City of Seattle
Fourth-year Report
Municipal Stormwater NPDES Permit

Part 1
1998 Update Report

Providing an update on the status of stormwater program activities conducted during 1998 with updates, as appropriate, for 1999.

Submitted pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NDPES) and State Waste Discharge General Permit for discharges from municipal separate sewers for the Cedar/Green Water Quality Management Area.

Municipal Stormwater NPDES Permit No. WASM23003

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September 2, 1999

Preface

This report is submitted by the City of Seattle pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for discharges from municipal separate storm sewers for the Cedar/Green Water Quality Management Area. This report provides a summary of monitoring activities conducted during the term of the permit through August 1999.

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1998 Stormwater Management Program Update Report

This report is submitted by the City of Seattle pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for discharges from municipal separate storm sewers for the Cedar/Green Water Quality Management Area. The report covers the 12-month period between January 1, 1998, and December 31, 1998, with updates as appropriate for 1999.

STATUS OF STORMWATER MANAGEMENT PROGRAM COMPONENTS

All program components have been implemented and are proceeding in accordance with the City's Stormwater Management Program (SWMP), as approved by Ecology on July 24, 1997.

A. COMPREHENSIVE PLANNING PROCESS (S7.B.1)

The following components of the Comprehensive Planning Process include public participation and intergovernmental efforts to coordinate planning issues across city and county levels. The City's planning process currently includes:

Public Participation

Citizen Advisory Committees

Seattle Public Utilities (SPU) has four Citizen Advisory Committees that provide input to SPU staff and the Director on policy and program development:

- Solid Waste Advisory Committee (SWAC)
- Water System Advisory Committee (WSAC)
- Creeks, Drainage and Wastewater Advisory Committee (CDWAC)
- Business Advisory Committee (BAC)

Each committee sets its own work-plan and operating procedures with input from staff and is free to work on any issue within their general area of focus. Decision-makers within SPU are briefed on a monthly basis on committee actions and input, and emphasis is placed department-wide on responding promptly to committee recommendations. The membership of each committee includes citizens that may have technical or other background in the subject area, represent relevant stakeholder groups, or contribute to the overall diversity of viewpoints.

The advisory committee most involved with stormwater-related issues is the Creeks, Drainage and Wastewater Advisory Committee (CDWCAC), which has decided to focus its involvement, in the near term, on:

- Drainage Policy Study (DPS). The committee has already reviewed and made recommendations on several drafts of the DPS;

- Endangered Species Act Response, which includes involvement in technical and community aspects of community response;
- 1999-2000 Drainage rates increase and allocation;
- Setting criteria for drainage CIP projects funded by the 1999-2000 rates increase;
- Urban Creeks Initiative/Urban Creeks Legacy program development. Areas of involvement include participation in Urban Creeks Legacy workshop and subsequent public involvement; and
- Drainage issues relating to the listing of chinook salmon under the Endangered Species Act.

Issues the committee may focus on in the future include:

- National Pollution Discharge Permit Implementation;
- Combined Sewer Overflow Reduction Planning;
- Stormwater Management Plan;
- Landslide Policy Implementation as it relates to drainage issues;
- CIP Development; and
- Regional Wastewater Services Plan.

Dee Dhlamini (206) 684-5846

Pipers Creek Watershed Action Plan Implementation Review Committee

In November of 1997, at the request of members of the Pipers Creek watershed community, Seattle Public Utilities convened a committee to evaluate progress and propose changes that might be necessary under the 1990 Pipers Creek Watershed Action Plan for Control of Nonpoint Source Pollution. The committee includes representatives from the various agencies and community groups involved in creating the original plan, which was one of the first watershed action plans in the state. This watershed action plan also resulted in Pipers Creek being removed from the list prepared under Section 303(d) of the Clean Water Act for violations of water quality standards. SPU also retained a technical consultant, who reported back to the committee with an analyses of water quality data and fish habitat data. SPU staff produced a status report on accomplishments under the 1990 Plan. Based on the evaluation report, the committee has developed proposals for modifications and improvements to the Plan. The committee's recommendations have gone to all of the agencies and groups participating in the original plan to identify those that can be implemented and those that will require new funding or new commitment from the involved jurisdictions to implement. A final report of the committee's work will be completed in the fall of 1999.

David McDonald (206) 684-7650

Longfellow Creek Watershed Action Plan and Habitat Restoration Master Plan

In the fall of 1998, Seattle initiated the Urban Creeks Legacy Millennium Program, which involves a number of special projects to commemorate the year 2000. Creek restoration is one of the primary goals of the Millennium program. Over the next two years, Millennium program funding will enable SPU to implement many of the projects described within the Longfellow Creek Habitat Restoration Master Plan (Master Plan). The Master Plan presents a series of

measures designed to improve aquatic habitat conditions in Longfellow Creek. This document, along with the Delridge Neighborhood Plan and the Longfellow Creek Watershed Action Plan, provides guidance to the City as it moves from the planning phase to the design & construction phases of Action Plan implementation.

Five major capital projects within Longfellow Creek have emerged as the "Southwest" component of the Urban Creeks Legacy Millennium Program. The projects are at various stages of completion—four with completed designs and one at initial design stage. Responsibilitie for four of the projects resides within SPU, the fifth, in Roxhill Park, is a Seattle Department of Parks and Recreation project. These capital projects include:

- 1999 Longfellow Creek Habitat Restoration Project. Erosion Control and Habitat Improvement Measures in Lower Longfellow Creek. Phase A – SW Andover St. to SW Brandon St.

- West Seattle Golf Course Improvements. Erosion Control and Habitat Improvement Measures in Lower Longfellow Creek. Phase B – SW Genesee St. to SW Brandon St.

- Delridge Drainage Basin, Phase II. Webster Street Detention Basin Modifications

- Delridge Drainage Basin, Phase II. Channel Improvements from SW Myrtle St. to SW Graham St.

- Roxhill Park. A number of Site Improvements.

These projects will help to mitigate the effects of urbanization on the natural environment by creating a sustainable system that enhances fish and other wildlife habitat along the riparian corridor as well as within City Open Spaces. Capital improvements will receive a long-term maintenance commitment by the City. The improvements will enhance the aquatic and riparian environment, and also set the stage for stewardship and citizen involvement, such as volunteer monitoring and maintenance, by enhancing and controlling community access.
Ann Shoemaker (206) 684-7596

Thornton Creek Watershed Action Plan

Community groups, schools, and business leaders joined with representatives from local, state, and tribal governments to form the Thornton Creek Watershed Management Committee (WMC). This committee is developing an action plan with strong support from Seattle Public Utilities. Under guidance from the WMC, SPU is completing a draft Characterization Report and a Water Quality Assessment. The WMC and SPU have conducted numerous public outreach efforts as part of the watershed Action Plan, including creek work parties, hikes, workshops, web sites, an on-line community library, newsletters and public meetings. SPU is working closely with neighborhood environmental groups.

The WMC developed a mission for the watershed Action Plan:

> *To protect and restore the Thornton Creek ecosystem for the welfare of fish, wildlife and people, and to improve the quality of life in the watershed.*

The WMC has created a draft Implementation Strategy to foster the goals shown below. After each goal, a few sample activities are presented.

Prevent non-point pollution and improve water quality. Develop a specific program for residents on ways to be watershed-friendly. Remind individuals about motor oil recycling. Promote natural lawn and garden care. Visit businesses to promote best management practices. Improve the temperature and dissolved oxygen levels in the creek. Build an environmental learning center that promotes watershed messages.

Reduce flooding and erosion and maintain or improve base flow while restoring natural areas. Create more detention ponds. Develop incentives for residents and businesses to infiltrate storm water. Improve the City of Seattle's and City of Shoreline's capital improvement plan (CIP) projects to incorporate more citizen involvement.

Preserve, restore and improve habitat for fish and wildlife. Plant conifers in local parks. Host creek cleanups and work parties. Create a "native plant" week event. Remove barriers to migrating fish. Strengthen the critical area laws. Identify ways to preserve more open space.

Increase public awareness and understanding, and develop stewardship of the watershed. Use signs and murals. Distribute colorful maps. Bring the watershed into the classroom. Collect habitat data.

Prevent further degradation as population and development increase in the watershed. Support bike lanes and mass transit. Promote environmentally sensitive development. Provide more stewardship opportunities.
Chris Woelfel (206) 684-7599

Intergovernmental Coordination

Interagency Regulatory Analysis Committee

Seattle Public Utilities regularly participates in the Interagency Regulatory Analysis Committee (IRAC). The Interagency Regulatory Analysis Committee (IRAC) began in mid-1993 as a forum for state and local regulatory agencies to share their diverse regulatory perspectives. IRAC's mission is to create a more effective and efficient means of protecting the environment, public health and safety through coordination of regulatory agencies. A primary goal of IRAC is to collaborate with other institutions to address gaps, overlap and inconsistencies relating to regulatory issues. One IRAC project currently underway in the Lake Union Watershed is to identify current regulatory authority and to investigate possible opportunities for improvement regarding dumping, spillage and other waste management practices from small vessels.

Monty McDaniel (206) 684-7790

NPDES Municipal Stormwater Permittee Interagency Working Group

The City of Seattle is a regular participant in the NPDES Municipal Stormwater Permittee Interagency Working Group, whose members represent all the NPDES stormwater-permitted jurisdictions in the State of Washington, as well as the Washington State Department of Ecology. The Working Group meets regularly to discuss and coordinate stormwater management programs and NPDES municipal stormwater permit issues. In addition to Ecology and Seattle, other member agencies include City of Tacoma, King County, Snohomish County, Pierce County, Clark County, Washington State Department of Transportation (WSDOT).
Robert Chandler (206) 684-7597

Lake Union Action Team

SPU currently chairs the Lake Union Action Team(LUAT), which was formed in 1988 as part of Ecology's Urban Bay Action Program. The goals of the Urban Bay Action Program include protecting ecosystems from further degradation, restoring damaged areas, and protecting the beneficial uses of the water body. The Lake Union Action Team is a multi-agency body that supports the goals of the Urban Bay Action Program by coordinating regulatory and source control efforts in the Lake Union drainage basins. Local, state and federal regulators involved with the Lake Union watershed meet on a bimonthly basis and sponsor a public forum once a year. In addition to SPU, members of the Lake Union Action Team include representatives from Seattle Parks and Recreation, Seattle Department of Design, Construction and Land Use, King County Industrial Waste Program, King County Hazardous Waste Program, King County Wastewater Treatment Division, Port of Seattle, Washington State Department of Ecology Toxics Cleanup Program, Washington State Department of Natural Resources, Washington State Department of Fish and Wildlife, Washington State Department of Transportation, and the US Army Corps of Engineers.
Robert Chandler (206) 684-7597

University of Washington Center for Urban Watershed Management

SPU serves on the advisory panel for the Center for Urban Water Resources Management at the University of Washington, which is one of the region's best resources for research and education in stormwater management related topics. The Center is funded in part by support received from the Stormwater Technology Consortium, of which the City of Seattle is a member. Other members of the Consortium currently include: King, Snohomish, Spokane, Pierce, and Kitsap counties, and the cities of Bellevue, Olympia, Kent, and Everett. In 1999 SPU provided $10,000 to the Center as a contributing member of the Stormwater Technology Consortium.
Robert Chandler (206) 684-7597

Coordination with other Planning Processes

Drainage Policy Study

In 1998 Seattle Public Utilities launched a Drainage Policy Study to evaluate emerging issues that might impact SPU's current suite of drainage programs and services, and to review SPU's current authority to expand or change its delivery of programs to address these issues. Using

input from the Creeks, Drainage and Wastewater Citizen Advisory Committee, interdepartmental dialogue, and a consultant team to assist the Utility, eight issues were identified as those likely to impact Seattle's drainage programs. These were: (1) management of urban creeks; (2) operations and maintenance; (3) neighborhood planning in Seattle and local drainage; (4) interdepartmental coordination; (5) education; (6) enforcement; (7) public/private responsibilities for drainage; and (8) funding drainage programs.

During 1999, a series of workshops are being conducted to identify approaches to dealing with the above issues. Policy options will be crafted from these approaches. It is expected that after public involvement and City Council consideration of these options, policy direction will be issued, and programming to implement these options will then occur.
Terry Kakida (206) 615-0507

EPA Team

The ESA Team is designed to coordinate the City's response to the listing of chinook salmon and anticipated listing of bull trout under the Endangered Species Act (ESA). The interdepartmental, city-wide team reports to the Directors of SPU and City Light, and to the Mayor's Office. The ESA team focuses on four primary issues: (1) negotiations with National Marine Fisheries Service (NMFS), (2) coordination with the Tri-County effort, (3) watershed planning, and (4) development of the City's Salmon Strategy. As part of developing the City's Salmon Strategy, the City has retained a team of consultants to conduct a study of the built environment of the city. The Built Environment Study is intended to improve the City's scientific knowledge regarding how chinook salmon use the urban environment and to identify strategies for improving habitat conditions. The study will utilize existing sources of information to inventory salmon habitat within the City limits; identify limiting factors and barriers to salmon recovery; identify cost-effective solutions; and develop an evaluation methodology to identify and prioritize salmon habitat investment decisions. The study will also identify information gaps and scientific data needs and is expected to be completed by the end of 1999.

In March of 1999, the City Council passed a resolution endorsing the City's Early Action Proposal (EAP). The EAP outlines a series of actions the City is committed to making, as well as actions the City is offering to make pending the development of a successful negotiating partnership with the federal government. The EAP is highlighted by an offer to spend, over five years, up to $3 million on habitat acquisition and protection in each of the four watersheds in which the City has operational interests, as well as $2.5 million in research and monitoring, for a total of $14.5 million. In addition to the habitat acquisition offer, the EAP includes a description of the City's commitment to strengthen the enforcement of the City's development regulations. The improvements include adding inspection capacity to better address Shoreline Management Program complaints and code violations, to respond to complaints about drainage from existing development, and to improve enforcement of the Stormwater, Grading and Drainage Control Ordinance. Additionally, the ESA Team has developed a budget for year 2000 and will be submitting it to the City's Central Budget Office as a mid-biennium request. The budget request reflects the Team's areas of focus.
Martin Baker (206) 684-5984

B. STORMWATER MANAGEMENT PROGRAM PRIORITIES (S7.B.2)

The City is in a constant process of examining unmet needs and developing actions to address them. Many of the results of recent reviews of unmet needs will be reflected in both the City's Drainage Policy Study and in the City's next SWMP for the 2000-2005 NPDES permit term. SPU currently uses several methods to identify and prioritize unmet needs, some of which are listed below:

1. The 1995 Comprehensive Drainage Plan, which provides criteria for the selection of Capital Improvement Projects (CIP). Included in these criteria is a water quality component, which evaluates a proposed project in light of water quality needs.

2. The SPU Drainage System Lateral Team (DSLT), which is comprised primarily of upper-management SPU personnel, meets twice monthly to discuss drainage-related issues. One function of DSLT is to identify important drainage needs (e.g., regulatory, CIP, fiscal) located throughout all the branches and divisions within SPU. Once identified, the DSLT develops an approach to address the issue(s) at hand.

3. A City Stormwater Technical Team, which meets regularly to address issues related specifically to stormwater. The group includes City staff from SPU, Department of Design, Construction and Land Use (DCLU), and Seattle Transportation (SEATRAN). By pulling together various City personnel involved with stormwater issues, this group has been a valuable tool in identifying stormwater needs on a City-wide basis. As appropriate, issues identified by the Stormwater Technical Team are referred to the DSLT for further action recommendations.

4. The Watershed Action Plans (described in this Annual Report under "Public Participation"), which are another vehicle used to identify stormwater-related unmet needs. In this context a watershed approach is used. Watershed Action Plans allow specific needs to be identified as they relate to unique areas of the City.

