CSO control facilities. WTD aims for optimal treatment.

Construction of CSO control facilities in the region began in the late 1970s. So far, about $360 million (2008 dollars) has been spent to control CSOs and another $400 million is planned to implement the CSO control projects in the RWSP. Many early projects involved sewer separation, flow diversion, and storage tunnels. Most current and future projects involve construction of conveyance improvements, storage tanks, and treatment facilities.

Control facilities that were under construction prior to RWSP adoption—the Mercer/Elliott West and the Henderson/Norfolk CSO control systems—were brought online in 2005.[5] Now, based on the last seven years of monitoring, 13 of King County's 38 CSOs are controlled to Ecology's standard. The control status at 5 more CSO sites where projects have been completed will be assessed after the facilities have operated a sufficient number of years.[6] The remaining 20 uncontrolled CSOs will meet state standards as capital improvement projects are completed between 2013 and 2030. The first four RWSP projects near Puget Sound beaches are in design.

Since 1988, when systematic monitoring and measuring of CSO flows began, these control efforts have reduced CSO volumes from an estimated 2.4 billion gallons per year to approximately 900 million gallons per year (Figure 1-1).

## 1.4 What Is in this CSO Control Plan Update?

The remainder of this CSO control plan update is organized in three chapters:

- **Chapter 2, Effectiveness of Current CSO Control Plan,** describes King County's wastewater system, including CSO control facilities and practices and the control status of county CSOs. It also shows how King County is meeting EPA's Nine Minimum Controls and describes the methods and results of efforts to monitor and model CSO volume and frequency and the water bodies that receive CSOs.
- **Chapter 3, CSO Control Projects,** describes completed, in process, and planned CSO control projects, including projects that will be implemented during the next NPDES permit cycle, and then describes available CSO control strategies and how they apply to county projects.
- **Chapter 4, Public Involvement Activities Related to the CSO Control Program,** presents King County's public involvement policies and planning strategies, public notification program, and public involvement activities.

[4] The 2006 CSO control program review is available at http://dnr.metrokc.gov/wtd/cso/library.htm#plans
[5] The projects to build the systems were called the Denny Way/Lake Union and Henderson/MLK/Norfolk CSO control projects.
[6] The five sites are Denny, Dexter, Henderson, Martin Luther King, Jr., and Norfolk.

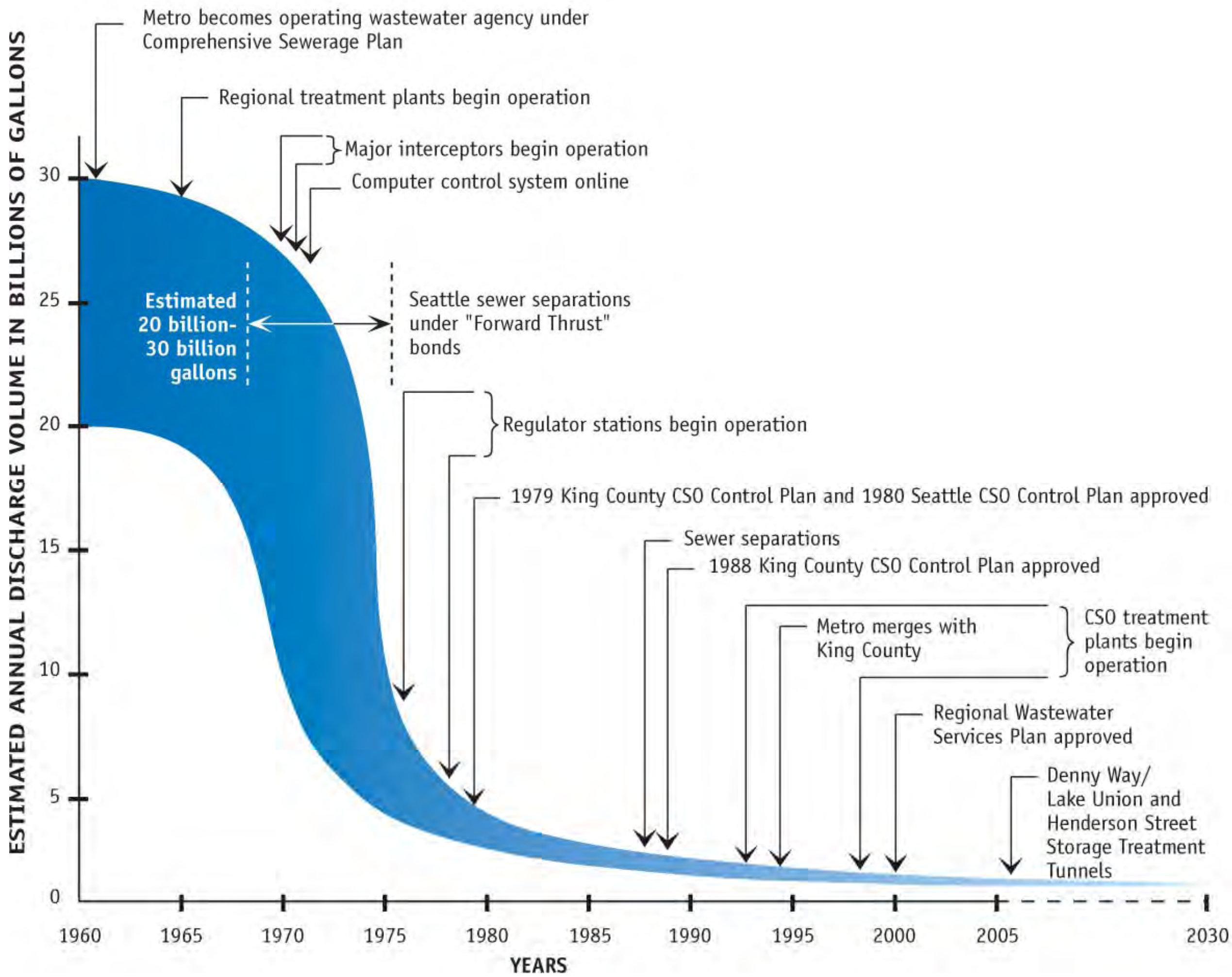



**Figure 1-1. Reduction in CSO Volumes Over Time**

Chapter 2

# Effectiveness of Current CSO Control Plan

This chapter describes King County's wastewater system, its management practices for CSO control, and its efforts to characterize control needs through tracking volume, frequency, and environmental impacts of CSOs.

## 2.1 Combined Sewers in King County's Service Area

In 1958, the Municipality of Metropolitan Seattle (Metro) was formed to clean up the waters of Lake Washington and the Seattle waterfront. At the time, most wastewater in King County was transported from homes and businesses by sewers that discharged the untreated wastewater to the nearest water body. In the 1960s, Metro assumed ownership of the City of Seattle's wastewater treatment plants and portions of its sewer system and then built large pipes, called interceptors, to carry regional wastewater from local systems to the treatment plants.

In 1994, King County assumed Metro's responsibilities for regional wastewater management. Today, the system serves 34 cities and districts in and adjacent to King County. The county operates a "wholesale" business, providing wastewater conveyance and treatment services to "retailers" (local agencies), who in turn sell wastewater services to area residents and businesses.

### 2.1.1 King County's Wastewater System

King County's wastewater system is the largest in the state (Figure 2-1). The system includes two large regional treatment plants (the West Point plant in the City of Seattle and the South plant in the City of Renton), one small treatment plant and one community septic system (Beulah Park and Cove) on Vashon Island, four CSO treatment facilities (Alki, Carkeek, Mercer/Elliott West, and Henderson/Norfolk—all in the City of Seattle), over 350 miles of pipes, 19 regulator stations, 42 pump stations, and 38 CSO outfalls. The West Point, South, and Vashon plants provide secondary treatment; the CSO treatment facilities provide CSO treatment (equivalent to primary treatment). All plants discharge treated and disinfected effluent to Puget Sound.

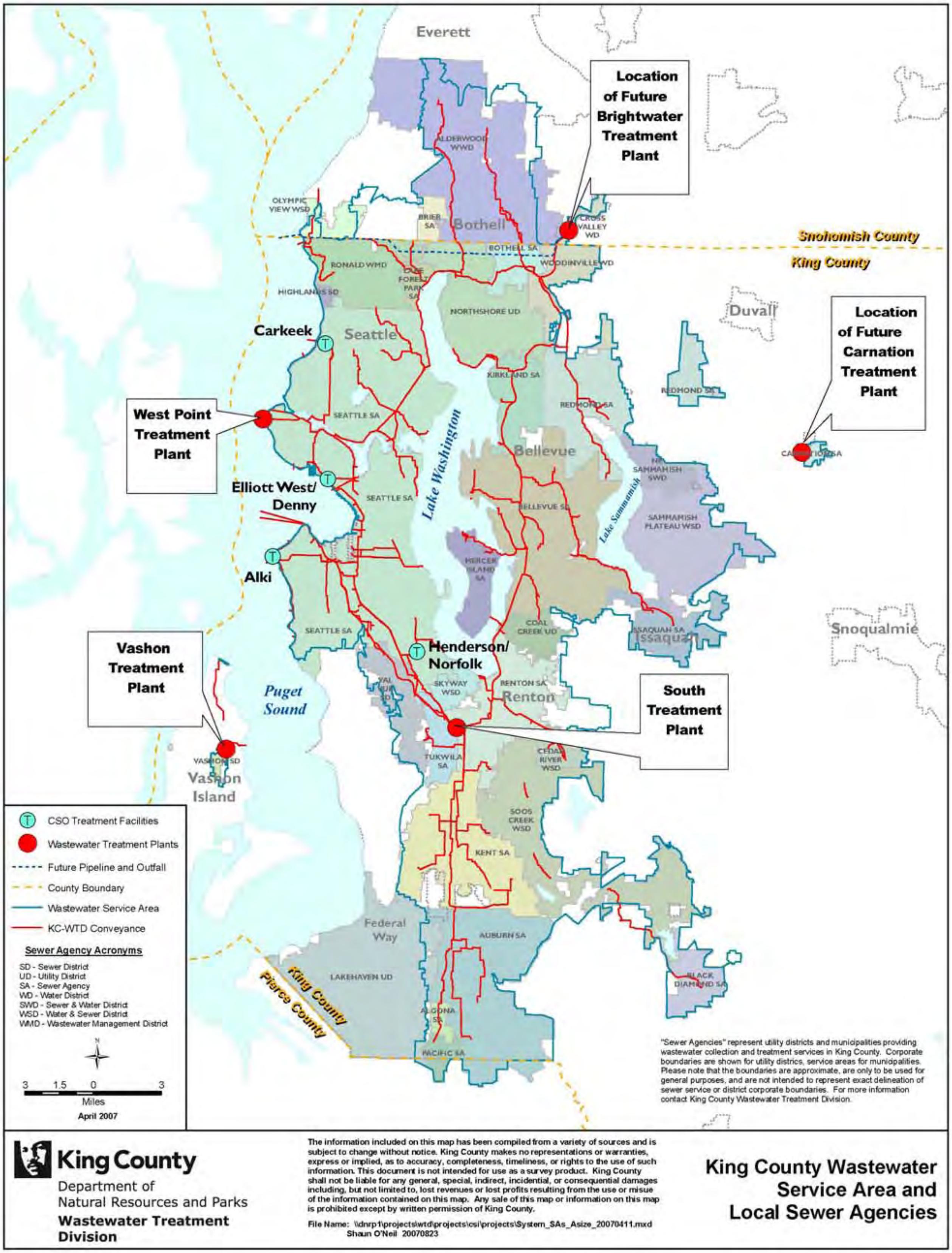


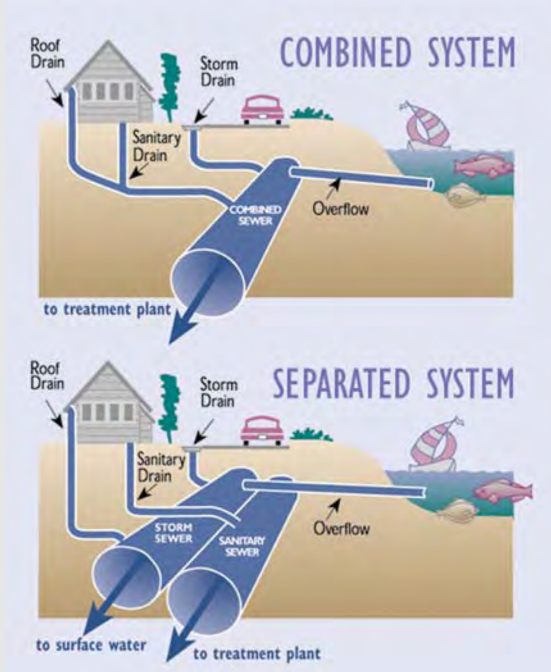

**Figure 2-1. King County Wastewater Service Area and System**

A new regional treatment plant, called Brightwater, is under construction in south Snohomish County. The plant and associated conveyance system are scheduled to start operating in 2010. A smaller treatment plant began serving the City of Carnation in spring 2008. Both new plants will use membrane bioreactors to produce reclaimed-quality water. Brightwater effluent will discharge to Puget Sound. Carnation effluent will discharge to the Snoqualmie River during startup, after which it will discharge to a nearby wetland as a permitted beneficial use of reclaimed water.

There are two types of sewer systems in the King County wastewater service area: separated and combined. In separated systems, different pipes carry stormwater and wastewater. In combined systems, the same pipes carry both stormwater and wastewater. Years ago when sewers were constructed in Seattle, combined sewers were common practice. Until the early 1940s, nearly all sewers constructed in the city were combined sewers. Approximately 41,000 acres of the 55,000 acres in Seattle are served by combined or partially separated sewers. Areas outside of Seattle are served by separated sewers.

Separated wastewater from more than 122,000 acres that lie mostly east and south of Lake Washington is sent to the South Treatment Plant. The area west of Lake Washington sends a mixture of separated wastewater from north of Lake Washington and combined wastewater and stormwater flows from Seattle to the West Point Treatment Plant (about 268,000 acres total). Once the new Brightwater plant is online, nearly all flow to West Point will be from the Seattle system.

**Combined and Separated Sewer Systems**




In ***separated systems,*** sanitary sewers carry untreated wastewater to a treatment plant and storm sewers carry stormwater from rooftops, driveways, sidewalks, streets, and other impervious surfaces to the nearest water body.

In ***combined systems,*** wastewater and stormwater are carried through the same pipes. During large storms, sewers may collect more stormwater than the pipes and treatment plants can handle. CSO outfalls act as relief points to protect treatment plants from huge influxes of water, which could compromise treatment processes, and to prevent wastewater from backing up into streets and basements.

During heavy rainstorms when sewers are full, untreated wastewater and stormwater in combined sewers discharge directly from CSO outfall pipes into marine waters, lakes, and rivers. These untreated discharges occur in three ways:

- Pump stations overflow to protect the stations from flooding (Figure 2-2).
- Regulator stations control the volume of flow entering main interceptors from the local system; flows greater than the capacity of the interceptor overflow (Figure 2-3).

- Weirs located in pipes allow for passive overflows when flow reaches the level of the weir (Figure 2-2).

Figure 2-2 illustrates that the wastewater system is managed to send as much flow as possible to secondary treatment plants, to send additional flow to CSO treatment facilities, and to discharge untreated flow only as a last resort.

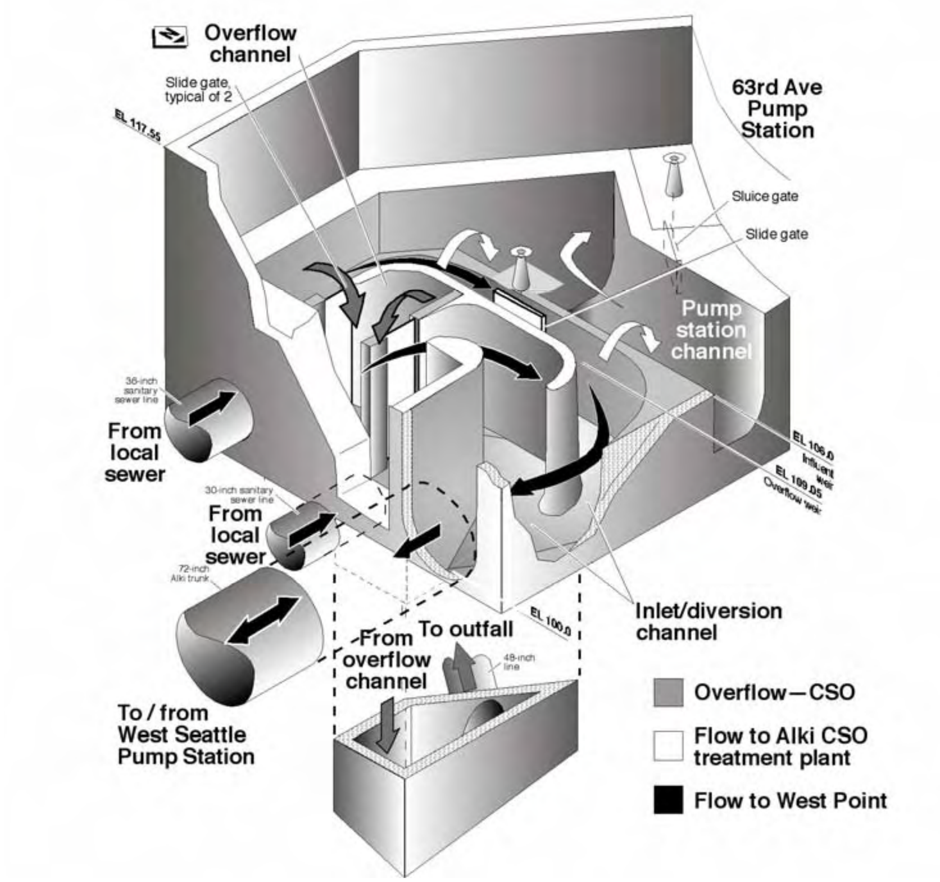



**Figure 2-2. Flow Strategy at a Pump Station**

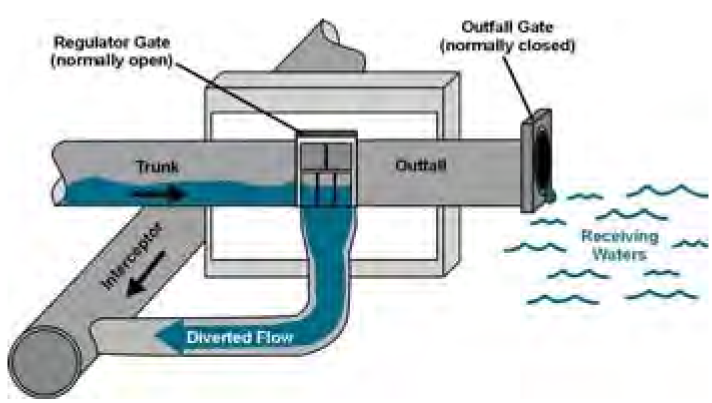



**Figure 2-3. Flow Strategy at a Regulator Station**

### 2.1.2 Relationship Between King County and City of Seattle Systems

The City of Seattle owns about 90 CSO outfalls; King County owns 38 CSO outfalls. (Figure 2-4 shows the locations of city and county CSO outfalls; Table 2-1 lists county CSOs and the water bodies where they discharge.) Because city drainage basins are smaller, overflows from the Seattle system are usually smaller in volume and shorter in duration than overflows from the county system. The two agencies communicate frequently and participate in each other's CSO planning efforts. The county pursues joint CSO control projects with the city if the projects are deemed to be cost-effective for ratepayers and/or if they have the potential to minimize construction disruption to nearby communities.

The city manages stormwater programs in the combined sewer area. It implements rules governing management of stormwater on private and public property through its stormwater code (currently undergoing revision). Seattle's NPDES CSO permit issued in December 2005 requires implementation of stormwater pollution prevention programs in the combined areas.

The county has responsibility for elements of stormwater management in the few places in the city where it has implemented sewer separation projects. To prevent duplication and conflicts, the county and city coordinate their stormwater management programs and stormwater NPDES compliance efforts.

**Table 2-1. Discharge Locations for County CSOs**

| | |
|---|---|
| 11th Ave. NW weir | Ship Canal |
| 30th Ave. NE pump station bypass | Union Bay |
| 3rd Ave. W regulator station | Ship Canal |
| 53rd Ave. SW pump station bypass | Puget Sound |
| 63rd Ave. pump station bypass | Puget Sound |
| 8th Ave. regulator station/ W. Marginal Way pump station bypass | Duwamish Waterway |
| SW Alaska St. weir | Puget Sound |
| Ballard regulator station | Ship Canal |
| Barton Street pump station bypass | Puget Sound |
| Belvoir pump station bypass | Uniion Bay |
| Brandon St. regulator station | Duwamish Waterway |
| Canal St. weir | Ship Canal |
| Chelan Ave. regulator station | Duwamish Waterway |
| Kingdome/Connecticut regulator station | Elliott Bay |
| Denny Way regulator station | Elliott Bay |
| Dexter Ave. regulator station | Lake Union |
| Duwamish Siphon W | Duwamish Waterway |
| Duwamish pump station bypass/ Siphon E | Duwamish Waterway |
| Hanford #1 regulator station (Hanford at Rainier) | Lake Washington |
| Hanford #2 regulator station | Duwamish Waterway |
| Harbor Ave. regulator station | Elliott Bay |
| Henderson pump station bypass | Lake Washington |
| King Street regulator station | Elliott Bay |
| Lander II St. regulator station | Duwamish Waterway |
| S Magnolia weir | Puget Sound |
| East Marginal pump station bypass | Duwamish Waterway |
| Matthews Park pump station bypass | Lake Washington |
| S Michigan St. regulator station | Duwamish Waterway |
| W Michigan regulator station | Duwamish Waterway |
| Martin Luther King Jr. Way weir | Lake Washington |
| Montlake regulator station | Ship Canal |
| Murray pump station bypass | Puget Sound |
| Norfolk St. regulator station | Duwamish Waterway |
| North Beach pump station bypass | Puget Sound |
| North Beach pump station inlet | Puget Sound |
| E Pine St. pump station bypass | Lake Washington |
| Rainier Ave. pump station bypass | Lake Washington |
| Terminal 115 weir | Duwamish Waterway |
| University regulator station | Ship Canal |


Figure 2-4. CSO Locations in King County

## 2.2 CSO Control Through Wastewater System Management

The policy set forth in the Regional Wastewater Services Plan (RWSP) states:

> *King County shall construct, operate and maintain facilities to prevent raw sewage overflows and to contain overflows in the combined collection system. In the event of a raw sewage overflow, the county shall initiate a rapid and coordinated response including notification of public health agencies, the media, the public and the affected jurisdiction. Preserving public health and water quality shall be the highest priority, to be implemented by immediately initiating repairs or constructing temporary diversion systems that return flow back to the wastewater system.* (Wastewater Services Policy 8)

The Wastewater Treatment Division's (WTD's) forecasting and demand modeling capabilities, in-field flow monitoring, and ongoing facilities inspection provide essential information to identify and address capacity, operational, and maintenance needs. The following sections describe the division's efforts to ensure adequate capacity and to operate and maintain the system to prevent overflows.

### 2.2.1 Providing Adequate Capacity

Implementation of policies and projects in the RWSP ensures that adequate wastewater capacity will be available when needed. To assess the need for new capacity, WTD conducts population and flow studies when new or updated census data become available from the Puget Sound Regional Council.

It is assumed that new CSO capacity at West Point and in the combined sewer system will not be needed to accommodate population growth, but the potential to expand West Point for CSO needs is being retained. Although the City of Seattle is physically built out, redevelopment will increase population density over time. City regulations that require stormwater management offset the effects of wastewater flows contributed by greater population densification. For other parts of the service area, it is assumed that build-out will occur by 2050. New conveyance facilities in the separated sewer system are designed to handle peak flows expected to occur from a 20-year peak flow from projected populations in 2050.[1] CSO control facilities, such as storage or satellite treatment, are also built to manage peak flows.

Planning started years ago for the Brightwater system to ensure that additional treatment capacity will be available when needed, and current plans call for expansion of South plant in 2029. In addition, the county examines ways to increase efficiencies at existing facilities, such as re-rating the capacity at South plant, to delay the need for more wastewater infrastructure.

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[1] See http://dnr.metrokc.gov/wtd/csi/csi-docs/ProgramUpdate/index.htm fordetails on the Conveyance System Improvement program.

### 2.2.2 Operating and Maintaining the System

Operation and maintenance (O&M) programs for the combined and separated systems are similar to enable efficiencies in sharing expertise and resources and to allow for quick response to unusual circumstances and emergencies. The treatment plants and the conveyance system are operated from Main Control at the West Point and South plants using a supervisory, control and data acquisition system (SCADA).

