King County's

Program

A Comparison with Programs in Other U.S. Cities

June 1996

King County
Department of Natural Resources

Clean Water--A Sound Investment

King County's CSO Program
A Comparison with Programs in Other U.S. Cities

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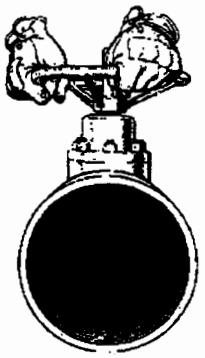


Executive Summary

Presently, King County is amending its comprehensive sewage plan which includes wastewater treatment and conveyance facilities, biosolids, water reuse, and combined sewer overflow facilities (CSO).[1] As part of the CSO portion of the planning effort, King County Facilities Planning conducted phone and written surveys from October to December 1995 to obtain information from other Association of Metropolitan Sewerage Agencies (AMSA) member cities regarding their own CSO programs and regulatory requirements. The purpose of this survey was to provide King County with a perspective on the County's position in the continuum of CSO programs across the United States.

The following agencies participated in the surveys:

- City of Atlanta in Atlanta, GA
- Massachusetts Water Resources Authority in Boston, MA
- Columbus Water Works in Columbus, GA
- Detroit Water and Sewerage Department in Detroit, MI
- Metropolitan Council Environmental Services in Minneapolis, MN
- New York City Department of Environmental Planning--Bureau of Clean Water in New York, NY
- City of Portland, Bureau of Environmental Services in Portland, OR
- Narragansett Bay Commission in Providence, RI
- City and County of San Francisco--Department of Public Works in San Francisco, CA
- District of Columbia Department of Public Works in Washington, D.C.

Each agency responded to 60 questions and the over 600 responses were analyzed and organized into this report. Overall, it was found that King County's regulatory requirements are generally not more stringent than requirements imposed on the above agencies. King County falls into the middle to low range in terms of stringency of CSO regulatory requirements, timeline to complete the CSO program, and program capital costs. Unfortunately, it was difficult to compare King County's residential sewer rate with the agencies surveyed because the rate structures for all the agencies were so different.

[1] On January 1, 1994 the Municipality of Metropolitan Seattle (commonly referred to as "Metro") formally merged with King County.

General Conclusions

- Only two of the eleven agencies surveyed follow the presumption approach of reducing combined sewer overflows to 4 to 6 overflows per year per CSO location as outlined in EPA's CSO policy. Five agencies follow the presumption approach imposed by their state regulatory authority and four agencies follow the demonstration approach as imposed by their state regulatory authority.

- Boston was able to reduce the size as well as the cost of its CSO program (from $1.2 billion to $372 million) by obtaining more accurate quantification of CSO flows, through system optimization, and using a watershed approach which accounts for both CSO and non-CSO pollution sources. Boston found that on an annual flow percentage basis, CSOs accounted for less than 5% of the pollution source to Boston's receiving bodies of water. Many of the other agencies surveyed would like to move to a watershed approach in the future as their CSOs may also not be the largest source of pollution relative to other pollution sources.

- Little information was available on how agencies define primary treatment of CSOs. Of the information obtained, Providence, RI, has to follow more stringent primary treatment requirements than King County.

- Many agencies do not have a specified time interval between overflow events to define the length of a CSO event. Of the agencies surveyed, the shortest time interval is six hours and the longest time interval is 48 hours. King County uses the 48 hour interval.

- Of all the agencies, King County is further along in developing a sediment monitoring and remediation program and undertaking sediment sampling. This is mainly because Washington state passed sediment program requirements before other states.

- Of the ten agencies submitting information, King County falls in the middle range for CSO program total capital costs since the implementation of the program to 1995 ($60.5 million). These costs ranged from $20 million for Detroit which is in the beginning stages of its CSO program to $1.1 billion for San Francisco which has almost completed its CSO program.

- Of the ten agencies submitting information, King County falls in the lower middle range for average yearly total capital costs of the CSO program's total capital costs since the implementation of the program to 1995 ($6.05 million). These costs ranged from $2.9 million to $65.4 million.

- Of the nine agencies submitting information, King County falls in the lower middle range for the CSO program's average annual total future capital costs to fully

implement the CSO program ($15 million). This is mainly due to the fact that several agencies expect to complete their CSO programs by 2000 while other agencies are just beginning the planning and implementing of CSO programs and projects.

- Only Columbus, GA, is funding its on-going CSO program through adding fees on top of its sewer rate to be used just for its CSO program.

- Many of the surveyed agencies question if the water quality benefits imparted by their CSO programs actually justify the expense. Agencies are also concerned that even with CSO projects in place, water quality standards may still be exceeded due to other pollutant sources.

In conclusion, King County's CSO program is in the middle to low range for regulatory stringency, program costs, and timeline to complete its CSO program compared to other agencies surveyed. The surveys also revealed some approaches that were successful or are being used elsewhere which King County might want to explore in terms of its own CSO program. Options include:

- Developing a watershed approach to determine actual water and sediment quality benefits that could be expected in a given area (potentially resulting in higher water quality benefits and/or a decrease in capital expenditures for the CSO program).

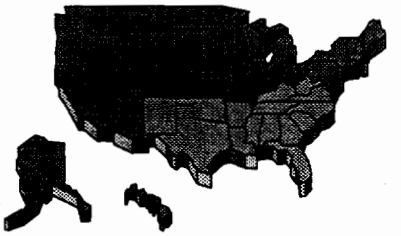
- Using hydrodynamic separators or other on-site treatment facilities which would decrease costs associated with building storage facilities and then sending the flow to treatment plants.

- Exploring the development of water quality standards based on wet weather versus dry weather conditions.

- Investigating the benefits of renegotiating the number of CSO discharges based on the season or mixing capabilities and sensitivity of the receiving water.

- Exploring other fee structures (such as what Columbus is using) for funding the CSO program.

I. Introduction



CSO Survey

Presently, King County is amending its comprehensive sewage plan which includes wastewater treatment and conveyance, biosolids, water reuse, and combined sewer overflow facilities (CSO).[1] As part of the CSO portion of the planning effort, King County's Facilities Planning section conducted phone and written surveys to obtain information from other Association of Metropolitan Sewerage Agencies (AMSA) member cities regarding their own CSO programs and regulatory requirements. The purpose of the surveys was to provide King County with a perspective on the County's position in the continuum of CSO programs across the United States and help King County to continue to develop a cost effective program that maximizes protection of environmental resources and human health.

The starting point of the surveys was the November 1994 AMSA report titled, Approaches to Combined Sewer Overflow Program Development: A CSO Assessment Report (1994 AMSA Report). Based upon information provided in this report (population, size of combined service area, number and volume of CSOs, and CSO issues the cities were facing), ten CSO/sewage agencies were chosen to be surveyed:[2]

- City of Atlanta in Atlanta, GA
- Massachusetts Water Resources Authority in Boston, MA
- Columbus Water Works in Columbus, GA
- Detroit Water and Sewerage Department in Detroit, MI
- Metropolitan Council Environmental Services in Minneapolis, MN
- New York City Department of Environmental Planning--Bureau of Clean Water in New York, NY
- City of Portland Bureau of Environmental Services in Portland, OR
- Narragansett Bay Commission in Providence, RI
- City and County of San Francisco--Department of Public Works in San Francisco, CA
- District of Columbia Department of Public Works in Washington, D.C.

[1] On January 1, 1994 the Municipality of Metropolitan Seattle (commonly referred to as "Metro") formally merged with King County.

[2] For ease of reading this report, the municipality will be cited instead of the agency. Thus, Narragansett Bay Commission will be referred to as Providence, etc.

All contacted agencies were extremely helpful in providing information and sharing issues related to their jurisdictions.

The phone and written surveys were conducted from October to December 1995 (surveys included in Appendices I and II). The phone survey included 25 questions under the major topics of CSO regulations and planning and CSO control and treatment. The written survey included 35 questions on the topics of meeting EPA Nine Minimum Controls, CSO statistics (number of CSOs, volume of CSOs, etc.), sampling and monitoring programs, and program costs and financing. The eleven agencies (including King County) provided over 600 responses that were analyzed and organized into this report.

Report Organization

This report is organized into seven chapters plus an Executive Summary and Appendices.

- Introduction--includes the purpose for developing this report, the agencies surveyed, and the contents of the report.

- King County CSO History and Legal Requirements--provides a short history of King County wastewater services, an overview of CSO planning history, and the CSO requirements King County must meet.

- CSO Planning and Requirements--identifies agency approaches used in meeting CSO requirements and difficulties encountered in meeting EPA's Nine Minimum Controls as well as other CSO requirements. The chapter also includes information on surveyed agencies major CSO improvements, differences in defining a CSO discharge, typical/average composition of CSOs, and frequency and volume reduction targets.

- CSO Control and Treatment--includes strategies used by the surveyed agencies for CSO control and treatment as well as information on defining primary treatment, designing for CSO treatment, and issues surrounding CSO on-site treatment.

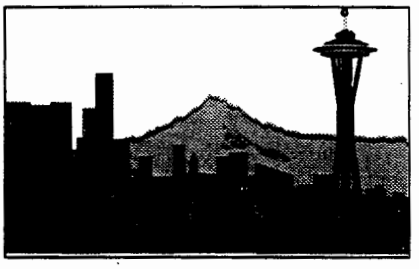
- Sampling and Monitoring Programs--identifies the agencies monitoring CSO volume and frequency as well as the type of sampling programs the agencies have in place. Information on sampling parameters and number of samples per year and per location is included.

- CSO Cost and Financing--identifies CSO capital costs since program implementation, future CSO capital costs, program funding, and sewer rates.

- Conclusions--provides an overview of King County's CSO program relative to the ten agencies surveyed.

In general, this report is based only on the information collected from the surveys regarding specific information on various aspects of the agencies' CSO programs. This report does not repeat the information included in the 1994 AMSA report, but provides additional information. While every effort was made to obtain "apple to apple" comparisons, this comparison could not be made in some cases based on differences in regulatory requirements, different language used in describing programs, and different factors used in computing the costs of programs. Appendix III includes a list of agency contacts who responded to the phone and written surveys.

II. King County CSO History and Legal Requirements



This chapter provides a short history of King County wastewater services, an overview of CSO planning history, and the CSO requirements King County must meet.

Overview of King County System

The wastewater services portion of King County was first formed as a metropolitan municipal corporation ("The Municipality of Metropolitan Seattle" or "Metro") in 1958 to clean up the waters of Lake Washington and the Seattle waterfront. In 1962, the City of Seattle transferred ownership of its treatment plants and portions of its sewer system to Metro, and Metro's monthly service charge went into effect. On January 1, 1994, Metro merged with King County to create a more comprehensive regional agency.[3] Today, King County provides sewage treatment services to 33 cities and districts within and adjacent to King County. King County operates secondary wastewater treatment plants at West Point within the City of Seattle and in the City of Renton, a CSO treatment plant at Carkeek Park in Seattle, and a primary treatment plant at Alki in Seattle which is presently being converted to a CSO treatment plant. King County also operates a series of large interceptor sewers to convey wastewater from local collection systems to the King County plants for treatment. King County thus operates a "wholesale" business, providing sewage conveyance and treatment services to "retailers" such as the City of Seattle, who in turn sell sewer services to area residents and businesses. Seattle and the other local agencies are responsible for maintaining their own sewer collection systems. Seattle is the largest of the 33 local agencies served by King County and the only one with a combined sewer system. In order to reduce CSOs in a more efficient manner, the City of Seattle and King County work together on some wastewater system improvements.

King County CSO Volume Reduction

Since the 1960s, Metro and now King County have conducted projects to improve water quality in the Seattle-King County area. Table 1 displays the progress made in reducing CSO volumes. As shown, the largest reductions in wastewater discharge occurred between 1960 and 1988, when centralized treatment plants and major interceptors were built and a number of City of Seattle

[3] Throughout this chapter, "Metro" is used to refer to activities taking place before the date of consolidation; "King County" is used for all activities taking place or planned after January 1, 1994.

separation projects were completed. The formal CSO control program began in 1979 with the development of the *1979 Combined Sewer Overflow Control Program (1979 Program).*

Table 1: Gallons of CSO Discharged Per Year	
Year	**Gallons of CSO**
1960	20-30 billion[1]
1988	2.4 billion (used as baseline volume)
1998	1.6 billion
2006	0.6 billion (75% systemwide volume reduction from baseline)
Long-term Goal: One Event Per Year (no end date)	0.36 billion (85% systemwide volume reduction from baseline)

[1]Between 1960 and 1983, Metro and/or the City of Seattle undertook separation projects, constructed treatment plants, as well as other infrastructure which helped to reduce CSO volume even before the baseline of 2.4 billion gallons was established.