5. Creeks, Drainage, & Wastewater Advisory Committee (CDWCAC, further described in this Annual Report under "Public Participation"), which reviews stormwater-related issues within the City and provides input to SPU. By delineating key issues and working directly with SPU staff, CDWAC has an instrumental role in the identifying and prioritizing unmet needs.

A summary of the status of the high priority unmet needs listed in the City's Stormwater Management Program is provided in this section.

Evaluation of sediment control at construction sites

In 1999, after examining various options for improving control of erosion and sedimentation at construction sites, DCLU conducted an internal reorganization. DCLU combined the formerly separate teams that conducted drainage plan review and on-site inspections. The intent is that the same individual conducting the plan review will also be most often responsible for conducting the verification on-site that erosion and sedimentation controls are being properly implemented.

The combined team is titled "Site Development Services (SDS)" In addition, DCLU added six full-time employees to SDS. Additional information on ESC can be found in this report under the section titled "Department of Construction and Land Use Inspection Services Division."

Mobile business as sources of nonpoint pollution

After examining various options for addressing mobile businesses as sources of pollution, SPU determined that over the next several years efforts related to source control at businesses will remain focused on watershed-based and stationary business outreach. This decision was based on available staffing levels and the high priority currently placed on source control in watersheds. Therefore, mobile business, such as firms involved in carpet cleaning and building washing, will not likely be specifically untargeted during the remainder of the current NPDES municipal stormwater permit term. The City still conducts several business-related source control activities, including SPU's Charity Car Wash Program, which provides tools to avoid contaminating storm systems with wash water, and SPU's Pet Waste Source Control Project, which encourages proper clean-up of pet wastes. Additional details on these programs are in Section 1.G of this report.

Retrofitting of structural BMPs

The City has a Centennial Clean Water Grant to examine the efficiencies of four structural BMPs. Sampling by a consultant team on contract with SPU is expected to commence during the 1999/2000 wet season. In addition, a study by SPU investigating both structural and nonstructural BMPs in the Lake Union watershed was completed in 1998, the results of which will be incorporated, as appropriate, into the City's long-range CIP program.

Development of business inspection program

A number of new initiatives have been implemented under the City's Business Inspection Program. Additional information is located in the Section 1.G.

Development of creek restoration program

The Urban Creeks Initiative coordinates various creek-related efforts, such as education, restoration and monitoring, with the aim of creating a comprehensive approach to creek restoration. In addition, an ambitious baseline data collection was completed by SPU in 1999 prior to initiating SPU work on numerous CIP projects. The baseline data will assist in evaluating CIP effectiveness as well as establish existing watershed-wide conditions. This baseline monitoring,, along with the Urban Creeks Initiative, will establish the foundation of the City's creek restoration program. Additional information regarding the Urban Creeks Initiative can be found under Section 8. Additional information regarding the CIP baseline study can be found in the *Cumulative Monitoring and Summary Analysis Report* included as a separate section of this fourth-year annual report.

Development of Thornton Creek Watershed Action Plan

The Thornton Creek Watershed Action Plan initiative is well underway. See Section 1.A. of this report for additional details.

Evaluation of SWMP effectiveness

Working with other municipal permittees and the Department of Ecology, SPU has developed a number of indicators for evaluating SWMP effectiveness in terms of how well some of the City's programs meet the intended objectives of individual permit components. Additional information regarding the SWMP effectivenss can be found in the *Report on Effectivenes* included as a separate section of this fourth-year annual report.

Evaluation of wetland BMP

An innovative monitoring program was initiated in 1999 by SPU to begin evaluating the performance of the Meadowbrook Pond in northeast Seattle. Initial data have been collected, but sampling had to be temporarily halted to accommodate additional construction at the site. Sampling is expected to resume as soon as feasible. Additional information regarding the Meadowbrook Pond study can be found in the *Cumulative Monitoring and Summary Analysis Report* included as a separate section of this fourth-year annual report.

Review of enforcement procedures

In 1998, SPU reviewed existing water quality enforcement procedures of SPU and determined that a consistent, written set of protocols would facilitate implementing stronger enforcement methods. SPU is currently contracting the development of a Surface Water Quality Enforcement Manual, which will articulate a consistent enforcement procedure. The manual will outline goals, objectives, priorities and investigative and enforcement procedures and strategies, referencing applicable laws and code sections. A draft manual is expected to be produced for SPU management review in late 1999.

Private detention inspection program.

The Private Detention Inspection Program is an on-going effort by the City, which recently hired a second inspector. Additional information on this program can be found in Section 1.G.

C. Legal Authority (S7.B.3)

Adequate legal authority to control discharges to and from Seattle's storm drainage systems has been established and is described in Appendices R-0 and R-1 of the SWMP.

D. Monitoring Program (S7.B.4)

This section summarizes monitoring activities undertaken by SPU during this reporting period. Additional details on the Monitoring Program and a review of all monitoring conducted during the past four years, can be found in the *Cumulative Monitoring and Summary Analysis Report* included as a separate section of this fourth-year annual report. Surface water quality sampling provides data on stream flow and stream chemical/biological composition. Sampling events over the course of the year include: storm event sampling, periodic creek water quality sampling, benthic macroinvertebrate sampling, quarterly street waste sampling, and miscellaneous sampling resulting from surface water quality complaints.

Storm event sampling

Storm event samples were gathered during a minimum 4-hour storm event, with 0.1 inch of rain over four hours necessary, and a dry antecedent of 8 hours (during which less than 0.1 inch of rainfall occurs). The storm event is considered ended once a four-hour dry period (i.e., less than 0.1 inches of rainfall) occurs. Three storm event samples were gathered over the course of 1998, all from Longfellow Creek.
Linda Gardner (206) 386-4024

Watershed-specific sampling

Water quality samples have also been obtained from creeks in specific watersheds of interest. As part of the development of the Thornton Creek Watershed Action Plan, temperature and dissolved oxygen (DO) samples were collected on summer days when temperatures exceeded 75° F in order to evaluate the extent to which these temperature and DO might be limiting factors for fish or other aquatic organisms. The temperature data show that depressed levels of dissolved oxygen are very likely a problem throughout the creek system, at least on hot afternoons. The creek-wide average concentration of DO was 6.71 mg/L, far below the 9.5 mg/L standard. Temperatures on hot sunny afternoons exceed 16° C in parts of the creek system. The average temperature in this study was 19° C. Elevated levels of fecal coliform exist at various locations along the creek. Fecal coliform counts were also taken during 1998 summer baseflows at multiple sites along the creek to determine whether high fecal coliform counts are a systemic problem or one limited only to specific sections of the creek. For a more detailed description of the studies conducted in Thornton Creek, see the attached report, *Sample Analysis Report for Thornton Creek Summer Base Flows.*
Chris Woelfel (206) 684-7599

Aquatic Community Assessment Program

Forty-eight samples of creek macro-invertebrates (aquatic insect larva) were gathered from the substrate of Seattle creeks in October of 1998. These samples were gathered from Fauntleroy, Longfellow, Pipers, Puget Ridge, Ravenna, Schmidt's, Taylor, Thornton (4 stations), and Venema (2 stations) creeks. The number of sites sampled by the team doubled in 1998, growing from eight to sixteen locations. Results from the 1998 sampling season, along with the results from previous years, are provided in the *Cumulative Monitoring and Summary Analysis Report* included as a separate section of this fourth-year annual report
Chris Woelfel (206) 684-7599

CIP Performance Evaluation

In 1999, SPU launched an ambitious long-term CIP monitoring program that will lay a foundation for future water quality and creek health monitoring. High priority in-stream construction projects in the Piper's Creek, Thornton Creek, Longfellow Creek and Taylor Creek watersheds are targeted to be evaluated. Types of projects to be evaluated include bank stabilization, bed control structures, riparian replanting, weir retrofit, in-stream improvements, culvert replacement, off-channel habitat creation, wetland creation and stormwater detention. The intent of CIP effectiveness monitoring will be to provide information on the level of improvement or protection afforded a water body as a result of the constructed system or BMP. This information will refine stormwater management decisions and advance the benefits gained

by strategically investing in the most effective activities and projects. Baseline data collection has been completed for all planned CIP projects. Future steps include developing a long-term CIP monitoring program and expanding CIP project evaluation to the watershed level to identify and track indicators of urban creek health.
Laura Reed (206) 615-0551

BMP Effectiveness Monitoring

The City of Seattle is a participating agency in the Lake Union Ultra Urban Stormwater Control Measure Test Facility, which is a project designed to evaluate structural best management practices (BMPs) that remove pollutants from stormwater runoff. With Washington State Department of Transportation (WSDOT) serving as the lead agency, this project will route highway runoff from a section of Interstate 5 into a test facility located in WSDOT right-of-way under I-5 immediately north of the Lake Washington Ship Canal. The runoff will be piped into as many as four installed BMPs (e.g., swirl technology-based units, filtration-based units, oil water separators), with sampling ports located so that flow rates and chemical concentrations can be determined at entry and exit points in each BMP. After leaving the structure(s), flow will be collected again into a common pipe, routed through a permanently installed BMP to remove or reduce suspended particles, oils, grease and other potential contaminants, before being discharged into the Ship Canal. This is expected to be a long-term monitoring and research project partnership between WSDOT and the City of Seattle for evaluating BMP efficiencies, operating procedures, and maintenance costs. Other participants in the initial project include the Environmental Technology Evaluation Center (EvTEC) of the Civil Engineering Research Foundation (CERF), Concurrent Technologies Corporation (CTC), and the Center for Urban Water Resources Management (CUWRM) at the University of Washington. Sampling protocols have been approved and research faculty at the University of Washington have been engaged on the project. Construction of the project was delayed in 1998 and early 1999, owing to required maintenance on the highway. It is currently anticipated that sampling will commence sometime during the 1999-2000 wet season.
Robert Chandler (206) 684-7597

E. INFORMATION SUPPORT PROGRAM (S7.B.6)

The City's Information Support program has been implemented per Section 10.6 of the SWMP. The City is committed to maintaining and updating its GIS system throughout the term of the permit and beyond. The City continues to maintain its system of 17 rain gauges and retains all records associated with precipitation, water quality, water quantity, and structural BMPs as required by the permit.

Surface Water Quality Database

SPU staff maintain a Microsoft Access database of all surface water quality complaint investigations, source control business inspections, monitoring and sampling data. This database is updated and backed-up weekly, and is stored indefinitely. The surface water quality database is accessible to all SPU staff.
Linda Gardner (206) 386-4024

GIS Support

The City of Seattle's operational Sewer and Drainage GIS layer contains over two million pipe records representing all sewer and storm drain mainlines and service laterals. Additional projects completed include:

- Redesigned the Drainage and Wastewater GIS data library from one square mile tile to ¼ square mile tile resolution.
- Delivered the Drainage and Wastewater GIS Maintenance (DW GIS) Editor and began training. The process of eliminating the DW GIS maintenance backlog began in 1998.
- Delivered two upgrades to the DW Maintenance and Operation application. In the second and fourth quarter of 1998, revisions to the DWD Maintenance and Operation application were released, providing easier map output, an annotated Side Sewer Card layer, depth values for invert elevations, and improved label placement.
- Delivered 2,200 page map sets to field crews to aid in inventory and maintenance of catch basins.

Other active projects include:

- Ditch/Culvert Mapping: a team of interns using GPS technology are helping to develop a city-wide ditch and culvert layer which will integrate with the main sewer and drainage pipe layer. This project is approximately 10% complete as of August 1999.
- CSO and Pump Station Data Integration: both CSO and Pump Station data have been created and used for mapping purposes. The next step is to integrate both of these data sets into the main sewer/drainage pipe layer for on-going maintenance and quality control processes.

Harvey Kocher (206) 233-0028

Precipitation Monitoring:

Currently, there are 17 rainfall monitoring stations located throughout the city. No major upgrades were performed in 1998. No major expenditures or major maintenance was performed in 1998. Table 1 provides average monthly rainfall accumulation. The average annual rainfall accumulation in Seattle is 35.7 inches.

Table 1. Average Monthly Accumulations in inches:

Jan	7.03	Jul	0.54
Feb	3.24	Aug	0.45
Mar	2.84	Sep	0.63
Apr	0.91	Oct	2.78
May	1.62	Nov	7.87
Jun	1.21	Dec	6.47

Hirad Mousavi (206) 615-0826

F. RUNOFF CONTROL FROM NEW DEVELOPMENT (S7.B.8.a)

Department of Construction and Land Use Inspection Services Division

Prior to 1999, when the Department of Construction and Land Use (DCLU) underwent reorganization, the Inspection Services Division (ISD) inspected and enforced the Erosion and Sedimentation Control ESC/BMP requirements of private development construction projects. In 1998, ISD had nine regular building inspectors whose duties included ESC/BMP construction inspection for all BMP project categories. In addition, one inspector was assigned specifically to construction projects in Environmentally Critical Areas (ECA). The nine regular building inspectors were divided into North and South teams. Each team had a supervisor whose duty, among many other things, was to facilitate field problem resolution. There were two structural building inspectors who, when required, became involved in particularly sensitive ESC/BMP problems or complaints.

DCLU issues permits under five BMP erosion control categories. Category 1 and Category 2 permits include almost all new single family residences and duplexes, and almost all additions and alterations to these building types. Category 3 permits include all of the above noted project types, but which also require a grading permit due to additional cut and fill. Category 4 includes projects over 9000 square feet of developmental area, and those projects with complex drainage characteristics. Category 5 permits are those projects over 5 acres of developmental area, thereby requiring a Construction NPDES permit from Department of Ecology. The details required in BMP planning for projects vary by the project category. A one-page Construction BMP Checklist is required for Categories 1 and 2. Category 3 requires more specific BMP details be included by applicants as part of their site or grading plan, and Category 4 projects require a separate detailed BMP plan prepared by a civil engineer. Category 5 projects have the same requirements as Category 4 projects, but also require an NPDES construction activities permit from DOE. Contractors of all projects in Environmentally Critical Area (ECA) sites, regardless of the category, are required to set-up a pre-construction conference with the DCLU inspector. The project's ESC/BMP plans are discussed in the pre-construction conference. DCLU issued about 2800 BMP Category 1 and 2 permits and 500 BMP Category 3 permits in 1998. A total of 124 BMP Category 4 permits were issued in 1998; of this number approximately five to seven were BMP Category 5 projects (DCLU does not keep records of Category 5 projects requiring separate Ecology permits). Table 2 provides a summary of BMP categories and requirements, and provides an listing of the approximate number of permits issued under each category in 1998.

In 1998, the site visit sequence of the building inspector was set by the types of inspections required. The inspections occurred at the request of the contractor. Typically, an inspector from the City did not view the site's ESC/BMP until the foundation inspection. Inspectors did not enforce ESC/BMP details that were not included in the approved project plans. This essentially meant that ESC/BMP requirements of BMP Category 1 and 2 projects were not directly enforced and BMP Category 3 and 4 projects were are not inspected until after site grading and excavation to the foundation base is completed. Exceptions to this occurred as a result of a complaint, on grading-only projects, and on projects in an ECA Geologic Hazard Area. According to the DCLU time records program, building inspectors spent 262 hours in 1998 inspecting non-ECA

construction ESC/BMPs. The ECA site inspector spent 646 hours in 1998 inspecting ECA sites; her ESC/BMP inspections are included in these hours.