The operating strategy is to send as much flow as possible to regional treatment plants while protecting the secondary biological treatment process and meeting NPDES permit requirements. The strategy is implemented in the following order: (1) direct transfer to a regional plant, (2) inline storage, followed by transfer to a regional plant, (3) offline storage in facilities such as tunnels or tanks, followed by transfer to a regional plant, and (4) satellite CSO treatment and discharge. CSO control facilities are built to operate as backup to the transfer of flows to regional treatment plants. They operate only when flows cannot be managed immediately at regional plants and may be used only a few times a year to achieve the regulatory control standard.

The O&M programs work well not only in routine but also in extreme conditions, as evidenced by the response to a number of unusual events in 2006 that taxed the wastewater system. Early in the year, the Barton Force Main failed and was replaced. In November and December, extreme wind and rain storms—and associated power outages—occurred. During the November storm, the West Point and South Treatment Plants handled record flows without overflows or disruption of the treatment processes. Both plants reached or exceeded maximum capacity on several days. Many of the pump stations ran at capacity for extended periods without any significant equipment failures.

During the December storm, King County struggled to keep up with the deluge of wastewater. Portions of the West Point plant were flooded and the plant lost treatment capability for several hours, 20 pump stations lost power and operated on emergency generators, the North Mercer Interceptor ruptured, and 344.5 millions gallons of combined sewage discharged through CSO outfalls.

Despite these conditions, neither West Point nor South plant experienced exceptions to NPDES secondary treatment permit limits in 2006.

#### 2.2.2.1 Secondary and CSO Treatment

In addition to providing secondary treatment for base wastewater flows, the West Point Treatment Plant provides CSO treatment for flows between 300 mgd and the peak hydraulic capacity of 440 mgd. After receiving CSO treatment, these 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 in total suspended solids (TSS) percent removal requirements. The small amount of combined flows that reaches South plant from southeast Seattle receives full secondary treatment. Treatment processes are monitored and optimized based on information from automatic sensors and a battery of analytical tests. Process control laboratories at each plant conduct the testing and analysis and recommend adjusting the processes if necessary.

The CSO treatment facilities at Elliott West, Henderson, Alki, and Carkeek are staffed during CSO events. These facilities require more operator control because of their intermittent operation and the variable conditions they must manage. Operators deploy to the facilities shortly after SCADA indicates the start of CSO treatment to ensure that proper influent, effluent, and process sampling is being done and that the chlorination and dechlorination systems are working correctly. When treatment ends, the operators ensure that the stored flows and removed solids are pumped back to the conveyance system for treatment at the secondary plant, and then they wash down and secure the facility so that it is ready for the next storm.

#### 2.2.2.2 Conveyance System Operation

Conveyance system operational strategies intended to prevent overflows include adjusting flow rate and direction, storing flows, and routing flows to other places inside and outside the system.

Under normal and expected conditions, the SCADA systems are automated based on programmed level setpoints and action sequences. Levels in pump station wet wells and at key points in the conveyance system trigger changes in pump speeds and adjustments of gate positions at pump, regulator, and outfall stations. These adjustments can change the rate and direction of flow through the pipes and optimize storage of flows in the conveyance system.

To a limited extent, the combined system has the capability to respond to localized storms. Storage tunnels with excess capacity in areas not impacted by storms can be used to hold back flows to relieve capacity in the storm-impacted areas. Flows that normally go to West Point can also be diverted to South plant:

- Up to approximately 24 mgd of flow from the southeast corner of Seattle, including stored flows and solids from the Henderson/Norfolk CSO control facilities, can be diverted to South plant via the Allentown Diversion. This diversion can be “turned off” if the Interurban Pump Station or South plant needs capacity relief, but this happens rarely and only with coordination between the east and west sections.
- During winter, flows from the northernmost parts of the west system are moved to the east system through changed operation of the York, Hollywood, and North Creek Pump Stations. This diversion opens up more capacity in the west system to manage combined flows. When the Brightwater Treatment Plant is online in 2010, most of these flows will become part of the new north service area.

The Brightwater System may increase the capability to move flows via interconnections between systems. The potential to do this will be looked at more closely as experience is gained in operating the new system.

Flows are also sent outside King County’s system through a long-term contract with the City of Edmonds. The contract allows the county to send flows from the northwest part of its service area to Edmonds for secondary treatment year round in exchange for accepting an equivalent amount of flow from the Mountlake Terrace area. A temporary agreement (through 2012) stipulates that during the wet season, King County will accept only excess peak flows from the Mountlake Terrace area.

The success of the county's efforts to operate the conveyance system to prevent overflows is evidenced by the low number of sanitary system overflows and sewer backups, the low percentage of untreated CSOs in terms of total system flow, the decline in CSO volume and frequency over time, and the lack of dry-weather overflow from the combined system.

#### 2.2.2.3 System Maintenance

Some of WTD's assets are over 100 years old. The division's asset management program strives to minimize the cost of owning and operating wastewater assets while maintaining a level of service that meets regulatory requirements and ratepayer expectations.

Maintenance is the first line in preventing dry-weather overflows and optimizing flow storage and transport to treatment. Inspections, condition assessments, and maintenance are performed—routinely and after storm events—of facilities and structures at the plants and in the conveyance system. Refurbishment projects are implemented and asset replacement plans are prepared to address needs identified in the inspections.

For example, inspections found that saltwater and sand are entering WTD pipes, aggravating the pipe linings, and diminishing their longevity. The intrusion is also causing premature corrosion at West Point, at pump stations, and in the Elliott Bay Interceptor. Additional flows are entering the plant at peak high tides and using valuable system capacity needed during critical overflow periods. In 2007, meters were installed at suspected intrusion points to better identify the areas of intrusion during high tide cycles in dry-weather months. Monitoring results prompted initiation of a new study in February 2008 to assess the extent of leaks and to develop a plan to address the problem. The plan should be completed by 2010.

Special reviews and studies identify other ways to increase system efficiency. For example, a review done several years ago indicated that installing permanent backup generators in pump stations that lack reliable dual power feeds could help to prevent overflows. The installation process is nearing completion.

WTD continues to seek out best asset management practices and to make improvements to its asset management program. A program update, scheduled to be completed in summer 2008, will include information on current asset management practices and planned program improvements. Examples of planned improvements include implementation of a maintenance best management practices program, expanded use of asset management tools such a standardized inventory systems and condition rating systems, and development of long-range asset replacement and renewal forecasts, including action plans, to avoid failure of critical assets.

## 2.3 Pollution Prevention and Source Control

Two programs work to prevent pollutants from reaching King County treatment plants—the Industrial Waste Program and the Local Hazardous Waste Management Program. Among other achievements, these programs have helped to reduce the levels of mercury in biosolids by 50 percent from levels in 2000. The county also participates in sediment remediation and source control efforts and builds, operates, and maintains facilities to prevent floatables from discharging to water bodies through CSOs.

In addition to describing these county pollution prevention efforts, this section summarizes City of Seattle programs to prevent stormwater pollution.

### 2.3.1 Industrial Waste Program

King County's Industrial Waste Program (IWP) regulates industrial wastewater discharged into the wastewater system to protect surface water and biosolids quality, the environment, public health, and the wastewater system and its workers. It applies the same program to the combined and the separated areas. The program works to ensure that industries treat wastewater for harmful substances such as metals, oils, acids, flammables, organic compounds, gases, and solids before discharging the wastewater to sewers. It also regulates the discharge of construction dewatering water and stormwater to sewers.

So far, it appears that CSO-specific industry permitting will not reduce the number or volume of CSOs, nor their pollutants. The county assesses influent quality to West Point for trends that would suggest concurrent changes in CSO discharges. In addition, it tracks biosolids quality data from West Point as an indicator of changed loading to the system that could influence CSO quality. Manhole monitoring may also be used to identify system character changes. The only trends seen are the slow decrease or stability in pollutant concentrations.

The section describes the types of discharge approvals and how they are enforced, followed by more detail on approvals for dewatering water, stormwater, and fats, oil, grease, and other solids.

#### 2.3.1.1 Approvals, Monitoring, and Enforcement

IWP may regulate any industry, from largest to smallest, if the industry discharges to the wastewater system. The program issues three main kinds of discharge approvals: permits, discharge authorizations, and letters of authorization. Letters of authorization are issued for limited-duration construction dewatering discharges. Discharge authorizations are issued to smaller industries. Permits are issued to industries that discharge more than 25,000 gallons per day and/or that are included in federally regulated categories. The Environmental Protection Agency (EPA) requires that at least 20 categories of industries get permits, regardless of their size or quantity of wastewater. Permits have more comprehensive operating and self-monitoring requirements than do discharge authorizations. In 2007, for example, 128 permits and 310 industrial waste discharge authorizations were in effect and 405 inspections were conducted.

IWP investigators inspect facilities before issuing discharge approvals and also inspect facilities with approvals to see that they are complying with regulations. Most companies are required to self-monitor their discharges. Industrial waste specialists take verification samples at facilities with permits to see whether wastewater discharges comply with regulations. If they find violations, the specialists conduct follow-up inspections and sampling. IWP staff also work with businesses to help them identify and employ pollution prevention practices.

The program issues a Notice of Violation when a company discharges more contaminants or volume than allowed, violates conditions of its discharge approval, or fails to submit required reports. For enforcement, IWP uses tools such as compliance schedules, fines, charges for monitoring and inspections, and cost recovery for damages. During 2007, IWP issued Notices of Violation to 29 companies for 58 violations.

#### 2.3.1.2 Dewatering Water and Stormwater Approvals

Construction dewatering water may be pumped to a sewer if the discharger obtains a discharge approval from IWP and permission from the local sewer agency. The type of approval depends on factors such as the volume of discharge. Discharges to the sewer system during the wet season months of November through April are limited to 25,000 gallons per day. Discharge upstream of CSO locations may be restricted during heavy rainstorms, depending on factors such as basin, discharge volume, and site. Dischargers can seek an authorization from Ecology or the local surface water permit jurisdiction for discharge to surface water of higher volumes than allowed during the wet season. If such a surface water discharge authorization is obtained, IWP will issue authorization to discharge to the sewer for emergency relief only. If authorization to discharge to surface water cannot be obtained because of site and/or regulatory restrictions, IWP will then process a request for discharge to the sewer.

Stormwater discharges are not permitted to the sanitary sewer in separated areas except when they are contaminated by industrial activities, and then under specified conditions. King County accepts this contaminated stormwater to provide the greatest environmental protection of surface waters. Combined sewer areas are designed to accept stormwater. However, King County may require best management practices or pretreatment of contaminated industrial stormwater discharges.

#### 2.3.1.3 Fats, Oil, Grease, and Other Solids

Discharge of fats, oil, and grease (FOG) from a petroleum or mineral origin (nonpolar FOG) is limited 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 IWP 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 IWP's review and approval.

Because solids capable of settling can restrict or block flow in sewer lines, 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.

### 2.3.2 Local Hazardous Waste Management Program

WTD funds 17 percent of King County's Local Hazardous Waste Management Program and administers the program. The goal of the program is to reduce the quantities of hazardous waste generated by households and small businesses and to divert these wastes from municipal waste streams and indiscriminate disposal in the environment. Program services include household hazardous waste education and collection; small business education, technical assistance, and compliance assistance; small quantity generator collection and waste handling; an industrial materials exchange; a hazardous waste library; and a pilot program for the collection of unused prescription medications.

In 2007, the program collected 2,998 tons of household hazardous waste from more than 69,950 customers at its collection facilities. Suburban city partners sponsored 47 events that resulted in the collection of an additional 184 tons of waste. Also, more than 221,050 gallons of used motor oil were collected at public and private collection sites throughout the county. Were it not for these collection services, much of this waste could have ended up in regional landfills, sewers, storm drains, and the environment.

### 2.3.3 Sediment Remediation and Source Control

In a related and supporting program to CSO control, WTD is remediating sediment contamination near county CSO outfalls. Sediments not only can be impacted by pollutant discharges but also can be a source of pollution through resuspension to the water column and through the food chain as benthic organisms and shellfish are consumed. Sediments are contaminated with a variety heavy metals (lead, copper, zinc), phthalates, polychlorinated biphenyls (PCBs), and hydrocarbons. Chapter 3 provides information on King County sediment remediation projects.

In 2002, King County, the City of Seattle, the Port of Seattle, and Boeing initiated the Lower Duwamish Waterway Source Control Project to increase the effectiveness of source control efforts in the Diagonal/Duwamish basin. The goal of the project is to prevent recontamination of the Lower Duwamish Waterway and Harbor Island/East Waterway Superfund sediment cleanup sites. King County activities have included participation in two interagency source control work groups and the sampling and analysis of industrial waste discharges and rainfall samples for contaminants, such as phthalates, found in the area. The large size of this industrial area makes source control particularly challenging. Four separate programs implemented by King County’s industrial and hazardous waste programs, Public Health–Seattle & King County, and Seattle Public Utilities are now being coordinated to make it easier for businesses to identify and control pollutant sources. Recontamination studies may lead to further controls of stormwater and CSOs.

### 2.3.4 Practices to Control Floatables

Floatables are not considered a significant problem in the Seattle area. Routine inspections find few floatables in King County CSO facilities. In general, floatables in CSOs are controlled by minimizing the amount of street and household trash put into the sewer and minimizing the release during a CSO event of trash that does find its way into sewers. The county engages in the following practices to control floatables:

- Constructing facilities with gates and weirs that retain and minimize the release of any solid and floatable materials. Gates are set to maximize flow containment and open from the top down (to hold back solids). Weirs help to hold back all but the smallest items in the flow that passes over the weirs.

- Coordinating with the City of Seattle and other agencies, under EPA's Nine Minimum Controls, 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.
- Encouraging wise water use to reduce unnecessary flows in the sewer that contribute to overflows.
- Maximizing flow to treatment plants by capturing the "first flush" so that most solids and floatables that do enter the sewer are conveyed to the plant for removal and disposal before pipelines reach overflow conditions.
- Building CSO control projects so that floatables and solids are retained in the sewer.
- Monitoring development of new floatables control technologies.

City of Seattle programs to control floatables in the combined sewer area are discussed in the section that follows.

### 2.3.5 City of Seattle Stormwater Pollution Prevention Programs

Under its drainage ordinance, the City of Seattle requires businesses and privately owned stormwater systems to implement operational and structural source controls to reduce stormwater pollution.

In addition, the City of Seattle's NPDES CSO permit requires implementation of stormwater pollution prevention programs in the combined areas. To that end, the city is implementing programs to promote storm drain stenciling, proper motor oil and pet waste disposal, natural lawn and garden care, green approach to cleaning, proper hazardous waste disposal and reduction, and other pollution prevention measures.

The city has begun an active pollution prevention program, under EPA's Nine Minimum Controls, to prevent street trash from entering the combined system. Literature reviews indicate that 85 percent of floatables can be prevented by activities such as those in Seattle's pollution prevention program. Activities include street maintenance, volunteer litter collection and debris removal from drain inlets, citizen education and involvement, illegal dumping report line and surface water pollution report line, and provision of litter and recycling receptacles. For more detail on these activites, see Appendix B.

## 2.4 Implementation of EPA's Nine Minimum Controls

EPA's Nine Minimum Controls were developed to provide early and relatively inexpensive actions to improve water quality in the interim while the more expensive capital CSO control projects are being completed. When they were published in 1995, the Nine Minimum Controls packaged and codified elements, including CSO-specific elements, contained in the O&M

programs of well-run wastewater management programs. Most of the controls were already standard practice in the King County system.

Table 2-2 summarizes King County actions that implement the Nine Minimum Controls. Further detail is in Appendix B. During development of the 1996 NPDES permit for West Point, Ecology requested additional information on county activities related to Controls 6, 7, and 8. The original documentation on compliance with the Nine Minimum Controls submitted for the 1996 permit, along with the requested additional documentation on Controls 6, 7 and 8, was included in the 2000 CSO control plan update that accompanied the NPDES permit renewal application. This documentation was ultimately accepted under the NPDES permit, which was reviewed by EPA (effective January 1, 2004, and modified June 20, 2005). King County updates this information in annual CSO control program reports to Ecology.

### Table 2-2. King County's Compliance with EPA's Nine Minimum Controls

| Nine Minimum Controls | King County Compliance Effort |
|---|---|
| **1. Proper operation and regular maintenance programs for the sewer system and CSOs** | Proper facility operation is managed by West Point staff using SCADA.[a] Asset management programs implemented by the West Point Treatment Plant, South Treatment Plant, and collection system maintenance division maintain CSO outfalls, regulator stations, and pump stations. Collection system 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. |
| **2. Maximize use of collection system for storage** | The Regional Wastewater Services Plan emphasizes storage projects for CSO control. SCADA manages regulator stations to maximize flows in interceptors and to store excess flows in large trunk sewers. |
| **3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized** | King County's Industrial Waste Program 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. WTD also administers and helps fund the Local Hazardous Waste Management Program. Current water quality assessment and sediment management plan data indicate that there is no need for a CSO-specific pretreatment program. |
| **4. Maximization of flow to secondary treatment plant for treatment** | SCADA is used to maximize flow to the West Point Treatment Plant via operation of regulator and pump stations. All analyses for CSO control project alternatives include storage and transfer to the secondary and CSO treatment plants. |
| **5. Elimination of CSOs during dry weather** | King County CSOs do not occur as a result of inadequate dry-weather flow capacity. 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. The only overflows seen in the combined system during dry weather result from problems such as power outages, mechanical failure, or human error. These overflows are rare and are immediately reported to Ecology. CSOs that occur during precipitation can also be exacerbated by power outages, mechanical failures, or human error.<br>Operation and maintenance programs, as described for the first control, focus on preventing such problems. The conveyance system is monitored through SCADA and direct observation; corrective action is taken immediately if a problem occurs. Equipment problems are immediately reviewed, and repair or replacement activity is undertaken in a timely manner. |

| Nine Minimum Controls | King County Compliance Effort |
|---|---|
| **6. Control of solid and floatable materials in CSOs** | The City of Seattle's catch basin maintenance program limits the introduction of floatable materials to sewers. King County developed an information campaign with brochures and TV spots to educate the public that trash should not be flushed to the sewers. Information is available on the CSO control program Web site under "Resources and Links" at http://dnr.metrokc.gov/WTD/cso/library.htm<br>The majority of floatables in the King County system are captured in the large volume of wastewater transferred to the treatment plant before overflows occur. Overflow weirs also hold back solids and floatables in the conveyance system prior to overflow. Observations of quantity of floatables are noted in logs at each facility and are available for inspection on request. These observations have indicated that additional floatables and solids controls are not needed at this time. If additional floatable controls are found to be needed in the future, the needs will be addressed in the CSO control projects implemented under the county's long-term control plan. |
| **7. Pollution prevention programs to reduce contaminants in CSOs** | WTD has implemented the Industrial Waste Program and has been a major participant in the Local Hazardous Waste Management Program. Both programs serve to reduce discharge to sewers of chemicals and other substances that adversely impact the environment and the wastewater treatment process. Educational materials on controlling trash disposal to sewers are a part of the larger public information program. |
| **8. Public notification program to ensure that public receives adequate notice of CSO events and impacts** | 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 the posting of signs at publicly accessible CSO locations, an information phone line, a Web site, brochure, and other public outreach activities. A public notification feasibility study, required in the most recent modification of the West Point NPDES permit, was submitted to Ecology on July 1, 2007. The study reviewed and recommitted to continuing the public notification program elements described above. It also identified the potential to provide real-time notification of overflows. A Web site that provides this notification is being piloted while the county continues to seek public opinion on the usefulness of the Web site's approach and format. |
| **9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls** | In 1986, King County began a sampling program to characterize each CSO and identify high priority sites for early control. The program included collecting water 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 state Sediment Management Standards. King 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.<br>Monitoring of CSO volume and frequency will continue after completion of CSO control projects to verify achievement of control goals. King County may undertake additional sampling on completion of specific CSO control projects where it is deemed useful to verify project effectiveness. Such monitoring plans will be developed during project implementation as needed. |

[a] The Supervisory Control and Data Acquisition (SCADA) system controls the West Point Treatment Plant collection system.

## 2.5 Monitoring and Modeling CSO Control—CSO Volume and Frequency

King County uses flow monitors in conjunction with a sophisticated supervisory control and data acquisition (SCADA) system to track both the frequency and volume of CSO events. The county models this and other information, such as rainfall patterns, to predict system behavior and to plan for future CSO control facilities. The following sections describe King County's monitoring and modeling efforts.

### 2.5.1 Relationship Between CSO Monitoring and Modeling

Monitoring consists of directly measuring overflows with flow meters or measuring the depth or flow level in a pipe with a known geometry and then using the data to calculate flow values. King County continuously monitors the frequency and volume of overflows using SCADA at locations where flow control occurs in the wastewater system, such as at regulators or pump stations. Portable monitors, which must be manually downloaded at set time intervals, are used at a few other locations. Monitoring data are used to determine compliance with Ecology regulations.

WTD uses a computer model to estimate the frequency and volume of overflows that would occur under average rainfall in the service area. Modeled data are compared to monitoring data, and the model is calibrated (adjusted) to provide more accurate predictions for use in CSO program planning and facility design. The model is continually refined as the science of computer simulations improves and as more field data are collected. The models that WTD has used over the past 30 years are described in Appendix C. For the RWSP, the types and sizes of CSO control projects were determined using a storm scenario ("design storm") to predict average CSO frequencies and volumes. The design storm represented a storm of a specified volume, duration, and intensity that occurs once per year on average. WTD currently uses a "continuous simulation model" that is based on historical rainfall patterns. The continuous simulation model simulates rainfall variability better than previous models and provides better long-term predictions of overflows. WTD is in the process of analyzing the differences between predicted and actual CSO frequency and volume in order to update and recalibrate the model. The process should be complete in late 2008 and may lead to changes in sizing, schedules, and costs of CSO control projects.

### 2.5.2 Measured CSOs in 2000–2007 Compared to Modeled Baseline and 1999 Predictions

Each year the county reports both monitored and modeled CSO data for the period of June 1 through May 31, allowing for analysis of one continuous wet season rather than dividing the data between calendar years.

The period between 1981 and 1983 is used as the baseline for measuring progress toward controlling CSOs. Baseline volumes were determined using computer modeling. The model used rainfall data and other parameters, such as system capacity and the amount of permeable and impermeable surfaces in the service area at that time, to estimate the frequency and volume of CSO flows during the period. The 1981–1983 modeled baseline for the system is estimated as 471 CSO events (frequency) and 2,299 million gallons (volume) per year.

The 1999 modeled estimate of average conditions indicted that a decrease from the baseline to 332 events and 1,536 million gallons had been accomplished. Frequency and volume based on actual measurements for 2000–2007 (since the last CSO control plan update) were lower than these predictions—260 events and 919 million gallons per year—possibly because the rainfall for that period was lower than average. Table 2-3 compares the modeled estimates to the monitored frequency and volume for the 2000–2007 seasons

Two major King County control systems—the Mercer/Elliott West and Henderson/Norfolk systems—came online in May 2005. It was anticipated that these systems would reduce untreated overflow volumes in the system by one-third of the modeled 1999 prediction. Long-term monitoring will be conducted to fully understand the effect of these two new systems on frequency and volume reduction.

### 2.5.3 Relationship Between Measured Rainfall and CSO Volume in 2000–2007

Figure 2-5 shows the relationship between total rainfall and total CSO volume in 2000–2007, the period since the last CSO control plan update. The 1981–1983 baseline average rainfall is 37 inches per year. Rainfall measured at local rain gauges in 2000–2007 averaged 31.89 inches per year.