Clean Water Act Requirements

The impetus for the *1979 Program* was the passage of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), also known as the Clean Water Act. The objective of the act was to "restore and maintain the chemical, physical, and biological integrity of the nation's waters" through a large federal grant program established to assist communities in building secondary wastewater treatment plants and through implementation of the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES permits set limitations on the volume and concentrations of pollutants that can be legally discharged into the environment by both municipalities and industries. In 1973, the Washington State Department of Ecology (Ecology) was authorized by the federal Environmental Protection Agency (EPA) to administer the NPDES program in Washington State.

By mid-1976, joint planning was underway by EPA, Ecology, and Metro to develop, evaluate, and fund alternatives which would provide secondary treatment and CSO control. In 1977, amendments to the Clean Water Act increased the amount of funding available through EPA CSO control projects. These amendments also provided for waivers from secondary treatment if receiving water quality could be adequately protected. It became apparent that the progress on planning for treatment facilities would be delayed significantly by requests for waivers. These developments eventually led to the segregation, in 1978, of the CSO control elements from treatment-related decisions.

The *1979 Program* identified a total of 30 projects to control CSO discharges to fresh and marine waters. EPA had stipulated that grant money would be available only to those projects which could demonstrate a benefit justifying the cost of the project. The thirty projects were evaluated

according to their benefit-to-cost ratio. That benefit-to-cost analysis was an important method of evaluating project proposals prior to 1986.

During the early 1980s, considerable public attention focused on Puget Sound water quality and pollution issues, particularly contamination in urban bays. In May 1984, Metro issued the *Toxicant Pretreatment Planning Study Summary Report*, which described toxicant problems in Elliott Bay and other bays and raised concerns about impacts on sediment quality at CSO discharge sites. That same year, Washington State adopted a statute requiring all municipalities with CSOs to develop plans for "the greatest reasonable reduction (of CSOs) at the earliest possible date."

Greatest Reasonable Reduction of CSO

In order to comply with Ecology legislation, Metro produced two documents: the *1985 Final Plan for Combined Sewer Overflow Control (1985 Plan)* and the *1986 Final Supplemental Plan for Combined Sewer Overflow Control (1986 Final Supplement)*. Each of these documents were part of a five volume *Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control,* which explored four alternative plans for secondary treatment and associated plans for varying reductions in CSO volumes.

The *1986 Final Supplement* was prepared in response to the agreement between Metro and the City of Seattle to evaluate a fifth secondary treatment configuration: the relocation of the West Point plant to a non-shoreline location. The supplement presented additional CSO controls which would accompany this fifth alternative. In addition, the supplement evaluated CSO projects which would achieve 75 and 90 percent volume reductions for all five secondary treatment configurations and included the results of upgraded computer modeling of the system.

In January 1987, before the *1985/86 Plan* could be implemented, Ecology adopted a new regulation for CSO control. The regulation (WAC 173-245) defined the "greatest reasonable reduction" in CSO volumes as "control of each CSO such that an average of one untreated discharge may occur per year" in a year of average rainfall. When the "one event" ultimate goal would be achieved was negotiated with each individual CSO jurisdiction. The regulation further required that each community submit, by 1988, a CSO plan specifying the means of complying with the new CSO control level. The regulation also required that updates on the progress of the plan be produced with NPDES renewals which occur at least every five years and that annual CSO program status reports would be required. King County worked with Ecology to develop an interim goal of achieving a 75 percent CSO volume reduction systemwide by the end of the year 2005 and agreed to continue to work towards achieving the ultimate goal of one event per year.

The revised plan, the *Final 1988 Combined Sewer Overflow Control Plan (1988 Plan)*, was submitted to Ecology in April 1988. The plan describes CSO control projects that would be

implemented to achieve the interim goal of 75 percent CSO volume reduction by the end of 2005. The *1988 Plan* also describes additional projects that could achieve the ultimate goal of one untreated CSO event per year.

A *1988 Plan* update was required in 1991, but King County and the Department of Ecology agreed that the 1991 update would include only monitoring data and status reports on all scheduled projects because only one project had been completed since the *1988 Plan*. However, as agreed with the Department of Ecology, King County has prepared annual reports on the status of CSO projects and submitted them to the Department of Ecology yearly since 1988. In February 1995, King County's *1995 CSO Update* was submitted to Ecology. The *1995 CSO Update* is the first major report on the status of the CSO projects which have been completed or are underway since the *1988 Plan*.

King County Comprehensive Sewage Planning

King County's CSO planning is only one component of King County's current long-range comprehensive wastewater planning effort, the *Regional Wastewater Services Plan (RWSP)*. The *Metropolitan Seattle Sewerage and Drainage Survey*, prepared in 1958, resulted in the comprehensive water pollution abatement plan which was the first comprehensive plan to guide a long-range program of sewerage and drainage services for the Seattle area. That first comprehensive planning document was intended to provide a concise, up-to-date, central source of information concerning King County's long-range plans. Since that time, numerous amendments have been made to the original comprehensive plan.

The *RWSP* will be another amendment to the *Metropolitan Seattle Sewerage and Drainage Survey* that will integrate long range planning in all areas of wastewater services, including treatment and conveyance, biosolids reuse, CSO control, and water reuse. The *RWSP* planning process will establish the priorities for all wastewater programs, including those that affect CSO controls.

III. CSO Planning and Requirements

This chapter identifies agency approaches used in meeting CSO requirements and in meeting EPA's Nine Minimum Controls. The chapter also includes information on surveyed agencies major CSO improvements, differences in defining a CSO discharge, typical/average composition of CSOs, and frequency and volume reduction targets.

Regulatory Authorities and CSO Statistics

All the agencies surveyed are regulated by their state agency except for Washington, DC, which is regulated by Region 3 of the EPA, and Boston which is regulated by both the Massachusetts Department of Environmental Protection and EPA Region 1. Most of the agencies must follow state CSO requirements as developed by their respective states. Several of the agencies noted that they had been involved with the development of the EPA's CSO Guidelines. Out of the eleven agencies (including King County), six agencies felt that their state's CSO requirements are more stringent than EPA's CSO guidelines (Atlanta, Detroit, Minneapolis, Portland, Providence, and King County), four felt that their state's CSO requirements are the same as EPA's requirements (Columbus, New York, San Francisco, Washington, DC)[4] and one agency felt that its state agency is more flexible than EPA requirements (Boston). In addition to CSO requirements, the agencies must meet state water quality standards.

Appendix IV includes some summary information on population, size of service area, treatment capacities of sewage treatment plants, and number and volume of CSO discharges of the agencies surveyed.

Nine Minimum Controls

All of the agencies meet all or most of EPA's nine minimum controls. These controls include: monitoring to effectively characterize CSO impacts and the efficacy of CSO controls; proper operation and regular maintenance programs for the sewer system and the CSOs; maximum use of the collection system for storage; review and modification of pretreatment requirements to assure CSO impacts are minimized; maximization of flow to the treatment plant for treatment; prohibition of CSOs during dry weather; control of solids and floatables in CSOs; a pollution prevention program; and public notification.

[4] Only phone survey response was available from Washington, DC.

Table 2 identifies specific issues raised by several agencies regarding specific minimum controls.

Table 2: EPA Minimum Controls Issues

EPA Minimum Control	Agency	Comments
Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls	Atlanta	• Lack of baseline data for the watershed to determine the impact of other pollution sources.
	Minneapolis	• Problems with determining the effectiveness of CSO strategies.
	King County	• May need to do post project monitoring.
Proper operation and regular maintenance programs for the sewer system and the CSOs	Atlanta	• Lack of a grit chamber at the sanitary interceptor causes an enormous amount of grit to accumulate in the sanitary sewer interceptor leading to the treatment plant (thus requiring monthly cleaning).
Maximization of flow to the treatment plant for treatment	Atlanta	• Presently, flow is maximized at two of the three permitted treatment plants
Control of solids and floatables in CSOs	Boston	• EPA compliance requirements and schedule are not well defined.
	Portland	• To be accomplished mostly through street cleaning; effectiveness needs to be established.
	Providence	• Overall funding for the CSO program expected to be difficult which could hinder floatable control.
	King County	• Floatables have not been an obvious problem at CSO sites. It may be a negligible, but expensive problem to control.
Pollution prevention program	Columbus	• Without wet weather water quality standards and total watershed management impact information, a pollution prevention problem may be of little value and virtually impossible to characterize.

Major CSO Improvements

The following are brief summaries of major CSO improvements surveyed cities must meet or complete to be in compliance with CSO regulations. For more detail, see the 1994 AMSA report or contact individual agencies.

Atlanta

- CSO planning began in the 1970s under the Clean Water Act.
- In the late 1970s and the early 1980s, Atlanta implemented its program to transfer treatment plant effluent out of the South River basin into the Chattahoochee River watershed.
- In 1990, Georgia state legislature passed a law that required CSOs to be eliminated or controlled to a level that meets site specific state water quality standards by December 1995.
- Atlanta was issued a permit and order to implement operable controls by the end of 1993.
- CSO facilities should be completed in 1996 and include deep tunnel storage, expansion of the treatment plants, some sewer separation, screening, and disinfection.

Boston

- CSO plan completed in 1995 (28 projects; $372 million in capital costs in 1997 dollars).
- The 28 projects include six sewer separation projects, five existing CSO treatment facility upgrade projects, three CSO consolidation/storage conduits, six new CSO treatment facilities, four sewer relief projects, two outfall improvements, one in-system storage project, and floatable controls.
- Plan follows a basin by basin approach. Out of 81 CSO outfalls, 22 will be closed (total elimination in swimming and shellfishing areas), 48 will to be reduced to 4 or less discharges per year, and 11 will include treatment.
- Design and construction to start in 1996 with expected completion in 2008.

Columbus

- In the 1970s under the Clean Water Act, Columbus undertook a CSO system inventory and characterization.
- In 1990, Georgia state legislature passed a law that required CSOs to be eliminated or controlled to a level that meets site specific state water quality standards by December 1995.
- CSO program includes expanding a treatment plant and conveyance lines, some sewer separation, and developing two CSO treatment plants.
- CSO treatment plants include several vortex separators.
- CSO program and facilities were completed in 1995.

Detroit

- Long-term CSO plan must be completed by July 1996.
- CSO projects include rehabilitating dam gates and interceptors of the CSO system (1995), the development of three major detention and treatment basins (1997/98), and additional in-line storage (1997/98).

Minneapolis-St. Paul

- In the 1970s under the Clean Water Act, Minneapolis-St. Paul undertook a wastewater system study which was completed in 1982.
- As part of the study, the agency looked at a variety of CSO options and decided to use sewer separation to entirely eliminate CSOs (as a large number of acres were already separated).
- Eliminating CSOs entirely also had the benefit of eliminating public notification of CSO discharges and eliminating the potential conflicts between CSOs and human health/recreation (fecal coliform issues).

New York

- The agency has divided the city into two halves. One half is divided into nine geographic areas for the development of CSO facility plans. Out of the nine facility plans, seven have been completed and the other two will be completed in 1996.
- For the other half of the city, a CSO comprehensive plan should be developed by 1997.
- As of yet, none of the CSO projects outlined in the plans have been completed.

Portland

- In 1990, the agency initiated a major CSO planning effort to improve the water quality in the Willamette River and Columbia Slough.
- In 1991, Oregon issued a Stipulation and Final Order (SFO) which required the agency to control overflows for storms less than the 1-in-10 year summer storm and the 1-in-5 year winter storm.
- Portland's 1994 CSO Plan includes CSO volume reductions targets of 99.6% for Columbia Slough and 94% for Willamette River. For the Willamette River, 42 outfalls are to be controlled by 2011. For the Columbia Slough, 13 outfalls are to be controlled by 2000.
- To complete its CSO schedule for the Willamette River, 7 outfalls will be controlled by 2001, 16 outfalls will be controlled by 2006, the remainder by 2011.

Providence

- CSO plan was approved in 1994 and includes near surface storage and three deep rock tunnels for storage.
- By 1997, final design for Phase 1 of its program must be completed (two storage tanks and two tunnels). There are no deadlines for the rest of the CSO program.
- The agency is trying to meet the goal of 4 to 6 events per year per CSO location.