Table 2. Summary of BMP Categories and Permits for 1998

Category	Criteria	Requirements	# of permits in 1998
Exempt	Projects with less than 750 square feet of developmental coverage.	Projects must comply with BMP requirements, but are exempt from DCLU BMP review and approval.	2000
1 and 2	Includes almost all new single family and duplex residences, and almost all additions and alterations to same: about half of new multi-family, commercial, and mixed-use buildings and most additions/alterations to same fall under this category.	One page construction BMP checklist; no separate BMP inspections.	2800
3	All of the project types noted above but which also require a grading permit (>25 cubic yards of cut and fill in an ECA or Shoreline zone; >100 cubic yards in all other zones)	Grading permit, separate BMP erosion control plan.	500
4	Projects over 9000 square feet of developmental coverage and projects with complex drainage characteristics.	BMP erosion control plan by civil engineer; pre-construction conference with DCLU erosion control inspector.	124
5	Projects over 5 acres of developmental coverage.	Same as above and a separate NPDES permit from DOE.	NA*

* Not available- but about 5-7 of the Category 4 were also Category 5.

DCLU requires an applicant to contract with a Geotechnical engineer for ESC/BMP Special Inspection if the project includes construction in an ECA Geologic Hazard Area. The Geotechnical engineer is required to submit daily reports to DCLU during ESC/BMP component construction and include the status of the ESC/BMP components in all subsequent reports throughout the project. There were 1056 ESC/BMP Special Inspections projects in 1998. Grading in Geologic Hazard ECA sites is limited to a period from May through October unless otherwise approved by DCLU's Geotechnical Engineer. A Special Inspection site is also a BMP Category 1, 2, 3, 4, or 5, so the number 1056, is not separate from the category numbers noted above.

Since 1998, DCLU has redefined its organizational assumptions, including the traditional separation of the review function from the inspection function. The two functions of review and inspection are now within the Regulating Construction Program. This effort included bringing construction erosion control review and inspection under one roof in the Site Development Services group. The 1999 budget added six new full-time employees in Site Development Services (SDS)—two geotechnical engineers, one civil engineer with littoral and riparian experience, and three new site inspectors with ECA and construction erosion control experience and responsibilities. The new SDS now has review and inspection responsibilities for new private construction erosion control. SDS has begun implementing a new requirement for BMP Category 4 and 5 projects—BMP erosion control measures must be inspected and approved by the SDS site inspector prior to site demolition or grading.
Kevin Donnelly (206) 684-5051

G. Treatment and Source Control Measures (S7.B.8.b)

Per section WQ-3 of the SWMP, treatment and source control measures have been implemented. The source control measures discussed in this section are business BMP inspections and specifically-targeted industry inspections.

Business BMP Inspections: Program Development

The business inspection program is designed to reduce potential sources of water pollution by encouraging the use of good housekeeping and other BMPs. Until now, SPU has conducted business inspections as part of a larger effort, usually funded by Centennial Clean Water grants, to study a specific watershed, improve city maintenance practices and educate businesses on what they can do to protect water quality. In the past, grant-funded business inspections have been carried out in the Lake Union, Piper's Creek, and Elliot Bay/Duwamish drainage basins. In 1998, a business inspection project was initiated targeting the Thornton Creek watershed, consistent with a range of surface water quality activities undertaken as part of the development of the Thornton Creek Watershed Action Plan.

The Thornton Creek Watershed is an 11-square mile, heavily urbanized area located in the north end of Seattle. Approximately two-thirds of the watershed is located within the City of Seattle with the remainder located in the City of Shoreline. Based on a review of Standard Industrial Classification (SIC) codes, staff identified over 700 out of approximately 2300 businesses within the watershed that had a high potential to pollute stormwater. Businesses in this category may work or store equipment outdoors, operate fleets, or have large quantities of liquids on-site. There have been 740 preliminary business inspections completed, where inspectors drove by the locations to evaluate the need for on-site visits. As a result of the preliminary inspections, 130 letters were sent to businesses indicating that they had been selected for on-site visits by SPU Surface Water Quality Team members. Ten additional sites have been added as a result of later information obtained, and a total of 140 on-site inspections are currently scheduled to take place in 1999. Approximately one quarter of the on-site inspections have currently been completed with a target of completing the remainder of the inspections before the end of the year.

Once the Thornton Creek Watershed project is completed, the Surface Water Quality Team will be developing an evaluation of the four major business inspection projects completed during the past five years, which will include Lake Union, Piper's Creek, Elliot Bay/Duwamish and Thornton Creek watersheds. Evaluation goals include summarizing the status of area-wide coverage within the city and characterize any possible trends in types of violations. Table 3 describes the types of BMP information provided to each targeted type of BMP.

Table 3. Best Management Practices targeted during business inspections

Target	BMP information provided
Secondary containment	Education on definition, requirements, manufacturing, and/or purchasing of secondary containment
Spill response	Ways to avoid spills General cleanup procedures Disposal of cleanup materials: hazardous and non-hazardous Phone numbers for spill reporting
Storage Issues	Suitable storage containers and locations Secondary containment
Employee training	Safety training Spill response and reporting
Uncovered parts outside	Proper storage management practices
Car wash drains to storm	Education on consequences of discharge, regulatory compliance and voluntary connection to the sanitary system
Junk disposal	Education regarding rain runoff impacts to surface waters Waste reduction
Dumpster condition	Impacts of runoff from open containers to storm system
Storm drain stenciling	Stencil drain with permission of the property owner
Condition/maintenance of catch basin/storm grates	Evaluate catch basin Education of purpose, responsibility and BMPs of catch basins Oil/water separator maintenance education
Fleet-owning business	Education on appropriate location for fleet maintenance BMP education of runoff's impact on the storm system
Fuel island condition	Notification onsite of fuel shut off valve? Emergency response? If there is runoff from fuel island, contact property owner.
Mechanical sweeping contracts	Sweeping vs. hosing Proper disposal of material swept up

In addition, SPU's Surface Water Quality Team sponsors a Charity Car Wash Program to prevent runoff from car washes from entering the drainage system and connected water bodies. The team delivers and installs a sump and pump kit, trains volunteers on the appropriate use of the equipment, and picks up the kit at the end of the event. The Team responded to six requests for sump and pump kits during 1998 and to date in 1999.
Monty McDaniel (206) 684-7790

Pet Waste Source Control Project

In 1999, the Surface Water Quality team launched a Pet Waste Source Control Project targeted at customers of pet-related businesses. A fecal coliform source tracking study conducted by the City in 1993 determined that the leading sources of identified fecal coliform in the Piper's Creek Watershed were cats, dogs and fowl. As part of the Pet Waste Source Control Project, the team visited 65 pet supply stores and veterinary clinics to raise awareness of the impact of animal waste on Seattle's surface waters. Each business was provided with an introductory letter explaining the purpose of the visits and information for their customers on pet waste disposal BMPs. The businesses also received a portfolio containing the City's Environmental Partnership's community brochure and contact number, and information about Resource Conservation's Water Wise, Wash Wise and Natural Lawn programs. Business owners and staff

responded very positively to this education outreach campaign.

Several months after the initial visits, each business will be visited again and re-supplied with the Water Quality Consortium pet waste brochure. A short questionnaire will be provided to evaluate the visits and BMP information. A phone number has been made available that will allow businesses to call and request brochures whenever they are needed.
Linda Gardner (206) 386-4024

H. Operations and Maintenance of Stormwater Facilities (S7.B.8.c)

SPU Drainage and Wastewater Operations Division is responsible for drainage system maintenance for culverts, pipes, inlets, catch basins, sand boxes, trash racks, and ditches (mowing and clearing debris). Table 4 and Table 5 describe the different activities that occurred during the 1998.[1]

Table 4. 1998 Quarterly Totals

Main Line Cleaning	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total lineal feet
Hydrocut	1,002	1,532	1,400	812	4,746
Machine Rodded	1,010	1,060	1,019	31,141	34,230
Jet Cleaning	11,285	9,676	3,695	5,444	30,100
Dragged Roots	-	351	-	-	351
Drag Sand /Gravel/Debris	-	-	-	-	-
				total	**69,427**

Main Line TV Inspection	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total lineal feet
TV Line	4,439	5,089	8,228	4,362	22,118
Mini Camera Inspection	70	80	396	168	714
Tractor TV Line	12,541	78,561	50,604	30,766	172,472
				total	**195,304**

[1] These figures reflect maintenance and operations on the drainage system only, and thus differ from the Third Year Report figures which reflected total drainage, sanitary and combined systems.

Table 5. 1998 Drainage Maintenance

Activity	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Mechanical Clean-Catch basin/Sand box	2,306	3,658	2,954	1,451	10,369
Manual Clean Inlets	4,833	4,964	2,967	5,455	18,219
Power Rodding*	2,590	1,214	864	1,852	6,520
Inspect Catch Basin/ Sand Box	7,043	8,537	6,060	6,732	28,372
Repair/Replace Drain Structure	97	100	119	78	394
Auger Ditch Cleaning	-	64,933	-	-	64,933
Maintain Ditches*	43,196	103,092	69,766	26,924	242,978
Closed circuit TV Inlet/Outlet Pipes*	45	118	529	473	1,165
Clean Settling Basins/Ponds	45	60	19	31	155
Jet Cleaning*	17,420	18,792	13,743	13,893	63,848
Clean Bridge Drains	1,045	530	871	224	2,670
Hydrocut*	212	216	166	260	854

** lineal feet*
Gary Lockwood (206) 684-7750

I. Operations and Maintenance of Roadways (S7.B.8.d)

Seattle Transportation Department (SEATRAN) Street Maintenance Division has a staff of approximately 80 field and management personnel involved in street sweeping and de-icing. The City has ten sweepers that follow a schedule (weather permitting) of cleaning public streets and roads. Industrial and commercial areas are regularly swept on a rotating basis. Bike paths are cleaned once a month. In addition, roadways known to receive a significant number of leaves falling from trees received repeated visits during autumn. Street cleaning crews also respond to emergency calls, such as when sand has been used to contain a large oil spill. During winter, the City uses both sand and deicing liquids to aid traffic during freezing weather. Street sweepers are used to pick up any remaining sand after it is no longer required. In 1998, there were approximately 26,000 curb miles of streets swept. Litter control is the responsibility of the SPU Community Services Division, which coordinates a number of volunteer programs to help keep the City's roadways clean, such as Adopt-a-Street, Neighborhood Cleanup, and Spring Clean. Table 6 shows the 1998 Street Maintenance expenditures for drainage-related work.

Table 6. 1998 expenditures for Street Maintenance include:

Activity	Work Quantity	Units	Budget
Mechanical sweeping	26,315	Curb Miles	$995,200
Street flushing	1,495	Work Miles	$36,400
Alley flushing	9,109	Alley Blocks	$115,600
Snow & ice response	1,775	Labor Hours	$124,200

Don Gatchalian (206) 684-5319

J. WATER QUALITY CONSIDERATIONS IN CIP PROJECTS (S7.B.8.e)

In 1998, SPU constructed several Capital Improvement Program (CIP) projects that included water quality elements. Some of the principal projects are listed below. (Although some of these were actually completed in 1999, the majority of work was done in 1998.)

Piper's Creek Phase I Erosion and Sedimentation Control Project - $900,000.

This project constructed erosion control, bank stabilization, and habitat enhancement improvements to the lower reach of Pipers Creek and two of its tributaries.

Thornton Creek Protection BMP Project – $275,000.

This project constructed an oil/grit separator *Downstream Defended* structure on a storm drain conveying freeway runoff into Thornton Creek.

Fauntleroy Creek Drainage Project - $1,300,000.

This project replaced a failing culvert under a roadway near the mouth of Fauntleroy Creek and constructed two fish ladders adjacent to the culvert to facilitate fish passage.

Genesee Dam Spillway Protection - $500,000.

This project constructed an armored surface on the downstream face of an earth-fill stormwater detention dam on Longfellow Creek to prevent the dam face from eroding and possibly leading to failure in a major storm event.

SW Tieg Place Sedimentation Vault – $50,000.

This project constructed a vault on a small creek in Schmitz Park to capture large quantities of sand that wash down the creek so the sand does not clog storm drains or end up in Puget Sound.

For all projects: Neil Thibert (206) 684-7589

K. REDUCTION OF PESTICIDES, HERBICIDES, AND FERTILIZERS (S7.B.8.f)

Green Gardening Program

Begun in 1993, Green Gardening is a program developed by SPU and funded by the Local Hazardous Waste Management Program (LHWMP). Green Gardening seeks to educate all King County residents about alternative pest management strategies in an effort to reduce pesticide use. All Green Gardening activities are designed and implemented by the consultant team of the Seattle Tilth Association, Washington Toxics Coalition and Washington State Cooperative Extension, King County. SPU's Program budget in 1998 was $81,500.

In 1998, the Green Gardening consultant team completed seven primary tasks:

1. Developed curriculum and trained staff at nine local garden centers and horticulture students at three colleges about less toxic pest control methods, which will help them

educate their own customers.

2. Made Green Gardening presentations to 34 groups in King County, reaching an audience of over 340 people.

3. Taught a Green Gardening curriculum as part of the regional Washington State University (WSU) Extension Master Gardener program and presented it to 135 Master Gardeners.

4. Presented a one-day training for professional groundskeepers on successful integrated pest management (IPM) strategies, which attracted 216 participants representing more than 45 public agencies and private landscaping companies. This workshop was designed as part of the City of Seattle's own pesticide recertification training.

5. Designed and produced three new fact sheets on alternative pest control for professional landscapers to add to the series produced by the Green Gardening Program in 1997 called *Pro IPM.* These fact sheets describe how to identify and manage eight of the most common Pacific Northwest garden pests using an IPM strategy.

6. Printed distributed approximately 35,350 copies of the four Green Gardening educational brochures.

7. Carried out a survey of City of Seattle groundskeepers gauging their knowledge of IPM and their specific topics of interest for future IPM training.

Carl Woestwin (206) 684-4684

Natural Lawn Care Program

(See Section 5.D for details.)

L. ILLICIT DISCHARGES (S7.B.8.g)

Investigation of illicit discharges and improper disposal of materials to surface water is handled by the Surface Water Quality Team as part of their investigations program (See Section 5.B). Between January 1998 and June 1999, two illicit sanitary waste connections to the City's stormwater conveyance system were identified.

M. CONTROL OF INDUSTRIAL DISCHARGES INTO MS4S (S.B.8.h)

As part of the City's Water Quality Source Control, Complaint Investigation, and Monitoring Program, evidence of stormwater contamination is investigated by the Surface Water Quality Team (see Sections 1.G and 5.B).

2. CHANGES IN PERMIT COVERAGE AREA:

There were no changes in permit coverage area in 1998, and none are anticipated in 1999.

3. EXPENDITURES FOR STORMWATER MANAGEMENT PROGRAM (S7.B.5):

In accordance with Section S9 of the permit, a permit modification is required if there is a greater than 20-percent difference between the *projected* annual budget values contained in the City's SWMP (Table 9.7 in the SWMP) and the actual budget *adopted* by the City Council. Stormwater budgets for 1997 and 1998 had already been adopted by the time the City's SWMP received final approval by Ecology, and therefore comparisons between projected and adopted budgets cannot be provided for these years. Table 7 shows the adopted and actual overall stormwater management program budget for 1998. In 1998, the City spent approximately 7.5% above the originally adopted value.

Table 7. Overall Stormwater Management Program Budget

Category	Adopted 1997	Actual 1997	Adopted 1998	Actual 1998
Stormwater Management Programs[1]	$2,441,326	$2,972,341	$2,481,200	$2,710,156
Drainage and Wastewater Operations Division	$2,690,598	$2,115,594	$3,066,423	$3,267,230
Total Annual Budget	$5,361,729	$5,087,935	$5,547,623	$5,977,386

[1] Includes Regulatory, Water Quality, and Public Involvement & Education programs. Category was formerly titled "Resource Planning Division (Drainage-Related)" in Table 9.7 of SWMP.