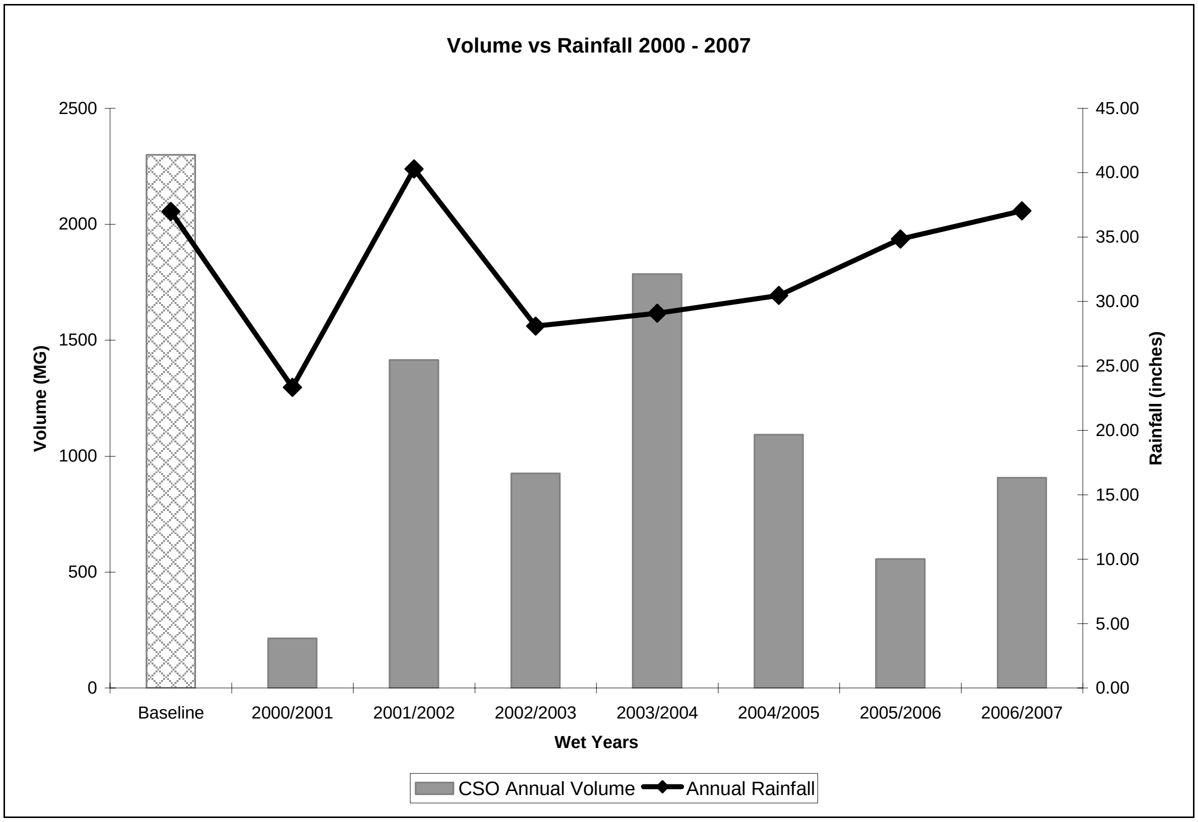


**Figure 2-5. Rainfall and CSO Volumes (2000–2007)**

While a reasonable relationship between annual rainfall and CSOs volumes can be seen in Figure 2-5, large and/or intense storms can contribute most of the year's CSO volume. A year of low-intensity storms that are easily assimilated by the sewer system could yield lower CSO volumes than a year with large, intense storms and the same total rainfall. Three wet seasons in the past seven years illustrate the variability of rain and CSO volume and the difficulty in using monitored data to predict CSO system response and control:

- Total rainfall during the 2000–2001 wet season was 24 inches, which is 35 percent below average annual rainfall. This was the driest year during this update period. The total CSO volume was 214 million gallons compared to the baseline of 2,299 million gallons.
- During the 2005–2006 wet season, approximately 80 percent of the annual CSO volume occurred during the extended period of rain in late December and January. A high amount of rain fell on the last three days of January, producing overflows at almost all

King County's CSOs. More than one-quarter of the year's total CSO volume—116 million gallons—overflowed in just three days.

- Despite near normal rainfall in 2006–2007, the pattern of rainfall created significant challenges for the region. Approximately one-third of the annual rainfall occurred during two storms that took place November 2–15 (8.67 inches) and December 9–15 (4.12 inches). Although producing less total rainfall than the November storm, the December storm was extremely intense and resulted in severe flooding throughout the city. On December 14 alone, 1.8 inches of rain fell.

## 2.6 Control Status of King County CSOs

Control status of CSO locations is continually assessed on the basis of annual monitoring data and modeling refinements. Ecology is kept apprised of control status through CSO control reports, submitted annually, and CSO control plan updates, submitted with each NPDES permit renewal application for the West Point plant. Monitored data from 2000–2007 indicate that 13 CSOs are controlled (see Table 2-3):[2]

- 30th Avenue Northeast Pump Station (049)
- 53rd Avenue Southwest Pump Station (052)
- 63rd Avenue Pump Station (054)
- 8th Avenue West Regulator Station/West Marginal Way Pump Station (040)
- Alaska Street Southwest (055)
- Belvoir Pump Station (012)
- Canal Street weir (007)
- Duwamish Siphon West (034)[3]
- Duwamish Pump Station/Siphon East (035)
- East Marginal Pump Station (043)
- Matthews Park Pump Station (018)
- East Pine Street Pump Station (011)
- Rainier Avenue Pump Station (033)

Control facilities at the Denny Way Regulator Station, Dexter Avenue Regulator Station, Henderson Pump Station, Martin Luther King, Jr., Way weir, and Norfolk Street Regulator Station—associated with the new Mercer/Elliott West and Norfolk/Henderson CSO control systems—are undergoing startup adjustments and modifications. The adjustments are expected to achieve CSO control at these locations. Control status will be confirmed in the hydraulic model recalibration that is currently under way and will be reported in the next CSO control plan update.

[2] The number in parentheses is the Discharge Serial Number, an identifier set in the NPDES permit for an individual CSO location. See Chapter 1 for locations of CSOs.
[3] The Duwamish Siphon West was monitored from 2004–2007.

# 2.7 Characterizing Environmental Impacts—Studies and Monitoring Programs

Metro, and now King County, have consistently considered scientific information in making wastewater management decisions, including decisions on CSO control. When needed information was not available, Metro and King County initiated or participated in special studies to develop the information.

This section describes these environmental studies and ongoing programs to monitor water and sediment quality.

## 2.7.1 Environmental Studies

Beginning with the 1958 *Metropolitan Seattle Wastewater and Drainage Study*, regional agencies have collaborated on studies to identify major environmental protection needs and to identify and prioritize corrective actions.

The sidebar on this page lists foundational studies done before the 2000 CSO control plan update and describes the implications of these studies for CSO control. (More detail on these studies is presented in Appendix D.) Each study has built on the findings of earlier studies.

The studies identified CSO impacts as being an important but relatively small part of the larger problem. No updated characterization has been required since the 1988–1997 CSO characterization because pollutants have remained stable or have decreased. The county now tracks West Point influent, biosolids quality, and industrial monitoring as indicators of change that should be evaluated for CSO implications.

**Findings and recommendations regarding CSO control—**
**1958–2000 environmental studies**

1958 *Metropolitan Seattle Wastewater and Drainage Study* recommended sewer separation and storage, as needed, to control CSOs as part of a larger schedule of projects.

1978 Areawide Section 208 Water Quality Plan recommended sewer separation and storage, as needed, to control overflows.

1979–1984 *Toxicant Pretreatment Planning Study* recommended that CSO control be part of a coordinated Elliott Bay Action Plan and that source control, including enhancement of Metro's pretreatment program, should be a priority.

1983 *Water Quality Assessment of the Duwamish Estuary* identified CSOs as a minor contributor to the larger pollution problem and CSO control as one part of the solution.

1988 *Elliott Bay Action Plan* recommended elimination of direct industrial discharges into the bay and implementation of stormwater source control to improve CSO quality; set Denny Way and Michigan Street as priorities for CSO control.

1988–1996 Metro Receiving Water Monitoring Program affirmed that CSOs were not a major part of larger wet-weather problems and that CSO control would not yield the largest benefit to water quality.

1988–1997 Metro/King County CSO Discharge and Sediment Quality Characterization affirmed the Denny Way CSO as a priority for control based on pollutant concentrations.

1999 *CSO Water Quality Assessment of the Duwamish River and Elliott Bay* recommended continuation of CSO control to meet state regulations and helped set control priorities.

1999 *Sediment Management Plan* recommended that sediment remediation at CSO sites proceed ahead of CSO control because most contamination was from historical inputs.

Superfund listings of Harbor Island, the East and West Waterways, and the Lower Duwamish Waterway set in motion more recent studies that further refine our understanding of the Duwamish environment. Now, together with studies being done for the Puget Sound Partnership, attention is turning to ways beyond industrial source control to address stormwater pollution. The next step may very well be to focus on how pollution is deposited from the air.

For this 2008 CSO control plan update, WTD reviewed new information and conducted studies to assess—both quantitatively and qualitatively—the health benefits to the public, environment, and endangered species of controlling all county CSOs.[4] The assessment drew from studies describing existing environmental conditions and predicted conditions at the completion of the program. It built on the findings of the county's 1999 *CSO Water Quality Assessment of the Duwamish River and Elliott Bay* and 1999 *Sediment Management Plan*—both done in support of the RWSP—and on annual water quality monitoring reports.

Studies conducted to better understand how to protect fish species listed as threatened under the Endangered Species Act (ESA) provided insight into the life stages of these species and the effects of degraded water, sediment, and habitat on their survival. WTD helped to generate some of this information through its participation in Watershed Resource Inventory Area (WRIA) groups in King County, initiation of a Habitat Conservation Plan, and review of CSO occurrence in relation to presence of juvenile chinook salmon. Also reviewed were published findings from studies being conducted in support of contaminated sediment cleanup in the Duwamish Waterway, which present some of the most current science available that is relevant to CSO control planning. Finally, the most recent science on climate change and sea-level rise in the Puget Sound was reviewed for issues that may affect CSO planning.

This section summarizes the findings and implications of this information for King County's CSO control program.

#### 2.7.1.1 Sediment Management Studies

WTD completed a sediment management plan (SMP) in 1999 in response to RWSP policy and in parallel with the RWSP adoption process. The plan addresses historical contamination of sediments near CSO outfalls.

Since completion of the SMP, King County has been coordinating its sediment management efforts in the Duwamish Waterway with two federal Superfund projects: the Harbor Island and the Lower Duwamish Waterway projects. Superfund is a highly structured approach to managing sediment contamination that could prompt changes in projects, schedules, and budgets in the county's CSO control plan.

King County has been working in partnership with the Port of Seattle since 2003 on the Harbor Island Superfund project. The project will remediate sediments at the county's Lander and Hanford CSOs.

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[4] For more information on the review of information and studies, see the 2006 *CSO Control Program Review* at http://dnr.metrokc.gov/wtd/cso/library.htm#plans

In 2001, EPA added about five miles of the Lower Duwamish Waterway (LDW) to its list of Superfund cleanup sites. Nine county CSOs are located in this stretch of the waterway. King County, the Port of Seattle, the City of Seattle, and Boeing voluntarily became involved early in the process before the site was listed under Superfund, entering into an Administrative Order on Consent in December 2000 with EPA and Ecology for the site and initiating work in support of the remedial investigation and feasibility study (RI/FS).

Phase 1 of the RI examined existing data on the risks to human health and the environment from sediment-associated chemicals in the LDW. As a result of the Phase 1 study, EPA identified seven early action sites. Two of the seven early action sites were near the county's Norfolk and Diagonal/Duwamish CSOs. Sediment near the Norfolk site had already been remediated in 1999; remediation of the Diagonal/Duwamish sediment was completed in 2004. Both projects were completed by King County, the City of Seattle, and the Elliott Bay/Duwamish Restoration Program (EBDRP).[5]

Phase 2 of the RI generated additional data and estimated risks that will remain after completion of early remedial actions. The draft RI was circulated for public review in November 2007. Some key findings are as follows:

- The waterway contains a diverse assemblage of aquatic and wildlife species and a robust food web that includes top predators.
- Much of the sediment contamination resulted from historical releases that are now generally buried under cleaner more recently deposited sediment. Almost all new sediment that enters the waterway comes from the Green River.
- In general, high concentrations of chemicals, including PCBs, were detected in surface sediment in localized areas—frequently called "hot spots"—separated by larger areas of the LDW with lower concentrations. Relatively high surface sediment contamination is present in some areas as a result of a number of processes, including low net sedimentation rates in a few areas with primarily historical contamination or because of the presence of ongoing localized sources.
- The highest risks to people are associated with consumption of fish, crabs, and clams, with lower risks associated with activities that involve direct contact with sediment, such as clamming, beach play, and netfishing.
- Most of the human health risk is from PCBs, arsenic, cPAHs, and dioxins and furans.
- Ecological risks to fish and wildlife were relatively low, with the exception of risks to river otter from PCBs.
- Sediment contamination in approximately 75 percent of the LDW is estimated to have no effect on the benthic invertebrate community; approximately 7 percent of the surface sediment has chemical concentrations exceeding the higher of the two state standards associated with potential adverse effects to the benthic invertebrate community. The potential for effects in the remaining 18 percent of the LDW is more uncertain. Most of

[5] The Elliott Bay/Duwamish Restoration Program administers projects funded under a 1990 settlement of litigation by the National Oceanic and Atmospheric Administration (NOAA) for natural resource damages from Seattle and King County CSOs and storm drains.

the state sediment standard exceedances were for PCBs and phthalates, although 41 different chemicals had at least one exceedance.

The draft RI included two recommendations in its key findings:

- The control of local sources of toxics is critical to the long-term success of specific remedial actions in the Lower Duwamish Waterway.
- Continued coordination of cleanup actions and source control will be necessary to ensure that any actions taken are not unduly impacted by local sources.

The feasibility study is now under way. The study will develop, screen, and evaluate alternative remedial actions.

#### 2.7.1.2 Studies in Support of Protection of Threatened Species Under ESA

Since the listing of bull trout and chinook salmon as threatened species under the ESA, King County has participated in or has taken the lead on studies to better understand the factors affecting the health of these species and to develop ways to protect them. WTD supports the multi-jurisdictional watershed planning efforts for the watersheds in King County. The Salmon Conservation Plans developed for the watersheds recommend actions in the lower reaches that should be considered in CSO planning.

Also in response to the ESA listings, WTD voluntarily began development of a Habitat Conservation Plan (HCP) for all its activities that could have an effect on these species. Although WTD ultimately decided that the commitment of resources required to match the uncertainty level was too substantial to continue the HCP process, the studies done in support of the HCP provided valuable direction for WTD activities and future studies.

Finally, as part of this CSO program review, WTD conducted an assessment of the presence and abundance of juvenile chinook salmon in comparison with average exposure to CSOs. The findings of the assessment contribute to the discussion of priorities for CSO control.[6]

The following sections describe this information in more detail.

***Presence of Threatened Species in the Watersheds***

CSOs occur in the lower reaches of each of the two primary watersheds in King County's wastewater service area. These watersheds—called Water Resource Inventory Areas (WRIAs)—are the Lake Washington/Cedar/Sammamish watershed (WRIA 8) and the Green/Duwamish and Central Puget Sound watershed (WRIA 9).

In WRIA 8, King County CSOs in Lake Washington are controlled but CSOs in the Lake Washington Ship Canal and the nearshore area near Carkeek Park are not yet controlled. Three chinook salmon populations migrate in and out of the watershed through the lakes, Ship Canal,

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[6] For more information on this assessment, see the 2006 *CSO Control Program Review* at http://dnr.metrokc.gov/wtd/cso/library.htm#plans

and Locks. Juveniles rear in the marine nearshore areas of Puget Sound before heading into the ocean. Studies indicate that all three populations are at extremely high risk of extinction. The Cedar River population is at highest risk, followed by North Lake Washington and then Issaquah populations.[7]

In WRIA 9, King County CSOs are located in the lower Duwamish Waterway from the turning basin to the mouth, in Elliott Bay, and along the Alki shoreline. There are no King County CSOs in the Green River. Four or five county CSOs in WRIA 9 are controlled (currently confirming whether the Norfolk CSO is controlled). Discharges to the Duwamish Waterway have been reduced over time. The Alki CSO Treatment Plant provides CSO treatment, and the Elliott West CSO treatment facility provides CSO treatment and control for the Denny Way CSO. The Green River/Duwamish Waterway system has not experienced the same decline in chinook salmon as has occurred in other systems. Currently, the system supports an average yearly total run (fish returning to the river and those caught in fisheries) of about 41,000 adult chinook salmon. Overall, Green River chinook are resilient and have survived the effects of large-scale production of hatchery fish, high harvest rates, and habitat alteration.[8]

Given the varied life history strategies of bull trout and the limited information regarding the species, the U.S. Fish and Wildlife Service assumes the presence of bull trout everywhere in their historical range unless proven otherwise. Bull trout are likely to occur in the same water bodies, except for Lake Washington, as outmigrating juvenile chinook (which bull trout prey on).

### *Presence of Chinook Compared to a Water Body's Exposure to CSOs*

In 2005, King County compared the presence and abundance of juvenile chinook salmon with average exposure to CSOs in the Duwamish Waterway and other water bodies where CSOs occur. The previous five years of discharge frequencies and volumes were graphed by month and then superimposed on a graph showing the presence and relative abundance of chinook. In general, the majority of juvenile chinook salmon are present during periods of the fewest discharges and the smallest volumes. This relationship is illustrated in the graph for the Duwamish Waterway (Figure 2-6).

Given the finding that most juvenile chinook are near CSO outfalls when very little CSO discharge activity occurs and given that chemicals in CSOs are diluted through mixing, it was concluded that CSO discharges present little measurable harm to juvenile chinook. Additionally, because the essence of an ESA-based evaluation is a comparison between existing and future conditions, implementation of the CSO control plan will show a consistent improvement in habitat quality over time.

[7] September 2001, *Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area*, Washington Conservation Commission, Olympia , WA.
[8] December 2000, *Habitat Limiting Factors and Reconnaissance Assessment Report, Green/Duwamish and Central Puget Sound Watersheds, Water Resource Inventory Area 9 and Vashon Island,* King County and the Washington Conservation Commission, Seattle and Olympia, WA.

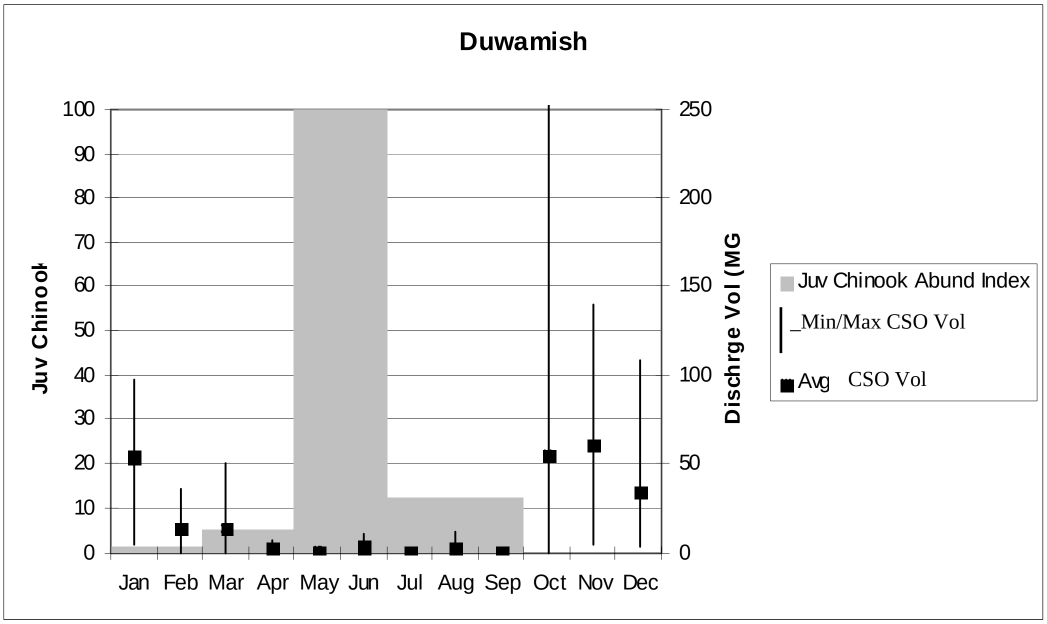


**Figure 2-6. Presence of Duwamish Waterway Chinook During CSO Discharge Monthly Average Volume, 1999–2004**

### *Salmon Conservation Plans: Strategies for Improving Habitat*

A Salmon Conservation Plan was published for WRIA 8 in July 2005 and for WRIA 9 in August 2005.[9] The plans describe long-term habitat conservation and recovery actions in WRIAs 8 and 9 that take an ecological approach but concentrate on the needs of the ESA-listed species of chinook salmon and bull trout. They include strategies, policies, and recommended projects to address factors that limit salmon habitat in the watersheds.[10]

Both WRIA plans recommend actions in the lower reaches of the watersheds that should be considered in CSO planning. One of the many recommended actions is to increase efforts to protect sediment and water quality, especially near commercial and industrial areas where there is the potential for fuel spills, discharge of pollutants, and degraded stormwater quality. While CSOs were not considered as a major concern in the plans, CSOs were perceived as contributing to the degradation of water and sediment quality in salmon habitat. This perception is linked with a larger concern about impacts from stormwater.

Habitat quality in the transitional areas of the estuaries is a priority. The WRIA 8 plan recommends the creation of pocket estuaries in the Lake Washington Ship Canal near the Hiram M. Chittenden Locks in order to enlarge the estuarine transition zone; the WRIA 9 plan recommends enlargement of the Duwamish estuarine transition zone habitat by expanding the shallow water and slow water areas. The WRIA 9 plan specifically recommends that area

[9] February 25, 2005, *WRIA 8 Steering Committee, Proposed Lake Washington /Cedar/Sammamish Watershed Chinook Salmon Conservation Plan.* August 2005, *Making our Watershed Fit for a King, Salmon Habitat Plan, Green/Duwamish and Central Puget Sound Watershed Water Resource Inventory Area 9.*

[10] These habit-limiting factors were documented in the Washington Conservation Commission's 2000 and 2001 reports cited earlier.

projects be leveraged to create improved habitat. Future CSO control projects may be viewed as opportunities to make needed habit improvements.

#### 2.7.1.3 Climate Change and Sea-Level Rise

On October 27, 2005, King County Executive Ron Sims called together experts from across the country in a conference to discuss the latest information on global warming and climate change and to begin a conversation on their implications to providers of public services in the Pacific Northwest. Despite differing opinions on the details and climate models, there is broad scientific consensus that climate change is occurring; that human actions, especially through the creation of greenhouse gases from burning fossil fuels, are contributing to these changes; and that steps need to be taken to both prepare for the expected effects of climate change and to possibly prevent them from worsening.

Sea-level rise and changes in storm patterns and intensity may occur from climate change. A rise of 6 to 50 inches by 2100 is projected for Puget Sound.[11] Low-lying areas may be at risk. Risks are greatest in southern Puget Sound because this area is sinking at up to 0.08 inch per year, or about an inch every 12 years, as the result of subsidence (sinking) as tectonic plates converge (move toward or under one another). The convergence of plates may cause uplift on the Washington coast, offsetting the effects of sea-level rise caused by climate change.

WTD will monitor the growing information on climate change and sea-level rise. The design of new CSO control facilities or of modifications to existing facilities will consider climate impacts and sea-level change anticipated during the life of the facility. Possible accommodations could include increased sizing, higher facility elevations with respect to nearby water bodies, increased pumping, and enhanced flood and storm surge protections. Decisions as to when to implement these design features will be made based on when it would be most cost-effective to do so while still meeting the need.

### 2.7.2 Ongoing Water and Sediment Monitoring Programs

To maintain vigilance in identifying environmental and public health needs and to support decision-making about the wastewater management system, including the CSO control program, King County regularly monitors wastewater treatment plant effluent, marine waters, beaches, major lakes, and streams (Table 2-4). The biological, chemical, and physical parameters used to assess a water body's health under Washington State Water Quality Standards include fecal coliform bacteria, dissolved oxygen, temperature, pH, ammonia, turbidity, and a variety of chemical compounds.

In addition to ongoing water and sediment quality monitoring, the county conducts special intensive investigations, such as pre- and post-construction monitoring for capital projects and for sediment remediation projects near CSO outfalls.

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[11] Mote, P., Petersen A., Reeder, S., Shipman, H., and Whitely Binder, L. 2008. *Sea Level Rise in the Coastal Waters of Washington State.* Report prepared by the Climate Impacts Group, University of Washington, Seattle, Washington, and the Washington Department of Ecology, Lacey, Washington. http://cses.washington.edu/db/pdf/moteetalslr579.pdf

The public can download substantial amounts of monitoring data from the Web at http://dnr.metrokc.gov/wlr/resource.htm

### 2.7.2.1 Ongoing Marine Monitoring

The marine monitoring program routinely evaluates the following:

- Nutrients, fecal coliform bacteria, dissolved oxygen, turbidity, temperature, salinity, chlorophyll, stratification, and other parameters at offshore ambient locations and at offshore locations near treatment plant and CSO outfalls in the main basin of Puget Sound.[12]
- Fecal coliform bacteria at Puget Sound beaches, including beaches near outfalls.
- Sediment quality at ambient locations and near outfalls.

All offshore marine monitoring locations met fecal coliform bacteria standards in 2007. One nearshore site in Elliott Bay along the Seattle waterfront and another nearshore site at the mouth of the Lake Washington Ship Canal failed fecal coliform bacteria standards because of their proximity to freshwater bacteria sources. Twelve of the twenty-five monitoring locations at Puget Sound beaches met fecal coliform bacteria standards. Most of the beach sites that failed both standards are near freshwater sources such as storm drains and the mouths of streams and creeks. Of the six beach sites near outfalls, only two met both standards (compared with all sites in 2006), most likely because 2007 was a wetter year.

Results of 2007 monitoring indicate that overall water quality in Puget Sound, as evaluated through the water quality index (WQI), is good.[13] Two of the fourteen monitoring sites, both in Quartermaster Harbor near Vashon Island, received a WQI score of high concern. All of the six marine outfall sites were classified as having good water quality (low level of concern).