Washington, DC

- A water quality study was conducted in the 1950s and CSOs were recognized as a contributing factor to water degradation. Interceptors were built to help improve water quality.
- In the 1970s, a feasibility plan was developed to further study CSO issues. Implementation of the plan was considered costly ($312--$457 million in 1973 dollars), but would reduce CSO occurrences on average to less than one per year.
- In 1983, the agency developed another CSO study. The recommended plan consisted of a two-segment abatement program including collection system optimization and capital intensive measures.
- In 1991, Washington completed segment one of its ongoing CSO abatement program improvements which included modifications to existing dams and regulators, installation of 12 inflatable fiberdams, installation of a swirl concentrator, sewer separation in selected areas, and installation of outfall gates.
- As required by EPA, Washington, DC will be developing its long-term CSO plan. A draft report is to be completed by February 1998.

King County

- Completed its long range CSO plan in 1988. This plan included in-line storage, separation, and two CSO treatment plants. Additional projects are being planned as part of a larger planning process to be completed in 1996.
- In developing projects, King County must meet 75% CSO systemwide volume reduction by the end of 2005 and meet an ultimate goal of one untreated event per year per CSO outfall (no completion date).
- To date, several projects have been completed or are underway at a cost of $60.5 million (1995 dollars).
- To reach 75% CSO systemwide volume reduction will cost $279 million; to reach one event per year will cost an additional $306 million (1995 dollars).

CSO Discharge/Event

Several agencies do not appear to have or use a formal definition or a formal time interval for a CSO event beyond a general description of a CSO. However, amongst the agencies which identified using a time interval between events, the interval ranges from 6 hours to 48 hours.

Table 3: CSO Discharge/Event Definition	
Agency	**Definition**
Atlanta	An overflow occurring not less than 48 hours since the previous overflow.
Boston	A rainfall event is separated from another event by 6 hours or more of zero precipitation. Multiple activations during one rainfall event are counted as one event.
Detroit	Anything discharged from a CSO outfall constitutes a CSO discharge/event. However, Detroit is in the process of developing a different definition based on precipitation data over its 800+ square mile service area and time of concentration. [1]
Portland	A single rain event is separated by 24 hours of dry time.
Providence	A discharge/event is a discharge associated with a particular storm. No time interval is specified between storms.
San Francisco	6 or more hours between discharges.
King County	A period of rainfall during which an overflow was recorded that was preceded and followed by 48 hours without overflow.[2]

[1]Time of concentration is a theoretical value based on the time it takes for the last drop of stormwater runoff that enters the farthest point in the sewer system to reach the wastewater plant. The state of Michigan deems that when this drop of runoff reaches the plant, the wet weather event is over, and considers flows after this time to be dry weather. Detroit is concerned that some I/I and dewatering of in-system and CSO storage devices will keep plant flows in the wet weather flow range well after the time of concentration has been exceeded. Detroit is discussing this issue with the state.

[2]Rainfall patterns for the King County wastewater system's service area often result in one storm causing more than one "event" (which is why the definition is so important to the agency).

Typical/Average Composition of CSO

The average composition of each agency's CSO varied widely across agencies. For almost all the agencies, stormwater is the largest component of the CSO. For the most part, stormwater ranges from 55% to 92% with residential sanitary sewage being the next largest component (5% to 40%). However, it is interesting to note that Boston's CSO is only 11% stormwater and 49% infiltration. It is likely that other jurisdictions' stormwater component might be lower if infiltration was identified as a separate component. Industrial wastewater ranged from 0.05% to 2% and commercial wastewater ranged from 1% to 6%. Some jurisdictions combined industrial and commercial, so industrial and/or commercial percentages could be higher if these percentages were not combined.

CSO Program Approaches and Volume Reduction Targets

As shown in Table 4, seven agencies are following EPA's presumption approach[5] and four agencies are following the demonstration approach.[6]

Table 4: Program Approaches and Volume Reduction Targets

Agency	Approach	Year CSO Program/ Plans Completed	Must Meet State WQS?[1]	Overall Systemwide Volume Reduction Target
Atlanta	Demonstration	Program completion in 1998.	Yes	No
Boston	Demonstration	Starting design and construction in 1996; program completion in 2008.	Yes	No, but expect program will result in 84% CSO volume reduction from 1988 baseline and 94% of the captured combined sewer flow will receive secondary treatment.
Columbus	Demonstration	Program completion in 1995.	Yes	No, but expect program will result in 85% or higher capture and treatment of CSOs.
Detroit	Presumption	Long-term CSO Plan due by 7/1/96 to the state. Some major projects to be completed from 1995–1998.	Yes	To be determined when the long-term CSO plan is submitted and approved.[2]
Minneapolis-St. Paul	Presumption	Total separation is almost completed; some rooftop disconnection still to be completed.	Yes	0 discharges
New York	Demonstration	CSO Plans to be completed from 1996-1997.	Yes	Volume reduction target varies from tributary to tributary. Each basin uses different standards to meet WQS and volume reduction targets. A total number is not available.

[1]WQS = Water quality standards
[2]The state of Michigan requires 95% volume reduction. Detroit is presently discussing this level of control with the state.
N/A = Not available

[5] The presumption approach is based upon the premise that an agency's long-term CSO control plan will meet the water quality-based requirements of the Clean Water Act by meeting certain minimum defined performance criteria in terms of expected frequency of overflow or percent capture of the CSO pollutant load.
[6] Under the demonstration approach, water quality modeling or other tools are used to demonstrate that predicted CSO discharges resulting from the CSO long-term control plan will attain water quality standards.

Table 4: Program Approaches and Volume Reduction Targets

Agency	Approach	Year CSO Program/ Plans Completed	Must Meet State WQS?[1]	Overall Systemwide Volume Reduction Target
Portland	Presumption	16 of the 55 CSOs to be controlled by 2006 and the rest to be controlled by 2011.	Yes	Yes, 94% volume reduction for Willamette River; 99.6% for Columbia Slough.
Providence	Presumption	Long-term CSO Plan approved in 1994. By 1997, final design for Phase one of its CSO program to be completed. No deadline for rest of the projects.	Yes	No, but expects 90-92% volume reduction.
San Francisco	Presumption	Program almost completed by end of 1996.	Yes	No
King County	Presumption	CSO projects done in phases. 75% volume reduction by end of 2005. Ultimate goal of one event per year (85% volume reduction); no completion date.	Yes	85% systemwide volume reduction (approximately the same as one event per year).
Washington, DC	Presumption	Some construction of CSO projects from CSO Abatement Plan. Draft CSO Plan must be developed by February 1998.	Yes	No

[1]WQS = Water quality standards

Minneapolis-St. Paul noted that it was probably the only jurisdiction that did not start with complete sewer separation, but ended up using complete sewer separation as the preferred CSO reduction choice. Minneapolis-St. Paul started its CSO study in the 1970s and completed the study in 1982. Based upon the study, Minneapolis-St. Paul decided separation was the easiest CSO control choice to undertake as Minneapolis was already 85% separated and St. Paul was 50% separated. Also, since the Mississippi is used for a variety of recreation, Minneapolis-St. Paul felt it was safer to entirely eliminate CSO discharges and thus reduce potential human health and recreation conflicts which could occur due to fecal coliform.

New York stated that even before the planning stage, the presumptive approach was identified as probably being too costly due to the high cost of land in New York City. In addition, little vacant

land is available to build the amount of storage needed to follow the presumptive approach, so New York is following the demonstration approach.

The agencies were divided six (yes) to five (no) regarding using an overall systemwide volume reduction target (some of the agencies identified meeting water quality standards or frequency as the preferred "basis" for reducing CSOs). However, even agencies which are not using a volume reduction target are expecting large CSO volume reductions due to the construction of CSO projects and because the agencies must also meet water quality standards (WQS). Systemwide volume reductions ranged from 75% to 85% volume reduction per year (King County) to 100% volume reduction (Minneapolis-St. Paul). Only one agency had different CSO volume targets for different water bodies (Portland).

Frequency Targets

As shown in Table 5, the agencies are divided five (yes) to six (no) regarding using an overall systemwide CSO frequency reduction target. Of agencies which use CSO frequency targets in developing their CSO projects, frequency targets range from one untreated event per year per CSO location (King County) to ten untreated events per year (San Francisco). Only two agencies are following EPA's presumption approach allowing for 4 to 6 events per year per CSO (Providence, Washington, DC). In addition, three agencies had different CSO frequency targets for different water bodies (Boston, Portland, San Francisco).

Table 5: Frequency Reduction Targets

Agency	Overall Systemwide Frequency Reduction Target	Frequency Varies According to location or time of year?
Atlanta	No	No
Boston	No	Yes, 0 discharges for swimming and shellfishing areas. 0-4 discharges in most other basins. For discharges over 4 per year, treatment is provided (screening and disinfection). One basin includes up to 28 treated (screening and disinfection) discharges per year.
Columbus	No	No
Detroit	No, but under discussion with the state to see if Detroit could follow the untreated reduction approach. However, state is adamant that there is to be *no untreated discharges.*	No
Minneapolis-St. Paul	0 discharges	No
New York	No, system is really too big and complicated to use this approach.	No

Table 5: Frequency Reduction Targets		
Agency	**Overall Systemwide Frequency Reduction Target**	**Frequency Varies According to location or time of year?**
Portland	Yes	Yes, varies for summer and winter storms and Willamette River vs. Columbia Slough. Willamette River level of control set at 4 overflows during the average winter (November through April) and one overflow on average every three summers (May through October); Columbia Slough level of control set at 1 overflow every 10 years during the average summer and 1 overflow every 5 years during the average winter.
Providence	Yes, 4 to 6 events per year per CSO or one untreated event per year[1]	No
San Francisco	No	Yes, varies with 0-10 untreated discharges per year depending on sensitivity of receiving area, shellfish beds, CSO ability to mix with receiving water, etc.
King County	One untreated event per year per CSO.	No
Washington, DC	4 to 6 events per year per CSO.	No

[1] Providence's CSO requirements are not so much based on number of events, but on either a flow basis (e.g. treating to a one year storm; this allows one untreated CSO per year) or on a mass removal of pollutants basis. The second approach allows Providence to meet the 4 to 6 events per year by defining primary treatment of CSOs as equivalent to the mass of pollutants that would be removed by primary treatment of flows during the one year storm.

To determine frequency and volume control targets for CSO programs, many of the agencies tried to meet WQS. In addition, agencies used cost-benefit analysis, field studies, computer modeling, and following EPA CSO policy to support CSO planning.

Boston's CSO Program and Changes to Control Targets

Boston's 1990 CSO Plan assumed annual CSO volume to be 5.2 billion gallons per year. To reduce this volume, Boston's 1990 CSO Plan proposed the construction of a deep tunnel sized to allow for four overflows per year. This approach was estimated to cost $1.2 billion, yet it did not show a corresponding benefit to water quality because of other sources of pollution in Boston's receiving bodies of water. Thus, through more accurate quantification of CSO flows, system optimization, as well as using a watershed approach which accounted for both CSO and non-CSO pollutant sources,[7] Boston was able to reduce the amount of its CSO volume from 5.2 billion

[7] Boston spent approximately $1.5 million on monitoring and $1 million on modeling its system and the receiving bodies of water.

gallons to 3.2 billion gallons and reduce the cost of its CSO program from $1.2 billion to $372 million (1997 dollars).

Both the federal court and the public accepted Boston's less expensive, watershed based approach as Boston was able to show that a higher level of CSO control did not greatly benefit water quality.[8] For example, Boston's CSOs accounted for less than 5% of the pollution of the receiving bodies of water relative to other pollution sources on an annual flow percentage basis. Boston's final CSO volume reduction estimate is 84% over baseline volumes, with 94% of the *captured* combined sewer volume receiving secondary treatment.[9]

The following table outlines Boston's CSO volume reduction and the strategy Boston used to obtain CSO volume reductions.

Table 6: Boston's Approaches to CSO Volume Reduction

Phases to CSO Volume Reduction	Annual CSO Volume	CSO Volume Reduction Strategy
	5.2 billion gallons per year	1990 CSO Control Plan assumption of CSO volume
	3.2 billion gallons per year	1994 CSO Control Plan assumption of CSO volume (this is used as baseline volume for further CSO volume reduction)
Phase I (1988--1992)	1.5 billion gallons per year	55% CSO reduction in annual CSO volume (from baseline) due to CSO related improvements to transport and treatment facilities (pump stations, remote headworks, treatment upgrades) as well as upgrades to and construction of new CSO facilities; 50% of CSO overflows receiving at least screening and disinfection.
Phase II (1992--1997)	1.0 billion gallons per year	70% CSO volume reduction over baseline year due to system optimization projects, further Deer Island Treatment Facility pumping improvements, and implementation of EPA's 9 minimum controls; 60% of CSO volume receiving at least screening and disinfection.
Phase III (1997--2010)	562 million gallons per year	84% CSO volume reduction over baseline year due to additional CSO control projects. Of 562 MG/yr, 540 MG/yr (96%) will receive at least screening and disinfection and the other 22 MG/yr (4%) will receive only floatable controls.