Trisha Erickson (206) 684-8082

4. REVISIONS TO FISCAL ANALYSIS

The City of Seattle increased its stormwater budget for fiscal years 1999 and 2000 by approximately 39-percent increase each year above the original budget listed in the City's SWMP. The increase in funding was the result of a drainage rate increase, which was approved in December 1998 and became effective in January 1999. Funds from the increased drainage rates are being used to supplement existing stormwater programs. Because the increase reflected a greater than 20-percent difference between the *projected* annual budget values contained in the City's SWMP (Table 9.7 in the SWMP) and the actual budget *adopted* by the City Council, a permit modification was requested by the City in a letter to Ecology dated January 29, 1999. The revised values for the remaining two years of the permit term are shown below in Table 8.

Table 8. Revised Overall Stormwater Management Program Budget

	Original Budget (1997)		Revised Budget (1999)	
Program Area	Projected 1999	Projected 2000	Adopted 1999	Projected 2000
Operations and Maintenance	$3,158,416	$3,253,168	$3,518,416	$3,518,416
Water Quality and Education	$1,929,401	$1,987,283	$3,224,401	$3,224,401
Regulation	$152,440	$157,013	$532,440	$532,440
General and Administrative	$473,795	$488,009	$673,795	$673,795
Total Annual Budget	$5,714,052	$5,885,474	$7,949,052	$7,949,052

5. COMPLIANCE ACTIVITIES

In the interest of monitoring and ensuring the success of the SWMP, the City conducts enforcement actions, inspections and investigations of businesses throughout its jurisdiction.

A. ENFORCEMENT ACTIONS

SPU's Surface Water Quality Team continues to pursue a policy of public awareness and education as the preferred approach to ensuring compliance with city ordinances. Staff rely on a combination of site visits, telephone contacts, and follow-up letters to educate potential drainage code violators about best management practices to protect stormwater quality. A review of water quality complaint data indicted that there were only 24 repeat offenders (based on location of violation) out of over 650 water quality complaints received between January 1995 and June 1999. SPU is currently contracting the development of a Surface Water Quality Enforcement Manual, which will articulate a consistent enforcement procedure. The manual will outline goals, objectives, priorities, and investigative and enforcement procedures and strategies, referencing applicable laws and code sections. A draft manual is expected to be completed for SPU management review in late 1999.
Linda Gardner (206) 386-4024

In 1998, the Department of Construction and Land Use (DCLU) issued a total of twenty Notices of Violation—fourteen for grading without permits, and six for tree cutting in a critical area. In the first six months of 1999, DCLU issued a total of ten Notices of Violation—nine notices for grading and one for tree cutting in critical areas.
Dianne Kelso (206) 684-8420

B. INVESTIGATIONS

SPU relies on citizens to spot and report potential surface water problems, and SPU water quality field investigators respond to water quality-related complaints within the City limits. The complaints originate from two sources: citizens who call the City's hotline (684-PKUP) and referrals from other departments and agencies. An internet online complaint form is available. When the team responds to a complaint, every attempt is made to determine the responsible party and stop the action that is polluting the surface water. Staff also provide information on clean-up, alternative disposal options, erosion control and other best management practices. If

practical, the responsible party is required to clean up the material. When necessary, the field crew requests that streets be swept, catch basins pumped out, or other remediation be taken by City maintenance crews. All complainants, if accessible, are notified of investigation results. A news brief, the "Grime Blotter" is circulated within the City once a month to notify staff of the problem, location and resolution of each water quality complaint.

SPU water quality investigators responded to 270 surface water quality complaints during January 1998- June 1999. Staff conducted on-site investigations at 207 sites. The most frequently reported pollutants were automotive fluids (particularly motor oil), paint, and soap. Staff resolved 263 (97%) of the complaints either through direct action by SPU or by referring the complaint to more appropriate authorities for action. Three cases are still on-going and three could not be resolved. As part of the resolution process, letters were sent to more than thirty alleged violators noting the problem(s) and stating the necessary actions to resolve the problem(s). Staff referred 39 cases to other departments or agencies, such as Seattle Police Department, SPU Illegal Dumping, SPU Drainage and Wastewater Operations, SEATRAN Street Use Department, Seattle Department of Design Construction & Land Use, the U.S. Coast Guard, Ecology, EPA, and King County. (Note that referrals are considered as "resolved" investigations by SPU.)

In order to determine the effectiveness of surface water quality team complaint resolution, in 1999 the team will be providing a follow-up survey to customers who call in surface water quality complaints. A performance target of 80% satisfaction with customer service has been established. In this way, the team will be able to assess the performance of the complaint resolution process. In addition, the surface water quality team will be working to enhance their ability to track their field work using Geographic Information Systems (GIS). Currently, efforts are underway to link the team's existing Microsoft Access databases to GIS in order to track surface water quality complaints, business inspections, and stormwater detention system problems. This change will have several useful functions for decision making and public education. Staff will be able to more quickly and easily identify areas of the city for source control programs. Watershed maps indicating different kinds of surface water quality problems would allow staff to show citizens physically where surface water quality problems have been occurring in their neighborhood. A summary of water quality complaints is provided in Table 9.

Table 9. Summary of Water Quality Complaints

Type of Action	1/98 to 12/98	1/99 to 6/99	1/98 to 6/99
Water Quality Complaints	204	66	270
Site Visits	159	48	207
Letters sent	30	4	34
Referrals	30	9	39
Resolved	199	64	263
Ongoing	3	1	4
Unresolved	2	1	3

Linda Gardner (206) 386-4024

C. INSPECTIONS

Business inspections

(See 1.G for details on this aspect of the source control program)

Side Sewer Connections

SEATRAN Street Use issues permits for side sewer connections in the Seattle area. There were 2769 sewer permits and 1187 drainage permits issued between the 1st of January 1998 and June 1999. There are nine inspectors currently working at Street Use. The funds collected during this period through side sewer connections were $433,246 for sewer permits and $384,062 for drainage permits.

Private stormwater detention system inspections

There are approximately 5,000 privately-owned detention systems located within Seattle city limits. Since 1991, the City has had a dedicated inspector for this program. In 1998, four significant changes in the program's design were made. First, the existing FoxPro database (which had irreparable problems) was converted into a Microsoft Access database with added capability for data entry, retrieval, and analysis. Second, the strategy for canvassing areas of the city was switched from a street-based to a watershed-based system. Third, a new notification process was developed in response to a state Supreme Court decision regarding right of entry on private property. As of 1998, property owners or managers are always notified that their property is due for an inspection, and verbal permission to inspect a site from the property owner is now obtained before inspections take place. Fourth, a web page for the inspection program was developed in order to reduce the amount of time invested in sending out special requests for information. This web page allows individuals to download commonly requested materials, such as the drainage maintenance contractor list, an outlet trap supplier's list, and best management practices for drainage system maintenance. An overview of the program, answers to frequently asked questions, pictures of stormwater drainage structures, and stormwater-related links are also available.

In January 1998, the privately-owned stormwater detention system inspector position was filled with a full-time permanent employee. Another full-time, long-term temporary detention inspector position was added in April of 1999. Between January 1998 and the end of June 1999,

566 initial inspections and 269 re-inspections of stormwater detention systems have been completed. This represents a complete canvass of the Seattle area north of Lake Union. Four hundred and six flow control detention structures and 1,487 catch basins have been inspected. Broken down into land use type, stormwater detention system inspections have been: 43% apartments, 37% commercial businesses, 9% condominiums and townhouses, 3% churches, 5% schools and other public buildings, and 3% single family residences. Upon initial inspection, 25% of the sites are appropriately maintained and not in need of repair, while 75% are in some way deficient. The most common sort of maintenance needed is catch basin cleaning. When all the dirty catch basins and flow control sumps identified through inspections thus far are cleaned, approximately 288 tons of material will have been removed from the system.
Laura Reed (206) 615-0551

D. PUBLIC EDUCATION ACTIVITIES (SECTION S7.B.8.i)

Household Hazardous Waste Program

Seattle participates in the Local Hazardous Waste Management Program (LHWMP) in King County by implementing a number of Household Hazardous Waste (HHW) public education and collection services. The Program provides numerous services for households and small quantity generators (SQGs) of hazardous wastes (as defined by WAC 173-303).

Among the longest operating HHW collection facilities in the U.S., Seattle's two HHW collection facilities served almost 13,000 households in 1998, collecting 435 tons of materials for proper disposal. Suitable materials – mostly latex paint and automotive products – are collected and then given away to be used by the general public or by other City departments. Some latex paint, antifreeze, and motor oil are recycled; other products are properly disposed of as hazardous waste. In addition to the two HHW collection facilities, Seattle's solid waste Recycling and Disposal Stations collected 138 tons of used motor oil in 1998 for re-refining, as well as several tons of used oil filters and vehicle batteries for recycling. The annual operating cost for Seattle's HHW collection program is approximately one million dollars.

HHW collection facility staff are active community educators, both on and off site. The collection facilities sport colorful education shelters that are equipped with displays and brochures. Knowledgeable staff are available to field numerous questions from the public and to encourage waste reduction and safe handling practices. Staff also participate in public events, such as the Seattle Home Show, where they provided information to thousands of attendees. During 1998, Seattle began an outreach project training volunteers in neighborhoods populated by multifamily and ethnic minority residents. HHW collection services are only one aspect of the City's program, which seeks to emphasize waste reduction and to reduce exposure to potentially harmful material. SPU delivers several innovative programs, which reach several thousand people each year, through promotional measures and face-to-face activities. Examples include:

- Green Gardening program, involving nursery staff and master gardeners in educating the public about gardening practices which reduce chemical use, toxic runoff, and water use;
- Natural Lawns program, demonstrating resource-efficient and less toxic methods for maintaining healthy turf;

- Green Cleaning, distributing lower toxicity cleaning products and simple recipes for common household cleaning jobs.

In addition to these services, which focus on specific product types or uses, Seattle provides general customer education materials, such as the "Buy Safe" product comparison guide, which is currently translated into five languages. Concern about reaching all groups within the City's population drives professional market research and program refinement efforts.
Shirli Axelrod (206) 684-7804

Storm Drain Stenciling Program

SPU's Storm Drain Stenciling Program promotes storm drain stenciling with the message " Dump no Waste, Drains to [Stream, Lake, Bay]." Table 10summarizes 1998 activities throughout the city:

Table 10. Storm Drain Stenciling in 1998

Community Group	No.	Community Group	No.
City-wide Community businesses	225	SPU Earth Day	182
UW Environmental Health & Safety Dept.	125	Seattle Schools(Salmon in the Classroom)	1423
Community Service	94	Seattle Pacific University City Quest	77
Volunteer Groups	62	Port of Seattle	120
Community Councils	170	West Seattle P. C. C.	81
		Total	**2559**

Salmon in the Classroom

The goals of SPU's Salmon in the Classroom (SIC) program include providing education on clean water and watershed-related issues, increasing community stewardship of watersheds and developing water quality partnerships between community and businesses. In a many-faceted education program, salmon are used as the focal point to teach about the importance of clean water and watersheds.

This is the eighth year of the Salmon in the Classroom program, which teaches the process of raising salmon in the classroom. Salmon are an indicator species for clean water. This six month-long salmon raising project gets teachers and students involved in the enhancements of water quality, habitat, conservation and stewardship for Seattle's streams, lakes and Puget Sound. The program supports 110 Seattle schools and touches over 30,000 students. The Department of Fish & Wildlife found that the SIC program got overwhelming support from the Seattle School District as the most used environmental education program. Teachers surveyed praised the program for its hands-on activities promoting community stewardship and water quality.

The 1998 SIC program also included sponsored field trips, an annual teacher's orientation, annual teachers watershed meetings and the annual SPU Seattle School Day on the Waterfront. SPU's ongoing partnerships with Seattle Public Schools, University of Washington School of Fisheries, Burke Museum, Washington State Department of Fish and Wildlife, Seattle Aquarium, King County, and Seattle Department of Parks and Recreation help teach students about the salmon life cycle, community watershed stewardship, natural habitat, and why it is important to

protect our water resources.
Carlton Stinson (206) 684-7624

Salmon Friendly Gardens
The City is currently launching Salmon Friendly Gardens, a public education program aimed at providing residents with ecologically sound landscape alternatives. The City has formed an advisory board and committed an initial budget of $200,000 to implement the program. Matching funds are being sought from other city and county organizations. The specific elements of the program will include selection of five demonstration sites, a design charette employing skills from national shoreline ecologists and landscape architects, a display garden at the Year 2000 Northwest Flower and Garden Show, and a public education program that will include a salmon-friendly landscape guidelines book. In addition to providing alternative landscape models, the program aims to inform residents about the water quality and salmon health benefits of pesticide, herbicide and fertilizer reduction.
Liz Fikejs (206) 615-0516

Green Gardening Program
(refer to section 1.K)

Natural Lawn Care
The Natural Lawn Care Program is a collaborative effort with King County Water and Land Resource Division, Thurston County, the City of Bellevue, and regional water purveyors. Each partner is aware of the ability to leverage more resources through this collaboration. For instance, the USGS/DOE pesticide monitoring of streams this year was the topic of a press event coordinated by King County, and it also played a part in a press event on the City's Natural Lawn Care pilot demonstrations at branch libraries.

Natural Lawn Care is broken down into six strategies, two of which directly address stormwater pollution issues. The City recommends moderate fertilization of lawns with "organic" or other slow release fertilizers and recommends an Integrated Pest Management (IPM) approach to lawn weeds and insect problems. This IPM approach means first focusing on healthy, vigorous turf that outcompetes weeds and stands up better to insect pests. It also includes accepting some weeds, hand weeding and spot-spraying, rather than broadcast applying pesticides.

The Natural Lawn Care Program is currently using two radio spots and a phone hotline to promote the concept of lower impact lawn care. The program uses a brochure for educational outreach, as well as a number of additional printed materials. The program also has an active public relations presence in the community, having organized four press events during the current season. These press events included alternatives to diazinon use, stream monitoring for lawn pesticides, adopting Seattle Public Libraries for pilot demonstration sites, and the pilot environmental landscape certification program.
Carl Woestwin (206) 684-4684

S.T.E.P. and Quick S.T.E.P.

S.T.E.P

SPU created a program for distributing small grants called Stewardship Through Environmental Partnerships (STEP) to provide financial and technical assistance to community groups interested in taking action to help protect and improve local waters. Special funding has been made available to SPU under the auspices of the King Conservation District. Through STEP, SPU is assisting community groups, schools, youth organizations, employee groups, and business organizations with projects and activities that will improve and protect surface water resources. STEP funds are available for stream bank restoration, bank stabilization, wetland restoration, informational brochures, restoring native vegetation, creating urban gardens, and cleaning or planting vacant lots. Applicants can receive assistance for many materials or services to help complete projects. Examples include: tools, plants, printing of educational materials, community outreach, and graphics. Thirty-five thousand dollars are available in grants each year. An informational pamphlet on S.T.E.P. is enclosed.

Quick S.T.E.P.

SPU also supports an accelerated grant program for community groups, schools, and employee groups that need up to $1,000 for special events. This fund is designed to encourage groups of neighbors and the under-served populations of the City who have limited time and technical resources to do special, one-day events in their community to help protect water quality or to educate their community about non-point pollution issues that can impact lakes and streams.

S.T.E.P. & Quick-S.T.E.P. 1998

SPU has funded 13 new projects throughout the City in 1998. Three of the projects were funded through the City's original STEP fund that gives groups up to $5,000 of materials and assistance. The other ten were funded through Quick-STEP. In 1998, SPU provided a total $14,003 in STEP assistance and $8,165 through Q-STEP, for a grand total of $22,168, plus in-kind of printing and technical expertise. Table 11 summarizes S.T.E.P. and Table 12 Quick S.T.E.P. programs.