Sediment quality in ambient locations in Elliott Bay and the Central Basin of Puget Sound is generally good, with some isolated impacts from human activity. Minor impacts were found in 2007 at the end of the West Point plant outfall.

### 2.7.2.2 Ongoing Freshwater Monitoring

Four programs monitor freshwater quality in King County: the Major Lakes, Swimming Beach, Stream and River, and Streams Sediment Monitoring Programs.

[12] Ambient monitoring measures surrounding (background) conditions.

[13] King County uses a modified version of the water quality index developed by the Washington State Department of Ecology to assess overall quality of offshore marine water. The determination is based on four indicators: dissolved oxygen, dissolved inorganic nitrate and nitrite, ammonia, and density stratification strength and persistence. Each location is categorized as low, moderate, or high concern.

## Table 2-4. Ongoing King County Water and Sediment Quality Monitoring Programs

| Program | Media and Locations | Parameters | Methods | Sampling Frequency | Program Purpose | Duration |
|---|---|---|---|---|---|---|
| **Ambient Monitoring** | | | | | | |
| Marine monitoring | Water and sediment in areas of Puget Sound away from outfalls and CSOs; shellfish from Puget Sound beaches | Water: temperature, salinity, clarity, DO, nutrients, chlorophyll, and bacteria<br>Sediment: metals, organics, and physical properties<br>Shellfish: lipids and metals | Water samples collected at multiple depths, ranging from 1 to 200 m<br>Sediment and shellfish | Water*:* monthly<br>Sediments: biannually (Elliott Bay), every 5 years (Puget Sound)<br>Shellfish: semi-annually; | To assess potential effects to water quality from nonpoint pollution sources and to compare quality against point source data | Ongoing |
| Major lakes monitoring | Water and sediment in Lakes Washington, Sammamish, and Union at ambient locations and near stormdrains and CSOs | Water: temperature, DO, pH, conductivity, clarity, phosphorus, nitrogen, and fecal coliform; micorcystin is measured at select stations<br>Sediment: metals, organics, and physical properties | Water samples collected every 5 m from 1 m below the surface to bottom at one station in center of lake and from the surface around various locations around the shoreline<br>Sediment: surface, petite ponar | Water samples: biweekly during the growing season; monthly during the rest of the year<br>Sediment: yearly | To monitor the integrity of the wastewater conveyance system and the condition of lakes | Ongoing |

BMP = best management practices; BOD = biochemical oxygen demand; DNR = Washington State Department of Natural Resources; DO = dissolved oxygen; Ecology = Washington State Department of Ecology; HPA = Hydraulic Permit Approval; SAP = sampling and analysis plan; TMDL = total maximum daily load; TOC = total organic carbon; TSS = total suspended solids.

| Program | Media and Locations | Parameters | Methods | Sampling Frequency | Program Purpose | Duration |
|---|---|---|---|---|---|---|
| Rivers and streams monitoring | Rivers and streams of both watersheds; emphasis on wadeable streams that cross wastewater conveyance lines or that could be a source of pollution<br>Stream sediment samples for trends analysis at 10 sites, plus spatial analysis of stations every creek mile | Baseflow and storm samples: turbidity, TSS, pH, temperature, conductivity, DO, nutrients, ammonia, bacteria<br>Storm samples: trace metals<br>Sediment: metals, organics, and physical parameters | Various methods for collectin water samples<br>Sediment: surface sediments, core tube, petite ponar | Monthly sampling under baseflow conditions; three to six times per year at mouth of streams under storm conditions<br>Sediment: yearly- | To monitor the integrity of the wastewater conveyance system and the condition of streams and rivers | Ongoing |
| Swimming beach monitoring | Cedar-Sammamish Watershed: Lake Washington, Lake Sammamish, and Green Lake | Bacteria; microcystin is measured at select stations | Water samples at swimming beaches | Weekly, in the summer from Memorial Day through end of September | To evaluate human health risks and necessity for beach closures | Ongoing |
| Benthic macroinvertebrate monitoring | Wade-able stream sub-basins | Size and distribution of aquatic macroinvertebrate populations | Samples colllected with a Surber stream bottom sampler | Annually | To establish a baseline for identifying long-term trends | Ongoing |
| **Treatment Plant and CSO Outfall Monitoring** | | | | | | |
| Marine wastewater plant outfall water column and beach monitoring | Puget Sound water column at treatment plant outfalls; water and shellfish at beaches near outfalls | Water: temperature, salinity, clarity, DO, nutrients, chlorophyll, and bacteria<br>Shellfish: lipids and metals | Water samples at outfalls collected at multiple depths, ranging from 1 to 200 m<br>Shellfish | Water samples: monthly<br>Shellfish: semi-annually | To assess potential effects to water quality from wastewater discharges | Ongoing |

BMP = best management practices; BOD = biochemical oxygen demand; DNR = Washington State Department of Natural Resources; DO = dissolved oxygen; Ecology = Washington State Department of Ecology; HPA = Hydraulic Permit Approval; SAP = sampling and analysis plan; TMDL = total maximum daily load; TOC = total organic carbon; TSS = total suspended solids.

| Program | Media and Locations | Parameters | Methods | Sampling Frequency | Program Purpose | Duration |
|---|---|---|---|---|---|---|
| Marine NPDES sediment monitoring | Sediments in Puget Sound near treatment plant outfalls and the Denny Way CSO | Grain size, solids, sulfides, ammonia-nitrogen, oil & grease, TOC, metals, organic compounds, and (at South and West Point plants) benthic infauna | Sediment samples in a grid pattern as defined in the SAP approved by Ecology | Sediment samples at outfalls once per permit cycle (about every 5 years) | NPDES permit requirement | Ongoing |

BMP = best management practices; BOD = biochemical oxygen demand; DNR = Washington State Department of Natural Resources; DO = dissolved oxygen; Ecology = Washington State Department of Ecology; HPA = Hydraulic Permit Approval; SAP = sampling and analysis plan; TMDL = total maximum daily load; TOC = total organic carbon; TSS = total suspended solids.

The Major Lakes Monitoring Program collects samples from 25 open-water sites in Lake Union and the Ship Canal, Lake Washington, and Lake Sammamish. Sampled parameters include temperature, dissolved oxygen, pH, conductivity, clarity (Secchi Transparency), phosphorus, nitrogen, and fecal coliform bacteria.

In 2007, the quality of major lakes in King County, as indicated by fecal coliform bacteria levels, was good. For non-beach areas, 100 percent of Lake Sammamish stations, 85 percent of Lake Washington stations, and 60 percent of Lake Union stations met the exceptionally high fecal coliform standard used for lake water. These percentages represent a slight decrease for Lakes Washington and Union from 2006 percentages, primarily because of higher concentrations of fecal coliform in samples collected after a record rainfall in January that produced greater volumes of stormwater and CSO discharges into the lakes.

Overall water quality of Lakes Sammamish and Washington between 1994–2007 varied from good to moderate.[14] Lake Union is typically in the moderate water quality range. In 2007, however, high phosphorus levels placed Lake Union in the poor water quality range.

The Swimming Beach Monitoring Program assesses 17 beaches on Lake Sammamish, Lake Washington, and Green Lake every summer for fecal coliform bacteria as an indicator of risk to human health. Bacteria levels were low in Green Lake beaches for the fifth year in a row (all samples met the standard). Levels at Lake Sammamish beaches remain consistently low, with slight variability from year to year (about 90 to 100 percent of samples have met the standard since 1999). High bacteria levels resulted in the closure of four beaches in Lake Washington in 2007. There were no beach closures in 2006.

The Stream and River Monitoring Program targets rivers and streams that cross sewer trunk lines and those that are considered a potential source of pollutant loading to a major water body. This long-term program has sampled at 56 sites on four rivers and twenty-eight streams for many years. Overall water quality in King County streams varies between and within streams, reflecting the effects of a population of almost two million residents and intense urbanization. Increased development and greater volumes of stormwater runoff have impacted and continue to impact the water quality of rivers and streams. In 2007, 45 percent of the sampling sites—compared to 63 percent in 2006—were considered moderate or high water quality (moderate or low concern) and 55 percent were rated to be of low water quality (high concern).

The Streams Sediment Monitoring Program monitors sediment quality in small wadeable streams. Samples are collected at one location in 10 index creeks each year and analyzed for trends, and one-time samples are collected every creek mile in approximately three stream basins each year.

[14] Overall water quality in Lakes Washington, Sammamish, and Union is determined by measuring the summer total phosphorus concentrations and converting them to the Trophic State Index, which relates phosphorus to the amount of algae that the lake can support.

## 2.8 Implications of Environmental Characterizations for CSO Control Planning

Information from recent scientific studies and ongoing monitoring programs does not warrant any change in course at this time. The findings from the review reinforce the direction of the RWSP CSO control plan. King County is committed to controlling all remaining CSO sites by 2030. The RWSP priorities to protect human health, endangered species, and the environment remain valid. Under the RWSP schedule, design has already begun on projects with the greatest benefit to human health protection—the Puget Sound Beach projects. Control projects will continue to be designed to transfer as much captured CSO flow as possible to regional plants for secondary treatment.

The studies underscore the finding of the 1999 water quality assessment that the primary benefit of the planned CSO control will be the reduction of risks to humans from pathogens in the area near each CSO. The improvement from these reductions, however, may be barely perceptible on a watershed level because CSO discharges contribute pathogens for only short periods while other sources, such as upstream stormwater agriculture runoff or leaking septic systems, are contributing high levels of pathogens on an ongoing basis.

Many recent studies have focused on the Duwamish Waterway because of sediment cleanup projects in the area. With regard to protection of human health, information generated from the Lower Duwamish Waterway Superfund process is increasing our understanding of fish consumption and human health risk. If an ongoing human health risk from CSOs in the Duwamish Waterway is identified, King County may consider changes in the control schedule to accelerate CSO control projects at those locations. Determining remaining relative priorities of projects scheduled for completion after the Puget Sound Beach projects will be difficult because comparable information is not as available for other areas where CSOs occur, such as the Ship Canal.

At this time, protection of endangered salmon does not appear to be enhanced by changes in the CSO control schedule that would prioritize the Duwamish Waterway over other locations. Although the waterway has the greatest volume of overflow, it has the healthiest salmon run in terms of numbers of both hatchery and naturally spawning fish.

At the end of 2010, King County will complete a review of the CSO control program that incorporates information from the recalibrated hydraulic model, the review of technologies including the results of CSO treatment pilots under way, and any new environmental or public health study findings with implications for CSO control. The priorities for scheduling control projects will be reassessed in light of any new information. Project definitions and implementation order may be redefined at that time and any modifications will be sent to the King County Council for approval.

# Chapter 3

# CSO Control Projects

King County's most recent CSO control plan was included in the Regional Wastewater Services Plan (RWSP) adopted in 1999 and confirmed in the CSO control plan update prepared in 2000. The plan lists 21 CSO control projects to reduce CSOs to one untreated event per year on average at each CSO location by 2030. Construction of two control projects under way at the time of RWSP adoption were completed in 2005, and design of four projects listed in the plan is in progress.

This chapter describes the factors that shape King County's CSO control decisions and the priorities for CSO control projects based on these factors. It also presents completed, current, and future CSO control projects and the results of a review of available and feasible technologies conducted for this CSO control plan update.

## 3.1 Factors Shaping CSO Control Decisions

As set forth in the following wastewater services policies and CSO control policies in the RWSP, decisions on CSO control must balance several factors, including public health and the environment, regulatory requirements, financial goals, scientific information, and public opinion (Figure 3-1):

> *WWSP-6: King County shall operate and maintain its facilities to protect public health and the environment, comply with regulations and improve services in a fiscally responsible manner.*
>
> *WWSP-11: King County shall design, construct, operate and maintain its facilities to meet or exceed regulatory requirements for air, water and solids emissions as well as to ensure worker, public and system safety.*
>
> *CSOCP-1: King County shall plan to control CSO discharges and to work with state and federal agencies to develop cost-effective regulations that protect water quality. King County shall meet the requirements of state and federal regulations and agreements.*
>
> *CSOCP-2: King County shall give the highest priority for control to CSO discharges that have the highest potential to impact human health, bathing beaches and/or species listed under ESA.*

The King County Council's review of Wastewater Treatment Division (WTD) programs, priorities, and costs during the annual rate setting process and budget process provides additional assurance that WTD is carrying out its programs in a fiscally responsible manner. Fitting CSO control projects into the overall WTD financial program has resulted in a schedule that steadily implements projects through 2030 and complies with permits and regulations.

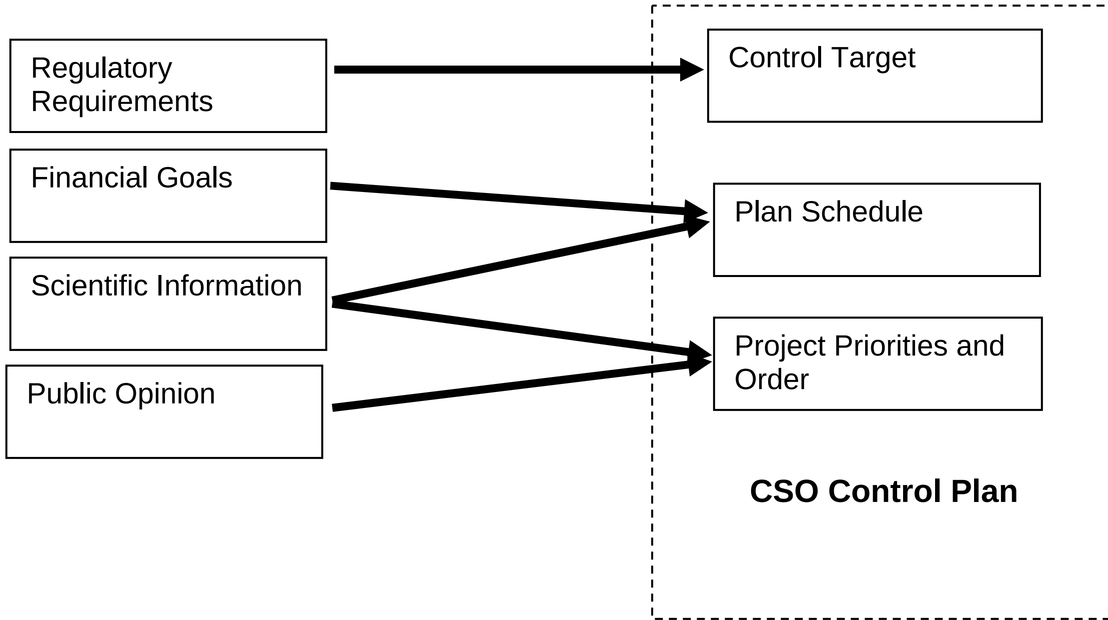


**Figure 3-1. Factors that Shape CSO Control Plan Decisions**

The county develops CSO programs and projects based on the most recent assessments of water and sediment quality and of risks posed to human health and the environment. The schedule for implementing CSO control projects gives highest priority to discharges that pose the greatest risk to human health, particularly at bathing beaches, and to environmental health, particularly those that threaten species listed under the Endangered Species Act.

WTD's public involvement for CSO control integrates several outreach programs. Public opinion is sought in advance of decisions on CSO control priorities and on the scope and timing of projects, and then again during project implementation.

For more information on RWSP CSO control policies, see Appendix A.

## 3.2 CSO Control Project Priorities

The CSO projects given the highest priority are at locations with recreational uses such as swimming where direct human contact with the water may occur. Projects at CSOs that discharge near beaches on Puget Sound are scheduled for completion next. The priorities, as shown in Figure 3-2, are as follows:

- **Priority 1, CSOs near Puget Sound Beaches.** These projects are under way and scheduled for completion in 2013. The SW Alaska project was removed from the list of Puget Sound Beach projects because the CSO at this site is controlled as a result of the Alki transfer project.
- **Priority 2**, **University/Montlake CSO.** This CSO is located at the east end of the Lake Washington Ship Canal. The control project, scheduled for completion in 2015, was

given high priority because of the amount of boating in the area, which could result in secondary contact with the water.

- **Priority 3, CSOs Along the Duwamish River and in Elliot Bay.** The RWSP designated that nine projects at CSOs along the Duwamish River and in Elliott Bay be completed by 2027. These projects were given third priority because the 1999 *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* indicated that the level of pollution originating upstream of CSOs was high enough to dwarf improvements by CSO control projects.
- **Priority 4, CSOs at the West End of the Ship Canal.** Three projects to control CSOs at the west end of the Ship Canal are scheduled as the last projects to be completed because significant CSO control has already been accomplished in this area.

Review of recent environmental studies suggests that these priorities are still appropriate (see Chapter 2). During the program review that is due to the King County Council by end of 2010, these priorities will again be reviewed against the most current information and will be adjusted if warranted.

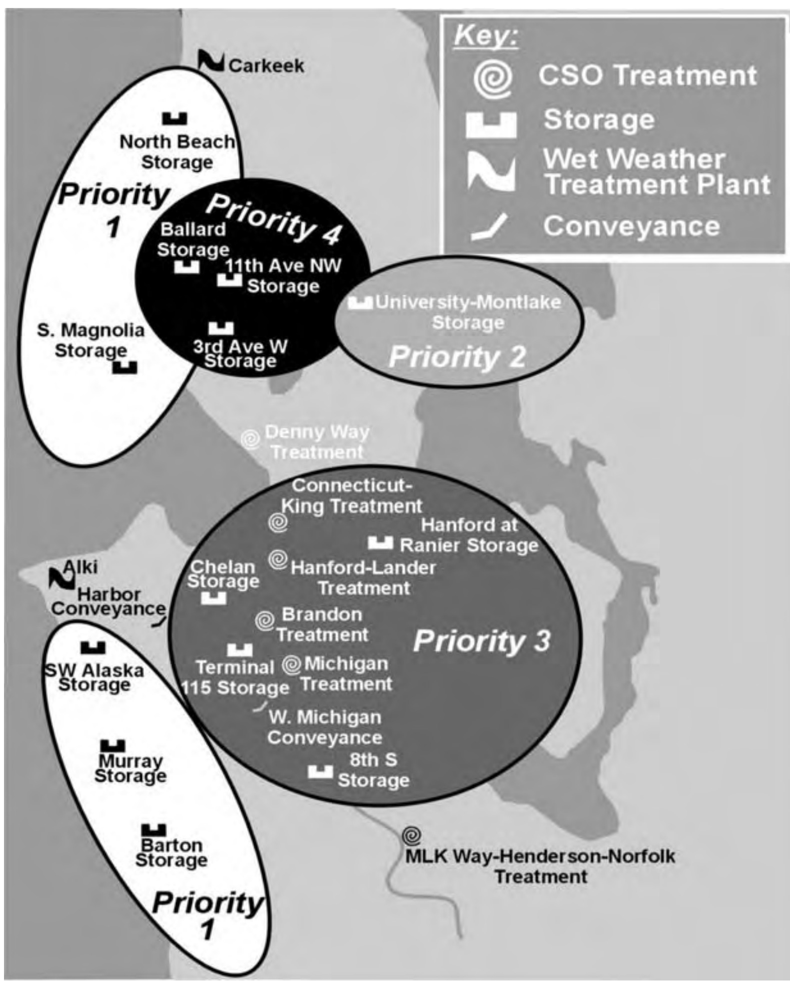


**Figure 3-2. Priority of CSO Control Projects**

# 3.3 Implementation of CSO Control Projects

This section presents an overview of King County's completed, current, and planned CSO control projects. Many early projects involved sewer separation, flow diversion, and new tunnels. Most current and future projects involve construction of storage and treatment facilities.

## 3.3.1 Completed CSO Control and Associated Projects

Tables 3-1 and 3-2 summarize CSO control projects and other projects associated with CSO controls that have been completed to date.

**Table 3-1. Completed CSO Control Projects**

| Project | Description | Completion Date | Status/Comments |
|---|---|---|---|
| Ft. Lawton Tunnel | Parallel tunnel to the West Point plant to provide greater transfer capacity. | 1991 | Completed. |
| Hanford/Bayview/ Lander Separation & Storage | Partial separation of the Lander and Hanford basins, and reactivation of the Bayview Tunnel. (Joint project with the City of Seattle.) | 1992 | Remaining control will occur under RWSP projects in 2017 (Hanford # 2), 2019 (Lander St.), and 2026 (Hanford at Rainier). Lander stormwater management is ongoing. |
| Carkeek Transfer/CSO Treatment | Transfer of flows up to 9.2 mgd from the Carkeek basin to the West Point plant. Treatment of flows above 9.2 mgd at the Carkeek CSO plant. | 1994 & 2005 | After completion of flow transfer project, the Carkeek plant was receiving more flow than anticipated. Upgrades were made in 2005 to the pumps that transfer flow to West Point to increase their capacity from 8.4 to 9.2 mgd. Also in 2005, the chlorine system at the plant was modified and a dechlorination system was added. |
| Kingdome Industrial Area Storage & Separation | Installation in 1994 of a storage pipeline in conjunction with Seattle and Washington State Department of Transportation street projects. Completion by the Public Facilities District in 1999 of 60 percent of the Level 1 sewer separation between Alaskan Way and 3rd Ave. in conjunction with Safeco Field construction. | 1994 & 1999 | Remaining control will occur in 2026 under an RWSP project (Kingdome/Connecticut CSO). |
| University Regulator Phase 1 and Densmore Drain | Separation of stormwater from northwest Seattle and parts of I-5, and diversion of Green Lake outflow away from the sewer to a new Densmore drain that discharges to north Lake Union. | 1994 & 2007 | Improvements to the hydraulics of the drain and upgrades to the Densmore pumps were completed spring 2007. Remaining control will occur in 2015 under an RWSP project (University/Montlake CSO). |
| Harbor Pipeline | Installation of a pipeline to convey overflow from the Harbor Avenue Regulator Station to the West | 1996 | Completed. The pipeline was put into operation in 2000–2001. |

| Project | Description | Completion Date | Status/Comments |
|---|---|---|---|
| | Seattle Tunnel for storage. | | |
| Alki Transfer/CSO Treatment | Transfer of flows up to 18.9 mgd from the Alki drainage basin to the West Point plant via the West Seattle Tunnel. Treatment of flows above 18.9 mgd at the Alki CSO plant. | 1998, 1999, & 2005 | In 1999, additional plant modifications were completed. In 2005, the chlorine system was modified and a dechlorination system was added. |
| 63rd Ave. Pump Station | Diversion of overflows to the West Seattle Tunnel or Alki CSO plant. | 1998 | Completed. |
| Denny Way/Lake Union CSO Control Project | Storage and primary treatment of Lake Union flows in the Mercer Tunnel, with screening, disinfection, and discharge to Puget Sound at Elliott West. | 2005 | Major construction completed. See the discussion on satellite CSO treatment later in this chapter. |
| Henderson/MLK/Norfolk CSO Control Project | Storage, primary treatment, and disinfection of Henderson and Martin Luther King, Jr., flows in the Henderson Tunnel; transfer of flows to secondary treatment plants; discharge of excess treated CSOs at Norfolk. | 2005 | Major construction completed. See the discussion on satellite CSO treatment later in this chapter. |

## Table 3-2. Completed Associated Projects

| Project | Description | Completion Date | Status |
|---|---|---|---|
| Renton Sludge Force Main Decommissioning | Stopped pumping sludge to the Elliott Bay Interceptor for conveyance to the West Point plant after South plant developed solids management capability; the decommissioning decreased solids discharge from the Interbay Pump Station at Denny during CSO events. | 1988 | Completed. |
| Ballinger and York Pump Stations | Construction of two new pump stations that can divert flows to and from the West Point collection system. Flows are currently diverted away from West Point during the wet season. | 1992 (York); 1993 (Ballinger) | Completed. |
| West Point Treatment Plant Expansion | Increased plant hydraulic capacity from 325 to 440 mgd in order to convey and treat more flow from the combined sewer system. | 1995 | Completed. |
| Allentown Diversion/ Southern Transfer | Designed to offset addition of Alki flows to the Elliott Bay Interceptor; resulted in significant volume reduction at Norfolk. | 1995 | Completed. |
| North Creek Pump Station | Diversion of flow away from the West Point to the South plant collection system during wet weather. | 1999 | Completed. |

| Project | Description | Completion Date | Status |
|---|---|---|---|
| Denny Way Sediment Remediation | Remediation in three phases of sediments in six areas:<br>Phase 1 – cap an offshore area to remediate historical contamination.<br>Phase 2 – dredge and fill two nearshore areas to remediate historical contamination.<br>Phase 3 – remediate three offshore areas for historical contamination near existing outfalls. | Ongoing | Phase 1 completed in 1991; 10-year monitoring completed in 2001.<br>Phase 2 completed in early 2008; 6-year monitoring began in 2008.<br>Phase 3 action to be determined in 2014 based on Phase 2 monitoring.<br>Ongoing monitoring for potential recontamination at outfalls for the completed Denny Way/Lake Union control project. |
| Norfolk Sediment Remediation[a] | Source control, dredging, and capping. | 2005 | Post-construction monitoring program was completed in 2007. |
| Duwamish/ Diagonal Sediment Remediation[a] | Source control, dredging, and capping. | 2005; ongoing monitoring | A 10-year monitoring program to assess the potential for recontamination is in progress. |

[a] These projects were done under the Elliott Bay/Duwamish Restoration Panel (EBDRP) under the consent decree to settle the 1990 litigation by National Oceanic and Atmospheric Administration (NOAA) against the City of Seattle and King County (then Metro) for natural resource damages attributed to CSOs and storm drains. These projects were identified as early action cleanups in the Lower Duwamish Waterway Superfund site.