[8] With the exception of one of the fourteen receiving water segments which will be re-evaluated in 1997.

[9] Total volume of combined sewer captured by 2010 will be 8,800 million gallons per year; 94% of this flow will be sent to a new treatment facility for secondary treatment (8,238 MG/yr). Of the 562 MG/yr not captured and not receiving secondary treatment, 540 MG/year will receive at least screening and disinfection and the remaining 22 MG/year will receive only floatable control.

Difficulties in Meeting CSO Requirements

The three largest concerns amongst most of the agencies surveyed were meeting the overall expense of the programs, meeting WQS, and meeting program deadlines. Portland stated that obtaining the necessary financing for the CSO program would be difficult. For example, $700 million is to be spent on the CSO program in the next 17 years (1993 dollars), with $350 million of the cost incurred in the next five years. Providence also raised this same concern as it is looking at a 300% to 400% rise in sewer rates due to its CSO program. Washington, DC, mentioned that funding is a huge concern and another concern is that the agency might have to reduce the number of overflow events from the combined sewer system to five per year and provide primary treatment (estimated capital cost at $2 billion). Washington, DC, would prefer to clean up the river by following a watershed approach as modeling indicated that even if CSOs were eradicated along the river, the river still would not meet WQS.

Detroit is grappling with how to ensure its CSO plan meets state WQS. Detroit estimates that meeting WQS could cost $1 to $3 billion (in 1995 dollars). Detroit is also concerned that Michigan has declared that the same WQS must be used for all water bodies (e.g., the Rouge and Detroit Rivers must be swimmable and fishable). This will be particularly difficult to meet in the Rouge River as it is a small, slow moving river and has been a dumping ground for industry since the 1920s. In addition, parts of the Rouge River do not meet fishable and swimmable WQS during dry weather.

Atlanta is also concerned that its CSO program will not meet WQS due to other pollutant sources in the watershed. Atlanta hopes to work more closely with the state to develop more realistic WQS as information is gathered through a major watershed study. The study is expected to identify other major pollutant contributors to the watershed besides CSOs and identify watershed management strategies to be implemented by the City. Products include a master plan for the management of water quality in the watersheds and detailed basin-specific water quality facility plans for each of the study's watersheds.

Columbus, San Francisco, and King County have found that meeting the program's timeline has been and is challenging. Columbus had only five years to develop its CSO program and projects while San Francisco had 20 years to complete its CSO program. However, San Francisco found it had to renegotiate schedule timelines at varying times. King County had hoped to be farther along in achieving 75% CSO volume reduction. However, capital costs have proven to be higher than originally projected in King County's *1988 CSO Plan*. For example, King County currently estimates that the capital expenditures to achieve 75% volume reduction will be $279 million (1995 dollars), this is closer to the capital expenditures anticipated to be needed to achieve one untreated event per year (85% systemwide CSO volume reduction) in the *1988 CSO Plan*.

IV. CSO Control and Treatment

This chapter includes strategies used by the surveyed agencies for CSO control and treatment as well as information on defining primary treatment, designing for CSO treatment, and issues surrounding CSO on-site treatment.

CSO Control Strategies

Most agencies use several CSO control strategies in reducing and/or eliminating CSOs. These strategies include sewer separation, in-line storage, storage tanks, on-site CSO treatment, primary and/or secondary treatment at treatment plants, rooftop disconnection, stream diversion from sewer system, and drainage and infiltration sumps. For most agencies, sewer separation was not the CSO control strategy of choice due to the expense and disruption of activities associated with ripping up streets and laying down new storm and/or sanitary sewer lines. However, several agencies may implement sewer separation in selected areas.

Both Columbus and Minneapolis-St. Paul have decided not to use storage as a major CSO control strategy. Columbus has decided that CSO treatment with vortex separators would be the best method in controlling CSOs. Minneapolis-St. Paul chose separation, but is currently considering using one of its old deep combined tunnels for storage.

In terms of treatment, many of the agencies have or will be upgrading their existing treatment plants to handle larger CSO volumes. Portland and King County operate and/or are building wet weather CSO treatment plants which provide primary treatment to a portion of their CSOs. New York uses a large on-site tank for CSO treatment (12 million gallons). San Francisco uses baffled storage tanks to remove total suspended solids and floatables. Boston stated that 94% of its captured CSO annual volume will receive secondary treatment at newly constructed treatment facilities. In addition, most of the CSO volume which is not captured will receive screening and disinfection and/or floatable control. Atlanta will use screening and disinfection at on-site facilities. Portland and King County appear the most interested in pursuing rooftop disconnection programs in specific basins. Minneapolis-St. Paul already undertook an active roofleader disconnection program for residential structures. For this program, the City of Minneapolis fully paid for residential rooftop disconnections while the City of St. Paul subsidized homeowners who completed rooftop disconnections.

In terms of swirl concentrators, Washington, DC, constructed a 400 million gallon per day on-line swirl concentrator CSO treatment facility, but has seen no measurable improvement in water quality (only 18% of total suspended solids removal compared to the 60% total suspended solids removal that Columbus expects to achieve with its vortex separators). Washington, DC, expects that many of its storms may not be large enough to activate the swirl concentrator so the agency now uses it to store CSOs. San Francisco uses vortex separators as grit tanks at one of its treatment plants. New York is pilot testing three types of hydrodynamic separators. King County pilot tested the Storm King vortex separator in 1995, but found results in removing 50% total suspended solids inconclusive as rainfall was not as heavy as anticipated and more time was needed to learn how to operate the unit.

Washington, DC, believes its current system has enough treatment and conveyance capacity for all CSOs to receive primary treatment and disinfection and a large portion of the CSOs could also receive secondary treatment. However, the system lacks pumping capacity in moving CSOs across the Anacostia River.

Designing for CSO Treatment

The following are two basic standards in designing for CSO treatment:

- Performance based standard (tends to include removal efficiency such as 35% total suspended solids and 15% biological oxygen demand to define effluent quality)

- Technology based standard (e.g. surface loading range between 800 and 1,200 gallons per day/square foot at average design flow and 2,000 to 3,000 gpd/sq. ft at peak design flow). This approach tends to assume that CSO flows are receiving primary treatment by following AKARPT (all known available reasonable prevention technology).

Of the eleven agencies surveyed, five agencies use performance based standards and four use technology based standards. King County uses both performance and technology based standards when designing for CSO treatment. Atlanta stated that it does not follow either standard, but basically tries to meet WQS. Specifics regarding how each agency defines "performance based" or "technology based" standards were not available.

Primary Treatment

EPA allows control of CSOs through primary treatment which it defines as "35% total suspended solids removal and 15% BOD_5 removal." This is the requirement that Boston follows as it is regulated by EPA Region 3. (Boston uses screening and disinfection and then samples for chlorides due to disinfection.) Washington State Department of Ecology defines primary treatment more stringently, "any process which removes at least 50% of total suspended solids from the waste stream and discharges less than 0.3 mg/l/hour of settleable solids" (WAC 173-

245). Rhode Island defines primary treatment yet more stringently, "50% total suspended solids removal and 35% biological oxygen demand removal or 100% of settleable solids removal." Providence also stated that up to a three month storm, CSOs will receive secondary treatment. In terms of the other surveyed agencies, it was not clear if the agencies are meeting, exceeding, or following EPA's definition of primary treatment.

Columbus is using vortex separators and expects that these units should provide better than EPA's definition of primary treatment with 60% total suspended solids removal. Portland stated that primary treatment for CSOs has not been defined in Oregon's CSO regulations. For the CSO treatment plant that is proposed to be in operation by 2000, Portland expects to operate the plant as efficiently as practical and is striving for no less than 35% total suspended solids removal.

San Francisco must meet whole effluent toxicity standards, fecal coliform standards, settleable solids standards, and zero chlorine residual. Atlanta and New York are treating CSOs to meet WQS.

Issues Surrounding CSO On-Site Treatment

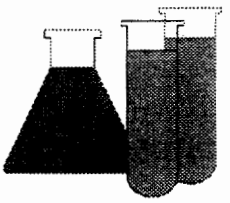
There were some concerns regarding the use of on-site CSO treatment. Atlanta stated that CSO treatment is working great in terms of removing garbage from CSOs, but the agency may not always be meeting WQS. For example, Atlanta must meet a fecal coliform standard with no chlorine residual, which Atlanta is finding extremely difficult to meet. Boston stated that the public and environmental community are questioning the use of chlorination; thus Boston is beginning to implement declorination. Washington, DC, found that its swirl concentrator was not as effective in total suspended solids removal as hoped (only 18% versus 35%).

Providence stated that one problem with its wet weather facility at its treatment plant is that it does not meet removal rates consistently and with secondary treatment, total suspended solids are so dilute that it is hard to achieve 50% TSS removal. Providence also needs to modify its chlorination unit for automatic operation.

King County's first CSO treatment plant, Carkeek Park, started operation in 1994. Some community complaints regarding vibrations were resolved by replacing a pump. King County must also chlorinate flows when they enter the plant as well as when the treated flows are discharged (to ensure all pathogens are eliminated before discharge into Puget Sound). Preliminary experience (one year of operation) has shown that the Carkeek Park CSO Treatment Plant can meet 50% total suspended solids removal rates on an annual average (but not per CSO event).

Columbus, Detroit, New York, and Portland had no information to provide on this issue at this time. When their CSO programs are on-line and more projects are constructed, each of these agencies will have more information. San Francisco also did not have any issues to add.

V. Sampling and Monitoring Programs



Monitoring CSO Volumes and Frequencies

As shown in Table 7, eight agencies have an on-going monitoring program of CSO frequencies and volumes. [10]

Table 7: Monitoring CSO Volume and Frequency

Agency	Monitor CSO Volume and Frequency	Comments
Atlanta	Yes	Monitors every event using meters which send the information back to its Foxboro computer system.
Boston	Yes	Only monitors the volume and frequency during every activation of CSO treatment facilities and at untreated locations only for special study purposes.
Columbus	Yes	Monitors CSO volume and frequency at every event.
Minneapolis-St. Paul	Yes	Continuous automatic monitoring at 15 sites.
New York	Yes	Monitors only at Fresh Creek outfall and not at other CSO discharge points.
Portland	Yes	Very few of Portland's outfalls have level sensors or flow meters. All CSO outfalls remaining, after CSO controls are in place, will be monitored.
San Francisco	Yes	Frequency is continuously monitored at all major CSO points where CSO control facilities are in place. Volume is continuously monitored at all major CSO points.
King County	Yes	Continuously monitored by automatic sensors (volume) and remote monitors (frequency).

Detroit expects to monitor CSO frequency and volume by 1999. Providence measured the volume of selected CSO discharges during facilities planning, but continuous monitoring has not been

[10] Only phone survey response was available from Washington, DC.

done subsequent to facilities planning. In addition, Providence has approximately ten selected CSOs which will be monitored to see if they discharge at all. If the CSOs do not discharge, Providence will not build CSO facilities for these locations.

Sampling Programs

Out of the ten agencies completing the written survey, only Detroit and Providence do not have a CSO-related sampling or monitoring program. However, Providence did conduct CSO discharge and water column sampling as part of its facility planning. Of the agencies which have CSO-related sampling and monitoring programs, six have water column sampling programs,[11] three have sediment sampling programs, and seven have CSO discharge sampling programs.

Table 8: Water Column Sampling

Agency	Sampling Parameters from Receiving Body of Water	Number of Samples per Year per Location
Atlanta	TSS; nutrients; dissolved O_2; pH; temperature; bacteria; metals; organics	For all parameters except organics, samples are taken at every third event. For organics, one sample per year per location.
Boston	Chlorophyll; TSS; Nutrients; dissolved O_2; Light transmission; pH; temperature; bacteria; turbidity; salinity	For all parameters, 30 samples are taken per year per location.
Columbus[1]	TSS; Nutrients; pH; temperature; bacteria; BOD; organics	For all parameters except organics, 20 samples per year per location. For organics, one sample per year per location.
New York	Chlorophyll; TSS; nutrients; dissolved O_2; temperature; bacteria; turbidity; salinity	Chlorophyll and nutrients--60 samples/year/location. TSS and bacteria--120 samples/year/location. For others, no sampling analysis is performed. Instead, measurements are taken.
Portland	TSS; nutrients; dissolved O_2; light transmission; pH; temperature; bacteria; turbidity; metals	Weekly at 4 sites
San Francisco	Dissolved O_2; light transmission; pH; temperature; bacteria; ammonia	For all but bacteria, conducts monthly cruises during wet weather in San Francisco Bay. For bacteria, collects shoreline bacteria samples 3 times per week all year at approximately 25 stations.