S.T.E.P. and Quick-S.T.E.P. Anthony Matlock (206) 386-9746

Table 11. Stewardship Through Environmental Partnership

S.T.E.P.	Funding Amount:
Waldorf School Wildlife/Botanical Gardens. Waldorf students, community, and public school students proposed a project and were given funds to transform a neglected and overgrown area of Waldorf School into a beautiful botanical garden with a wildlife habitat. The area will include a pond with native plants, an educational site for students to study and learn about botany, water quality, composting and cultivating medicinal plants.	$4,003
TREEmendous Seattle used STEP funds to extend its outreach from 800 potential stewards to 2000. The Utility receives ad space for a year to educate their readers and solicit grantees.	$5,000
West Seattle Art-Nature Literature Festival. This West Seattle group received a grant to host an environmental fair that focused on water quality, water conservation, art, literature, music and beach cleanup. The event lasted three days and included environmental displays and information booths for all types of involvement and stewardship activities around the sound.	$5,000
total	**$14,003**

Table 12. Quick S.T.E.P.

Quick S.T.E.P.	**Funding Amount**
Plumis Park Erosion Control. The Plumis Park advocates purchased ground cover plants, straw, and jute fabric to help stabilize a steep hillside to disburse run-off from NW 89th street to prevent large amounts of erosion. The erosion protection is part of a larger community open space project.	$996
Amataga and Gataaga Youth.This group of 50 Samoan Youth from High Point have come together to cleanup trash, stencil storm drains, and report illegal dumping. The group also works with other organizations in the High Point area to restore habitat and provide services for other Highpoint residents.	$1,000
Dearborn Park Children's Forest. The students from Dearborn Park Elementary created interpretive signage for the entrance to their wetland/forest area next to the school. Through this signage, other students and community visitors can learn about, study and observe habitat and wildlife in this urban setting.	$600
Seattle School District. The district received a grant to purchase tools for their district tool bank. The tools are used by students, parents, and community volunteers to cleanup, plant, and maintain school grounds and surrounding communities. The tools also are used by SPU during Spring Clean events.	$1,000
Friends of Bradner Gardens Park. The friends received a grant to solicit volunteers for the restoration of Bradner Gardens. The group created brochures, flyers, and created a newsletter for a horticulture display and learning park.	$750
Thornton Creek Project. High School and University students from North Seattle Community College created a watershed atlas. The atlas will be used to provide information in the Thornton Creek Watershed regarding, for example, salmon sightings and demographics. These youth hope it will improve the degree in which decisions for the future are based by having knowledge to make better decisions about the watershed.	$1,000
The Student Conservation Association. SCA was awarded a grant to buy tools to cleanup litter, clean and stencil storm drains, plant trees, restore habitat in parks and around creeks. This is a year-round program for students from all backgrounds.	$880
The Summer Academy. Hawthorne Elementary School and University Prep received a grant for a Summer Academy to teach summer school students about water quality and water conservation. They were taught how to apply what they learned at home and with fellow neighbors and friends. The students also learned about how they can take action in and around public recreation areas.	$500
The Village Project. The students from B.F. Day Elementary received a grant for a project in Canal Park near Fremont. The students noticed the amount of erosion from the overused and neglected trail to the water. The group decided to repair the trail and replant some of the areas to reduce erosion along the path. The Students then created interpretive signage to encourage people to stay on the trail and to protect the habitat.	$739
Wilderness-Inner City Leadership Development (Project WILD). This is a group of Asian-American youth from the International District that have come together to increase awareness in their community about environmental justice issues on water quality and how they pertain to their community. The group created bilingual storm drain stencils and brochures in six other languages (Vietnamese, Chinese, Cambodian, Tagalog, Spanish, and Laotian).	$700
Total	$8,165

6. KNOWN CHANGES IN WATER QUALITY

Based on the City's data, there were no known significant changes in the water quality of the City's receiving water bodies, as measured by chemical analysis.

7. STATUS OF WATERSHED-WIDE COORDINATION (S7.B.7a)

The City of Seattle is involved with the following groups to forward governmental coordination of projects and planning efforts.

LAKE WASHINGTON SHIP CANAL GENERAL INVESTIGATION STUDY

The staff from SPU, King County and the Corps of Engineers have worked together over the past several years to develop a comprehensive scope of work for a water management and salmon restoration study for the greater Lake Washington Basin (WRIA 8). The City of Seattle is the umbrella sponsor for restoration activities at the Hiram A. Chittenden Locks, the Lake Washington Ship Canal, and Shilshole Bay. The Federal Cost Sharing Agreements (FCSAs) which stipulate the study scope of work and funding requirements have been signed by the Corps of Engineers and the City of Seattle. The City-sponsored projects will include studies of water conservation, fish passage improvements and juvenile salmon habitat studies. As a forerunner to the FCSA studies, the City is currently involved in a pilot study focused on techniques for mapping habitat and collecting juvenile salmon in the estuary.
Gail Arnold (206) 684-7613

WATERSHED RESOURCE INVENTORY AREA (WRIA) PLANNING

The City of Seattle has been actively involved in Watershed Resource Inventory Area (WRIA) planning for WRIA 7 (Snohomish), WRIA 8 (Cedar/Lake Washington) and WRIA 9 (Green/Duwamish). The City recently hired three full-time, senior-level WRIA coordinators to build inter-jurisdictional coalitions and to integrate city-wide efforts within each WRIA. The WRIA planning bodies have focused planning agendas on developing baseline salmon habitat assessments and recovery plans, which have included identifying watershed-wide informational needs and limiting factors to salmon recovery. In the coming year, the WRIAs will be active in coordinating inter-jurisdictional prioritization and funding for salmon habitat restoration. The WRIA coordinators will help integrate the City's activities and programs with basin-wide salmon health and water quality goals.
Steve Moddemeyer (206) 386-1981

WATERSHED FORUMS

The City of Seattle elected officials and staff have participated in all five local Watershed Forums (Green/Duwamish, Cedar/Lake Washington, Snoqualmie, Sammamish, and Central Puget Sound) since the inception of these forums several years ago. The Forums are an outgrowth of the Regional Needs Assessment for surface water management, and were originally formed to address surface water management needs, including flooding and water quality. They

were later expanded to specifically include salmon and related riparian and aquatic habitat. Given the recent listing of chinook salmon as threatened under the Endangered Species Act, coordination has also been elevated. In each watershed, projects have been identified and prioritized that address priority needs. It is anticipated that funding for projects to improve salmon habitat, including water quality, will be from the King Conservation District, the federal government, and local governmental sources. Funding for projects has already been set aside from 1998 through 2000 King Conservation District monies.

The Forums, WRIAs, and the Tri-county coordination are unique opportunities for local governments operating within watersheds to coordinate, prioritize, and fund surface water needs, habitat restoration, water quality, and flooding. In addition, cooperative arrangements have resulted in studies and projects being undertaken with other entities including Port of Seattle and the U. S. Army Corps of Engineers.
Nora Smith (206) 233-7894 and Gail Arnold (206) 684-7613

LOWER DUWAMISH SEDIMENT CLEANUP AND RESTORATION

Staff from SPU are actively involved in a joint jurisdictional Restoration Panel addressing sediment contamination in the Duwamish River. The Restoration Panel, which includes representatives from NOAA, Department of Ecology, King County and the City of Seattle, prioritizes and funds clean-up and restoration projects on the Duwamish. Thus far, the panel has funded a clean-up project at the Norfolk site, removing 5500 cubic yards of contaminated sediment for disposal. Other projects include habitat restoration and the Diagonal storm drain and Combined Sewer Overflow cleanup. The City is also in preliminary negotiations with the Port of Seattle, King County and Boeing to develop a partnership for addressing issues related to contaminated sediments in the Duwamish.
Linda Hammons (206) 684-7845, Martha Burke (206) 684-7686

8. OTHER ACTIVITIES

Although not specifically required under the NPDES permit process, the Urban Creeks Initiative described in this section represents the City's proactive stance toward stormwater management issues, environmental stewardship, and public participation.

URBAN CREEKS INITIATIVE

In 1998, Seattle Public Utilities began planning urban creek projects and programs for the 1999-2000 budget cycle within the framework of the Mayor's Millennium Project, a city-wide effort to create and celebrate a vision for the optimal type of Seattle for future generations. The Urban Creeks Legacy Program officially commences with Millennium projects located in Seattle's four major creek systems: Longfellow Creek in southwest Seattle, Taylor Creek in southeast, Thornton Creek in northeast and Pipers Creek in northwest.

The Urban Creeks Legacy Program coordinates creek restoration efforts among SPU staff, city agencies and citizen groups to achieve the following goals:

- ***Improve*** major drainage and water quality systems;
- ***Restore*** natural creek habitat through in-stream improvements, removal of fish passage barriers, and control of peak storm flows;
- ***Create & enhance*** access between neighborhoods, creeks & trails;
- ***Sustain*** creek systems through a city-wide coordinated stewardship and education program;
- ***Celebrate*** our resources and citizen volunteers with art and cultural themes.

Earth Day 2000 has been chosen as the target celebration date for the Mayor's Millennium projects. SPU will culminate two years of urban creek projects during the week leading up to Earth Day 2000 with a series of events marking project milestones, including ribbon cuttings, groundbreakings, volunteer restorations and celebrations.

The Urban Creeks Legacy Program will continue beyond the Millennium with the creation of a ten-year plan incorporating discussions with citizens and other departments, community-based Watershed Action Plans, recovery actions taken following the federal listing of salmon as a threatened species, and the results of a Comprehensive Drainage Study.
Denise Andrews (206) 684-4601

City of Seattle
Fourth-year Report
Municipal Stormwater NPDES Permit

Part 2
Report on Effectiveness

Providing an assessment of the effectiveness of the City of Seattle's NPDES Stormwater Management Program

Submitted pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NDPES) and State Waste Discharge General Permit for discharges from municipal separate sewers for the Cedar/Green Water Quality Management Area.

Municipal Stormwater NPDES Permit No. WASM23003

Submitted by:
Seattle Public Utilities
10th Floor, Dexter Horton Building
710 Second Avenue
Seattle, Washington 98104

September 2, 1999

Preface

This report is submitted by the City of Seattle pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for discharges from municipal separate storm sewers for the Cedar/Green Water Quality Management Area. The report covers the 12-month period between January 1, 1998, and December 31, 1998, with additional information provided, as appropriate, for 1999.

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STORMWATER MANAGEMENT PROGRAM EFFECTIVENESS

Introduction

Section S10 of the City of Seattle's NPDES municipal stormwater permit requires that at the end of the fourth year of the permit term the permittee provide "a detailed evaluation of the effectiveness of the stormwater management program" (S10.A.1). Subsequent guidance provided by the Department of Ecology provided clarification, stating that Ecology expects assessments of individual program components, followed by an assessment of the overall success of the program. Table 1 below lists the 16 program components in the order they are listed in the municipal stormwater permit.

Table 1. Sequential Listing of Stormwater Permit Components

Permit Section	Stormwater Permit Component
S7.B.1	Planning
S7.B.2	Prioritization
S7.B.3	Legal Authority
S7.B.4	Monitoring
S7.B.5	Fiscal Analysis
S7.B.6	Information Support
S7.B.7	Watershed-wide Coordination
S7.B.8a	Stormwater Runoff Control
S7.B.8b	Treatment and Source Control
S7.B.8c	Stormwater Facilities Operations and Maintenance (O&M)
S7.B.8d	Street Operations and Maintenance (O&M)
S7.B.8e	Water Quality in Capital Improvement Projects (CIP)
S7.B.8f	Landscape Pollutant Reduction
S7.B.8g	Illicit Discharge Elimination
S7.B.8h	Industrial Pollutant Control
S7.B.8i	Education

Evaluation Framework

In order to provide a more cohesive framework for evaluating the effectiveness of the permit components and to facilitate discussions on programmatic effectiveness, the 16 permit components have been divided into the four categories described below and as shown in Table 2.

Stormwater Control Actions. This category encompasses those components that are most directly related to programmatic stormwater management activities and actions. These consists of the activities listed in permit section S7.B8 under "Stormwater Control Components," and include: Stormwater Runoff Control, Treatment and Source Control, Stormwater Facilities O&M, Street O&M, Water Quality in CIPs, Landscape Pollutant Reduction, Illicit Discharge Elimination, Industrial Pollutant Control and Education.

Monitoring. This category includes the component of Monitoring, the purpose of which is to collect data and information related to stormwater control actions in order to support the needs of decision makers involved in stormwater runoff management.

Resources. This category contains the foundational components essential to conduct a stormwater management program and necessary to guide various decisions regarding stormwater control actions. This category includes: Legal Authority, Fiscal Analysis, and Information Support.

Planning and Prioritization. This category comprises those actions conducted by decision makers involved in stormwater management, particularly as stormwater control actions. This category includes: Planning, Prioritization, and Coordination.

Table 2. Stormwater Management Categories and Permit Components

Category	Permit Section	Stormwater Permit Component
Stormwater Control Actions	S7.B.8a	Stormwater Runoff Control
	S7.B.8b[1]	Treatment and Source Control
	S7.B.8f	*Landscape Pollutant Reduction*
	S7.B.8g	*Illicit Discharge Elimination*
	S7.B.8h	*Industrial Pollutant Control*
	S7.B.8c	Stormwater Facilities O&M
	S7.B.8d	Street O&M
	S7.B.8e	Water Quality in CIPs
	S7.B.8i	Education
	S7.B.8f[2]	*Landscape Pollutant Reduction*
Monitoring	S7.B.4	Monitoring
Resources	S7.B.3	Legal Authority
	S7.B.5	Fiscal Analysis
	S7.B.6	Information Support
Planning and Prioritization	S7.B.1	Planning
	S7.B.2	Prioritization
	S7.B.7	Coordination

[1] The effectiveness of permit components S7.B.8f (Landscape Pollutants), S7.B.8g (Illicit Discharges), and S7.B.8h (Industrial Pollutants) are all included in the analysis of permit component S7.B.8b (Treatment and Source Control).
[2] The effectiveness of permit components S7.B.8i (Education) includes the analysis of permit component S7.B.8f (Landscape Pollutants).

The relationships among these four categories are illustrated in Figure 1. *Stormwater Control Actions* are conducted to address the potentially adverse impacts of stormwater runoff. *Monitoring* is performed to ascertain the effectiveness of specific actions and to provide recommendations to decision makers on future enhancements to programmatic activities. The results of monitoring activities are integrated into the available *Resources*, which provide a context and set boundaries for decisions that are made regarding stormwater runoff management. *Planning and Prioritization* involves coordinating stormwater management activities with other planning efforts and making decisions on options and recommendations related to improve

stormwater management activities. These decisions, in turn, are reflected in changes to stormwater control actions.