### 3.3.2 CSO Control Projects Under Way

Four CSO control projects are under way: South Magnolia, North Beach, Barton Street, and Murray Avenue. These four projects are referred to collectively as the Puget Sound Beach projects.

In 2006, the formal planning and predesign phase of the projects began. Initial alternative screening criteria were developed and will be further refined based on community feedback. Community involvement meetings are being held in each of the four project basins. Public comments are being tracked and will be used to involve stakeholders in future community meetings (see Chapter 4).

Flow monitoring in the local Seattle sewer system will be conducted in each of the four basins to assess whether removing stormwater from these sewers is a viable option for CSO control. King County will explore the use of a low-impact development strategy (green infrastructure) as an alternative for CSO control in one of the basins. The most suitable basin will be identified in cooperation with the City of Seattle, and the feasibility and costs of the strategy will be assessed.

Predesign will continue through 2009 and end with issuance of facility plans in 2010. Construction is expected to begin in 2011 and to be completed by 2013. Because CSO control facilities run intermittently, a reasonable and effective commissioning period is needed before a facility is considered fully operational. Depending on the alternatives selected for these projects, the commissioning period is expected to extend at least into the following permit cycle.

More information can on Puget Sound Beach projects can be found at http://dnr.metrokc.gov/wtd/projects/cso/index.htm.

### 3.3.3 Future Projects

Table 3-3 lists the projects in the CSO control plan that will be completed in the future to bring all CSOs under control by 2030. These projects were identified in the RWSP. Five other projects that were in the RWSP are not listed because they are either under way (Puget Sound Beach projects) or have been eliminated because monitoring and modeling data indicate that they are already controlled (SW Alaska Street CSO). Alternatives analysis during project implementation may identify approaches other than those listed.

**Table 3-3. Planned CSO Projects in Order of Priority**

| Project Name | DSN[a] | Project Description | Projected Year of Control | Water Body |
|---|---|---|---|---|
| University/Montlake | 015/ 014 | 7.5 MG (million gallon) storage tank | 2015 | Lake Union/ East Ship Canal |
| Hanford #2 | 032 | 3.3 MG storage/treatment tank | 2017 | Duwamish River |
| West Point Treatment Plant Improvements | | Primary/secondary enhancements | 2018 | Puget Sound |
| Lander Street | 030 | 1.5 MG storage/treatment at Hanford | 2019 | Duwamish River |
| Michigan | 039 | 2.2 MG storage/treatment tank | 2022 | Duwamish River |
| Brandon Street | 041 | 0.8 MG storage/treatment tank | 2022 | Duwamish River |
| Chelan Avenue | 036 | 4 MG storage tank | 2024 | Duwamish River |
| Connecticut Street (now called Kingdome) | 029 | 2.1 MG storage/treatment tank | 2026 | Elliott Bay |
| King Street | 028 | Conveyance to Connecticut Street treatment | 2026 | Elliott Bay |
| Hanford at Rainier Avenue | 031 | 0.6 MG storage tank | 2026 | Duwamish River |
| 8th Avenue S | 040 | 1.0 MG storage tank | 2027 | Duwamish River |
| West Michigan | 042 | Conveyance upgrade | 2027 | Duwamish River |
| Terminal 115 | 038 | 0.5 MG storage tank | 2027 | Duwamish River |
| 3rd Avenue W | 008 | 5.5 MG storage tank | 2029 | West Ship Canal |
| Ballard[b] | 003 | 1.0 MG storage tank (40% King County) | 2029 | West Ship Canal |
| 11th Avenue W[c] | 004 | 2.0 MG storage tank | 2030 | West Ship Canal |

[a] DSN refers to the Discharge Serial Number, an identifier set in the NPDES permit for an individual CSO location. See Chapter 2 for locations of CSOs.
[b] A CSO control project may not be needed at the Ballard Regulator Station because this location may be controlled as the result of replacing the Ballard Siphon, scheduled for completion in 2010.
[c] The scope of the control project at 11th Avenue West may be reduced as a result of replacing the Ballard Siphon.

Note: Alternative analysis and cost estimating for these projects were submitted to Ecology in the 1997 *King County CSO 5-Year Update, Task 4, Development of Alternatives* as part of the RWSP. It can be found at ftp://dnr.metrokc.gov/wtd/cso/library/RWSP-CSO/Task4.pdf. Documentation of the county's funding for these projects was submitted in the 1997 *RWSP Draft Financing Plan* (prepared by Gibson Economics, Inc.) and was updated in Chapter 13 of the *2006 RWSP Comprehensive Review* (http://dnr.metrokc.gov/wtd/rwsp/documents/06CompReviewAR/Ch13.pdf).

### 3.3.4 Ballard Siphon Replacement

The Ballard Siphon, built in 1935, consists of two woodstave siphon barrels that rest on the bottom of the Lake Washington Ship Canal. The siphon carries flows collected from Seattle's north end near Carkeek Park and from the Ballard area across the Ship Canal for treatment at the West Point Treatment Plant.

In November 2005, a sonar inspection showed abnormalities in the Ballard Siphon that raised concerns for its integrity. Subsequent analyses and inspections indicated that the anomalies were not severe, and the concern for imminent failure was significantly reduced.

Despite the reduced concern, replacing the siphon is considered a high priority project in order to maintain its reliability. The project includes two major components: (1) slip-lining the existing woodstave siphon barrels to extend their useful life, and (2) tunneling an 84-inch-diameter pipe below the canal. Final design is scheduled for completion in third-quarter 2008; construction is scheduled to begin in first-quarter 2009 and to end in 2010.

The completed project will eliminate CSO discharges at the Ballard Regulator Station, accelerating the schedule for control at this site. The project will also reduce CSOs at 11th Avenue West, likely reducing the scope of a future control project at this site.

## 3.4 Approaches for Consideration in CSO Control Projects

This section describes available control technologies and their applicability to King County's CSO control program. Categories of technologies discussed are as follows:

- Stormwater management
- Storage
- Conveyance improvements
- CSO treatment

### 3.4.1 Stormwater Management

Reducing the amount of stormwater that enters combined sewers can be an effective means to control CSOs. Stormwater can be separated from the combined sewers and channeled to new stormwater sewers or controlled through low-impact development (LID) systems (green infrastructure). By controlling stormwater at its source, LID systems can also serve to prevent stormwater from entering the combined system in the first place.

Because of increased understanding of the potential adverse environmental impacts of stormwater, the federal NPDES permit system now covers stormwater. Stormwater separation and LID projects require negotiation and coordination with the stormwater management agency (the City of Seattle). Other factors that add to the complexity of such projects include acquisition of right-of-way and possible work on private property. Many LID projects require more land than practicable in dense urban areas.

Separation of stormwater from the sanitary system is complicated and expensive. Separation may be more costly than treatment or storage depending on the characteristics of the basin. But separation could also reduce costs if land is not available for LID facilities or is too expensive compared to construction in the right-of-way. Parts of King County's combined system have been separated in the past (see Table 3-1) and other parts may be separated, to a more limited extent, in the future on a case-by-case basis. None of the 21 projects under way or planned identify separation as the preferred alternative for control, but all will consider it among the alternatives evaluated in predesign.

A LID system is a decentralized system that distributes stormwater across a site. LID employs a combination of structural devices (engineered systems) and non-structural devices (vegetated, natural systems) to maintain or restore the natural hydrologic functions of a site by filtering and infiltrating water into the ground. It promotes the use of roofs, parking lots, and other horizontal surfaces to convey water to distribute it into the ground or collect it for reuse. LID is a sustainable stormwater management strategy that is practiced extensively in Europe. It is rapidly gaining acceptance in the United States as a holistic and sustainable means to comply with regulations and meet resource protection goals. The Puget Sound Action Team published an LID manual in 2005 for Puget Sound communities, and the City of Seattle incorporated LID practices into its 2005 drainage code (being revised in 2008).[1] The revised code will require incorporation of LID in new or replacement projects.

Common LID methods include bio-retention cells, grass swales, localized detention structures, cistern collection systems, permeable pavement surfaces, and vegetated roof systems. Bio-retention swales typically consist of grass buffers, sand beds, a ponding area, organic layers, planting soil, and vegetation that provide storage, away from buildings and roadways, where stormwater collects and filters into the soil. Grass swales function as alternatives to curb and gutter systems, usually along residential streets or highways. Grasses or other vegetation reduce runoff velocity and allow filtration, while safely channeling away high volume flows. Cistern collection systems can be designed to store rainwater for dry-period irrigation.

Although application of LID practices is growing, data are limited regarding effectiveness of these practices and their costs. Most information comes from case studies of projects associated with new development or retrofit of existing streets. Work in Portland, Seattle and Vancouver, B.C., has focused on small-scale projects on city blocks. The ability to incorporate LID into county CSO control projects is limited because most LID is implemented at the local level. King County is planning on evaluating the use of LID as a CSO control alternative for one of basins being controlled through the Puget Sound Beach projects that are under way.

[1] *Low Impact Development Technical Guidance Manual for Puget Sound*, January 2005 (revised May 2005), Puget Sound Action Team and Washington State University, Pierce County Extension. http://www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

#### 3.4.1.1 Infiltration and Inflow Control

Infiltration and inflow (I/I) are groundwater or stormwater that flow into sanitary sewers through leaky sewer lines or manholes or from direct connections to catch basins or roof drains. Reduction of I/I has the potential to lower the risk of sanitary sewer overflows and free up more capacity to handle sanitary flows. The regional I/I control program was created in 1999 as part of the RWSP to explore ways to reduce the amount of I/I entering the county's separated sewer system and to implement reduction projects when it is cost-effective to do so.[2]

Lessons learned and methodologies and protocols developed in the I/I control program may have application to CSO control efforts. Opportunities are limited for increasing capacity through control of I/I in fully combined sewer areas, but I/I techniques will be considered as sewer separation and LID alternatives in partially separated areas during predesign for CSO control projects.

### 3.4.2 Storage

Storage can serve to reduce overflows by capturing combined wastewater in excess of treatment or conveyance capacity during wet weather for controlled release into wastewater treatment facilities after a storm. Storage facilities may be located upstream in the system, at overflow points, or near CSO treatment facilities. A major factor determining the feasibility of using storage is the volume of flow to be stored, how quickly the storage can be drained, and land availability. Operation and maintenance costs are relatively low, generally to cover collection and disposal of residual solids, unless inlet or outlet pumping is required.

Storage projects need to consider downstream conveyance and treatment capacity to ensure that stored flows do not overload facilities. The impact of these flows on the secondary treatment process must also be considered because storage increases the flow over a longer period.

Flows can be stored offline or inline. Offline storage is provided by a tank or tunnel located outside the conveyance system. Once capacity is available in the system, the stored flows are returned to the conveyance system and sent to treatment plants, preferably to secondary treatment plants. King County has constructed two offline storage tunnels as part of the Mercer/Elliott West and Henderson/Norfolk CSO treatment systems (discussed later under the CSO treatment section). The four Puget Sound Beach projects currently in predesign include some offline storage; the CSO control plan calls for a number of additional offline storage projects in the future.

The county accomplishes inline storage through its SCADA system, which holds flows back and stores them in upstream pipes and tunnels until treatment plants can accommodate them. Inline storage can involve optimized use of existing pipeline capacity or can be created by building larger sections of pipes or tunnels or by building new parallel sections. The West Seattle Tunnel, built in 1998, provides significant inline storage in addition to conveying Alki area flows to West Point for secondary treatment. Inline storage is easier to maintain than offline storage but often cannot be built large enough to reduce CSOs.

[2] See http://dnr.metrokc.gov/wtd/i-i/ for more information on the I/I control program.

### 3.4.3 Conveyance Improvements

Improvements to pipelines and other facilities in the conveyance system can be undertaken to remove bottlenecks and obstructions and to route flows to storage facilities. For example, the Harbor CSO was controlled by conveying flows to the West Seattle Tunnel. Other conveyance improvements are planned to help control CSOs at King, North Beach, and West Michigan.

Improvements can be made to pump stations to move flow more efficiently. Such improvements often can be done in conjunction with the routine retrofit and upgrade of older facilities. Upgrades to the West Seattle and Henderson Pump Stations have reduced CSOs upstream. Pump station upgrades are planned for the Barton and North Beach Pump Stations.

### 3.4.4 CSO Treatment

The West Point Treatment Plant treats flows that would otherwise discharge at CSO sites. The county also runs satellite treatment facilities that provide CSO treatment to flows in excess of treatment and storage capacity. Treatment technologies are being pilot tested for use in future CSO control projects where treatment has been identified as a component because of the volume of flows to be controlled.

#### 3.4.4.1 CSO Treatment at West Point Treatment Plant

In addition to providing secondary treatment for base wastewater flows (defined as 2.25 times the average wet-weather flow of 133 mgd), the West Point Treatment Plant provides CSO treatment (equivalent to primary treatment) for flows between 300 mgd and the peak hydraulic capacity of 440 mgd. After receiving CSO treatment, these 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 in total suspended solids (TSS) percent removal requirements (85 percent removal, under WAC 173-221A-100 3(a)(ii)). Ecology permits this treatment and discharge as a “CSO-related bypass.”

#### 3.4.4.2 Satellite CSO Treatment

All King County CSO treatment facilities must meet technology and water quality–based effluent limits and performance standards defined in the West Point NPDES permit. County experience to date is that conventional primary treatment and disinfection of wet-weather flows are quite challenging because of intermittent occurrence and high peak flows. Other challenges include the high costs of staffing remote sites and variable influent quality.

The county operates four satellite CSO treatment facilities. The Alki and Carkeek plants are former primary treatment plants that were converted to CSO treatment plants after completion of projects to transfer their base flows to West Point. These facilities provide storage, primary sedimentation, and disinfection of CSO flows during storms. Sodium hypochlorite is used for disinfection; both facilities dechlorinate flows before discharge. The Mercer/Elliott West and Henderson/Norfolk CSO control systems came online in 2005. Both systems provide storage and primary treatment in a tunnel, and chlorinate (sodium hypochlorite) and dechlorinate flows before discharge.

During the first three years of operating the Elliott West facilities, King County faced challenges that are typical for such large and complex systems. According to EPA, it takes about 60–90 days to start up a treatment plant that runs continuously.[3] The Elliott West Treatment Facility, however, runs seasonally and intermittently. It has operated approximately 23 days since it went online. This intermittent operation has prolonged the commissioning period. Although the system has not yet achieved complete CSO control, it has made substantial inroads into controlling CSOs at the Denny and Dexter locations.

On September 6, 2007, Ecology issued Notice of Violation (NOV) 5059, citing instances of monitoring, disinfection, and dechlorination failure at the Elliott West Treatment Facility. King County submitted a response on October 5, 2007. Work is under way or being planned to diagnose and successfully address operational problems. Staff and consultants are working to improve screenings removal; modify sampling pumps and sampling stations; improve automatic power transfer; and make chemical system improvements and modifications to the dechlorination structure.

Another hurdle to effective operations were dry-weather flows that entered the Mercer Storage and Treatment Tunnel from City of Seattle connections. In 2006, 2007, and 2008, the city conducted five extensive pipeline cleanings. The city and county are making temporary modifications to the weir to prevent dry-weather flows from entering the tunnel, and will continue to monitor pipes, conduct additional cleanings as necessary, and investigate the cause of the problem.

King County is committed to completing refinements to the Mercer/Elliott West system to achieve full control as quickly as possible and is keeping Ecology informed of progress. Appendix E contains a summary of work that is under way or being planned to diagnose and successfully address operational problems in the system.

The Henderson/Norfolk CSO control system also has operated intermittently. Since it came online in 2005, the system has discharged treated flow three times. It has performed well during storms with only minor issues that were addressed.

More detail on the operation of county CSO treatment facilities is available in the CSO control program 2006–2007 annual report at http://dnr.metrokc.gov/wtd/cso/library.htm#annualreport.

### 3.4.5 CSO Treatment Technology Pilot Program

The county regularly evaluates new technologies for use in its CSO control program. As part of the 2000 CSO control plan update, the county monitored other agency's implementation of new high-rate sedimentation treatment processes. An assessment, completed in 2006, of new technology developments and progress by other agencies found that other jurisdictions have not

[3] U.S. Environmental Protection Agency, *Start-Up of Municipal Wastewater Treatment Facilities*, December 1973, EPA 430/9-74-008.

yet made performance data available for review. The 2006 CSO program review recommended that pilot testing be done of high-rate sedimentation processes.

The CSO treatment technology pilot began in 2007. The objective of the program is to determine if high-rate sedimentation technologies hold the potential to be more cost-effective alternatives than the currently planned conventional primary CSO treatment at the Hanford/Lander No.2, Michigan, Brandon Street, and Kingdome/Connecticut Street CSOs. The program will provide reliable information to support decision-making and will help the county to better understand the performance and limitations of various technologies.

The pilot program consists of three phases:

- Phase 1 (2007) – Project development, jar testing, technology identification, and public involvement
- Phase 2 (2008) – Pilot-scale testing at a treatment plant
- Phase 3 (2009) – Pilot-scale testing at a CSO site, if necessary

Chapter 4

# Public Involvement Activities Related to the CSO Control Program

Public involvement policies in the Regional Wastewater Services Plan are intended to guide King County's Wastewater Treatment Division (WTD) in maintaining public information and education programs and to engage the public and local agencies in planning, design, and operating decisions that affect them. The policies direct that public officials and citizens of affected jurisdictions be involved early and actively in the planning and decision-making processes for wastewater capital projects.

Public involvement for the CSO control program occurs as a component of WTD's larger public involvement program. Since completion of the last CSO control plan update in 2000, public involvement activities have been carried out in support of the following CSO control program elements:

- CSO control program reviews and plan updates
- CSO public notification program
- CSO control projects
- Special projects related to CSO control
- General wastewater management and water quality education

Public outreach objectives and activities were identified for each element and were coordinated among elements through common messages and materials. This chapter describes the activities associated with each element.

## 4.1 Program Reviews and Plan Updates

Whenever the CSO control plan is updated, community input is sought both to shape any changes and to respond to proposals. This process provides a focused opportunity to inform the public about the program and impending decisions and to solicit their opinions.

The 2006 CSO control program review, completed in preparation for this 2008 plan update, recommended that the need for any major program modifications be analyzed after information from the recalibrated hydraulic model and the technology pilot project is available. The focus of the public involvement effort for this update, therefore, has been on preparing the public for later, rather than near-term, decisions. Public involvement activities and their purposes are listed in Table 4-1.

**Table 4-1. Public Involvement Activities for the 2008 CSO Control Plan Update**

| Public Outreach Activity | Date | Purpose |
|---|---|---|
| Public workshop | October 25, 2006 | To educate the public regarding CSOs, current projects, other ongoing work, the technology pilot project, and potential notification program improvements. |
| Interviews and small group meetings | 2007 | To obtain information on local issues and concerns from workshop attendees and other stakeholders who did not participate in the workshop. |
| Area-specific outreach:<br>• Fliers with comment form mailed to stakeholders<br>• Stakeholder briefings<br>• Booths at farmers markets in the vicinity | 2007 | To inform and increase public and stakeholder awareness of CSOs in the Ship Canal and Duwamish Waterway, prepare them for providing input on control priorities and upcoming decisions, to build mailing/contact lists, and to gain understanding of issues and perspectives. |
| CSO control program Web site | Ongoing | To provide program information; access to compliance reports, plans and studies; contact phone numbers; and links. |

Seventy-two individuals were invited to the public workshop, held October 25, 2006. Twenty-one individuals representing seventeen organizations attended. Throughout 2007, follow-up interviews and small group meetings were held with workshop participants and with groups not able to attend the workshop. Proposed improvements to the public notification program were discussed in the interviews. In addition, fliers targeted to the Ship Canal and Duwamish Waterway areas were sent to provide basic program, schedule, and contact information. Recipients of the flier could use a tear-off mailer to request more information or a briefing and to indicate level of interest in Web-based notification.

Public involvement will accelerate again when information from the hydraulic model and treatment pilot project is available. In late 2009 and early 2010, these findings will be presented to the public and dialogue about control project priorities, scope, and schedule will occur. The modeling and pilot project information, along with public input, will be used to propose possible changes to the CSO control plan for inclusion in the 2010 CSO control program review, for submission to the King County Council in 2010, and for inclusion in the CSO control plan update that follows.

## 4.2 Public Notification Program

One of the Environmental Protection Agency’s (EPA’s) Nine Minimum Controls calls for development of a public notification program to “inform the public of the location of CSO outfalls, the actual occurrences of the CSOs, the possible health and environmental effects of CSOs, and the recreational or commercial activities curtailed as a result of CSOs.”

In 1999, King County, Seattle Public Utilities (SPU), and Public Health–Seattle & King County (PHSKC) collaborated to develop a public notification program that would meet EPA's requirement. The program, approved by the Washington State Department of Ecology (Ecology), included posting signs at all publicly accessible CSO locations, providing an information hotline at PHSKC, and conducting outreach activities.

In July 2007, WTD completed a CSO public notification feasibility study. The study focused on the feasibility of providing real-time overflow information to help the public in making decisions regarding contact with affected water and of implementing other program enhancements. Input from SPU, PHSKC, the public, and stakeholders was solicited during the development of the study.[1]

WTD began pilot testing a Web-based real-time notification system in November 2007 (http://dnr.metrokc.gov/wtd/cso/status/). A map on the site shows county CSOs that are overflowing or that have overflowed in the last 48 hours. Status of CSO locations that are linked to the county's SCADA system is updated every 10 minutes. The site is monitored for use by the public to determine if it is useful. The county is working with PHSKC on ways to make the real-time status available by phone and in other languages. If this information is found to be useful, further improvements will be made. To ensure development of a seamless public information system for all CSOs in the area, the county is coordinating with SPU as it explores ways to provide real-time status of city-owned CSOs.

In addition to the real-time Web-site, the notification program now includes a combination of previous and new components:

- Outreach and education through an integrated program that addresses CSO control planning, control projects, public notification, special projects, and general wastewater management and water quality topics (as described in this chapter).
- Communication of status and projects through a county CSO Web site (http://dnr.metrokc.gov/wtd/cso/) that contains data, reports, and links to related information and contacts.
- Maintenance of signage at all publicly accessible CSO sites. The warning signs include a graphic and description of a CSO, the information phone number, and a CSO number assigned to each site that corresponds to its NPDES Discharge Serial Number.
- Continued funding of Public Health–Seattle & King County to provide a Web site covering CSO-related public health information, brochures on CSO risks and precautions, business and group CSO educational visits, and a CSO information telephone line.

[1] The feasibility study can be found at http://dnr.metrokc.gov/wtd/cso/library/Notification/FinalPublicNotificationFeasibilityStudyReport-July2007.pdf

## 4.3 Puget Sound Beach CSO Control Projects

At the start of 2007, work began on four CSO control projects near Puget Sound beaches—Barton and Murray in the West Seattle area, South Magnolia on the north side of Elliott Bay, and North Beach just south of Carkeek Park. State low-interest loans were awarded to fund facility plans for all but the South Magnolia project.

Community involvement for the two West Seattle projects began in 2005 so as to be integrated with pump station improvements (electrical and pump upgrades, installation of emergency generators and odor control facilities). Six meetings have been held with neighborhood associations and Seattle Parks and Recreation, open houses were held in March 2006 and June 2007, a public meeting was held in April 2007, and a Web page was developed (http://dnr.metrokc.gov/wtd/projects/cso/westseattle.htm). Additional activities are planned in 2008 and 2009.

Seven briefings to community groups in the North Beach area and interest groups for Carkeek Park/Piper's Creek have been held so far. In April 2007, WTD participated in an Earth Day event at Carkeek Park. For the event, WTD gave tours of the Carkeek CSO Treatment Plant and provided information on CSOs. A similar event is planned in 2008. The Web page for the North Beach project is at http://dnr.metrokc.gov/wtd/projects/cso/northbeach.htm. Additional activities are planned in 2008 and 2009.

In Magnolia, community interviews were completed, an initial community meeting was held in October 2007, and community group briefings are under way. Four community group briefings have been held to date. The Web page for the South Magnolia project is at http://dnr.metrokc.gov/wtd/projects/cso/southmagnolia.htm. Additional activities are planned in 2008 and 2009.

## 4.4 Special Projects

CSO outreach and education activities are integrated with those of special projects to ensure that the projects are understood in a broader context and to engage the public in the larger CSO control program. Two CSO-related special projects are the cleanup of sediment in the Lower Duwamish Waterway and the CSO treatment technology pilot.