[1]As of 1995, Columbus has not collected any sampling data to date. Facilities (CSO plants/vortex units) will be on-line in 1996. Monitoring as per the permit will be initiated at that time.

[11] King County's water column sampling is done in conjunction with planning and CSO project specific design. Water column sampling has included organics, nutrients, conventionals, and metals.

As identified in Table 8, the samples most frequently taken by the six agencies, which have on-going water column sampling programs, include TSS, dissolved oxygen, temperature, and bacteria. As each program varies by sampling parameters and number of samples taken per year per location, it is difficult to determine the relative stringency or comprehensiveness of programs relative to each other.

King County has done very little water column sampling in CSO locations, but expects to sample CSO events in the receiving water in 1995--1996.

Table 9: Sediment Sampling

Agency	Sediment Samples from Receiving Body of Water[1]	Number of Samples per Year per Location
Boston	Organics; metals; PAH; PCB; Grain size; LAB/coprostanol	Sampling is performed approximately once every 3 years; samples are in triplicate; not all CSO locations are sampled. For LAB/coprostanol a small number of stations are sampled every three years. Also photographs are taken of depth of oxidized layer.
Portland	Metals	52 samples at 2 sites; 4 samples at 6 sites
King County	Organics; total solids; total organic carbon; BOD/COD; total acid volatile sulfides; metals; total sulfides; PCB; PSD	Sampling was conducted for each CSO location between 1989--1994. One sample was taken at each site. Additional sampling has been conducted at most of the sites as part of previous planning studies or as part of CSO project design efforts.

[1]Sediment sampling at the vicinity of the CSO discharge

As identified in Table 9, sediment sampling is only required of three of the agencies surveyed. However, the other agencies may have to incorporate sediment sampling within their programs once EPA has established formal criteria and codified the criteria. Unlike many state agencies, Washington State has developed sediment standards. The standards were adopted in 1991 and have three parts: sediment quality standards that define concentration levels acceptable anywhere in Puget Sound, sediment source control standards that regulate impacts to sediment from wastewater and stormwater discharges, and sediment cleanup standards that establish the sediment cleanup process and cleanup standards for contaminated sites. In 1994, in response to these standards, King County developed a Sediment Baseline Monitoring Plan for monitoring marine sediments in the vicinity of its wastewater treatment plant outfalls and CSOs.

Table 10: CSO Discharge Sampling		
Agency	**CSO Discharge Samples[1]**	**Number of Samples per Year per Location**
Atlanta	Organics; TSS; BOD; nutrients; metals; temperature; bacteria	For organics, one sample/year. For all others, samples are taken at every third event.
Boston[2]	Organics; TSS; BOD; metals; fecal coliform; pH; settleable solids; total Cl residual	For organics and metals, one sample/month. For all others, samples taken at every activation.
Columbus[3]	Organics; TSS; BOD; metals; temperature; bacteria; nutrients; total chlorine; pH	For organics, one sample/year. For all others, 20 samples are taken per year.
Minneapolis–St. Paul	TSS; BOD; metals; COD nutrients; total phenols	N/A
New York[4]	TSS; BOD; temperature; bacteria; total coliform; conductivity/salinity; filtered BOD; fecal coliform; total Kjeldahl nitrogen; ammonia; nitrate + nitrate; total phosphorous; oil & grease; long-term BOD; volatile suspended solids	For BOD, 200 samples are taken per year per location. For all others, a total of 124 outfalls have been sampled for up to 5 separate rain events, representing 600 outfall sampling events. A total of 46,000 individual analyses have been performed.
San Francisco	TSS; metals; PAHs; NH_3	Eight samples per year at nine representative CSO structures.
King County	Organics; TSS; BOD; metals; temperature; bacteria; PCB; oil; grease; cyanide	Four per year per location. CSO discharge sampling was completed in 1995. Additional sampling has been conducted at most of the sites as part of previous planning studies or as part of CSO project design.

N/A = not available

[1]The sampling of CSO discharges takes place within the CSO pipe itself (e.g., the CSO sample of the CSO discharge itself before it is released into a receiving water body).

[2]For Boston, the information included is only for CSO treatment facilities. In addition, Boston takes effluent samples for all parameters listed and takes influent samples for TSS and BOD.

[3]As of 1995, Columbus has not collected any sampling data to date. Facilities (CSO plants/vortex units) will be on-line in 1996. Monitoring as per the permit will be initiated at that time.

[4] The information included is for 124 citywide CSO outfalls out of 460 of NY's CSO outfalls. New York also has on-going sampling at its Fresh Creek outfall (a very large outfall).

As identified in Table 10, the sampling parameters favored by the seven agencies with CSO discharge sampling programs include TSS, organics, metals, and BOD. Sampling parameters and number of samples vary for each agency's program and thus it is difficult to judge any program as more or less stringent or comprehensive relative to the others.

In 1995, Portland did not have a sampling program for CSO discharges, but in the future is planning to sample six to eight events at four sites. In addition, Portland is developing a scope of work and a request for proposals to refine its CSO Control Plan for the Willamette River.

Additional work will include an assessment of the benefits on the receiving water of the proposed CSO control projects. Providence also does not have an on-going sampling program, but as part of facilities planning, Providence sampled TSS, BOD, metals, and bacteria.

Most agencies included no additional comments regarding their CSO programs. However, Detroit stated that the required monitoring for the Detroit River may actually be unnecessary since the river is so large it can assimilate CSO discharges relatively well. Atlanta noted that not only does the agency undertake water column and CSO discharge sampling, but the agency also samples with the same frequency and with the same parameters at its reference stream. This helps Atlanta determine if it has met or exceeded water quality standards.

Sampling/Monitoring Costs

Most of the agencies were not able to provide total costs of sampling and monitoring programs on a yearly basis. Boston estimates that the agency spends $250,000 annually on sampling and data analysis and routine monitoring is basically low cost. Boston also mentioned that in 1992 it spent approximately $1.5 million on sampling and monitoring programs to support its long-term planning. New York stated that the agency spends at least $1 million a year just on sampling. Portland estimated that the agency spends $30,000 on sampling and $20,000 on data analysis. San Francisco estimated that sampling, monitoring, and data analysis costs $150,000 per year. King County estimated that sediment sampling and analysis costs $15,000 to $20,000 per year and CSO discharge sampling and analysis $20,000 to $30,000 per year. However, in any year, King County costs may be more or less depending on number and type of samples needed and if Ecology finds the sampling and data acceptable.

Water Quality Standards and Sediment Quality Standards

In terms of pollutants routinely exceeding water quality standards due to CSO discharges, Boston, Minneapolis-St. Paul, San Francisco, and King County identified fecal coliform as a culprit. Boston also noted an aesthetic problem due to sticks and floatables. San Francisco stated that zinc, lead, and total PAHs may routinely exceed WQS. Providence identified bacteria and floatables as issues. Portland noted that based on a limited number of samples, bacteria, toxic metals, and turbidity are suspected to exceed water quality standards.

As most of the agencies do not follow any sediment monitoring requirements, most agencies did not indicate whether their state has developed sediment standards or uses EPA's proposed requirements. New York and King County indicated that their states have developed their own sediment quality standards. Minneapolis-St. Paul, Portland, and Providence all indicated that their states use EPA's sediment quality recommendations. San Francisco mentioned that the California State Water Code directed the State Water Resources Control Board (SWRCB) to develop sediment quality objectives or utilize EPA sediment quality objectives when published if the EPA objectives met the criteria of state law. The SWRCB has formed scientific advisory panels, but

has not yet produced draft criteria. The subject of sediment standards is becoming a very contentious issue in California.

Only King County identified pollutants routinely exceeding sediment standards due to CSO discharges. Pollutants included mercury, PAH, phthalates, benzoic acid, and phenols.

VI. CSO Cost and Financing

This chapter includes the costs of the agencies' CSO programs.[12] However, since specifics regarding each agency's program costs and the factors used in developing the costs were not always available (e.g. operation and maintenance may have been included in some estimates but not others, the base year for calculations may be different, inflation factors may be different, etc.), these numbers should not be seen or used as direct comparisons.

Table 11 includes information regarding the capital costs of the agencies total wastewater system programs.

Table 11: Capital Costs of Wastewater Systems

Agency	Capital Cost of Agency's Total Wastewater System Program	Time period	Future Capital Cost of Agency's Total Wastewater System Program	Time Period
Atlanta	N/A	N/A	$400 million	1994--2001
Boston	$2.9 billion	1985--1995	$1.4 billion	1996--2008
Columbus	$99 million	1990--1995	N/A	N/A
Detroit	$1 billion	1966--1995	N/A	N/A
Minneapolis--St. Paul	$1.1 billion	1970--1995	$1.9 billion	1995--2015
New York	$4.6 billion	1986--1995	$4.5 billion	1996-2005
Portland	$150 million	1995 only	N/A	N/A
Providence	$100 million	1982--1995	$51.9 million	1995--2000
San Francisco	$1.4 billion	1976--1998	Included in the $1.4 billion	Not applicable
King County	$3.3 billion	1961--1995	$1.4 --1.8 billion	1996--2030

N/A= Not available

CSO Program Capital Costs Since Program Implementation

Table 12 summarizes the agencies' CSO programs total capital costs since implementation of the program by time period. As shown, San Francisco was the first of the surveyed agencies to

[12] Cost information was unavailable from Washington, DC.

implement a CSO program (1976) and has expended the most money as its program is almost completed.

Table 12: CSO Program Capital Costs Incurred To 1995[1]

Agency	CSO Program Total Capital Costs Since Implementation of the Program	Time Period	Average Cost Per Year of CSO Program Total Capital Costs Since Implementation of the program to 1995[1]
Atlanta[2]	$205 million	1980--1998	$11.4 million
Boston[2,3]	$23.4 million	1988--1996	$2.9 million
Columbus	$91 million	1990--1995	$18.2 million
Detroit	$20 million	1992--1995	$6.7 million
Minneapolis--St. Paul	$500 million	1986--1995	$55.6 million
New York	$130.8 million[4]	1993-1995	$65.4 million
Portland	$60 million	1991--1995	$15 million
Providence	$40 million	1984-1996	$3.3 million
San Francisco[2]	$1.1 billion	1976--1998	$50 million
King County	$60.5 million	1985--1995	$6.05 million

N/A = Not available

[1] Or as close as possible to 1995 (depending on agency information).

[2] Note that these agencies did not have data to 1995, so average yearly cost could be slightly higher if 1995 was used.

[3] Note that Boston spent $210 million on capital projects from 1988--1996 which were not dedicated to the CSO program. However, these improvements led to significant reduction in CSO volumes. If the cost of these improvements were included, the total capital and average year costs would be much higher than shown in the table.

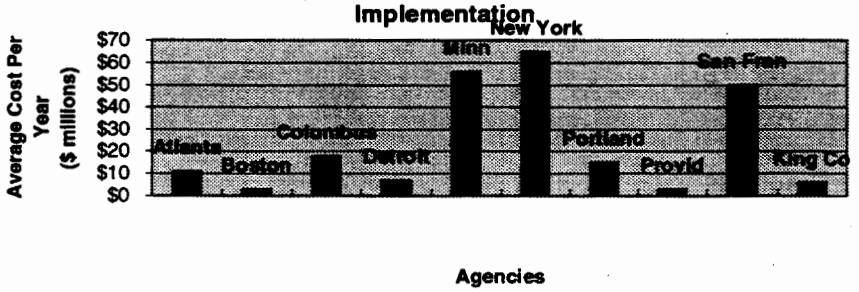
[4] This number includes the purchase cost of a floatable skimmer boat.

In terms of CSO program total capital costs since the implementation of the CSO program up to and including 1995, San Francisco has spent the most followed by Minneapolis-St. Paul, Atlanta, New York, Columbus, King County, Portland, Providence, Boston, and Detroit. This order is not surprising as San Francisco's first CSO facilities were on line in 1982 and the program will be mostly completed by 1996, thus more money has been expended to date. Minneapolis-St. Paul is second as the agency choose total sewer separation as the CSO control method of choice (which is very expensive especially on a large scale), it started implementing its CSO program earlier than many of the other agencies, and its program is almost completed.