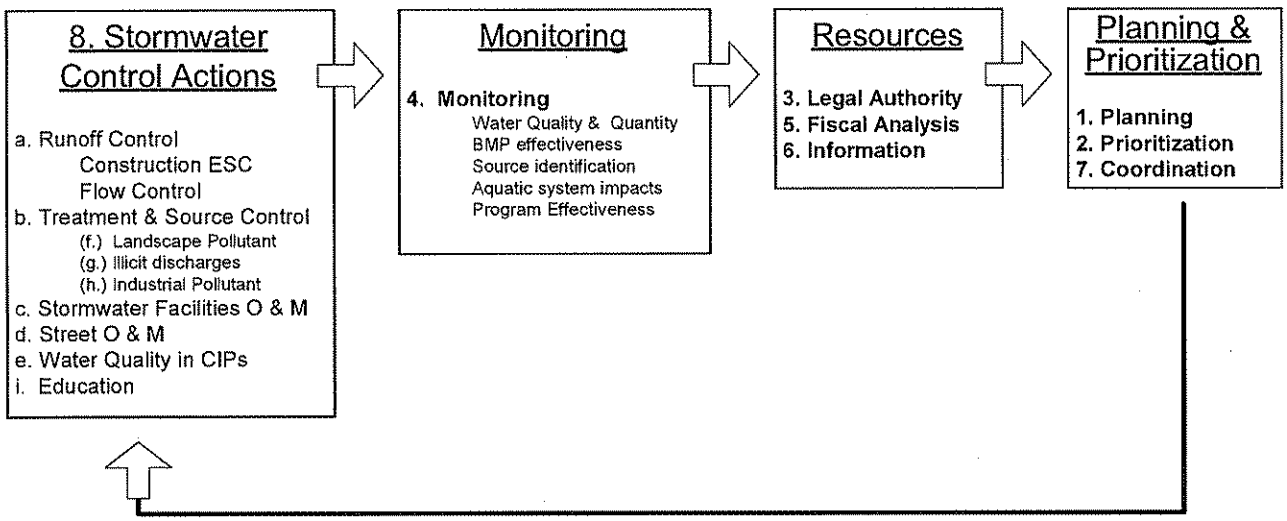

Figure 1. A Framework for Evaluating NPDES Permit Components

Combining Effectiveness Evaluations

There are some program components that are so closely tied to other components that to evaluate them independently would be repetitive. Treatment and Source Control (S7.B.8b), for example, directly involve programs for reducing pesticides, herbicides, and fertilizers (S7.B.8f), programs for eliminating illicit connections (S7.B.8.g), and programs for controlling industrial discharges (S7.B.8.h). These four components are, therefore, discussed together under the main heading of "Treatment and Source Control." Similarly, because Education (S7.B.8.i) also includes information delivered to encourage the reduction of pesticides, herbicides, and fertilizers (S7.B.8f), Landscape Pollutant Reduction is also included under Education.

Organization of Report

The remainder of this report is presented in five sections, as outlined below. The first four sections evaluate the stormwater permit components as organized using the four categories described earlier: *Stormwater Control Actions, Evaluation, Resources*, and *Planning and Prioritization*. The final section provides a general analysis of the effectiveness and overall success of the City's Stormwater Management Program.

Section I - Stormwater Control Actions. A detailed evaluation of the effectiveness of the permit component activities contained in Section S7.8.

Section II - Monitoring. An evaluation of the effectiveness of various types of monitoring programs.

Section III - Resources. A general description of how the components of Legal Authority, Fiscal Analysis and Information Support relate to the overall effectiveness of the City's Stormwater Management Program.

Section IV - Planning and Prioritization. An analysis of the planning, coordination and decision-making processes as they pertain to the City's Stormwater Management Program

Section V - Overall Stormwater Management Program Effectiveness. A discussion of stormwater management effectiveness as it is conducted at the local jurisdictional level, and an overall assessment of the success of the program.

Because certain components lend themselves more readily to an effectiveness analysis than others, the analysis approach taken varies among the 16 permit components. The way one chooses to examine the effectiveness of Legal Authority, for example, will differ from the way one evaluates Maintenance and Operations activities. Therefore, each of these first four sections provides a different type of effectiveness analysis. Most, however, will include the following:

Program description. A description of the activity by component of the Stormwater NPDES permit component and including, as appropriate, a description of how the activities address the impacts of stormwater pollution to beneficial uses.

Program goal(s). A description of the primary reason for conducting the activity.

Program objective(s). A listing of the objectives, some of which are quantifiable, and from which a measure of programmatic effectiveness can be derived.

Program effectiveness. An estimate of the effectiveness of the activity, using appropriate measures, both qualitative and quantitative. Where appropriate, discussions regarding the extent to which the activity is implemented to its full potential is also provided.

Suggested program effectiveness improvements. A listing of possible ways the effectiveness of the activity may be improved.

SECTION I - STORMWATER CONTROL ACTIONS (S7.B.8)

This category encompasses those components that are most directly related to programmatic stormwater management activities and actions (Table 3). These include: Stormwater Runoff Control, Treatment and Source Control, Stormwater Facilities O&M, Street O&M, Water Quality in CIPs, Landscape Pollutant Reduction, Illicit Discharge Elimination, Industrial Pollutant Control and Education. Note that discussions regarding Treatment and Source Control (S7.B.8b) will incorporate a review of three other permit components, namely: reducing pesticides, herbicides, and fertilizers (S7.B.8f), programs for eliminating illicit connections (S7.B.8.g), and programs for controlling industrial discharges (S7.B.8.h). Discussions regarding Education (S7.B.8i) will also include education conducted to encourage the reduction of pesticides, herbicides, and fertilizers (S7.B.8f).

Table 3. Permit Components Included in Stormwater Control Actions

Category	Permit Section	Stormwater Permit Component
Stormwater Control Actions	S7.B.8a	Stormwater Runoff Control
	S7.B.8b[1]	Treatment and Source Control
	S7.B.8f	*Landscape Pollutant Reduction*
	S7.B.8g	*Illicit Discharge Elimination*
	S7.B.8h	*Industrial Pollutant Control*
	S7.B.8c	Stormwater Facilities O&M
	S7.B.8d	Street O&M
	S7.B.8e	Water Quality in CIPs
	S7.B.8i	Education
	S7.B.8f[2]	*Landscape Pollutant Reduction*

[1] The effectiveness of permit components S7.B.8f (Landscape Pollutants), S7.B.8g (Illicit Discharges), and S7.B.8h (Industrial Pollutants) are all included in the analysis of permit component S7.B.8b (Treatment and Source Control).

[2] The effectiveness of permit components S7.B.8i (Education) includes in the analysis of permit component S7.B.8f (Landscape Pollutants).

Each of the six stormwater permit components reviewed in this section includes discussions under the following headings:

- Program goal(s)
- Program description or Method of controlling stormwater
- Program objectives
- Programmatic effectiveness (which may include parameters, targets and/or measurements, as appropriate)
- Suggested program effectiveness improvements

Stormwater Runoff Control (S7.B.8a)

Construction Sites—Erosion and Sediment Control Program

Program Description

DCLU requires Erosion and Sediment Control (ESC) BMPs for any project over 750 square feet of developmental coverage as summarized in Table 4. Projects are assigned a BMP category based on the location, size, and grading changes. City staff conduct an on-site pre-construction inspection for all projects in Environmentally Critical Areas (ECAs) and all Category 4 and 5 projects. City staff conduct spot checks and respond to complaints from the City's Illegal Dumping and Water Quality Complaint Hotline, or the Construction Complaint Hotline, to ensure ESC BMPs are being properly maintained throughout the construction process. The objectives of the program have been organized to reflect this system of checkpoints throughout the permit and construction process.

Table 4. Summary of BMP Categories Criteria and Requirements

Category	Criteria	Requirements
Exempt	Projects with less than 750 square feet of developmental coverage.	Projects must comply with the water quality goals of the Stormwater code and BMP requirements, but are exempt from DCLU BMP review and approval.
1 and 2	Includes almost all new, and additions to, single family and duplex residences, about half of new multi-family, commercial, and mixed-use buildings and most additions/alterations to multi-family, commercial, and mixed-use buildings. Minor grading possible but no permit required (<25 cubic yards of cut and fill in an ECA or Shoreline zone; <100 cubic yards in all other zones)	One-page construction BMP checklist; no separate BMP inspections. Pre-construction inspections and spot checks in ECAs.
3	All of the project types noted above but which also require a grading permit (>25 cubic yards of cut and fill in an ECA or Shoreline zone; >100 cubic yards in all other zones)	Grading permit, separate BMP erosion control plan. Pre-construction inspections and spot checks in ECAs and shorelines .
4	Projects over 9000 square feet of developmental coverage and projects with complex drainage characteristics.	BMP erosion control plan by civil engineer; pre-construction conference with DCLU erosion control inspector. Pre-construction inspections for all projects and spot checks.
5	Projects over 5 acres of developmental coverage.	Same as above and a separate NPDES permit from DOE. Pre-construction inspections and spot checks.

Program Goal

To prevent receiving water quality degradation as a result of runoff from construction sites through effective implementation of on-site best management practices (BMPs).

Program Objectives

The objectives of the Construction Site Erosion and Sediment Control Program include:

1. Ensuring BMP categories are properly assigned to each project based on its developmental coverage.
2. Ensuring appropriate BMPs are properly designed for all projects involving ECAs and shorelines, and for all projects classified as Categories 4 and 5.
3. Ensuring appropriate BMPs are properly installed for all projects involving ECAs and shorelines, and for all projects classified as Categories 4 and 5.
4. Ensuring all ESC BMPs are properly maintained throughout construction.
5. Ensuring all ESC BMPs are effective at the development site.

Program Effectiveness

The effectiveness of the Construction Site Erosion and Sediment Control Program was evaluated based on the input received from knowledgeable staff. Table 5 provides a summary of the program objectives, methods of measurement, target values, checkpoints (i.e., the point during the permitting/construction process at which a measurement can be obtained), and the effectiveness of the program at achieving the stated objective.

Suggested Program Effectiveness Improvements:

Staff in the City's Department of Design, Construction and Land Use (DCLU) estimated that 20% of construction projects are not assigned the appropriate BMP category. This 20% factor is due to the variable level of knowledge and experience of the project intake staff at DCLU, and due to the lack of a procedure for assigning specific BMP requirements to Master Use Permit (MUP) demolition projects. Proper BMP category assignment may be improved by:

- Educating staff at the intake desk.
- Creating a process for MUP demolition applications to be assigned a BMP category and formal notification to the inspection staff.

Additional improvements could include:

- Lowering thresholds for review below the current 750 square foot threshold.
- Requiring pre-construction inspections on all Category 3 projects (projects requiring a grading permit).
- Requiring all demolition projects to undergo drainage review.
- Applying BMPs and requiring a pre-demolition activity inspection by staff at DCLU.

Table 5. Construction ESC Program Objectives, Measurements, Targets, Checkpoints, and Effectiveness

Objective	Measurement	Target	Check point	Effectiveness
1. Assign appropriate BMP category to projects over 750 s.f. developmental coverage	% of projects assigned to appropriate BMP category	100%	Applicant Services Center; BMP category designation reviewed during drainage review	80%
2. Installation of appropriate ESC BMPs on all ECA and shoreline projects and Category 4 and 5 projects.	% of projects with proper ESC BMP design prior to construction	100%	Pre-Construction Conference	60%
3. Installation of appropriate ESC BMPs on all ECA and shoreline projects and Category 4 and 5 projects.	% of projects with proper ESC BMP installation prior to construction	100%	Pre-construction inspection	100% (new process as of 8/99)
4. Maintenance of ESC BMPs throughout construction.	% of projects with properly maintained BMPs during spot checks	90%	Field spot checks; Construction Complaint Hotline and Illegal Dumping Hotline; direct complaints to inspector	50%
5. Effectiveness of BMP measures as installed correctly	% of repeat complaints on a project site after initial complaint and correction	0%	Field spot checks; Construction Complaint Hotline; direct complaints to inspector	0%

New Development and Redevelopment—Flow Control Program

Program Description

The city requires the installation of permanent flow control structures for all new and redevelopment projects unless its stormwater runoff discharges to a designated receiving water, either directly or by way of a public storm drain system. Numerical target of 0.2 cfs acre in 25-year design storm is imposed. For projects over 9000 square feet of developmental coverage, additional target of 0.15 cfs per acre in a 2-year design storm is imposed. If there is discharge to a stream, sources of sediment and other contaminants must be controlled, and impacts on streambank erosion must be minimized.

Program Goal

To reduce the flow of stormwater runoff from new development or redevelopment to pre-development conditions, excepting those that discharge to a designated "receiving water."[1]

Program Objectives

1. Review all projects over 750 square feet of developmental area.
2. Require all projects that do not discharge to a designated receiving water to install proper flow control structures.
3. Ensure required flow control structures are properly installed.
4. Ensure required flow control structures are properly maintained.

Program Effectiveness

The effectiveness of the City's Flow Control Program, based on the four objectives outlined above, is summarized in Table 6.

Table 6. Evaluation of Effectiveness of Flow Control Program

Objective	Measurement	Target	Check point	Effectiveness
1. Review all projects over 750 square feet of developmental area	% of projects appropriately assigned to Drainage Review	100%	Permit application process	90%
2. Require all projects that do not discharge to a designated receiving water to install proper flow control structures	% of appropriate projects required to install flow control	100%	Drainage Review Desk; SEATRAN (Street Use) side sewer permit application.	90%
3. Ensure required flow control structures are properly installed	% of projects with properly installed flow control structures	100%	SEATRAN (Street Use) inspector	100%
4. Ensure required flow control structures are properly maintained	% of projects with properly maintained flow control structures	Privately owned detention inspection program—see Inspection Program section for more details		

[1] Designated receiving water is defined as Duwamish River, Puget Sound, Lake Washington, Lake Union, and the Lake Washington Ship Canal, designated as having capacity to receive drainage discharges, but not including tributary stream, creeks, and lakes.

Suggested Program Effectiveness Improvements

1. Conduct additional education of DCLU drainage personnel about significance and application of key Director's Rules. Possibly conduct cross-departmental seminars regarding methods and goals.
2. Develop better methods for determining "complex or unusual" development conditions, including accessibility of SPU-documented drainage problems and ESA-significant drainage basins.
3. Lower thresholds for review (below 750 s.f.) and lower thresholds (2000 s.f. new impervious surface) for required flow control structures once improvements in design allow for application to smaller projects.

Treatment and Source Control (S7.B.8f, S7.B.8g, S7.B.8h)

In addition to the Erosion and Sediment Control Program (see discussion under Runoff Control Program) and a number of education strategies, the City has three principal programs designed to detect, reduce, remove and/or prevent illicit discharges and spills. Each of these programs employs education, inspection and enforcement strategies to reduce stormwater pollutants from landscape, construction and industry activities. An evaluation of the following programs is included:

- Surface Water Quality Complaint Response
- Business Inspection Program
- Private Detention Inspection Program

Surface Water Quality Complaint Response

Program Description

SPU water quality field investigators respond to water quality-related complaints within the City limits. The complaints originate from citizens who call the City's Illegal Dumping and Surface Water Quality Complaint Hotline (684-PKUP), as well as from SPU crews, and from referrals from other departments and agencies. An internet online complaint form is also available. When the team responds to a complaint, every attempt is made to determine the responsible party and stop the action that is polluting the surface water. Staff also provide information on clean up, alternative disposal options, erosion control and other best management practices. If practical, the responsible party is required to clean up the material. If necessary, the Surface Water Quality Inspector at the site will request street sweeping, catch basin cleaning, or other remediation be performed by City maintenance crews. If possible, all complainants are notified of investigation results. A news brief, the *Grime Blotter* is circulated within the City once a month to notify staff of the problem, location and resolution of each water quality complaint.

Program Goal

To reduce stormwater runoff pollution by providing an Illegal Dumping and Surface Water Quality Complaint Hotline and response processes that address illegal dumping and spills which could potentially contaminate storm sewers.

Program Objectives and Program Effectiveness

1. **To provide a citizen complaint process to notify City staff of illegal dumping or spills.**
   The City's Illegal Dumping and Surface Water Quality Complaint Hotline is advertised in the phone book, on the internet, on Environmental Partnership Brochures, and in other education materials handed out during business visits and private detention system inspections.

2. **To respond to and resolve all citizen complaints and agency referrals.**
   From January 1995 to June 1999, the city has resolved 96% (627 out of 651) of the surface water quality complaints received.

3. **To track and reduce repeat offenders.**
   From January 1995 to June 1999, 24 repeat offenders were reported to the hotline. The number of repeat offenders and type of pollution is summarized below in Table 7.

Table 7. Number of repeat offenders by type of pollution.