### 4.4.1 Lower Duwamish Waterway Sediment Cleanup

Historical discharges from industries, stormwater outfalls, and CSOs have contributed to sediment contamination in the Duwamish Waterway. The Lower Duwamish Waterway Group (LDWG) was formed as a partnership between King County, City of Seattle, Port of Seattle, and Boeing to address sediment remediation. The partnership is continuing its work under the Superfund project, initiated in 2001 to clean up sediment in the area. WTD's CSO control program initiated this work for the county; the work was later incorporated into the Sediment Management Program.

EPA requires public involvement activities under Superfund. King County contributes funding to EPA to support groups like the Duwamish River Cleanup Coalition (DRCC)—an alliance of community, environmental, and small business groups affected by pollution and cleanup plans for the Duwamish River. This coalition promotes an ongoing exchange with the community regarding CSOs, control status of CSOs, and scientific developments. DRCC and other Duwamish stakeholders have been involved in the update of the public notification program, the technology pilot project, and discussions of CSO control priorities.

### 4.4.2 CSO Treatment Technology Pilot

WTD plans to test high-rate sedimentation technologies at bench- and pilot-scale levels to determine their ability to treat CSOs in the county's system. A stakeholder workshop was held on December 18, 2007, to gain input on technologies to be tested and contaminants to include in the test plan. Stakeholders expressed interest in reviewing the draft test plan, touring the pilot project, and reviewing results. These follow-up activities will occur in 2008 through late 2009.

## 4.5 General Wastewater Management and Water Quality Education

Information on the CSO control program is presented to the public in the context of the county's overall wastewater management programs through various venues, including wastewater treatment plant tours and presentations to community groups, schools, and other agencies.

Questions related to CSO control are included in a water-quality phone survey that King County has been conducting every year since 2002. Results from the most recent survey, completed in 2007, were consistent with those of previous surveys. They indicate that a strong majority of residents (71 percent) are willing to pay $1.50 per month on their sewer bill to reduce wastewater and stormwater releases into Puget Sound. However, only 54 percent indicated that they would be willing to pay $3 more per month in order to build the system in 10 as opposed to 20 years.

In addition, WTD's industrial pretreatment program and the county's local hazardous waste, natural yard care, and related programs educate businesses and residents on what they can do to protect water quality.

Appendix A

# RWSP Combined Sewer Overflow Control Policies

The CSO control policies are intended to guide the county in controlling CSO discharges. Highest priority for controlling CSO discharges is directed at those that pose the greatest risk to human health, particularly at bathing beaches, and environmental health, particularly those that threaten species listed under ESA. The county will continue to work with federal, state, and local jurisdictions on regulations, permits, and programs related to CSOs and stormwater. The county will also continue its development of CSO programs and projects based on assessments of water quality and contaminated sediments.

| Combined Sewer Overflow Policies | How Implemented in 2000–2007 |
|---|---|
| **CSOCP-1:** King County shall plan to control CSO discharges and to work with state and federal agencies to develop cost-effective regulations that protect water quality. King County shall meet the requirements of state and federal regulations and agreements. | The county continues to implement the RWSP CSO Control Program to meet the Washington State Department of Ecology (Ecology) standard of no more than an average of one untreated discharge per year at each CSO location. Highlights in 2000–2007 to achieve this goal include:<br>• In 2005, completed construction and began startup of Mercer/Elliott West CSO and Henderson/Norfolk CSO control systems (these projects were under way prior to approval and adoption of RWSP)<br>• Completed CSO Control Program annual reports as required per the NPDES (National Pollutant Discharge Elimination System) permit for the West Point Treatment Plant<br>• In 2005, upgraded the pumping capacity at the Carkeek CSO plant from 8.4 mgd to 9.2 mgd<br>• Submitted the *CSO Control Program Review* to King County Council in 2006<br>• Continued investigations to determine if proposed levels of CSO control will be sufficient to meet sediment standards<br>• Continued participation and involvement in the Lower Duwamish Waterway Group Superfund studies<br>In 2007, predesign began on four RWSP CSO control projects: South Magnolia, North Beach, Barton Street and Murray Avenue. |

| Combined Sewer Overflow Policies | How Implemented in 2000–2007 |
|---|---|
| **CSOCP-2:** King County shall give the highest priority for control to CSO discharges that have the highest potential to impact human health, bathing beaches and/or species listed under ESA. | The current CSO control schedule aligns with the priorities outlined in CSOCP-2. The CSO program review that was submitted to the King County Council in spring 2006 reaffirmed the RWSP priorities of protecting public health, the environment, and endangered species, which shaped the development of the CSO control program. |
| **CSOCP-3:** Where King County is responsible for stormwater as a result of a CSO control project, the county shall participate with the City of Seattle in the municipal stormwater National Pollutant Discharge Elimination System permit application process. | This policy was developed with the Lander and Densmore separated drains in mind. In accordance with memoranda of agreements, King County and the City of Seattle jointly manage stormwater discharges in the Lander and Densmore drainage basins that occur as the result of county sewer separation projects. In addition, the county is a co-permittee with the City of Seattle for the Densmore NPDES municipal stormwater permit.<br><br>The county and city continue to discuss how to address stormwater prevention and enforcement needs. |
| **CSOCP-4:** Although King County's wastewater collection system is impacted by the intrusion of clean stormwater, conveyance and treatment facilities shall not be designed for the interception, collection and treatment of clean stormwater. | The county remains committed to not building facilities to collect or treat new separated stormwater. |
| **CSOCP-5:** King County shall accept stormwater runoff from industrial sources and shall establish a fee to capture the cost of transporting and treating this stormwater. Specific authorization for such discharge is required. | WTD's Industrial Waste Program coordinates the approvals of and cost recovery for such discharges. |
| **CSOCP-6:** King County, in conjunction with the city of Seattle, shall implement stormwater management programs in a cooperative manner that results in a coordinated joint effort and avoids duplicative or conflicting programs. | To prevent duplication and conflicts, the county and Seattle coordinate on their stormwater and wastewater management programs. In areas served by combined sewers, the city manages stormwater before it enters the county sewers; the county manages the stormwater after it enters the county sewers. The county is responsible for the stormwater that results from county sewer separation projects. In areas served by separated sewers, the city manages most of the stormwater. The county and city are working together and coordinating on source control inspections in the Lower Duwamish basin. |

| Combined Sewer Overflow Policies | How Implemented in 2000–2007 |
|---|---|
| **CSOCP-7:** King County shall implement its long-range sediment management strategy to address its portion of responsibility for contaminated sediment locations associated with county CSOs and other facilities and properties. Where applicable, the county shall implement and cost share sediment remediation activities in partnership with other public and private parties, including the county's current agreement with the Lower Duwamish Waterway Group, the Department of Ecology and the Environmental Protection Agency, under the federal Comprehensive Environmental Response, Compensation and Liability Act.<br>*(Ordinance 15602 amended CSOCP-7 to reflect that a sediment strategy has been developed and is in place.)* | The county continues to work to improve water quality in the Lower Duwamish Waterway through actions such as reducing CSOs, restoring habitats, capping and cleaning up sediments, and controlling toxicants from industries and stormwater runoff. WTD is partnering with the City of Seattle, the Port of Seattle, and the Boeing Company under a consent agreement with EPA and Ecology to prepare a remedial investigation and feasibility study for the Lower Duwamish Waterway Superfund Site. A draft of the remedial investigation report, which defines the extent and inherent risks of contamination, was made available for public review in autumn 2007. The feasibility study, which will identify cleanup alternatives, is scheduled to be completed in 2009.<br>The county is participating in two early action sites—the Diagonal/Duwamish CSO/Storm Drain and Slip 4 CSO. The cleanup at Diagonal/Duwamish was completed in February 2004. Follow-up work was completed at the site in February 2005, and monitoring of these actions is providing critical information on cleanup alternatives for the Superfund site.<br>In 2006, EPA approved a cleanup plan for Slip 4 CSO sediments. Sediments with the highest contamination will be removed, and the remaining sediments will be capped.<br>Monitoring activities in 2005 showed accumulations of phthalates and some other chemicals in front of the Diagonal/Duwamish outfall. This discovery led to formation of the Sediment Phthalate Work Group, composed of representatives from EPA, Ecology, King County, and the Cities of Seattle and Tacoma. The work group is looking at environmental occurrence, sources, risks and receptors, source control and treatment, and regulatory aspects of phthalate sediment contamination.<br>In 2008, King County completed an interim cleanup near the Denny Way CSO. In cooperation with Ecology, King County remediated 18,000 cubic yards of contaminated sediment near Myrtle Edwards Park. A monitoring program established in 2000 will continue to monitor sediments in this area. |

| Combined Sewer Overflow Policies | How Implemented in 2000–2007 |
|---|---|
| **CSOCP-8:** King County shall assess CSO control projects, priorities and opportunities using the most current studies available, for each CSO Control Plan Update as required by the Department of Ecology in the NPDES permit renewal process, which is approximately every five to seven years. Before completion of an NPDES required CSO Control Plan Update, the executive shall submit a CSO program review to the council and RWQC. Based on its consideration of the CSO program review, the RWQC may make recommendations for modifying or amending the CSO program to the council.<br><br>*(Ordinance 15602 updated this policy to reflect current information.)* | CSO control plan updates are due to Ecology every five years–-the updates are done in coordination with the NPDES permit renewal for the West Point Treatment Plant. The CSO program review was submitted to the King County Council in 2006. The next review will be done by 2010.<br><br>New technologies that offer some promise for greater cost-effectiveness will be pilot tested between 2007 and 2009. The hydraulic model used to predict the effectiveness of CSO control and to design CSO control projects is being updated and recalibrated. WTD expects the updated model to be ready in 2008. The Lower Duwamish Waterway Source Control Project is pilot testing enhanced source control methods that if effective, could be added to future efforts. |
| **CSOCP-9:** Unless specifically approved by the council, no new projects shall be undertaken by the county until the CSO program review has been presented to the council for its consideration. CSO project approval prior to completion of CSO program review (beyond those authorized in this subsection) may be granted based on, but not limited to, the following: availability of grant funding; opportunities for increased cost-effectiveness through joint projects with other agencies; ensuring compliance with new regulatory requirements; or responding to emergency public health situations. The council shall request advice from the RWQC when considering new CSO projects. King County shall continue implementation of CSO control projects underway as of the effective date of this section, which are the Denny way, Henderson/Martin Luther King, Jr. way/Norfolk, Harbor and Alki CSO treatment plants. | This policy has been fully implemented. The CSO program review referred to in this policy was submitted to the King County Council in April 2006. No new projects were initiated prior to the submittal of the CSO program review.<br><br>The projects that were under way as of December 13, 1999, have been completed. The Alki transfer of base flow was completed in 1998 and conversion of the plant to CSO treatment was finished in 2000. The Mercer Elliott/West and the Henderson/Norfolk systems were completed in 2005. |

# Appendix B

# EPA's Nine Minimum Controls

The U.S. Environmental Protection Agency's (EPA's) Nine Minimum Controls were developed in 1994 to provide early and relatively inexpensive actions to improve water quality without having to wait for completion of the more expensive capital projects. When they were published, the Nine Minimum Controls packaged and codified elements, including CSO-specific elements, contained in the operations and maintenance programs of well-run wastewater management programs. Most of them were already standard practice in the King County system at the time.

In developing the county's 1996 NPDES permit for West Point, Ecology determined that the County was meeting Controls 1, 2, 3, 4, 5, and 9 and that additional information was needed on county activities related to Controls 6, 7, and 8.[1] King County described how it is meeting the Nine Minimum Controls as part of its CSO control plan update that accompanied the NPDES permit renewal application in 2000. Ecology accepted the county's documentation on Nine Minimum Controls under the 2004 NPDES permit, which was reviewed by EPA. King County updates this information in annual CSO reports to Ecology.

## Control 1. Proper operation and regular maintenance programs for the sewer system and CSOs

Operation and maintenance (O&M) programs are implemented by a matrix of Wastewater Treatment Division (WTD) groups, representing many specialties. Programs do not differ significantly between the combined systems and the separate systems. This ensures consistent planning and procedures, enables efficiencies in sharing expertise and resources, and makes the agency more responsive to unusual circumstances and emergencies. The only significant difference between programs in the combined and separate systems is the greater reliance on flexible and on-call employee scheduling necessary to staff intermittently operated facilities in the combined system.

### Proper Operation

King County operates the treatment plants and the conveyance system from Main Control at each of the secondary treatment plants—West Point and South plants—using a Supervisory, Control and Data Acquisition system (SCADA). Under normal and expected conditions, the systems essentially run themselves based on programmed level setpoints and action sequences. Levels in pump station wet wells and at key points in the conveyance system trigger changes in pump speeds and adjustments of gate positions at the pump, regulator, and outfall stations. These adjustments change the rate of flow through the pipes and, in some cases, its direction. The system setpoints have been developed through an assessment of the elevations and hydraulic

[1] For ease of communication, controls are numbered in this appendix in accordance with EPA's *Guidance for Nine Minimum Controls*, May 1995 (EPA 832-B-95-003 http://www.epa.gov/npdes/pubs/owm0030.pdf).

gradelines in the conveyance system, the combination of years of observation and trial-and-error, and more recently the support of hydraulic models. Setpoints and programming may be modified over time as changes in conveyance or weather patterns are identified, or as new facilities come on line. They also may be reviewed following updates and recalibration of the hydraulic model if optimization opportunities are identified.

Operators are in constant attendance to monitor the SCADA management of the system and can override the automatic controls in unusual circumstances not accounted for in the programming. Such circumstances may include extreme, but localized storms, and equipment shutdowns. County operators are trained and certified under the state's program and maintain their certification through ongoing continuing education.

The operational goal is to move as much flow to the secondary plants as they can handle, while protecting the secondary biomass and meeting NPDES permit requirements. At West Point, this occurs within the constraints of the designed plant capacity—300 mgd secondary, 140 mgd CSO/primary, and 440 mgd peak hydraulic capacity. The final mixed secondary and CSO effluent must meet secondary effluent limits, with a small reduction from the typical percent removal limits for BOD and TSS allowed to account for the variability of wet-weather influent flows. The basis for these West Point design flows is described under Control 4. The transfer of combined flows to South plant is also covered in that discussion.

Treatment processes are monitored and optimized based on information from automatic sensors and a battery of analytical tests. Process control laboratories at each plant implement the testing and assess the results. Both laboratories maintain accreditation under Ecology requirements. Additional analysis, primarily in support of NPDES testing, is done at the county's Environmental Lab, also an accredited lab.

CSO treatment facilities require more operator control because of their intermittent operation and the variable conditions they must manage. These facilities are staffed only when active. Operators deploy to facilities shortly after the SCADA system alerts that CSO treatment is beginning. These operators ensure that proper influent, effluent, and process sampling is done and that the chlorination and dechlorination systems are working properly. When treatment events end, the operators ensure that the stored flows and removed solids are pumped back to the conveyance system for treatment at a secondary plant, and they wash down and secure the facility for the next storm.

Operational coordination and communication among these groups on CSO control objectives and issues occurs through storm debriefs, annual cross-divisional CSO team meetings, an intranet site providing central access to information supporting the work of CSO control, staff briefings, and a CSO team email network. The intranet site has been providing CSO facility operation parameters and overflow frequency and volume data since 1986. Features recently brought online include:

- A blog for cross-divisional communication
- Real-time operational information and conditions for facilities in the combined area, including the ability to scroll back in time for past information and conditions
- Cumulative daily rainfall data

- Tides
- Electronic copies of all documents and studies related to facilities
- Links to engineering drawings and O&M manuals
- Several CSO control-specific training modules

### Regular Maintenance

Inspection and maintenance is done routinely and after storms of treatment plants, offsite facilities, and in the conveyance system. Preventive maintenance is performed during expected dry periods. The conveyance system is maintained primarily by WTD's Asset Management Group. The group conducts inspections, including closed-circuit television inspections, on a schedule and implement refurbishment projects as needs are identified.

Discharges of fats, oils, and grease (FOG) into sewers leading to the county conveyance system are regulated by the county's Industrial Waste Program so as to not result in significant accumulations alone or in combination with other wastes that are capable of obstructing flow or interfering with the operation of sewer facilities. FOG is distinguished in two forms: non-polar FOG (mineral origin) and polar FOG (animal and vegetable origin). Each has different discharge limits or conditions. Dischargers with the potential to violate these limits and conditions may be required to develop a FOG control plan. The goal of the FOG control plan is to implement reasonable and technically feasible controls of free floating FOG.

King County also prohibits discharge to the sewer of materials such as ash, sand, grass, and gravel that are capable of settling and restricting or blocking flow. 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.

## Control 2. Maximize use of collection system for storage

Using the collection system for storage requires a balance between the central plant's capacity to accept combined flows and avoiding backups into streets and home basements or exacerbating City of Seattle CSOs. This balance is accomplished using the SCADA system to operate the conveyance facilities, as described in Control 1.

When flow levels in interceptors reach designated level setpoints (nearly full), the regulator gates modulate, limiting new flows to the interceptors. Flows build up behind the regulators until available upstream capacity is used. Only then will outfall gates be triggered to open and discharge CSOs. In four locations—Carkeek, Lake Union and Denny, West Seattle, and the Henderson/MLK—flows above set levels overflow into CSO storage/treatment facilities. When the storage is full, these facilities provide primary clarification, screening, chlorination, dechlorination, and discharge. At the end of the storm stored flows and removed solids are pumped back to the conveyance system for transfer to the associated central secondary plant.

King County moves flow from its west service area (Figure 1) through year-round and seasonal "flow swaps." The county has a long-term contract with the City of Edmonds whereby the city receives flows from the northwest part of King County's service area via the Richmond Beach

Pump Station near Puget Sound, in exchange for the county's taking an equivalent flow from the Mountlake Terrace area through the Lake Ballinger Pump Station. A temporary agreement (through 2012) stipulates that Edmonds will take all the flow it can from the Mountlake Terrace area during the wet season, with King County taking only the excess peak flows. Edmonds provides secondary treatment to these flows and manages them under its NPDES permit.

Up to approximately 24 mgd of flow from the southeast corner of Seattle and stored storm flows from the Henderson/Norfolk CSO treatment/storage facility are diverted to South plant via the Allentown Diversion. South plant manages these flows under its NPDES permit. This diversion can be turned off if the Interuban Pump Station or South plant need capacity relief, but this happens rarely and only with coordination between the two sections.

A seasonal swap occurs during the winter when flow from the northern parts of the west service area is moved to the east service area through changed operation of the York, Hollywood, and North Creek Pump Stations. The swap offloads the west system during the winter, opening up more capacity to manage combined flows. This swap does not occur on a set schedule. It is fit around other maintenance activities and weather conditions. When the Brightwater Treatment Plant is completed, most of these flows will become part of the new north service area.

The west service area has limited capability to use storage in response to storms. If storms are localized, impacting discrete areas of the system, storage tunnels with excess capacity can be used to hold back flows to relieve the storm-impacted areas. When the Brightwater plant is complete, there may be an increased capability to move flows between the systems via their interconnections. This will be looked at more closely as experience is gained operating the new north service area.

King County operates the system to give priority to moving flows coming in from the north end of the system to West Point and to moving southeast system flows to South plant. A few CSO locations in the northwest part of the service area overflow to saltwater beaches. Most overflow to fresh water—Lake Washington, Lake Union, and the Ship Canal. The southeast part of the combined service area overflows to Lake Washington. Fresh waters have less mixing than saltwater and have high recreational use.

In the southwest part of the service area, priority is given to moving flows away from locations that discharge in the more upstream parts of the Duwamish Waterway to minimize discharges to fresh water and to move discharges downstream, closer to Elliott Bay, for improved saltwater mixing.

Balance between the southern and northern system flows is controlled by the operation of the Interbay Pump Station. When flows begin to rise, the wet well is kept low to boost flow to West Point and draw down the water surface elevation in the Elliott Bay Interceptor, maximizing available storage capacity in the interceptor. When flows from the north are high, they are accommodated at West Point by adjusting the pump station to allow flow into the Mercer/Elliott West CSO storage/treatment facility.

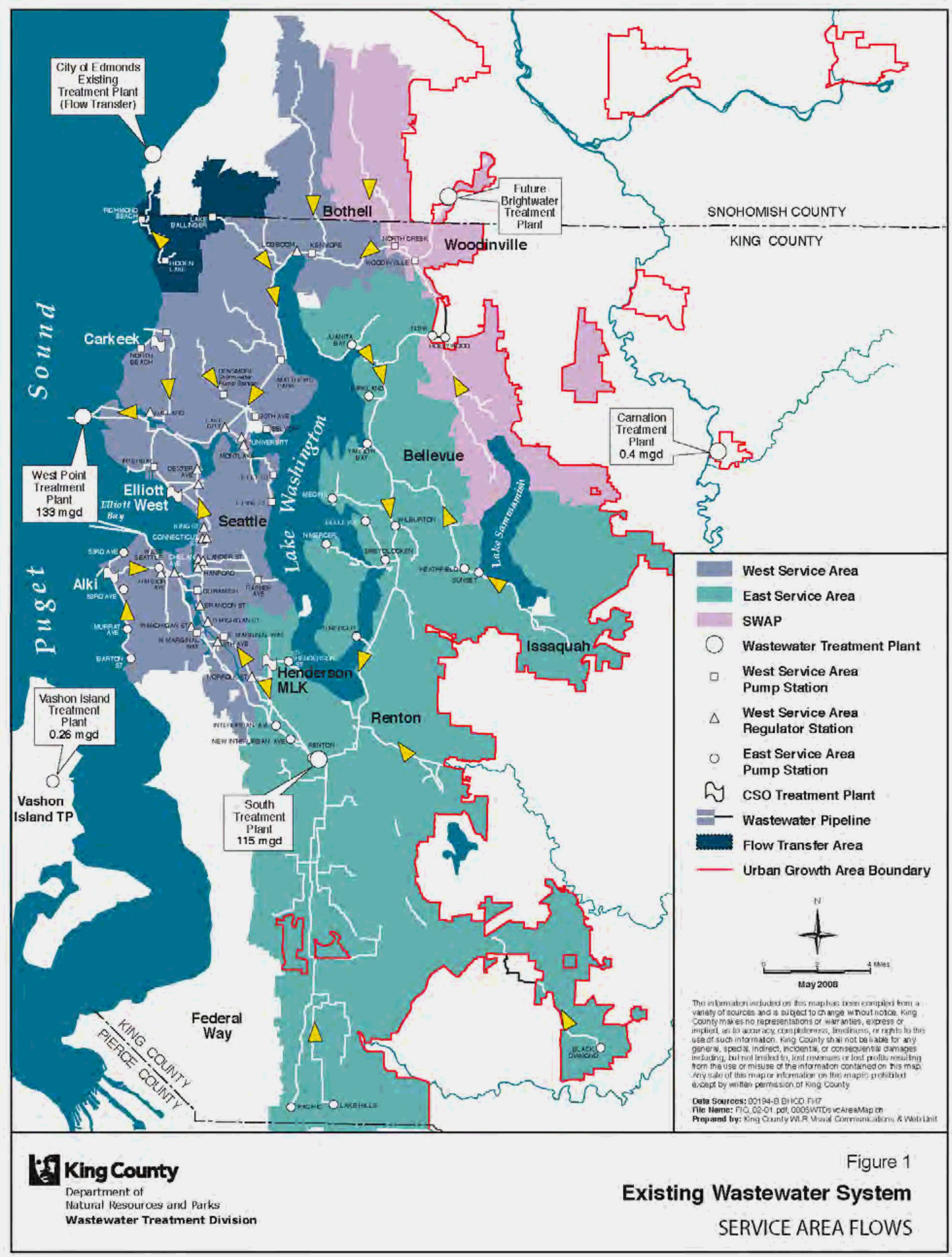


**Figure 1. King County Service Area Flows**

The setpoints and programming may be modified over time as changes in conveyance or weather patterns are identified, or as new facilities come on line. If unused storage capacity is identified during routine conveyance inspections, set points may be adjusted or projects may be implemented to make use of that storage capacity. Additionally, as City of Seattle CSO control projects enter predesign, negotiations occur on the use of the county's system storage and conveyance capacity for their new captured flows.

Saltwater leaking in through gates and outfalls during high tides can use conveyance capacity that would otherwise be available to store and convey combined flows. King County has been periodically monitoring sites throughout the system and at West Point over the past few years to determine the locations and extent of this intrusion. Sufficient information has been gathered to take the assessment to the next level. A new study was initiated in 2008 to assess leaks and to develop a plan to address problems at gates, outfalls, or other sites where intrusion is identified. Any needed small repairs will be performed in house as identified; major repairs will be done through work orders or major capital contracts.

Opportunities to increase storage capacity through control of infiltration and inflow (I/I) are limited in the fully combined areas. I/I control techniques may have application in partially separated areas and are being considered as sewer separation and green infrastructure alternatives in predesign for CSO control projects under the county's long-term CSO control plan.