The order of the other agencies reflects the fact that the agencies which have completed or almost completed their programs tend to have spent more in terms of total capital costs since implementation of their CSO program to date than the agencies which are just starting their programs. The main "outlier" is New York which is just beginning its CSO program and yet has spent $130.4 million (mostly due to the expense of purchasing a floatable skimmer boat).

As shown in Figure 1, New York has spent the most money on an average yearly basis since implementation of the program to date followed by Minneapolis-St. Paul, San Francisco, Columbus, Portland, Atlanta, Detroit, King County, Providence, and Boston.
New York is the most expensive according to Figure 1 because most of the cost incurred was for a floatable skimmer boat and its program costs are averaged only over two years. As noted previously, sewer separation is expensive and averaged over nine years makes Minneapolis-St. Paul's CSO program average cost per year since implementation of the program the next expensive. San Francisco's CSO program is third according to Figure 1, basically due to the large amount of money already spent on the program and because the program is nearing completion. It is interesting to note that in terms of average cost per year versus the total capital costs since implementation of the program to date, Columbus moves ahead of Atlanta (because while it spent less in total, Columbus spent its total amount in a shorter period of time) and King County moves farther down in order of cost (mostly because King County had a longer time period to average its costs than the other agencies).

Figure 1: Average Capital Costs Per Year of CSO Program Since Implementation



CSO Program Future Capital Costs

Table 13 summarizes the agencies' CSO program total future capital costs to fully implement the CSO program. As shown, Detroit has the highest future capital costs followed by New York, Portland, King County, Providence, Boston, and then Minneapolis-St. Paul. Detroit is first mostly because it still is in the process of deciding what its CSO program will include (the cost given is an estimate), it has the second largest CSO volume to control and second largest number of CSO outfalls and, and it is in the beginning stages of its CSO program. New York is second mostly because it has the largest number of CSO outfalls and largest CSO volume of the agencies surveyed and it is just beginning its CSO program (when Detroit has a better estimate of CSO program costs, New York could shift to first). Portland has the third highest total future capital costs to fully implement the CSO program as:

- Portland, next to Minneapolis-St. Paul, seems to have the most stringent volume control measures (94% to 99.6%).
- The agency has a short timeline to complete its program as it is just beginning to implement its CSO control measures and must complete its program by 2011.

King County's CSO program total future capital costs to fully implement the CSO program falls between Portland and Providence. The reasons that Portland's future program is more expensive is included above, plus Portland has a larger CSO baseline volume and number of CSO locations which need to be controlled. Providence also has a larger CSO volume and number of CSO locations than King County which need to be controlled. However, King County must meet a higher level of control (one event per year) versus Providence's four to six events per year. Boston is near the end of the group in terms of expense as shown in Table 12 mostly because it was able to reduce the cost of its future CSO program from $1.2 billion to $372 million by the strategies outlined in Chapter III and because Boston previously received some CSO volume reduction benefit through capital projects undertaken from 1988 to 1996 which were not CSO program specific.

San Francisco did not have a breakout of its future capital costs, but these will probably be minimal compared to its past expenditures as the program is expected to be mostly completed by the end of 1996. Minneapolis-St. Paul's program is almost completed and the majority of the $1 million will be spent on regulator modifications.

Table 13: CSO Program Future Costs

Agency	CSO Program Total Future Capital Costs to Fully Implement the CSO Program	Time Period	Average CSO Program's Total Future Capital Costs to Fully Implement the CSO Program Per Year
Atlanta	N/A	N/A	N/A
Boston	$372 million	1996--2008	$31 million
Columbus	None anticipated	--	--
Detroit	$1 to $3 billion[2]	1996--2010	$143 million[1]
Minneapolis--St. Paul	$1 million	1996--2000	$250,000
New York	$1.46 billion	1996--2005	$104 million
Portland	$640 million	1996--2011	$43 million
Providence	$476 million	1994--2024	$16 million
San Francisco	Included in the $1.1 billion	--	--
King County	$525 million	1996--2030	$15 million

N/A = Not Available

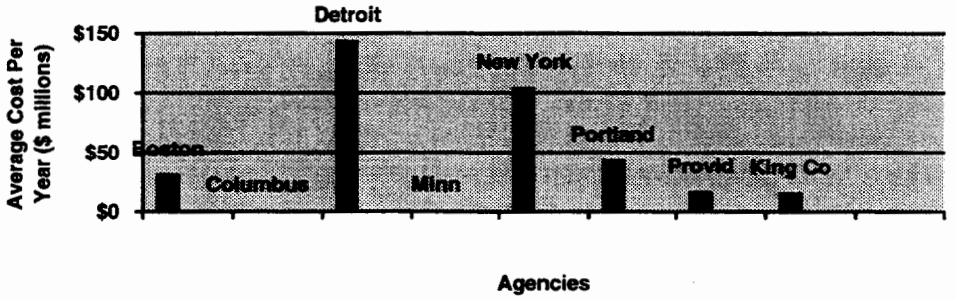
[1]This number represents the average of the midpoint of the costs indicated over the years identified.

[2]These numbers are a ballpark; alternatives have not been selected yet.

As shown in Figure 2, Providence and King County are very close in terms of their programs average annual future cost per year. This may be because while Providence's program has a

somewhat lower level of control than King County's (4 to 6 events per year per CSO location versus one event per year), Providence's program is just beginning while King County's program implementation began in the 1980s. In addition, since both programs have longer time lines for completion than the other agencies submitting information, their average costs per year tend to be lower. The other agencies order tend to reflect the same reasoning as included for Table 12.

Figure 2: Average Annual Future Cost Per Year of CSO Programs



CSO Program Funding

Most of the agencies surveyed did not have dedicated funds for CSO financing; CSO projects tended to be funded out of the overall program budgets for wastewater facilities. Boston, Columbus, and New York have funding sources dedicated to CSO programs. Boston's funding sources include grant funding (1.3% state; .3% federal) and bonds/cash financing for the balance. Columbus' funding sources include grant funding (26.5%) and a 1% sales tax (73.5%). To pay for the operation of its CSO treatment plants, Columbus also includes an additional CSO charge based water use. New York also has dedicated funding for CSO programs, but did not include a breakout.

Sewer Rates

The agencies surveyed were retailers, wholesalers, and a mixture of both. The agencies used both flat rates for sewage service charges as well as billing per gallon or per hundred cubic feet of sewer service. Due to these differences in billing, it is difficult to make an overall rate comparison amongst agencies.

Table 14: Sewer Rates				
Agency	**Type of Service**	**1995 Monthly Sewer Rate for average residential customer**	**Includes local sewer service fees?**	**Portion of Rate which is CSO Related**
Atlanta	Retailer and Wholesaler	$18.00	No	N/A
Boston	Wholesaler	$34.02	Yes	$4.00
Columbus	Wholesaler	$4.91 per 100 cubic feet up to 400 cubic feet; next 20,000 cubic feet cost per 100 cubic feet is .93 with various prices for additional cubic feet [1]	No	Additional charges are added based on water use: 0--30 cubic feet $1.75/month 31--408 cubic feet $3.50/month 409--2008 cubic feet $35.00/month 2009 and over $100.00/month
Detroit	Retailer and Wholesaler	$8.41 per 1,000 cubic ft (residential retail rate)[4]	No	N/A
Minneapolis-St. Paul	Wholesaler	$8.50 per 7,500 gallons per month	No	N/A
New York	Retailer	$1.69 per 100 cubic ft	Yes	N/A
Portland	Retailer; minor wholesale	$2.18 per 100 cubic ft (approximately $22.36 per month)[3]	Yes	$0.80
Providence	Retailer	$14.00 per 280 gpd	No	0[2]
San Francisco	Retailer	$1.68 per 100 cubic ft (approximately $16.66 per month)	Yes	70% of sewer bill
King County	Wholesaler	$17.95	No	$0.80

N/A = Not available

[1]This is a 1996 rate.

[2]The amount is zero as the debt service to 1995 has not included CSO costs because previous work had been carried out using state bond money.

[3]The $22.36 includes an account service fee of $3.33, a drainage fee of $5.26, and sanitary fee of $13.77.

[4]There is also an additional residential drainage charge of $2.50 per month.

VII. Conclusions and Options

This chapter provides an overview of King County's CSO program relative to the ten agencies surveyed and provides a summary of information drawn from the previous chapters.

King County's CSO Program Relative to Other Surveyed Agencies

Of the surveyed agencies, King County's CSO program is one of the smaller programs and is less complex in terms of volume and number of CSO locations that need to be managed compared to Detroit, New York, and Boston . In addition, King County's CSO program falls in the middle to low range for regulatory stringency, timeline to complete CSO projects, and program capital costs compared to the other agencies surveyed.

CSO Requirements

Although Ecology's regulatory requirement of one untreated event per year per CSO location (which results in 85% systemwide CSO volume reduction) seems stringent compared to EPA's guideline of 4 to 6 events per year per CSO location, it requires less CSO volume reduction on both a volume reduction and percentage of volume reduction basis when compared to the reduction requirements of several of the surveyed agencies.

- Minneapolis-St. Paul is required to reduce CSO volume by 100% per year (0 discharge).
- Portland is required to reduce CSO volume by 94% to 99.6% per year.
- Detroit is required to capture and treat 95% of its CSOs.
- Providence does not have a volume reduction target, but expects its program will reduce CSO volumes by 90% to 92%.
- Boston does not have a volume reduction target, but expects its program will reduce CSO volume by 84%. In addition, Boston will provide secondary treatment for 94% of Boston's annual captured combined sewer flow. Any remaining CSO will receive screening, treatment, and/or floatable control.
- Columbus does not have a volume reduction target, but expects its program will result in 85% or higher capture and treatment of CSOs.

Of the agencies surveyed, only Providence and Washington, DC, are following the 4 to 6 event per year approach outlined in EPA's CSO policy. However, as stated above, Providence's

program actually translates into a 90% to 92% volume reduction[13] which is higher than King County's one event per year (85% systemwide volume reduction).

Unlike Boston and San Francisco, King County does not have the flexibility of varying its one event goal according to the sensitivity of the CSO location or the time of year the CSO is discharging (such as Portland). However, King County's CSO requirements are flexible in allowing for discharges above one event per year if on-site treatment is used (as long as the total treated and untreated annual discharge from the on-site treatment plant is the same volume or less as the baseline volume at that same location). Thus, King County is exploring on-site treatment as a control strategy. In addition, King County may want to model the impacts of increasing or decreasing the number of discharges per year based upon mixing capability and sensitivity of receiving water and CSO location. King County may also want to model the impacts of allowing a greater number of discharges at CSO locations in winter than summer. If it was found that these approaches were less expensive and yet still protected water quality, King County might be able to renegotiate its interim and long-term CSO volume reduction and discharge goals.

All of the surveyed agencies meet or almost meet all of EPA's Nine Minimum Controls.

CSO Control and Treatment

There was not much information available on how agencies define primary treatment of CSOs or a CSO event. Of the information obtained, Providence currently plans to follow more stringent treatment requirements than King County. However, other agencies may have more or less stringent treatment requirements based on meeting their state's WQS. In addition, many of the agencies do not use an event definition. Of the agencies that use an event definition, the interval of time between discharges ranges from 6 hours to 48 hours. King County uses a 48 hour interval between events.

While King County's 1995 vortex pilot project was not as informative as hoped, this and other types of hydrodynamic separators may still be a technology King County may decide to pursue. When the results of New York's pilot projects are completed and when Columbus' vortex system has been implemented and running for some time, King County may want to contact these agencies regarding project results.

[13] Also, as noted in Chapter III, Providence's CSO requirements are not so much based on number of events, but on either a flow basis (e.g. treating to a one year storm; this allows one untreated CSO per year) or on a mass removal of pollutants basis. The second approach allows Providence to meet the 4 to 6 events per year by defining primary treatment of CSOs as equivalent to the mass of pollutants that would be removed by primary treatment of flows during the one year storm.

Sediment Monitoring

Of all the agencies, King County is further ahead in developing a sediment monitoring and remediation program. This may be because Washington State has more sediment requirements than other states.