Type of pollution	# of repeat offenders
Construction/muddy water	4
Automotive	7
Wash/soapy water	4
Grease/oil	6
Miscellaneous	3
Total	24

4. **To track and analyze the number and type of complaints.**
   The Surface Water Quality Complaint database tracks the date, location, and nature of the water quality complaint. This information will be useful for future prioritization and planning efforts in the inspection, enforcement and education programs. Table 8 summarizes the number and type of complaint for the period of January 1995 to June 1999.

Table 8. Number of Complaints by Pollution Type

Type of Pollution	Total # of Complaints	Percent of Complaints
Automotive Fluids	226	34%
Wash Water (including muddy water)	81	12%
Construction	70	11%
Unknown	60	9%
Paint	49	7.5%
Soap	48	7%
Chemicals	31	5%
Sewage	24	4%
Oil	22	3%
Grease	17	3%
Pet Waste	12	2%
Other	12	2%
Total	652	100%

Suggested Program Effectiveness Improvements:

1. Conduct a media campaign educating citizens about how to report water quality violations and what kinds of actions constitute violations.
2. Map surface water complaints by linking the Surface Water Quality Complaint database to GIS to provide a valuable tool for source control planning.
3. Increase coordination between inspection and educational programs throughout the City.

Business Inspection Program

Program Description

City staff conduct watershed-based inspections of businesses that are evaluated as having a high potential to pollute. On-site inspections include evaluating the business site and practices relating to stormwater quality, informing business owners of potential stormwater quality violations, and providing the information needed to correct potential violations and improve stormwater quality. Additional detail on the Business Inspection Program is provided in the *1998 Update Report.*

Program Goals

- To inform business owners of proper source control BMPs.
- To inspect and improve business practices and structures to ensure stormwater quality protection.
- To enforce the portion of the City's Stormwater, Drainage and Wastewater Code related to illicit discharges and spills.

Program Objectives

1. Identify the major businesses within each watershed contributing to stormwater quality degradation.
2. Provide one-on-one education regarding stormwater quality violations and BMPs to all owners of businesses that have a high potential to pollute within the City's jurisdiction.
3. Identify needs and conduct follow-up actions with violators.

Program Effectiveness

The program focuses on businesses with a high potential to pollute. Inspections are conducted on a watershed basis with a target of inspecting all potentially high polluting businesses within the City. Staff have completed Lake Union and Elliot Bay/Duwamish watersheds, and are currently inspecting Thornton Creek Watershed. Program effectiveness is currently measured by number of inspections completed by watershed, which are listed below. The current strategy aims to complete 100% of the necessary inspections within each watershed before moving to the next watershed. Two watersheds have been completed at this point.

Table 9. Inspections per Watershed

Measurement	Lake Union	Elliot Bay/Duwamish
# of Inspections	176	282
# of Follow Up Inspections	51 (29%)	55 (20%)
# of 2nd Follow Up Inspections	12 (7%)	14 (5%)

Suggested Program Effectiveness Improvements

1. Develop method for identifying which violations are most prevalent by business type.
2. Assess percent of total targeted business inspections completed.
3. Develop outcome based effectiveness measurement system.
4. Develop spot checking method for calculating the stewardship improvements achieved through the inspection program.
5. Develop enforcement guidance manual.

Private Detention Inspection Program

Program Description

Stormwater pollution discharged from private detention facilities can be reduced by ensuring the sumps, pipes, and catch basins are cleaned, thereby removing sediment, fluids, and other material contained by these drainage structures. This program is designed to ensure proper maintenance is conducted by property owners on their private detention facilities. Staff estimate that sediment removal from all the catch basins and flow control sumps identified through inspections will equal approximately 288 tons of material.

Program Goals

- To protect creeks, lakes, and other water bodies from the damaging effects of stormwater pollutants and high flows during rain events by ensuring proper operation of private detention systems.
- To reduce flow overloads that contribute to combined sewer overflows.

Program Objectives

- To control excessive stormwater inputs to the city stormwater/combined sewer system.
- To reduce pollutant loading.
- To educate private property owners on how to best manage and maintain their stormwater detention systems.

Program Effectiveness

The long-term goal for the program is to complete the initial canvass of the city, assessing all existing privately-owned stormwater detention systems, and to develop a schedule for regular re-inspection of these systems. So far, over half the area of the city has been inspected. The predicted date when re-inspections could begin is three to five years after the initial inspections, depending on staffing levels. The short-term goal for 1999 is to complete inspection and processing of 480 detention systems. Program effectiveness is measured by:

- the ability to respond to information requests regarding the program.
- the number of inspections initiated and structures inspected.
- the compliance rate for property owners that need to maintain/repair their systems.
- the number of "problem" or "no-problem" letters sent.
- the number of re-inspections carried out.

Ability to respond to information requests

The ability to respond to information requests was improved in 1998 by making the transition from outdated FoxPro software to a more flexible and powerful Microsoft Access97 database. Forms, queries, and reports were rebuilt, and the information from past inspection years stored in tables was retained. It is now possible to get quick and accurate information on a number of different parameters of the program.

Number of inspections Initiated
Figure 2 and Figure 3 show the number of inspections conducted during this permit term. In April 1999, a second stormwater detention system inspector was hired, and performance based on number of inspections initiated significantly improved with increased staff time. Note that in 1997, the position of Privately-Owned Stormwater Detention System Inspector was vacant.

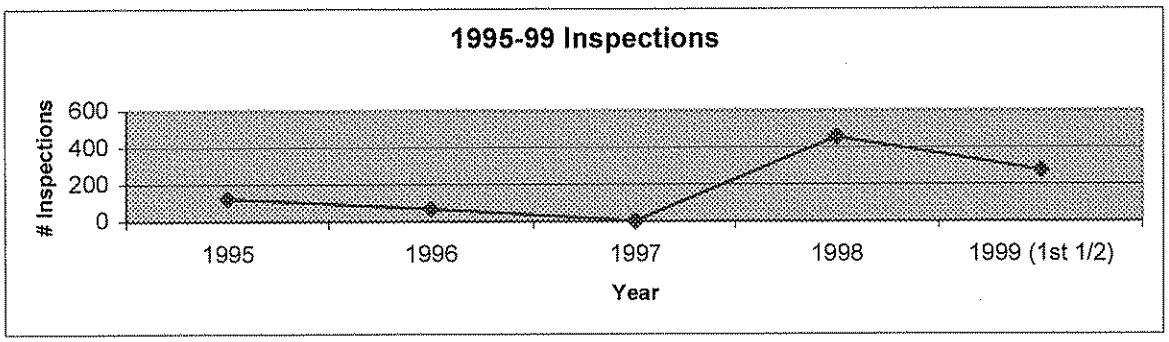

Figure 2. Number of Inspections 1995 - 1999

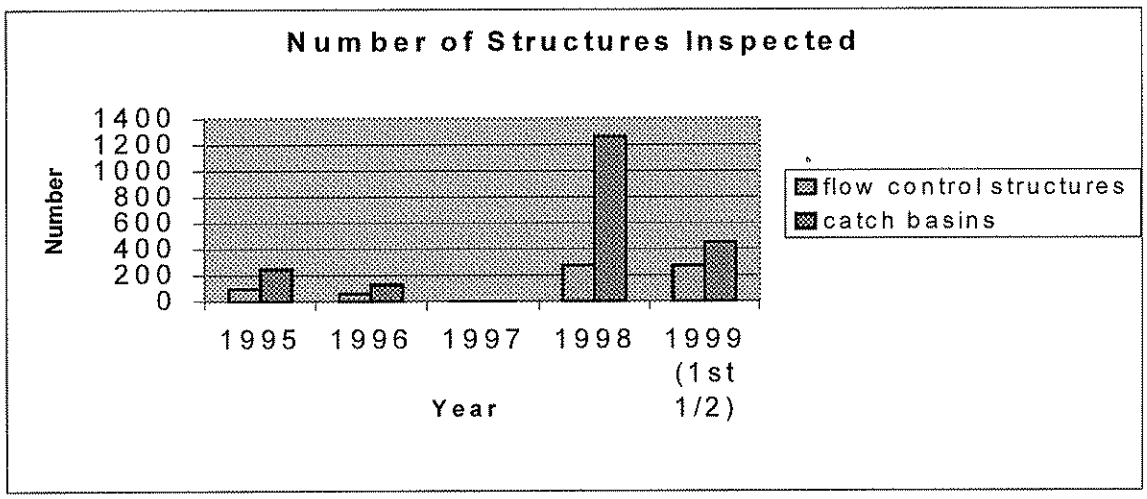

Figure 3. Number of Structures Inspected 1995 - 1999

Number of letters sent and re-inspections completed (1998-1999)
Information on the number of letters sent and re-inspections completed is not available for 1995-1997. However, detailed information regarding 1998 through 1999 inspections is provided in the *1998 Update Report.*

Compliance statistics for 1998-1999
Table 10 illustrates the effectiveness of the program based on the increasing level of compliance with successive follow-ups.

Table 10. Increasing Compliance with Successive Inspections

	# of sites inspected that are out of compliance	% of total in compliance
Upon initial inspection	404	31%
At 60-day follow-up	171	58%
After 3 months	110	73%
After 4 months	59	85%
After 5 months	32	91%

Suggested Program Effectiveness Improvements

1. Dedicate more staff time to inspect and do the intensive data entry required.
2. Develop a feedback loop so that the inspectors will be regularly informed of new private stormwater detention systems being permitted by other departments in the city.

Stormwater Facility Maintenance and Operation (S7.B.8c)

Program Description

This program improves stormwater quality runoff by regularly inspecting, cleaning and repairing stormwater facilities. Maintenance includes removing sediment, pollutants and debris from catch basins, ditches and detention structures; mowing ditches; and cleaning oil/water separators. Regular maintenance schedules seek to reduce stormwater pollutants which can pass through these facilities and enter natural bodies of water.

Program Goals

reduce surface water flooding in streets and roads, reduce property damage and improve stormwater quality runoff by maintaining existing structures to the established design standards and service levels.

Program Objectives

1. Inspect all catch basins once per year.
2. Pump all catch basins that need cleaning.
3. Inspect and clean bridge drains and catch basins receiving runoff from sanded snow and ice routes when sanding is required by freezing storms.
4. Reinstall traps in catch basins as needed during inspections.
5. Inspect all grass ditches once per year and maintain grass heights of 4 to 8 inches.
6. Inspect critical areas as needed during potential flood events.

Program Effectiveness

Catch basin and inspection cleaning is the most relevant quantifiable means for measuring effectiveness. Additional improvements in the program include:

- Reduced the number of critical flooding areas from 737 in 1996 to a current level of 289 (through inspection or placement on a scheduled maintenance).
- Developing maintenance BMP manuals for drainage maintenance practices, which includes refining specific procedural steps that could impact water quality.
- Ongoing training of operations and maintenance staff in spill response procedures when drainage or wastewater systems are impacted.
- Replaced all non-performing catch basin traps in 1998 inspections (and continue as needed).
- Developed performance measures and tracking system to improve program efficiency.

Table 11. Catch Basin Inspection Effectiveness

Measurement	Target	1/98-12/98	1/99-6/99
Catch basins inspected	35,000 - 40,000	28,372	19,469
Catch basins cleaned	*	10,369	4,484

* Numbers in this row should initially descend and then stabilize as maintenance schedule increases (currently equals approximately 25% of inventory per year).

Suggested Program Effectiveness Improvements

- Improve maintenance scheduling.
- Develop and implement ditch standards.
- Develop and implement consistent maintenance BMP standards.
- Complete inventory of drainage structures.
- Integrate drainage structures into work management software.

Street Operations and Maintenance (S7.B.8d)

Program Description

Street sweeping is the street maintenance activity that most significantly improves stormwater quality. Scheduled route frequencies have been determined and prioritized based on traffic volume. Additional one-time or periodic sweeping includes:

- Post-sanding
- Spill response
- Citizen requested
- Bike paths once per month

Leaf litter removal is an additional activity conducted by street maintenance that helps improve stormwater quality.

Program Goal

The City's street maintenance program responds to water quality, air quality and human health and safety goals. The specific water quality goal is to improve stormwater quality runoff from high-traffic volume streets through routine maintenance.

Program Objectives

Reduce the amount of sediment, pollutants and debris that collects in storm drains.

Program Effectiveness

Scheduled sweeping routes include arterial streets and the central business district. Frequencies are determined based on traffic volume and departmental resources. Table 12 presents the annual total of street cleaning performed in 1998.

Table 12. Street Cleaning Desired Frequencies and 1998 Annual Totals

Target Streets	Total Curb Mile Inventory	Frequency	1998 Annual Total
Arterial	2,387	Based on volume: 1x/week 3x/week 1x/day	22,700
Central business district	390	1x/day	4,400

Suggested Program Effectiveness Improvements

1. Evaluate street maintenance data maintained in order to develop useful measures of effectiveness.
2. Increase resources designated for maintenance.
3. Update equipment as needed to reflect current improvements.

Water Quality Considerations in CIPs (S7.B.8e)

Program Description

Develop projects to improve surface water quality. Types of projects include:

- Improve drainage infrastructure to relieve localized flooding and improve stormwater conveyance.
- Reduce sediment inputs to stream systems from actively eroding hillsides and street runoff.
- Protect stream channels from incision and stream bank erosion to reduce sediment input and improve in-stream habitat.
- Install structures such as oil/water separators and sedimentation vaults to remove harmful chemicals and excessive sediment.
- Install bioengineering techniques such as swales and detention facilities to reduce stormwater runoff and peak stream flows, improve water quality and provide wildlife habitat.

Program Goals

Reduce local flooding, protect and improve urban streams integral to the drainage infrastructure as vital wildlife habitat and improve stormwater quality runoff by promptly identifying and constructing projects that actively improve or promote water quality through elements of location, design, and construction.

Program Objectives

- Prevent street flooding or property damage in a 25-year storm.
- Maintain a drainage system that functions and prevent failures.
- Eliminate all fish passage barriers on city property.
- Ensure habitat within city property that can sustain fisheries.
- Manage water quality to meet water quality standards.

Program Effectiveness

A rating is provided for each SPU Capital Improvement Project according to the degree it addressed water quantity, habitat, water quality and flooding issues. These issues are defined as follows:

- Water Quantity: Improvement to, or installation of, drainage system(s) involving detention and/or conveyance.
- Habitat: Enhancements for fish and/or wildlife, such as fish passage projects.
- Water Quality: Prevention of erosion or reduction of sedimentation.
- Flooding: Reduction or prevention of flooding or recurring drainage problems.

Each project is rated according to the degree it addresses each issue as follows:

● = Primary objective of the project
◗ = Addressed to some degree, or as secondary benefit
○ = Not addressed

The ranking is organized into categories of *Completed Projects* (Table 13), *In Process Projects* (Table 14), and *Planned Projects* (Table 15). The percent of projects that address each issue either "fully" or "to some degree" are totaled within each category.

Suggested Program Effectiveness Improvements

1. Monitor pre to post construction conditions to evaluate project effectiveness.
2. Complete trunk drainage system and begin implementing neighborhood improvements.
3. Develop an operation and maintenance program for non-standard facilities.
4. Construct fish ways at all passage obstructions and improve habitat.
5. Construct and evaluate water quality treatment facilities.