In 2006, the county proposed ways to improve the wastewater program's system-wide management of flows during emergency flow events. As a result, a cross-sectional collection systems team was formed to work on collection system programs and projects. A second team of conveyance system advisers has also formed to provide additional resources to Incident Commanders during emergency and peak flow events. This team provides advice to decision-makers during emergency and peak flow events and works in conjunction with WTD's Incident Response and Emergency Coordination Team (DIRECT). Members of the advisory group rotate on-call duty.

The county's long-term CSO control program, articulated in the Regional Wastewater Services Plan (RWSP), is built upon conveyance improvements, storage of CSO flows until capacity is available, and satellite CSO treatment facilities. Satellite CSO treatment facilities are considered where siting of large storage tanks is not feasible or the volumes to be managed are so large they cannot be drained from storage tanks fast enough between storms. The RWSP was approved by Ecology in 2000, and the CSO control plan was accepted as an amendment to the original 1988 control plan under the 2004 West Point NPDES permit. In that plan, 21 project concepts were identified for completion by 2030 when full system control would be achieved. Control is defined by Ecology as no more than one untreated event per year per outfall on average. The CSO control plan is updated for each West Point NPDES permit renewal application.

## Control 3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized

This section discusses King County's efforts to determine whether CSO-specific industry permitting is necessary in its service area. The discussion under Control 7 describes industrial pretreatment requirements implemented and enforced through King County's Industrial Waste Program.

Industrial employment population and growth forecasts are provided after each census and updated at interim points by the Puget Sound Regional Council. King County assesses this information, along with historically permitted industrial discharge data, to project flows and identify capacity needs at regular intervals. These assessments indicate that industry discharge volumes are a minor contributor to CSOs and do not warrant special industrial waste permitting in CSO areas.

The industrial character of the combined areas in Seattle has changed over time wastewater quality in these areas differs very little from that in separated system areas. Monitoring done in the late 1980s and early 1990s to characterize CSOs did not identify priority areas for control based on chemical composition. The *1999 CSO Water Quality Assessment of the Duwamish River and Elliott Bay* found that pollution from CSOs is less significant than that from stormwater and upstream sources. Sediment quality is now considered to be a better indicator of pollutant loading to the environment. Far-field recontamination modeling studies done for the county's *Sediment Management Plan* suggests CSO quality is not contributing additional contamination that would cause violations of the sediment standards. The county is working on improvements to that assessment through development and use of near-field models.

King County has concluded that CSO-specific industry permitting will not reduce CSOs or their pollutants, but monitors for changes in conditions that would modify this approach. Influent quality to West Point is assessed for trends that would suggest concurrent changes in CSO discharges. Biosolids quality data from West Point is also tracked as an indicator of changed loading to the system that could influence CSO quality. Key manhole monitoring may also be used to identify system character changes. The only trends seen are the slow decrease or stability in pollutant concentrations. Emerging chemicals of concern are assessed for their impact on CSOs through local and national studies.

King County will focus on implementing control projects to achieve remaining CSO control as the most efficient way to improve water quality.

## Control 4. Maximize flow to the central plant

Maximizing flow to the central plant is a balance between the central plant's capacity to accept and manage the combined flows and avoiding backups into streets and home basements or exacerbating City of Seattle CSOs. This balance is accomplished using the SCADA system to operate the conveyance facilities and careful planning of new facilities and their operation. Operators are in constant attendance at each plant's Main Control and can run the system manually as needed. Under normal and expected conditions, the conveyance systems essentially run themselves based upon programmed level setpoints and action sequences. The goal is to move as much flow to the secondary plants as they can handle while meeting NPDES permit requirements.

The design of the West Point secondary plant upgrade in the late 1980s was constrained by three major factors: a small site, the need to meet secondary discharge limits, and the requirements of a settlement agreement with the residents in the area and other groups that enabled the county to move forward with the upgrade. In the settlement agreement, the county agreed to limit all future pollutant loadings to the Puget Sound from the plant to that permitted in the first secondary plant NPDES permit in 1996.

If unused storage capacity is identified during routine conveyance inspections, setpoints may be adjusted or projects may be implemented to make use of that capacity and to transfer more flow to the central plant. This most recently led to upsizing of the pipeline from the Brandon Regulator Station to the Elliott Bay Interceptor. Setpoints and programming also may be reviewed if optimization opportunities are identified following updates and recalibration of the hydraulic model. This is done recognizing that flow from one location may displace that from another and that those flows must then be managed. See Control 1 for more details on the operation of the central plants and conveyance system.

## Control 5. Elimination of CSOs during dry weather

The King County combined system experiences almost no dry-weather overflow, which typically occur in places with inadequate conveyance capacity for base flows. The need for new base flow capacity is assessed as part of population and flow studies done by the county when new or updated census data become available from the Puget Sound Regional Council.

Until recently, King County reports on sanitary sewer overflows included discharges that occurred during rain but which were worsened by other factors such as power outages, mechanical failures, or human error. Ecology now requires more specificity in defining dry-weather overflows. Review of overflow reports from 2003 to the present indicate that approximately four true dry-weather overflows occurred from CSO facilities. These overflows resulted from programmable logic controller failures, human error during maintenance, and a power outage. During this period, the county reported that eight discharge events at CSO facilities were caused by power outages or mechanical failures and not by storms. The most significant events were related to the rupture and repair of the Barton Force Main in early 2006 and to significant regional storms in November and December of both 2006 and 2007.

Several years ago a review of overflow data indicated that power outages was the only common factor in dry-weather overflows. The county had been relying on portable generators at most pump stations, but a decision was made to install permanent backup generators in pump stations lacking reliable dual power feeds. That process has been under way for several years and is nearing completion. O&M activities that help avoid dry-weather overflows are described under Controls 1 and 2.

## Control 6. Control of solid and floatable materials in CSOs

Floatables from CSO are not an identified problem in the Seattle area because of routine inspections and the following practices:

- County facilities are constructed with weirs and gates that minimize the release of solid and floatable materials.

- Gates are set to maximize flow containment and open from the top down (to hold back solids) or over weirs that tend to hold back all but the smallest items.
- Flows to the treatment plant are maximized to capture the "first flush" so that solids and floatables are conveyed to the plant for removal and disposal.
- CSO control projects are built to retain any floatables and solids in the sewer.

The county's further approach to floatables includes coordination with the City of Seattle and other agencies on measures to reduce the amount of solids and trash carried into sewers by stormwater. These approaches are covered under Control 7.

The City of Seattle has all authority and funding under its drainage ordinance and fees to manage stormwater in the city. All businesses and privately owned stormwater systems are required to implement operational and structural source controls to reduce stormwater pollution.

The county will focus resources on implementing CSO control projects as a part of its long-CSO control plan that will include additional floatables controls. The count will also monitor developing technologies for better benefits.

## Control 7. Pollution prevention programs to reduce contaminants in CSOs

Pollution prevention keeps contaminants from entering the sewer system and discharging to receiving water in CSOs. Pollution prevention is aimed at controlling pollution at its source, before it is produced and before it enters stormwater runoff or surface waters. The focus is on changing people's behaviors rather than building new facilities. The following sections describe King County and City of Seattle pollution prevention programs.

### Industrial Waste Program

The King County Industrial Waste Program is delegated to administer the federal pretreatment program of the Clean Water Act (33 U.S.C. 1251 et seq. and General Pretreatment Regulations - 40 CFR 403) by Ecology (Chapter 35.58 RCW). In addition, under King County Code 28.84.060 and Public Rule PUT 8-13, the program has developed local limits for indirect discharges into the county system to ensure that WTD workers are protected from hazardous chemical exposure, to protect the quality of biosolids for recycling, and to prevent pass-through of chemicals to receiving water bodies in violation of water quality standards. Worker safety is often the most important factor in setting limits. The county applies the more stringent of applicable federal discharge limits or local limits to industries and businesses through discharge authorizations.

The type of approval is determined by the nature of the business, the volume and characteristics of wastewater, and potential risk to the system. Types of approvals are as follows:

- Permits - Wastewater discharges generally greater than 25,000 gallons per day (gpd) or federally required industry (categorical industry).
- Discharge authorizations - Wastewater discharges generally less than 25,000 gpd but more than 1,000 gpd.

- Letters of authorization - Wastewater discharges generally less than 1,000 gpd
- Verbal authorizations - Small and one-time discharges.

Under these authorizations, businesses may be required to implement self-monitoring and to report that data and other aspects of their compliance. King County performs inspections and monitoring to verify compliance. Outreach to businesses occurs through compliance assistance visits, a newsletter, and a Web site at http://dnr.metrokc.gov/wlr/indwaste/index.htm .

Industrial Waste regulates the discharge of construction dewatering water through discharge authorizations. Discharges to the sewer system are allowed during dry weather and during the wet season months of November through April if limited to 25,000 gpd. Higher volume discharges will be considered if authorization to discharge to surface waters cannot be obtained from Ecology or if the discharge is an emergency temporary discharge. Dischargers upstream of CSOs may be required to provide storage onsite and to cease discharge during heavy rainstorms when CSOs may occur.

Discharges of stormwater from private property are not permitted to the sanitary sewer in separated areas except when it is contaminated by industrial activities, and then under specified conditions. Combined sewer areas are designed to accept stormwater, but King County may require best management practices (BMPs) or pretreatment of contaminated industrial stormwater discharges.

### Local Hazardous Waste Management Program

WTD funds 17 percent of the King County Local Hazardous Waste Management Program and administers the program. The goal of the program is to reduce the quantities of hazardous waste generated by households and small businesses and to divert these wastes from municipal waste streams and indiscriminate disposal in the environment. Program services include household hazardous waste education and collection; small business education, technical assistance, and compliance assistance; small quantity generator collection and waste handling; an industrial materials exchange; a hazardous waste library; and a pilot program for the collection of unused prescription medications. In 2006, 1,800 tons of hazardous waste was collected from 36,000 customers at transfer stations and mobile collection sites.

### Public Information Programs

King County has developed public information programs as part of our ongoing public information activities to discourage flushing household trash down toilets and to promote proper disposal of the trash.

### City of Seattle Programs

The County also relies on City of Seattle implementation of programs that minimize the discharge of pollutants into the combined system, such as storm drain stenciling, motor oil disposal pet waste disposal, natural lawn and garden care, green approach to cleaning, hazardous waste disposal and reduction

The city runs a program through its compliance with Nine Minimum Controls to prevent street trash from entering the combined system (see the city's NPDES report). Literature reviews indicate that 85 percent of floatables can be prevented by programs like the ones that Seattle is implementing:

- ***SDOT Street Maintenance.*** Seattle Department of Transportation Street Maintenance crews sweep major arterials on a regular basis, ranging from daily to every two weeks, depending on the need. Most minor arterials are swept once a month; some are swept only when requested. Because of their heavy use, downtown streets are swept every night, and alleys are cleaned five nights a week. They are hand-cleaned and flushed once per week. They also clean streets after parades and other special events.
- ***Clean Seattle.*** (Citizen and business education and involvement).
- ***Adopt-a-Street.*** Volunteer litter collection (citizen and business education and involvement).
- ***Adopt-a-Storm Drain.*** Volunteer removal of leaves and debris from drain inlets.
- ***Illegal dumping report line.*** Provides a mechanism for the general public to report the illegal dumping of material in Seattle.
- ***Waste Free Holidays.*** Also sponsored by King County Solid Waste Program. Educates the public regarding holiday gifts that result in little or no waste byproducts.
- ***Event recycling.*** Provides temporary recycling receptacles at public and private festivals and events to encourage recycling.
- ***Public litter and recycling cans*** at numerous public locations throughout the city.
- ***Spring Clean.*** An annual event to provide the general public with an opportunity to properly dispose of household surplus items.
- ***Surface water pollution report line.*** Provides a mechanism for the public to report observed pollutants entering surface waters. The focus of the program is to reduce pollution in surface waters that eventually make their way to waters of the state; however, these surface waters can sometimes enter the combined sewer system.
- ***Street Sweep Project.*** A pilot project to determine the effectiveness of focused street sweeping and evaluate street sweeping technology for reduction of debris and sediment entering the storm drain system. (If results are favorable, focused street sweeping could be expanded to combined sewer areas.)
- ***Friends of Recycling.*** A volunteer program to provide educational materials and training to apartment and condo dwellers so that they can share the information with their neighbors.

## Control 8. Public notification program to ensure that public receives adequate notice of CSO events and impacts

The King County Department of Natural Resources and Parks, Public Health–Seattle & King County, and Seattle Public Utilities jointly developed and are implementing a CSO Notification and Posting Program. Ecology approved the program as meeting state and federal requirements for public notification and providing information to the community regarding the possible health impacts of CSOs. Public notification is one of EPA's Nine Minimum Controls. The County's program has evolved to integrate with other WTD public information and involvement programs. The current program includes the following elements:

- Outreach and education through an integrated program that addresses CSO control planning and updates, control projects, public notification, special projects (e.g., sediment remediations and technology pilots), and general wastewater management and water quality topics. Program activities include workshops, open houses, brochures, mailings, briefings, meetings, and treatment plant tours. A list of recent public contacts is available on request.
- Communication of status and projects through an informative county CSO Web site that contains data, reports, and links to related information and contacts.
- Maintenance of signage at all publicly accessible CSO sites. The warning signs include a graphic and description of a CSO, the information phone number, and a CSO number assigned to each site that corresponds to its NPDES discharge serial number.
- Continued funding of Public Health–Seattle & King County to provide a Web site covering CSO-related public health information, brochures on CSO risks and precautions, business and group CSO educational visits, and a CSO information telephone line.

The recently modified NPDES permit for West Point required the County to conduct a study to determine the feasibility of providing more immediate notification of overflows, including the feasibility of providing a Web-based system. Technology upgrades to the West Point SCADA system allowed for provision of "real time" overflow information on the Internet. This information is available at http://dnr.metrokc.gov/WTD/cso/status/index.htm

More detail on this program, the alternatives considered, other agency approaches, and public involvement is provided in the *Final Public Notification Feasibility Study*, submitted to Ecology on July 1, 2007.

Discussions are occurring with Public Health–Seattle & King County and Seattle Public Utilities on methods to provide information on City of Seattle CSOs, to inform the community, including non-English speaking residents, about the availability of this information, and to increase accessibility to the information. The notification program will evolve and change over time.

## Control 9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls

Studies have been done since the 1970s to assess water quality and develop solutions to problems identified through the assessments. These studies have looked at CSOs but have often identified other pollution inputs as being a higher priority for control activities. King County and its predecessor agency Metro have relied on scientific studies in their decision-making. They have actively contributed to those studies and when data gaps have been identified, have been quick to initiate studies to address them. More detail is provided in Appendix D on the history and the implications of these studies to the CSO control program.

Metro implemented specific monitoring in the late 1980s and early 1990s to characterize CSOs and the sediments in front of the outfalls. This monitoring did not identify priority areas for control based on chemical composition.

Receiving water monitoring done under the 1986 and 1999 NPDES permits could not distinguish any CSO impacts distinct from seasonal water quality changes unrelated to CSOs. Recognition of the limitations of receiving water monitoring led the County to turn to modeling to identify any CSO impacts. The 1999 *CSO Water Quality Assessment of the Duwamish River and Elliott Bay* was a sophisticated monitoring and modeling study done to assess CSO impacts and predict improvements from CSO control. This assessment found that pollution from CSOs is less significant than that from stormwater and upstream sources.

King County now considers sediment quality and projected sediment quality to be a better indicator than water quality of pollutant loading to the environment. Far-field recontamination modeling studies done for the county's 1999 *Sediment Management Plan* suggest that CSOs are not contributing additional contamination that would cause violations of the sediment standards. As a result, the county is moving forward on sediment remediation projects rather than waiting for the CSO control projects to be completed. The county is also working on developing near-field models to better understand sediment contamination near CSOs. Work related to sediment remediation in the Lower Duwamish Waterway and East Waterway Superfund sites is developing the most state-of-the-art science available on the impacts of CSOs. The county CSO control program will continue to monitor developments from these processes for any implications to the control plan.

All completed CSO control projects are monitored for the number of overflow events and total volume each year to confirm successful control and continued compliance with the state's control standard of no more than one untreated discharge per outfall per year on average. The state's water quality standards exempt the one untreated event per year from mixing zone limitations. Controlled sites will essentially have an unlimited mixing zone while still meeting water quality standards.

All CSO treatment plants have effluent limits defined in the West Point NPDES permit. Discharges are monitored for total suspended solids, settleable solids, pH, bacteria, chlorine, and any other parameters required by the permit. Permit limits are designed to ensure that discharges do not violate water quality standards. Discharges in compliance with the permit will meet EPA requirements.

Sediment modeling described above predicts no recontamination from the currently uncontrolled discharges, so none is expected after control. Post-construction sediment monitoring will be negotiated on a case-by-case basis.

Appendix C

# Description of Models Used for Metro/King County CSO Planning


1979 CSO Control Program .......... C-1
1986–1988 CSO Control Plan .......... C-2
CATAD Program Improvements—Predictive Control Program Begins .......... C-3
The 1995 and 2000 CSO Control Plan Updates .......... C-4
SCADA/CATAD as of CSO Control Program Review .......... C-4


King County’s approach to modeling has changed over time. This has resulted from improvements in the science of modeling and available models, as well as improved information about the conveyance system. The history of this effort follows. It is also summarized in Table 1.

## 1979 CSO Control Program

In this program, models specifically developed for the 1976 Metro 201 Facilities plan were used. These included a model known as HYDRO to generate runoff from storms.

HYDRO used a synthetic unit hydrograph technique to calculate surface runoff from rainfall. The synthetic unit hydrograph is a triangular hydrograph of the flow that would result from one inch of rain in a ten-minute period. Unit hydrograph shape was dependent on the shape of the area from which runoff was being calculated. Two sets of independent calculations were performed for impervious and pervious surfaces.

Sanitary sewage flows were represented in the 1979 modeling by diurnal hydrographs adjusted in magnitude based on the land use of individual tributary areas. A base infiltration factor (usually 1,100 gpad, but adjusted for measured flows) was added to compute base sewage flow. Runoff computed by the unit hydrograph technique was then added to base wastewater flows.

The total flow hydrographs computed in each basin of the system were routed through Metro's interceptors using a model known as “NETWORK.” NETWORK was a specially developed model using a kinematic wave approximation to the full equations of motion. The kinematic wave approximation does not fully account for backwater effects from pump stations and regulator gates, or any other downstream flow restriction. Thus, a complete description the system operation was not available (the actual impact of throttling back on the Interbay pump station could not be precisely simulated for example). Because flows from the north end of the system were not large, these were simulated as a constant value in development of the 1979 plan.

# 1986–1988 CSO Control Plan

In the modeling effort for the 1986–1988 CSO Control Plan, consultants used different programs to generate inflow hydrographs from the separated and combined portions of the service area. For the separated sewer area (upstream of the Lake City Regulator) the program LCHYD was used to generate flows from nine sub-basins. A diurnal base flow (e.g., showing two peaks within the same day) hydrograph was developed based on domestic/commercial and industrial populations. A linear relationship was assumed between rainfall and inflow, up to a maximum amount. Infiltration was assumed to be constant for the wet season. A maximum inflow value of 500 gallons per acre per day (gpad) was used for simulating future flows from currently non-sewered areas that were expected to develop and include sewers in the future.

The program LCPRE was used to take into account that peak flows do not occur at the same time in all parts of the system. This lag was incorporated into the simulation.

For the combined system, the program HyDRO72 was used to generate hydrographs from 19 basins in the Northern service Area (NSA). This was a modification of the HYDRO program used in the 1979 CSO control program. Several of the basins in the HYDRO simulation were combined for use in the HYDRO72 model. Furthermore, the length of simulation was increased from24 hours to 72 hours for HYDRO72, which allowed for longer storm events to be simulated.

The same basin parameters from the 1979 CSO Control Program effort were used in the 1986 effort. Despite concerns about the model, a decision was made to continue using the model for continuity with past planning. Five design storms were used to estimate annual CSO volumes and frequencies under existing (at that time) conditions and under future conditions.

The input hydrographs were then used as input to the SACRO (Seattle Area Central Routing Organization) simulation. SACRO simulated the routing of flow through the northern service area (NSA) of the wastewater system. It was designed to give reasonable estimates of the volume of flow through the NSA system. The flow from Interbay Pump Station was assumed to remain the same throughout the study period (1982–2030).

For the wet season, it was assumed that infiltration would remain the same as in the 1981-83 model calibration, at 1100 gpad. HYD72 (similar to HYDROT2) was used to generate synthetic unit hydrographs from 62 basins in the SSA. Seven design storms of varying length and intensities were used to estimate annual CSO frequencies and volumes for the SSA.

The Southern Service Area (SSA) large pipe flow was simulated using SSACRO (South Seattle Area Control Routing Organization). It was developed using primarily SACRO and some of NETWORK. It is based on level pool storage routing concepts and therefore does not accurately represent dynamic wave storage or routing. The program only calculated how the different input hydrographs travel through the system – combining sewer junctions, splitting at diversions, etc. It did not simulate the restriction of flows at the Interbay Pump Station due to flows at the West Point treatment plant exceeding its setpoint, which at that time was 325 million gallons per day.

SSACRO and SACRO basically added up all flows into a particular node (regulator, pump station, etc.), subtracted away that which could be hydraulically conveyed away from the node, and if anything was left, it was either stored or called an overflow. They are mass balance models, and do not compute water surface elevations in the collection system.

The program EBIPRE was developed to simplify and reduce the time involved in routing flows through the Elliott Bay Interceptor. It lagged inflow hydrographs and then combined them to be used in the routing model SSACRO. It also accounted for some of the City of Seattle CSOs and storage projects.

SACE (Seattle Area Combined Sewer Overflow Evaluator) was written to allow rapid testing of alternatives and to determine recurrence periods of overflows for design events. It calculated annual overflows for the wastewater system for the 1942-84 period. The SACE program simply assigned portions of each rainfall event to (l) system capacity; (2) system storage; and (3) rainfall that couldn't get into the sewer. The amount of available storage was increased during inter-event periods to reflect the draining of wastewater from storage. For each rainfall event, the wastewater entering the sewer that could not be contained in “system capacity” or “system storage” was considered to be CSO. There was no simulation of the flow as it proceeded toward the treatment plant.

# CATAD Program Improvements—Predictive Control Program Begins

In 1986, a different approach was begun to model the West Point (combined) system, leaving behind the previous model. The effort was to support the development of an optimized real-time control program for the West Point collection system. The Predictive Control Program was to allow the Computer Augmented Treatment and Disposal System (CATAD) to automatically operate regulator gates and optimize in-line storage throughout the entire collection system to minimize CSOs.[1]

As part of this new approach, two new programs were developed to simulate flow through the West Point system. A kinematic wave runoff program was developed to simulate overland flow resulting from rainfall. Flow over both pervious and impervious areas that enters the sewer system was simulated. The West Point system was divided into over 400 basins to simulate this overland flow. This flow was then routed through a kinematic wave transport program, which effectively simulates the lagging and attenuation of flows through the local sewer pipes. The program also computes depths and velocities of flows in each pipe, and is a good approximation of actual conditions as long as there are no backwater effects or hydraulic transients (e.g., hydraulic phenomenon that are short in duration). Unlike previous programs used to model the wastewater, the runoff/transport program is a physically-based model that attempts to directly simulate the flow mechanics of the local sewer system. The program simulates a diurnal base domestic flow and a constant groundwater leakage. Inflow from rainfall induced hydrographs were simulated and input into the appropriate pipes for routing.

[1] Automatic control by CATAD was implemented in 1974. Predictive Control optimizes it.

Over 70 flowmeters were installed to calibrate the runoff/transport model in the late 1980s.

The model UNSTDY was obtained in 1986 from Colorado State University to simulate the routing of runoff/transport flow hydrographs through the Metro/King County trunks and interceptor system. UNSTDY is a complex, fully dynamic simulation that computes flows, depths, and velocities in all pipes in the system. The full hydraulic equations are solved implicitly which enables it to simulate backwater effects, flow reversals, and gravity waves effectively. This sophistication was required to accurately simulate the in-line storage being utilized throughout the collection system. The model was enhanced to simulate the operation of the regulator gates and pump stations.

UNSTDY was programmed to simulate the regulator system using local control (manual control), the existing Automatic Control, and the new Predictive Control. In early 1992 it was discovered that several of the level sensors (bubblers) were reading incorrectly, and probably had been since installation. The UNSTDY simulation was modified to be able to simulate control structures as they would have been operated if the sensors were reading incorrectly, as well as if they were reading correctly. This option (which simulates flow assuming errors in the levels sensors) is used when simulating conditions under “baseline” (1981 -83) conditions.

The runoff/transport program was enhanced in the early 1990s to include rainfall-induced infiltration into the sewer system. This infiltration can be the largest component of I/I during large storms in the separated portion of the County sewer system. This modification allows King County to simulate the flow from the northern part of the West Point service area much more accurately than had been possible previously.