Capital Costs

In terms of average capital costs per year since implementation of the CSO program to the present and average future capital costs per year of the CSO program, King County's CSO program falls into the low to middle range *of the agencies submitting information*. This may be due to the fact that King County has completed some major CSO projects, but still has many more to construct while several agencies expect to complete their CSO programs by 2000 (Atlanta, Columbus, Minneapolis, San Francisco) and other agencies are just beginning the planning or implementation stages of their CSO programs and projects (Detroit, New York, Portland, Providence, Washington, DC). In addition, since some agencies require or will include larger volume reductions than King County (Minneapolis-St. Paul, Portland, Providence) their CSO programs may require or have included more extensive CSO infrastructure (which raises their CSO expenditures).

Water Quality Benefits Versus Program Costs

Many of the surveyed agencies, including King County, question if the benefits imparted by the CSO programs actually justify the expense. For example, Providence is finding its CSO program very expensive and the water quality benefits do not appear to provide the economic benefits (e.g., shellfishing revenues) equal to project costs. In addition, many of the agencies are concerned that even with CSO projects in place, water quality standards (WQS) may still be exceeded due to other pollutant sources. Providence indicated that the WQS as set by the state do not address wet weather issues as Providence's rivers are urban rivers and thus will generally have lower water quality than water bodies in less urbanized areas. Columbus mentioned that state law requires jurisdictions to meet WQS; however, WQS are based on dry weather and not on wet weather when pollutants such as fecal coliform are more of a concern. King County may want to explore developing wet weather water quality standards to be followed as part of its CSO program if it is unable to meet dry weather quality standards due to other sources of pollution in the watershed.

Funding

Only Columbus is funding its on-going CSO program through additional fees on top of its sewer rate to be used just for the CSO program. King County may want to explore a number of options including charging based on a percentage of sewer service used, charging additional fees based

upon a percentage of inflow and infiltration exacerbating CSOs, or possibly charging sewage fees based on cubic foot (rather than a flat rate) for all customers. These changes in fee structure may be especially important as more issues regarding equity are raised through the comprehensive planning effort.

Watershed Approach to CSO Control

Unlike King County, many of the surveyed agencies are following a watershed approach and/or are looking at water quality impacts of CSOs. The main reason for this is that Washington State law required CSO abatement programs to be developed in the 1980s and required that a presumption approach be followed. Thus, King County used a cost per gallon reduction approach instead of water quality assessments in planning and designing its CSO projects. However, in the past three years, Washington State has begun to establish a watershed basin planning approach for selected state watersheds. King County will be providing some assistance to Ecology by taking the lead in the development of watershed forums in King County and the development of a water quality assessment for the Duwamish River and Elliott Bay.

The watershed approach may be especially important, as King County's *interim* goal of meeting 75% volume reduction is less than ten years in the future and is expected to cost $279 million.[14] This approach will help to identify the County's pollutant loading contribution relative to other inputs to the Duwamish River and Elliott Bay and help determine the benefits of controlling the CSOs relative to the costs.

Boston was able to reduce the size as well as the cost of its CSO program (from $1.2 billion to $372 million) by obtaining more accurate quantification of CSO flows, through system optimization, and using a watershed approach which accounts for both CSO and non-CSO pollution sources. Boston found that on an annual flow percentage basis, CSOs accounted for less than 5% of the pollution source to Boston's receiving bodies of water. Many of the other agencies surveyed would like to move to a watershed approach in the future as their CSOs may also not be the largest source of pollution relative to other pollution sources. While Atlanta's CSO program is almost complete, the program may not meet WQS. Thus, Atlanta plans to undertake a watershed study to identify sources of pollution in the watershed, develop controls, and compare these polluters to CSOs.

In conclusion, King County's CSO program is about the same or less stringent in terms of regulatory requirements, is in the middle to low range in terms of program capital costs, and benefits from a longer timeframe to complete its CSO program compared to other agencies surveyed. However, the surveys revealed some approaches that were successful or are being tested elsewhere which King County might want to explore in terms of its own CSO program.

[14] This includes the $60.5 million spent on CSO projects from 1985--1995 (1995 dollars). In addition, to meet the long-term goal of one event per year will cost an additional $306 million (1995 dollars).

Options include:

- Developing a watershed approach to determine actual water and sediment quality benefits that could be expected in a given area (potentially resulting in higher water quality benefits and/or a decrease in capital expenditures for the CSO program).

- Using hydrodynamic separators or other on-site treatment facilities which would decrease costs associated with building storage facilities and sending the flow to treatment plants.

- Through computer modeling and sampling, investigate the benefits of increasing and/or decreasing the number of CSO discharges based on the season or mixing capabilities and sensitivity of the receiving water.

- Exploring the development of water quality standards based on wet weather versus dry weather conditions.

- Exploring other fee structures (such as what Columbus is using) for funding the CSO program.

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Appendix I: King County CSO Phone Survey

CSO Survey 1995--Phone Version

I. CSO REGULATIONS AND PLANNING

1. Who is the regulatory authority for your agency's CSO control programs?

2. Does your agency follow EPA's CSO guidelines or has your regulatory authority adopted its own CSO requirements?

- ❑ We follow EPA's CSO guidelines
- ❑ We follow my agency's regulating authority's CSO requirements
- ❑ Other (please specify: e.g., operate under consent decree)

3. Compared to EPA CSO guidelines, overall how would you characterize your regulating agency's CSO regulations

- ❑ The same as EPA's CSO guidelines
- ❑ More stringent than EPA's CSO guidelines
- ❑ Less stringent than EPA's CSO guidelines
- ❑ Don't know

4. What are the major CSO improvements or changes that **your agency** is required to meet/complete? (major phases or milestones)?

5. Is your agency having difficulty meeting any CSO requirements? Which ones? Why? Please explain.

6. In developing CSO projects, does your agency use or plan to use EPA's presumptive approach (4--6 events per year or 85% capture of CSO baseline volume systemwide) or EPA's demonstrative approach (water quality based requirements)?

- ❑ We follow EPA's presumptive approach
- ❑ We follow EPA's demonstrative approach
- ❑ Other. Please explain_____

7. Does your agency have **an overall systemwide CSO volume reduction** target (ultimate goal)? Over what time period (e.g., 5 billion gallons by 2010)?

- ❑ Yes, it is _____
- ❑ No, we use_____

8. Does your agency have an **overall systemwide CSO frequency reduction** target? Over what time period target (e.g. 4-6 overflow events per outfall per year by 2015)?

- ❑ Yes, it is_____
- ❑ No

9. Does your agency have **different CSO frequency targets** (ultimate goals) for different water bodies or different recreation areas (e.g., 4 discharges per year for shellfish areas, 1 discharge per year for swimming areas, etc.)?

10. Does your agency have **different CSO volume targets** (ultimate goals) for different water bodies or different recreation areas? (e.g. freshwater vs. saltwater, lakes vs. rivers, recreation vs. non-recreation)?

11. How does/did your agency determine the frequency and volume control targets (ultimate goals) for its CSO program? Please explain.

12. Does your agency have any other targets (e.g., water quality, sediment quality, etc.)? Please explain (how they were derived.).

13. When was your NPDES permit last renewed? ____year

14. Do you have CSO documents (like a CSO Control Plan; CSO policies; CSO strategies) that you could send me?

15. Do you have a CSO Annual Report (or annual summaries of CSO discharge volumes & frequencies or sampling results) that you could send me?

II. CSO CONTROL AND TREATMENT

16. I am going to read you a list of CSO control strategies, if can just indicate which ones your agency tends to use (feel free to choose more than one):

- ❑ Sewer separation
- ❑ Storage
- ❑ Stand alone/on-site CSO treatment (includes vortex separators, screens, swirl concentrators)
- ❑ Centrally located facilities (e.g. CSO facilities at your treatment plants which provide primary and/or secondary treatment)
- ❑ Other _____ (please specify)

17. If your agency's uses stand alone on-site CSO treatment, what type of technology do you use? (vortex, primary sedimentation tanks, others?)

- ❑ We don't use stand alone on-site CSO treatment
- ❑ We use_____

18. Of your agency's controlled CSOs, do they receive (please check all that apply):

- ❑ Primary treatment as defined by EPA (35% total suspended solids removal and 15% BOD_5 removal)
- ❑ Less than EPA defined primary treatment
- ❑ More than EPA defined primary treatment
- ❑ Secondary treatment
- ❑ Combination of secondary & primary treatment as defined by EPA
- ❑ Other_____

_____

19. How does **your agency** define primary treatment for CSOs?

- ❑ We don't treat CSOs
- ❑ We define CSO primary treatment as _____

20. **Is your agency's** definition **the same** as **your regulatory agency's**?

- ❑ Yes
- ❑ No, our regulatory agency defines CSO primary treatment as

_____

21. Does this same definition apply for

- ❑ CSO treatment at your treatment plants
- ❑ Stand alone on-site CSO treatment facilities
- ❑ If no, please explain

22. What standards does your agency use to design for CSO treatment?

❑ Performance based standard (please specify standards, removal efficiency (e.g., 35% total suspended solids removal and 15% BOD_5 removal) or effluent quality or something else

❑ Technology based standard (please specify standards, e.g., surface loading range between 800 and 1,200 gpd sq. ft. at average design flow and 2,000 to 3,000 gpd/sq ft at peak design flow). This approach tends to assume the CSO flows are receiving primary treatment, by following AKARPT (all known available reasonable prevention technology)

❑ Other (please explain)

23. If you treat CSOs, how has treating CSOs at the site of the CSO worked for you? Specific problems or concerns (e.g. neighborhood issues, treatment efficiency, total suspended solids issues, etc.)? Please explain.

IV. CLOSING REMARKS

24. Is there anything you'd like to add about specific issues your agency has faced that we haven't touched upon?

25. Would you like a copy of the finalized issue paper?

- ❑ Yes, I'll add it to the stack on my desk. Thank you!
- ❑ No, I have more than enough paper in my in-box!

Appendix II: King County CSO Written Survey

CSO Written Survey--1995

Why Is King County Conducting The Attached Survey?

Presently, King County is amending its Comprehensive Sewage Plan. As part of the CSO portion of the planning effort, we are obtaining information from other AMSA member cities regarding their own CSO programs and regulatory requirements. The information we gather from the various cities will be combined into an issue paper which will discuss the differences between Federal CSO policies and Washington State Department of Ecology's CSO requirements as well as compare King County's CSO program and regulatory requirements with those of other AMSA agencies across the United States.

The attached survey includes 35 questions which cover the following topic areas: "EPA's 9 Minimum Controls," "CSO Statistics," "Sampling/Monitoring Programs," and "CSO Costs & Financing."

As you complete the survey, you may find questions which are not applicable to your agency or which you do not have the information. While answers to all the questions are important, if you find a question which is not applicable to your agency or you do not have the information, feel free to "not applicable" or "we don't have this information" next to the question. In addition, if you have information already included in a document, please feel free to copy and highlight that information and attach the information to the survey.

We would very much appreciate your assistance in answering and mailing or faxing the attached survey by **December 1, 1995**. Please feel free to fax or mail it to Kathryn White at the address included on the back page.

We would be happy to share the survey results with all of the participants and AMSA. If you would like us to send you a copy please just check off the appropriate box at the end of this survey.

Thank you for your help in developing this issue paper!

I. Nine Minimum Controls

1. EPA requires that all CSO programs must implement the "9 Minimum Controls" by January 1, 1997. In answering this question, please check all that apply.

Nine Minimum Controls as Defined by EPA	Which of the nine do you meet?	Which of the nine do you anticipate any specific problems with?
1. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls		
2. Proper operation and regular maintenance programs for the sewer system and the CSOs		
3. Maximum use of the collection system for storage		
4. Review and modification of pretreatment requirements to assure CSO impacts are minimized		
5. Maximization of flow to the treatment plant for treatment		
6. Prohibition of CSOs during dry weather		
7. Control of solids and floatables in CSOs		
8. Pollution prevention program		
9. Public notification		

2. Of the ones you anticipate having specific problems meeting, what might be the problems? (Please explain)

II. CSO STATISTICS

3. How many CSO discharge points are in your agency's system as of 1995? (or use the most recent year that your agency has data and include year)

_____discharge points as of 1995 (or specify other year_____)

4. What is the approximate frequency of discharges per year for each CSO discharge point as of 1995? (or use the most recent year that your agency has data and include year) If you have more detail listed in a document, please feel free to copy and attach the page.

_____
_____
_____
_____

5. What is the average discharge volume for each CSO location as of 1995? (or use the most recent year that your agency has data and include year). If you have more detail listed in a document, please feel free to copy and attach the page.