## The 1995 and 2000 CSO Control Plan Updates

For the 1995 CSO Control Update the same seven design storms used in the 1988 plan were used to estimate annual CSO volumes. For the 2000 CSO Control Update, 11-year continuous simulations were used to estimate CSO frequencies and volumes. As each flow transfer or CSO project is constructed, UNSTDY is modified to include that facility. For example, the Hanford/Lander Separation Project is included for simulations past 1990. The Carkeek flow transfer was included beginning in 1994. The Allentown Diversion was included in 1996. The Alki Flow transfer was included in 1998 as was the University CSO Project (Densmore Pump Station). The Denny Way CSO facility, the Harbor CSO transfer to the West Seattle Tunnel, and Henderson/Martin Luther King Way CSO facility are being simulated for 2005 and beyond.

## SCADA/CATAD as of CSO Control Program Review

Computer hardware at West Point has been replaced in 2004–2005 for the offsite facilities. Software upgrades have also been done for operating the offsite facilities and for collecting, storing, and retrieving their data. The links and software are currently undergoing QA/QC. New control strategies are being tested and implemented for the facilities that came online in 2005.

## Table 1. Summary of Hydraulic Models Used by King County

| Decade | Models: Hydrologic (surface runoff and local system flows) | Models: Hydraulic (Metro/KC trunks and interceptor flow) | Brief Description of Capabilities |
|---|---|---|---|
| 1970s | HYDRO | | Used synthetic unit hydrograph method for runoff due to rainfall from 58 NSA basins and 62 SSA basins. |
| | | NETWORK | Used kinematic wave approximation for simulating flow through Metro trunks and interceptors. |
| 1980s | LCHYD | | Used diurnal base flow and constant infiltration to generate hydrographs from separated areas. Linear rainfall/inflow relationship. |
| | HYDRO72 | | Used synthetic unit hydrograph method for 19 basins in NSA. |
| | HYD72 | | Used synthetic unit hydrograph method for 62 basins in SSA. |
| | | LCPRE | Lagged the hydrographs from LCHYD to put into SACRO. |
| | | SACRO | A mass balance model that simulated flow through the NSA. (Kept track of flow but didn't solve hydraulic equations for levels.) |
| | | SSACRO | A mass balance model that simulated flow through the SSA. |
| | | EBIPRE | Lagged the hydrographs from HYD72 to put into SSACRO. |
| | | SACE | Estimated total system overflows based on rainfall only. |
| 1990s — 2000s | RUNOFF | | Kinematic wave simulation of runoff due to rainfall from > 400 basins. Variable inflow and infiltration based on rainfall and soil conditions. A physically based model. |
| | | UNSTDY | A fully dynamic simulation of flow through King County trunks and interceptors. Computes flows, depths, and velocities in all pipes in the system. Simulates backwater effects, flow reversals, gravity waves, surcharges, etc. Simulates automatic operation of regulator and outfall gates and pump stations. Also, simulates Predictive Control, a computer program that controls the regulator gates to optimize the use of in-line storage.<br><br>Used seven design storms in early 90s to estimate annual overflows. Now continuous 11-year simulations are run to estimate annual averages. |

NSA = Northern Service Area (North of the Ship Canal)
SSA = Southern Service Area (South of the Ship Canal)

Appendix D

# Foundational Studies

King County, and its predecessor agency Metro, have consistently considered scientific information in making wastewater management decisions. When information has not been available, they have initiated or participated in special studies to develop the needed information. This appendix describes the foundational studies that have shaped King County's decisions on CSO control through submittal of the 2000 CSO control plan update. Studies conducted since the 2000 update are described in the body of the report.

## 1958 *Metropolitan Seattle Wastewater and Drainage Study*

Beginning with the 1958 *Metropolitan Seattle Wastewater and Drainage Study,* regional agencies have collaborated on studies to identify major environmental protection needs and to identify and prioritize corrective actions. This study recognized that providing better wastewater management would result in the most environmental improvement. As a result, the regional wastewater agency, Metro, was formed to put the new wastewater system in place.

**CSO Implication:** As part of the larger three-stage schedule of projects, the study recommended a program of sewer separation and storage, as needed, to control overflows in the City of Seattle.

## 1978 *Areawide Section 208 Water Quality Plan*

As early as 1974, Metro recognized the need to consider the presence and fate of toxic chemicals in its planning and management activities. The initial focus was on characterizing treatment plant and combined sewer discharges for heavy metals. Investigation of sediment conditions near Metro outfalls was a component of these first efforts. The scope of later studies was expanded to assess organic compounds (notably pesticides and PCBs) and the complex interaction of chemical contamination, biological impairment, and source identification and control strategies.

Two years of investigation was done under Section 208 of the federal Clean Water Act. Toxic chemicals were identified as one of the five main water quality problems facing the Seattle–King County region. The plan recommended public and private actions to control pollutants entering regional waters.

**CSO Implication:** The plan recommended CSO control as part of improved wastewater management and identified the need for more understanding of the toxic impacts of CSOs.

# 1979–1984 *Toxicant Pretreatment Planning Study*

In 1979, Metro, with the support of the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology), initiated a 5-year, $7 million (1979 dollars) study—the *Toxicant Pretreatment Planning Study* (TPPS)—to develop a better understanding of toxic chemicals in the environment and in wastewater, and of their impacts and treatability. A scientific advisory panel provided advice, oversight, and review during the study.

Recommendations of the study included the following:

- Develop an action plan to clean up toxicants in Elliott Bay.
- Strengthen Metro's industrial pretreatment program to meet increasing emphasis on toxicant control at the source.
- Continue source control programs and promote a general “source control attitude.”
- Implement Metro's adopted facilities plans.
- Focus on continued toxicant research.

Table 1 lists the reports produced as a part of the *Toxicant Pretreatment Planning Study*. Information from the TPPS and from two complementary studies, *Household Hazardous Waste Disposal* and *Toxicants in Urban Runoff*, became a basis for the policy decisions in the 1980s.

**CSO Implication:** The TPPS recommended that CSO control should be part of a coordinated Elliott Bay Action Plan and that source control, including enhancing Metro’s pretreatment program, should be a priority.

**Table 1. Documents Produced as Part of the *Toxicant Pretreatment Planning Study***

| Title | Topics |
|---|---|
| TPPS Summary Report | Synthesis of all TPPS and related project information, problem definition, conclusions and recommendations. |
| Al: Treatment Plant Evaluation | Occurrence of toxicants in wastewater treatment plants, removals, mass loadings, and balances. Alum addition and the impacts of Renton sludge. |
| A2: Collection System Evaluation | Occurrence of toxicants in various land use types, estimates of total loadings by land use types, toxicants in CSO's, and evaluation of a Duwamish satellite treatment plant. |
| A3: Industrial Waste Characterization | Occurrence of toxicants at selected industrial locations, identification of total industrial loads of toxicants to West Point and Renton (South plant). |
| A4: Source Controls—Pretreatment Evaluation | Industrial pretreatment program review and recommendations plus other toxicant control options. |
| Technical Report B: Pilot Plant Studies | Occurrence of toxicants, mass loadings, and balances of pilot-scale studies on alum-assisted primary treatment, secondary treatment of West Point wastewater, and anaerobic digestion. Bench-scale alum and powdered activated carbon studies. |
| C1: Evaluation of Toxicant Transport and Fate | Occurrence of toxicants in receiving waters, sources of toxicants, transport, and deposition. |
| C2: Puget Sound Benthic Studies and Ecological Implications | Analysis of biological testing of bottom sediments in Puget Sound and correlation with toxicant loadings. |
| C3: Lake Washington Benthic Studies and Ecological Implications | Analysis of biological testing of bottom sediments in Lake Washington and correlation with toxicant loadings. |

# 1983 *The Water Quality Assessment of the Duwamish Estuary*

Because of the potential conflict between uses of the Duwamish Waterway, EPA and Ecology classified the estuary as a high priority study area. In the 1982 state/EPA agreement, both agencies identified the Duwamish Waterway as having one of the four worst water quality problems in the state. As the designated water quality management agency for the Green/Duwamish basin, Metro was awarded a grant to inventory pollutants entering and impacting the waterway and to develop a strategy for pollution control. The 1983 *Water Quality*

*Assessment of the Duwamish Estuary* (also known as the Harper-Owes Study) documented this work. It overlapped TPPS activities in some areas.

The assessment synthesized the findings of the many Duwamish studies performed through July 1982 in order to identify data strengths, deficiencies, and gaps requiring further investigation. Public input and interagency task force review comments were considered in developing a ranked list of beneficial uses of the estuary. Mass balances were performed for 20 parameters to identify impacts to beneficial uses. Upstream sources were found to contribute more than two-thirds of the total sediment, iron, and mercury load, as well as much of the organic carbon and pesticides. Major impacts to beneficial uses were attributed to ammonia, residual chlorine, copper, lead, mercury, PCBs, and PAHs. Temperature, dissolved oxygen, nitrite, cadmium, DDT, pathogens, and sediments were considered to produce only minor impacts.

The Renton Treatment Plant (now called South Treatment Plant) was found to contribute nearly 80 percent of the total ammonia load. The anticipated diversion of Renton plant effluent out of the Duwamish River in 1986 was expected to result in marked reductions in ammonia, chlorine, dissolved oxygen, nitrite, and cadmium impacts. CSOs were found to be a source of all pollutants measured—but only a small source. One exception was fecal coliform bacteria. An estimated 80 percent of the total pathogens released to the estuary was estimated to originate from CSOs. While concentrations of toxicants were found to be relatively high in CSOs, the small annual volume made them a minor source.

The most significant finding was that the majority of metal and organic toxicants could not be attributed to documented sources, which shifted attention to the heavy industrial and commercial activity along the river. Future conditions were projected to adversely impact beneficial uses. Temperature, sediment, pathogens, copper, lead, mercury, PCBs, and PAHs were identified as the greatest contributors to future adverse impacts.

The study made 11 recommendations:

- Flow augmentation
- River bank shading
- Erosion controls
- Maintenance dredging
- CSO controls
- Paving of a contaminated parking area on Harbor Island
- Control of shipyard emissions
- Additional investigations
- Good housekeeping measures
- Preservation of local wildlife habitat
- Improved river access

**CSO Implication:** CSOs were identified as a minor contributor to the larger pollution problem; CSO control was recommended as a part of the solution.

# 1988 Draft *Elliot Bay Action Plan*

In 1985, the Puget Sound Estuary Program (PSEP) was formed to minimize toxic chemical contamination of Puget Sound and to protect its living resources. The Urban Bay Action Program, an element of the PSEP, developed the 1988 action plan for the Elliott Bay Action Program. Its objectives were as follows:

- Identify specific toxic areas of concern in the bay and the Duwamish Waterway based on chemical contamination and associated adverse biological effects
- Identify historical and ongoing sources of contamination
- Rank toxic problem areas and sources (to the extent possible) in terms of priority for development of corrective actions
- Implement corrective actions to reduce or eliminate sources of ongoing pollution and restore polluted areas to support natural resources and beneficial uses.

The plan described actions that had been completed and actions to be completed in the future. It identified and ranked environmental indicators and problem areas. Problem areas included the following:

- Seattle South Waterfront
- North Harbor Island I
- North Harbor Island II
- West Waterway I
- West Waterway II
- Denny Way CSO Area

Problem stations included the following:

- EW-05 (center of East Waterway between Terminals 25 and 30)
- AB-01 (east of Duwamish Head)
- KG-01 (near mouth of Slip 1 across from the southern end of Kellogg Island)
- KG-05, KG-06 (north of Kellogg Island)
- DR-12 (in Slip 3)
- DR-15 (in Slip 2)
- DR-16 (north of Terminal 115 on west side of waterway)

Early accomplishments of the Elliott Bay Action Program included more than 175 inspections at 102 sites, identification of 42 unpermitted discharges, and development of permits and best management practices for shipyards. Fifteen contaminated upland sites were identified for cleanup; two cleanups and negotiation of cleanups for twelve additional sites were completed. By September 1987, enforcement actions included 36 notices of violation, 22 administrative orders, and 28 fines totaling $44,500 (1988 dollars).

Through these efforts, most known direct industrial discharges to the bay and river were ended or routed to the municipal sewer system under permits. In addition, the effluent discharge from the Metro Renton Treatment Plant was relocated from the Duwamish River to Puget Sound off Duwamish Head in 1987. The remaining ongoing contaminant sources were believed to include contaminated groundwater, storm drains, CSOs, and a few unidentified direct discharges.

To characterize contaminant inputs from CSOs and storm drains, sediment was collected from the downstream end of 7 CSOs, 20 storm drains (SDs), and 15 combination CSO/storm drains. These inline sediments were compared to offshore sediments to evaluate CSO and storm drain contributions to the contamination in priority areas and stations. Ten priority drainages were identified for source control activities. Six of these drainages discharged to priority problem areas and were considered high priority:

- SW Lander CSO/SD (Seattle 105)
- SW Hanford CSO/SD (Seattle 162)
- SW Florida CSO/SD (Seattle 098)
- Fox S CSO/SD (Seattle 116)
- Michigan CSO (Metro W039)
- Michigan SD (Seattle)

Four of the drainages were outside of priority problem areas:

- Slip 4 CSO/SD (Seattle 117)
- Duwamish SD (Seattle)
- Slip 6 SD (Seattle)
- S 96th Street SD (Seattle)

Site-specific action plans were then developed. Potential sources, status, actions, responsible entities, and implementation dates were compiled. Recommended actions included underground tank removal, upland soil and aquatic sediment remediation, rerouting of discharges to the sewer system, enhanced permitting by Metro’s Industrial Waste Program and by Ecology, stormdrain and CSO outfall cleaning, CSO control, implementation of BMPs, and further investigations.

**CSO Implication:** Control of direct discharges and stormwater source control were identified as the greatest needs; these controls were expected to improve CSO discharge quality. Metro’s Denny Way and Michigan CSOs were identified as priorities for control. Although the Denny Way CSO was not identified as a candidate for source control activities, it was determined that controlling the site would benefit the Denny Way “problem area.”

# 1988–1996 Metro Receiving Water Monitoring Program

In Administrative Order number DE-84-577, Ecology instructed Metro to develop and implement a plan for monitoring receiving waters in the vicinity of its primary treatment plants—West Point, Alki, Carkeek, and Richmond Beach—and in other point source discharge areas. (The Renton plant provided secondary treatment.) The proposed plan included water column surveys of fecal coliform and enterococcus bacteria; subtidal sediment surveys including benthic taxonomy, amphipod bioassays, and analysis of conventional constituents (particle size distribution, total organic carbon, oil, and grease), metals, and extractable organic priority pollutants (plus a survey); intertidal monitoring of water for bacteria and of sediments for metals and extractable organic priority pollutants; and clam and algae tissue samples for analysis of bacteria, metals, and extractable organic priority pollutants. Monitoring was to occur quarterly to biennially at a range of stations near the treatment plants and nearby shorelines.

This “point source” monitoring program was approved by Ecology on April 5, 1988, in a first amendment to Administrative Order DE-84-577. Data were reported to Ecology as QA/QC was completed and were summarized in annual water quality status reports for marine waters. The monitoring program was implemented until discontinued after issuance of the 1996 NPDES permit for the West Point plant, which was upgraded to provide secondary treatment, and after closure of the Richmond Beach plant. After 1996, Metro focused its monitoring program on collecting data on key parameters that could be used in long-term trend assessments. This monitoring continues under ongoing programs described later in this appendix. In parallel, an ambient monitoring program was implemented to provide background data that could be compared to the point source monitoring data. The comparison would help identify impacts related to Metro discharges and ensure that water quality improvements were not undermined.

**CSO Implication:** These monitoring efforts affirmed that CSO control was a minor to moderate part of a larger wet-weather problem and that while CSO control was part of the solution, it would not bring the largest benefit.

# 1988–1997 Metro/King County CSO Discharge and Sediment Characterization Study

In approving Metro’s 1988 CSO control plan, Ecology required characterization of CSO and sediment quality. The purpose of the characterization was to obtain additional information to be used in setting site control priorities and a control project schedule. Because some sampling had already been done, the approved monitoring plan called for taking four discharge samples at five active overflow sites per year until all sites had been sampled. The sampling was completed in 1994. Sediment sampling was also completed for all sites at the rate of five sites per year. When the state promulgated the Sediment Management Standards and attendant testing protocols, additional sediment sampling was done to fully meet these requirements. This additional sampling was completed in 1997.

Analysis of overflow samples showed that the variability between different samples at a site was generally greater than variability among sites. Sediment sampling confirmed that sediments had been significantly impacted by pollution and that the contamination resulted from many sources. Recognizing that further understanding of sediment contamination was needed, King County made it a focus of both the 1999 *CSO Water Quality Assessment of the Duwamish and Elliott Bay* and the 1999 *Sediment Management Plan*.

**CSO Implication:** The Denny Way CSO, containing overflow from the Elliott Bay Interceptor via the Interbay Pump Station, was slightly higher in pollutant concentrations than the other CSOs, affirming it as a priority site for control; chemistry at other overflows did not greatly influence their control priority.

## 1999 *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay*

King County completed the 1999 *CSO Water Quality Assessment of the Duwamish and Elliott Bay* (WQA) with support from a large stakeholder group and a peer review panel. The WQA reviewed the health of the Duwamish River and Elliott Bay estuary and the effects of CSO discharges. A computer model was developed to predict existing and future water and sediment quality conditions, and a risk assessment was undertaken to identify risks to aquatic life, wildlife, and human health. Findings identified during the course the WQA were taken into account during development of the RWSP CSO control program.

The WQA identified some risks to fish, wildlife, and humans in the estuary and predicted limited improvement if CSO discharges were eliminated from the estuary (Table 2).

**Table 2. Water Quality Assessment Findings Regarding CSOs**

| Risk Target | Risk | CSO Control Benefit |
|---|---|---|
| Water column–dwelling aquatic organisms; salmon by direct or dietary exposure | None identified | No benefit |
| Sediment-dwelling organisms; salmon via dietary exposure | Potential risk from PCBs, TBT, bis(2-ethylhexyl) phthalate, mercury, PAHs; low risk from 1,4-dichlorobenzene | Slightly reduced risk[a] ; slight decrease in loadings of bis(2-ethylhexyl) phthalate, mercury, PAHs, and 1,4-dichlorobenzene |
| Wildlife | Low-to-high risks, depending on the species, from PCBs, lead, copper, and zinc | Slight decrease in loadings of lead, copper, and zinc |

**Table 2. Water Quality Assessment Findings Regarding CSOs**

| Risk Target | Risk | CSO Control Benefit |
|---|---|---|
| Humans – chemical exposures | Significant risk from exposure to arsenic and PCBs from fish consumption; potential risk from exposure to arsenic and PCBs when netfishing, swimming, windsurfing, and SCUBA diving | No benefit; the identified risk is not related to CSOs |
| Humans – pathogen exposures | Potential risk from fecal coliform, giardia, and viruses. People should avoid water contact during and for 48 hours after overflows. | Reduced risk; any benefit from reduced fecal coliform would not be apparent because inputs from other sources are so high |

[a] CSOs were not believed to be a significant source of PCBs or tributyl tin (TBT), but were considered a moderate source of 1,4 –dichlorobenzene.

**CSO Implications:** The findings of the WQA affirmed that CSO pollution is a very small part of a larger problem, mainly because of the low pollutant concentrations in CSOs and the brief and infrequent exposure to CSOs. It recommended the continuation of CSO control to meet state regulations and helped determine the priority of the CSO projects in the RWSP. It recommended that locations with greater potential for human contact—the Puget Sound beaches—be controlled first. Locations in the Duwamish Waterway were set later in the schedule because of the perceived lower human health and environmental benefit from CSO control at these sites. It identified sediment contamination as the largest risk in the river environment.

# 1999 *Sediment Management Plan*

The *Sediment Management Plan* assessed areas near seven county CSOs that were listed on the Washington State Contaminated Sites list. The areas were assessed for their risk, preferred cleanup approach, partnering opportunities, and potential for recontamination after remediation (Table 3). The remediation schedule for these areas, shown in Table 3, is being implemented.

The *Sediment Management Plan* highlighted the growing interest in sediment management as a factor in CSO control planning and the need for more information about CSOs as an ongoing or historical contributor to contamination. The sediment management program was formed to implement the plan and any new projects developed after the plan in the broader context of wastewater planning. The program addresses sediment quality issues near CSO discharges and treatment plant outfalls, evaluates and addresses emerging wastewater treatment sediment quality issues, and incorporates sediment quality considerations into comprehensive planning.

**CSO Implications:** Contamination of sediments with chemicals such as PCBs was identified as resulting mainly from historical inputs. The plan, therefore, recommended that sediment remediation near CSOs proceed ahead of CSO control (except near the Denny Way CSO where control should come first). It recommended coordinated efforts to solve phthalate pollution problems.

### Table 3. Recommended Projects in the Sediment Management Plan

| Nearby CSO and Water Body | Cleanup Priority | Recommended Cleanup Approach | Partnering Opportunity | Cost (million $)[a] | Scheduled to be Completed |
|---|---|---|---|---|---|
| Duwamish/ Diagonal[b] (Duwamish River) | High | Dredging and capping | King County under direction of EBDRP[c] | 8.90[d] | Completed 2004 |
| King Street (Puget Sound, Elliott Bay) | High | Capping | WSDOT and Seattle | 2.60 | 2008 |
| Hanford (Duwamish River) | Medium/ High | Dredging and confined aquatic disposal | Port of Seattle | 15.49 | 2007 |
| Lander (Duwamish River) | Medium/ High | With Hanford | U.S. Army Corps of Engineers | 3.45 | 2007 |
| Denny A & B[e] (Puget Sound) | Medium | Dredging and capping | | 2.23 | 2006 |
| Denny C & D (Puget Sound) | Medium | Capping | | 0.90 | 2009 |
| Chelan Ave. (Puget Sound, Elliott Bay) | Low/ Medium | Dredging and confined aquatic disposal | | 2.80 | 2010 |
| Brandon St. (Duwamish River) | Low | Capping | | 0.50 | 2012 |

[a] These costs are given in 2005 dollars (the original estimates, given in 1998 dollars, escalated by 3 percent per year).
[b] This project was added after the SMP.
[c] These costs were not included in the SMP; it was assumed that they would be paid by the Elliott Bay/Duwamish Restoration Program (EBDRP).
[d] EBDRP administers projects funded under a 1990 settlement of litigation by the National Oceanic and Atmospheric Administration (NOAA) for natural resource damages from City of Seattle and King County CSOs and storm drains.
[e] This is a City of Seattle storm drain; King County's Hanford No. 1 CSO uses this outfall.

Appendix E

# Work Being Done to Improve Mercer/Elliott West System

The table below summaries the work that is under way or being planned by King County staff or contractors to diagnose and successfully address operational problems in the Elliott West system.

| | Item | Issue to Be Addressed | Status |
|---|---|---|---|
| **Screening** | | | |
| 1 | Improve screenings removal | Existing screens are not effectively removing floatables. | Ongoing work under consultant contract |
| **Returned Flow by Main Pumps – Sampling** | | | |
| 2 | Modify the sampling pipe intake to ensure collection of composite sample | The sampler was too far away from the sample intake, creating a loss of suction. | Completed in October 2007 |
| **Returned Flow by Dewatering Sump Pumps – Sampling** | | | |
| 3 | Relocate the dewatering composite sampler closer to dewatering sump pumps | Current location of the sample intake on the discharge piping is sometimes under negative pressure. | To be completed in summer 2008 |
| **Power** | | | |
| 4 | Install an automatic transfer switch | Switching power supply to the treatment facility to an alternative feeder can only be done manually. | Evaluating alternatives and securing funds |
| **Chemical System** | | | |
| 5a | Upgrade hypochlorite mixing equipment | Inadequate mixing is causing poor disinfection of discharged flows and excessive usage of hypochlorite. | Ongoing work under consultant contract |
| 5b | Upgrade bisulfite mixing equipment | Inadequate mixing is causing poor dechlorination of discharged flows and excessive usage of sodium bisulfite. | Ongoing work under consultant contract |
| 5c | Install a pre-dechlorination sampling system | Existing sampling system needs to be replaced because of poor design, location, and corrosion. | Installed an interim sampling system |
| 5d | Install a feedback loop control for disinfection and dechlorination systems to optimize chemical usage and comply with permit | Existing controls are inadequate for optimal chemical dosing. | Awaiting completion of pre-dechlorination sampling system (see item 5c above) |
| **Dechlorination Structure** | | | |
| 6 | Add an aboveground structure over the dechlorination structure to overcome hydraulic grade line (HGL) limitations | During large storms, the HGL in the effluent pipeline is higher than the tops of the dechlorination and transition structures, forcing flow to escape the structures and move overland through Myrtle Edwards Park and into Elliott Bay. | Will issue a construction contract under an emergency waiver summer 2008 |