_____
_____
_____
_____

6. **As of 1995**, what is your agency's **total** annual CSO discharge volume? (or use the most recent year that your agency has data and include year)

_____

7. How does **your regulatory authority** define a CSO discharge/event (e.g., a period of rainfall in which an overflow is recorded and which is followed by 48 hours without an overflow)? (Please feel free to attach a copy of the relevant definition).

_____
_____
_____
_____
_____
_____
_____

8. How does **your agency** define a CSO discharge/event?

   ❑ The same as my regulatory authority
   ❑ We use a different definition

   If **your agency uses a different definition**, please write below:

   _____
   _____
   _____
   _____
   _____
   _____

9. What is the typical/average composition of your agency's systemwide CSO?

   ___% Stormwater
   ___% Industrial wastewater
   ___% Residential sanitary sewer
   ___% Commercial wastewater

III. SAMPLING/MONITORING

10. Does your agency have a CSO-related sampling program?

❑ Yes ❑ No

11. If your agency does have a CSO-related sampling program, please complete the following table:

Water Column Samples from Receiving Body of Water			**Sediment Samples from Receiving Body of Water[1]**			**CSO Discharge Samples[2]**		
Main Sampling Parameters	**Check all that apply**	**# of Samples /yr/CSO location**	**Main Sampling Parameters**	**Check all that apply**	**# of Samples /yr/CSO location**	**Main Sampling Parameters**	**Check all that apply**	**# of Samples /yr/CSO location**
Chlorophyll			Organics			Organics		
Total Suspended Solids			Total Suspended Solids			Total Suspended Solids		
Nutrients			Total Organic Carbon			Total Organic Carbon		
Dissolved Oxygen			BOD/COD			BOD		
Light Transmission			Total Acid Volatile Sulfide			Metals		
pH			Metals			Temperature		
Temperature			Total Sulfides			Bacteria		
Bacteria			Other?			Turbidity		
Turbidity						Other?		
Other?								

1 For purposes of this question, sediment sampling would take place in the vicinity of the CSO discharge.
2 For purposes of this question, the sampling of CSO discharges would take place within the CSO pipe itself (e.g. the CSO sample of the CSO discharge would be of the discharge itself before it is released into a receiving water body).

Comments_____

12. How often does your agency monitor the volume of CSO discharges?

❑ We monitor the volume of CSO discharges (please specify how often)_____

_____

_____

_____

❑ We do not monitor the volume of CSO discharges

13. How often does your agency monitor the frequency of CSO discharges?

❑ We monitor the frequency of CSO discharges (please specify how often)_____

_____

_____

_____

❑ We do not monitor the frequency of CSO discharges

14. On average, how much do you estimate your agency spends on CSO sampling and/or monitoring programs each year?

$_____ on sampling $_____ on monitoring
$_____ on data analysis ❑ Don't know

15. Has **your state developed its own set** of Water Quality Standards/Contaminants Of Concern (WQS/COC) and/or sediment quality standards? (Please check all that apply)

❑ Yes, our state has developed its own WQS/COC
❑ No, our state uses EPA's WQS/COC
❑ Yes, our state has developed its own sediment quality standards
❑ No, our state uses EPA's sediment quality recommendations
❑ None of the above (please explain) _____

_____

_____

_____

_____

_____

_____

_____

16. What pollutants routinely exceed water quality standards in your agency's CSO discharges? (Please list).

17. What pollutants routinely exceed sediment standards adjacent to your agency's CSO discharges? (Please list).

IV. CSO COSTS & FINANCING

18. What is the total **capital cost** of your agency's total **wastewater system program** up to and including 1995? (or the amount that your agency has most recently developed)

$_____

19. Over what time period (e.g. 1955 to 1995)

_____

20. What do you estimate is your agency's **total future capital cost** to implement your agency's **wastewater treatment program**?

$_____

21. Over what time period (e.g. 1955 to 1995)

_____

22. What are your agency's **total CSO program's capital costs** since the implementation of your agency's CSO program?(or the amount that your agency has most recently developed)

$_____

23. Over what time period (e.g. from 1960-1995)?

_____

24. What do you estimate are your agency's **CSO program's total future capital costs** to fully implement your agency's CSO program?

$_____

25. Over what time period (e.g. from 1996 to 2030)?

$_____

26. What does the **CSO program's estimated future capital costs include** (e.g. 5 storage tanks, 2 on-site treatment plants, regulator modifications, inflation rates, etc.)?

_____
_____
_____
_____
_____
_____
_____

27. What are your normal sources of funding for your agency's wastewater facilities? (Please check all that apply; include percentages if possible).

- ❑ Sewer rates (____%)
- ❑ Grant funding (____%)
- ❑ Drainage fees (____%)
- ❑ Connection fees (____%)
- ❑ Bonds (____%)
- ❑ Investment income (____%)
- ❑ Taxes (____%)
- ❑ Other (please specify)_____ (____%)

28. Are there dedicated funds for your CSO program?

❑ Yes ❑ No

If yes, how is **your CSO program** funded? (Please check all that apply; include percentages if possible).

- ❑ Sewer rates (____%)
- ❑ Grant funding (____%)
- ❑ Drainage fees (____%)
- ❑ Connection fees (____%)
- ❑ Bonds (____%)
- ❑ Investment income (____%)
- ❑ Taxes (____%)
- ❑ Other (please specify)_____ (____%)

29. Is your agency a wholesaler or retailer of sewer service (e.g. does your agency sell sewer service directly to the customer or does your agency sell its service to other agencies)?

- ❑ Wholesaler ❑ Retailer
- ❑ Other (please explain)_____

_____

_____

_____

30. What are your agency's 1995 monthly sewer rates for the following?

1995 Residential customers monthly rate is $_____ per ___ (volume)

31. Does the above residential customer monthly rate include local agency rates?

❑ Yes ❑ No

32. How much of the 1995 monthly sewer rate is CSO control related (e.g., $2.00 out of a total sewer rate of $15.00 per month for residential customers is CSO related)?

1995 Residential customers CSO portion of the monthly sewer rate is $____

❑ Don't know

33. How much of the future monthly sewer rates does your agency estimate for CSO control? (Please include time period, e.g., we expect that CSO control will be $4.00 out of the sewer monthly rate of $16.00 per month by 2010).

Residential customers monthly CSO rate $_____ by _____

❑ Don't know

V. CLOSING REMARKS

34. Is there anything you'd like to add about specific issues your agency has faced that we haven't touched upon?

35. Would you like a copy of this issue paper?

- ❑ Yes, I'll add it to the stack on my desk. Thank you!
- ❑ No, I have more than enough paper in my in-box!

If you have any questions, please feel free to call Kathryn White at 206-684-1469.

Please send or fax the completed survey to:

Kathryn White
Water Quality/ Capital Facilities Planner
King County Department of Metropolitan Services
821 Second Avenue, MS 81
Seattle, WA 98104-1598

Phone 206-684-1469
Fax 206-684-1850

Thank you very much for your assistance!

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Appendix III: Participating Agencies

Participating Agencies

Atlanta, GA

Ms. Tyler Richards
Operations Manager
City of Atlanta
2440 Bolton Road
Atlanta, GA 30318
(Phone) 404-350-4959

Boston, MA

Mr. Mike Hornbrook
Director of Sewage Facilities Development
Massachusetts Water Resources Authority
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
(Phone) 617-241-6218

Mr. Dave Kubiak
Massachusetts Water Resources Authority
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
(Phone) 617-242-6000

Columbus, GA

Mr. Billy Turner
President
Columbus Water Works
P.O. Box 1600
Columbus, GA 31991
(Phone) 706-649-3400

Mr. Jim Paterson
Columbus Water Works
P.O. Box 1600
Columbus, GA 31991
Phone (706) 649-3458

Detroit, MI

Mr. Gary Fujita
Assistant Director
Wastewater Operations Group
Detroit Water & Sewerage Department
303 South Livernois Street
Detroit, MI 48209
(Phone) 313-297-8402

Minneapolis--St. Paul, MN

Ms. Melba Hensel
Principal Environmental Scientist
Minneapolis--St. Paul Metropolitan Council
Mears Park Center
230 E. 5th Street
St. Paul, MN 55101
(Phone) 612-229-2072

Mr. Jim Roth
Staff Engineer
Minneapolis--St. Paul Metropolitan Council
Mears Park Center
230 E. 5th Street
St. Paul, MN 55101
(Phone) 612-229-2123

New York, NY

Mr. Harold Klinsky
Chief of the Office of Water Quality Planning
Bureau of Clean Water
96-05 Horace Harding Expressway
Corona, NY 11368
(Phone) 718-595-4946

Portland, OR

Mr. Lester E. Lee
Supervising Engineer
City of Portland
Bureau of Environmental Services
Environmental Engineering Division
1120 SW 5th Ave., Room 400
Portland, OR 97204-1972
(Phone) 503-823-7186

Mr. Jim Dixon
Project Coordinator, CSO & Stormwater
City of Portland
Bureau of Environmental Services
1120 SW 5th Ave., Room 400
Portland, OR 97204-1972
(Phone) 503-823-7162

Providence, RI

Mr. Tom Brueckner
Chief of Operations and Engineering
Narragansett Bay Commission
235 Promenade Street, Suite 500
Providence, RI 02908
(Phone) 401-277-6680

San Francisco, CA

Mr. David Jones
Environmental Policy Planner
City & County of San Francisco
Department of Public Works
30 Van Ness Ave.
San Francisco, CA 94102
(Phone) 415-558-4528

Washington, DC

Mr. Lewis A. Strealy
Interjurisdictional Program Advisor
District of Columbia
D.C. Department of Public Works
Water & Sewer Utilities Administration
5000 Overlook Avenue SW
Washington, DC 20032
(Phone) 202-645-6276

King County, WA (Seattle, WA)

Ms. Laura Wharton
CSO Program Manager
King County
Department of Natural Resources
821 Second Ave., MS 81
Seattle, WA 98104
(Phone) 206-684-1238

Ms. Kathryn White
Water Quality/Capital Facilities Planner
King County
Department of Natural Resources
821 Second Ave., MS 81
Seattle, WA 98104
(Phone) 206-684-1469

Appendix IV: Summary Information Of Cities

Summary Information Of Agencies

City	Population			Service Area		Treatment Capacities[1]		CSO Statistics Before Improvements		CSO Statistics As of 1994/95**	
	Total	Served by Combined Sewers	Percentage Served by Combined Sewers	Total Acres	Combined Acres	Dry Weather MGD	Wet Weather MGD	Number of CSO Discharge Points Before Improvements	Vol. BG/yr Before Improvements	Number of CSO Dis-charge Points as of 1994/95	Vol. BG/yr as of 1995
Atlanta, GA	1,500,000	120,000	8%	12,096	9,152	176	380	10	6.7	7	N/A
Boston, MA	2,069,000	407,200	19%	320,000	8,700	455	1,200	81	3.2	81	1.6
Columbus, GA	175,000	25,000	14%	26,600	2,600	40	66	12[2]	1.6	12	1.6
Detroit, MI	2,900,000	2,388,000	82%	563,800	340,000	859	1,500	78	21**	78	26
Minneapolis-St. Paul, MN	2,080,000	1,418,000	68%	63,700	3,150	250	650	66	4.6	79	10 MG
New York, NY	7,323,000	5,785,000	79%	206,000	118,600	1,770	3,540	460	54.3	460	31.5
Portland, OR	490,000	288,000	59%	93,952	29,500	108	233	55	6	55	6
Providence, RI	360,000	250,000	69%	70,400	9,152	123	250	85	3	80	3.2
San Francisco, CA	727,000	727,000	100%	25,000	25,000	185	455	36	7.5	35	2.6
Washington, DC	600,000	350,000	58%	38,860	12,640	370	1,080	58	7.2	N/A	N/A
King County	1,200,000	510,000	42%	159,000	30,400	236	855	37	2.4	37	1
TOTAL	19,400,000	13,549,000	70%	1,954,826	589,754	4,560	10,722				

N/A = Not available

[1]Flow capacities posted as wet weather includes at least primary treatment capacity; some capacity listed as wet weather is secondary or tertiary.

[2]Columbus has 10 minor CSO points and 2 major CSO points. A minor CSO point is one that Columbus is not required to treat on a frequent basis and has to monitor once per year. A major CSO point must include treatment of all events and monitoring at every third event.

Sources: Much of the information included in this chart is from the AMSA Approaches to Combined Sewer Overflow Program Development (1994). However, some of it has been revised as per the surveyed agencies. ** Indicates specific information gathered through the King County CSO Survey.

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