Table 13. Effectiveness of Capital Improvement Projects at Addressing Water Quality Considerations (Completed Projects)

Date of completion	Project	Water Quantity	Habitat	Water Quality	Flooding	Comments
2Q95	South Park Drainage	●	◗	◗	●	Improvement to drainage system and wetland
1Q98	Thornton Creek – Meadowbrook Pond	●	◗	◗	●	Detention facility incorporating wildlife habitat and water quality elements in it's design
4Q98	Thornton Creek – Jackson Park Detention	●	◗	○	◗	Aid in reducing future flooding problems. Addition of wetland and open stream channel
4Q97	Thornton Creek Culvert Replacement/33rd	●	○	○	●	Added capacity and storage to relieve localized flooding
3Q97	Pipers Creek Slope Stabilization	○	○	●	○	Control of sediment input to creek from surrounding ravines
4Q95	Puget Ridge Drainage Project	◗	○	○	●	Conveyance improvement to reduce localized flooding
3Q95	South Norfolk Street Drainage Project	○	○	◗	●	Formalize drainage system in area to reduce flooding. Water quality and wetland improvements
4Q96	Denver S Drainage Rehab	○	○	○	○	Replacement of deteriorated pipe
4Q98	NE 107th St/Midvale Ave NE Drainage	●	○	○	●	Drainage improvement to address flooding problems
4Q96	Bitter Lake Drainage	●	○	○	●	Improved drainage system to reduce flooding
4Q98	Seola Beach Channel Stabilization	◗	○	●	○	Stabilize erosion of creek banks and bed scour
4Q97	NSCC Detention	●	◗	◗	○	Water quality enhancement through filtration of stormwater. Downstream fish habitat improved by providing source of food. Infiltration benefits
4Q98	Fauntleroy Creek Culvert	○	●	○	○	Replacement of failing culvert providing fish passage and access to upstream habitat

Table 13. Completed Projects, continued

Date of completion	Project	Water Quantity	Habitat	Water Quality	Flooding	Comments
4Q98	West Seattle Freeway Oil/Water Separators	○	○	●	○	Allows for better maintenance of oil/water separator vaults. Assist in containing hazardous waste spills
4Q98	Alki Ave SW Storm Drains	●	○	○	○	Repair of small drainage system to reduce City liability and maintenance
4Q98	Pipers Creek Erosion/Sedimentation – Phase I	◗	●	◗	○	Control of sediment inputs will enhance fish habitat. Improvements for fish passage
4Q98	SW Tieg Place Sedimentation Vault	○	○	●	○	Replacement of failing sedimentation structure and erosion control upstream
4Q99	Holly Park Redevelopment - Phase I	●	○	○	○	Installation of new drainage system
4Q97	20th Ave NE Drainage	●	○	○	○	Culverting of a ditch
3Q96	Sunnyside N Boat Ramp Drainage Rehabilitation	●	○	○	◗	Drainage improvement to address localized flooding issues and replacement of broken pipe
4Q98	Genessee Dam Spillway Protection	●	○	○	○	Provide overtopping protection of dam
2Q99	Drainage Spot Improvements 1998	●	○	◗	●	Drainage improvements to address flooding issues, improvements such as grassed swales can enhance water quality
Percentage of Projects (● or ◗)		73%	27%	41%	45%	

Table 14 - Effectiveness of Capital Improvement Projects at Addressing Water Quality Considerations (In-Process Projects)

Expected completion date	Project	Water Quantity	Habitat	Water Quality	Flooding	Comments
4Q99	Delridge Basin – Phase II Channel Improvement	●	◗	◗	●	Stream improvements to increase conveyance capacity, stabilize stream banks, enlarge culverts to provide fish passage. Addition of wetland habitat
4Q2001	Thornton Creek Phase 5 (Lake City Outfall)	●	○	○	●	Repair outfall to improve storm flow conveyance and relieve downstream flooding
4Q99	Burke Gilman Basin (Lake Washington North Drainage)	●	○	○	●	Addresses drainage and flooding issues in the Lake Washington North Drainage Basin
3Q99	51st Ave SW Seawall Storm Drain	●	○	○	○	Replacement of failing storm drain
4Q99	Webster Street Detention Basin Revision	●	◗	◗	●	Assist in maintaining dry weather creek flows, improve wetland habitat, and trap sediment
4Q99	Thornton Creek Restoration - 1999	◗	●	◗	◗	Maintain integrity of creek system as part of drainage infrastructure, while addressing fish habitat, passage, erosion, and flooding
3Q99	Linden Ave Swale	●	○	●	◗	Water quality benefits through filtration by swale and reduced flooding downstream
4Q99	Taylor Creek Culverts – Phase I	○	●	○	○	New culverts will allow for fish passage and access to upstream habitat while maintaining conveyance of storm flows.
4Q99	Pipers Creek Erosion/Sedimentation Phase II	○	◗	●	○	Retrofit of existing structures and placement of additional structures to convey storm flows. Addresses sediment and fish habitat
4Q99	Thornton Creek Protection Best Management Practice	○	○	●	○	Installation of structures to intercept and treat highway sediment runoff before entering Thornton creek
4Q2000	Drainage Spot Improvements 1999/2000	●	○	◗	●	Drainage improvements to address flooding issues, improvements such as grassed swales can enhance water quality
2Q2000	Alki Landslide (FEMA)	●	○	○	○	Improvements to drainage system to reduce City liability and maintenance

Table 14. **In Process Projects, continued**

Expected completion date	Project	Water Quantity	Habitat	Water Quality	Flooding	Comments
2Q2000	Yancy Street Creek Rehabilitation	◗	●	◗	◗	Creation of a wetland/detention facility to relieve flooding. Incorporating fish & wildlife enhancements, improve water quality
4Q99	Willow Street Wetland	○	◗	◗	◗	Wetland to provide detention and alleviate flooding while providing wildlife habitat and water quality benefits
1Q2000	West Seattle Detention (Golf Course)	●	●	○	◗	Detention facility to reduce peak flows and address future flooding
2Q99	Meadowbrook Pond – Phase II (Lake City Detention)	○	◗	◗	●	Repair of pond and in-stream structures regulating flow and storage capacity. Removal of accumulated sediment
4Q99	Meadowbrook Bypass Pipeline Phase II	●	○	○	●	Bypass to Lake Washington to provide reduction of peak storm flows and downstream flooding
2Q99	Stone Ave N/NE 107th St Drainage	●	○	○	●	Improvement to address recurring drainage problems
3Q99	30th Ave SW Drainage	●	○	○	◗	Improvement to address recurring flooding problems
2Q2000	South Park Drainage – Phase I	○	○	○	●	Install storm drains to prevent flooding
2Q2000	Holly Park Redevelopment - Phase II	●	○	○	○	Installation of new drainage system
3Q99	Durland Ave NE & NE 115th St Drainage	●	○	○	◗	Installation of new storm drain to address recurring drainage problems
1Q2000	Westlake Drainage Rehabilitation	●	○	●	○	Replacement of substandard drainage system incorporating filtration devices to address street runoff
Percentage of Projects (● or ◗)		74%	39%	48%	70%	

Table 15. Effectiveness of Capital Improvement Projects at Addressing Water Quality Considerations (Planned Projects)

Expected start date	Project	Water Quantity	Habitat	Water Quality	Flooding	Comments
4Q2000	Waterway 18 N/N Lake Drain Pipe Replacement	●	○	○	◗	Replace undersized pipe to prevent street flooding
2Q2000	Jackson Park Detention Phase II	●	◗	◗	●	Detention facility to relieve downstream flooding and erosion
4Q2000	Taylor Creek Culverts Phase II	●	●	○	○	Culvert replacement to maintain conveyance of storm flows and provide fish passage & access to upstream habitat
3Q2000	S.E.A. Street	●	○	●	◗	Demonstration project incorporating design features to reduce runoff and improve water quality
3Q2000	Thornton Creek Restoration – 2000	◗	●	◗	◗	Maintain integrity of creek system as part of drainage infrastructure, while addressing fish habitat, passage, erosion, and flooding
2Q2000	Lake City Wetlands Detention – 32nd Ave NE	●	◗	◗	●	Detention facility to address flooding issues, provides wildlife and water quality benefits
3Q2001	South Park Drainage – Phase II	○	○	○	●	Install storm drains to prevent flooding
2Q2001	Licton Springs Drainage	●	○	○	●	Drainage improvement to Licton Springs Park to address localized flooding
3Q2001	Marine Drive Landslide Mitigation	●	○	○	○	Improvement to drainage system to reduce City liability and maintenance
3Q2000	NW 132nd St & 12th Ave NW Storm Drain	●	○	○	○	Improvement to drainage system to reduce City liability and maintenance
2Q2000	Culvert Rehabilitation – 35th Ave NE & NE 125th St	●	◗	○	○	Replacement of deteriorated culvert to maintain conveyance and improve fish passage
2Q2000	Carkeek Park Detention	●	●	◗	○	Detention facility to increase storage capacity of the creek system while providing water quality improvements and reducing stream flows

Table 15. Planned Projects, continued

Expected start date	Project	Water Quantity	Habitat	Water Quality	Flooding	Comments
3Q99	47th Ave SW Landslide	●	○	○	○	Improvements to drainage system to reduce City liability and maintenance
2Q2000	SW Bertona Street Headwall	●				Added project
2Q2000	West Raye Street Storm Drain	●				Added project
2Q2000	Seola Beach Drive Culvert	●				Added project
4Q2000	Airport Way and Military Road Drainage	●				Added project
Percentage of Projects (● or ◗)		94%	31%	26%	70%	

Definitions

Water Quantity: Detention and conveyance, improvement or installation of drainage systems.
Habitat: Enhancements for fish and/or wildlife such as fish passage projects.
Water Quality: Sediment or pollutant removal or erosion prevention.
Flooding: Reduce or prevent flooding or recurring drainage problems.

Education (S7.B.8i, S7.B.8f)

Program description

The City employs a number of educational strategies to encourage residents, businesses and City staff to improve stormwater quality through stewardship practices. Venues include media campaigns, literature, one-on-one education and hands-on classroom and field education. Table 16 outlines the multiple education programs by topic and target audience. Topics range from a specific focus, such as the landscape practices taught in the Green Gardening Program, to broad watershed stewardship, such as tours and newsletter in Pipers Creek and Longfellow Creek Watersheds. The *1998 Update Report* includes detailed descriptions of the Stormwater Management Education Program; three relatively recent projects are described below:

- **Environmental Coalition of South Seattle (ECOSS):** ECOSS is a non-profit organization working with Seattle businesses and citizens to improve environmental quality stewardship. ECOSS has an active governmental agency and business staff education program. The City recently contracted with ECOSS to educate business owners and staff in the Elliot Bay/Duwamish watershed, and to conduct an internal water quality education program with City inspector staff.

- **Environmental Management Program (EMP):** Adopted in February 1999, the EMP is a collection of City-wide policies giving staff direction in environmental sound work practices. The policies are supported by the City's Office of Environmental Management, an inter-departmental advisory group, a departmentally distributed book containing the EMP policies, a series of forum, and informational flyers. Many of these policies address stormwater quality issues such as fleet management, hazardous waste management, chemical reduction, landscape maintenance practices and environmentally responsible purchasing.

- **Contractor/Developer Education:** Current plans are in process to require Contractor certification for Environmentally Critical Areas.

Program Goal

To educate residents, businesses, industries and City staff regarding stormwater quality stewardship practices.

Program objectives

The City has three overall objectives for stormwater quality education:

1. Increase awareness by informing citizens of the relationship between stewardship activities and stormwater quality.
2. Improve behavior by increasing public stewardship of stormwater.
3. Integrate educational efforts by coordinating among appropriate education programs within the city and other agencies.

Program Effectiveness

Table 17 provides an evaluation of effectiveness of each program at meeting the stormwater quality education objectives outlined above. The stormwater quality education programs are

building on a strong informational base. Program managers are continually seeking opportunities to increase coverage by coordinating among programs. All programs are striving to develop means of measuring improved public stewardship.

Suggested Program Effectiveness Improvements

1. Increase coordination among programs.
2. Increase coordination with non-profit educational partners.
3. Develop methods for measuring improved stewardship.

Table 16. Education Activities Organized by Target Audience and Topic

Topic	Target		
	Residents	Business and Industry	City staff
Landscape stewardship (pesticides, herbicides, fertilizers)	Natural Lawn Care Green Gardening Program Water Quality Consortium	Natural Lawn Care Green Gardening Program	Environmental Management Program Natural Lawn Care Green Gardening Program
Construction activities		*In planning:* Contractor certification requirements for ECAs	
Illicit discharge definition, impacts and removal	Private Detention Inspection Program Water Quality Consortium Hazardous Waste Program Storm Drain Stenciling Spill Response Kit Water Quality Complaint Response	Business Inspection Program Private Detention Inspection Program ECOSS Storm Drain Stenciling Spill Response Kit Water Quality Complaint Response	ECOSS Water Quality Complaint Response
Oil and toxic materials management and disposal	Household Hazardous Waste Program Water Quality Consortium Storm Drain Stenciling Spill Response Kit	ECOSS Storm Drain Stenciling Spill Response Kit	ECOSS Environmental Management Program
Broad Watershed Stewardship	Salmon in the Classroom Pipers and Longfellow Watershed Educators STEP Grants	Pipers and Longfellow Watershed Educators	

Table 17. Education Program Effectiveness

Forum	Objectives			Comments
	1. Inform	2. Improve Stewardship	3. Cross coordination	
Salmon in the Classroom • Broad, hands-on watershed stewardship education for children	●	●		Over 100 schools participate in this program each year.
Spill Response Kit • Kits and one-on-one education provided to businesses with a high potential for spills			●	This program has just begun and has had very good response. The program is well-integrated with the Inspection Program and Watershed Educators.
Storm Drain Stenciling • Informs general public of storm drain connection to water bodies. • Hands-on stewardship for schools, businesses and community groups.	●	●	●	Integrated with Salmon in the Classroom, Watershed Educators and Inspection Program..
Natural Lawn Care • Intergovernmental collaborative effort to reduce chemical fertilizers and pesticides	●	●	●	Evaluation conducted as regular part of Local Hazardous Waste Management Program. Pre- and post- campaign surveys indicate positive changes in landscape care activities.
Green Gardening Program • Collaborative effort among agencies and organizations to inform landscape professionals of environmentally friendly maintenance techniques	●	●	●	Evaluation conducted as regular part of Local Hazardous Waste Management Program. Fourth year training nursery staff at ten nurseries in Seattle. Participant surveys indicate positive stewardship changes. The program also conducts interagency staff training.
Household Hazardous Waste Program • Inter-agency program providing education about and collection services for household hazardous wastes	●	●	●	Household Hazardous Waste Collection provides best management of hazardous wastes, emphasizing recycling and destruction as appropriate. Educational venues include collection shelter displays, one-on-one education, event booths, brochures and "buy-safe" product comparison guide and other information on safe alternatives.

Table 17. Education Program Effectiveness, continued

Forum	Objectives			Comments
	1. Inform	2. Improve Stewardship	3. Cross coordination	
Media: Water Quality Consortium • Intergovernmental collaborative media campaign targeted at water quality stewardship activities	●	◗	○	
Non-Profit Education Partnerships • ECOSS	NA	NA	NA	The ECOSS partnership has just been launched.
Grants-STEP Program • This environmental stewardship grant program funds educational projects such as brochures, ads, a watershed atlas, festivals and interpretive signage	NA	●	NA	This community-based grant helps promote water quality education projects at the neighborhood level.
Inspection Education Inspection staff provide literature and one-on-one, on-site BMP education on: • Business Inspections • Private Detention Inspections • ESC Inspections	●	◗	◗	Contact provides opportunity for cross-training with other stormwater quality stewardship topics.
Watershed Educators Designated education stewards integrate and tailor a number of watershed-specific programs for: • Pipers Creek • Longfellow Creek	◗	○	●	SPU funds two half time educators, one for Pipers Creek and one for Longfellow Creek. The Educators coordinate, plan and implement recommendations from the Watershed Action Plans.

○ = could use improvement ; ◗ = moderately effective; ● = very effective

SECTION II - MONITORING (S7.B.4)

Introduction

This section comprises the single permit component of Monitoring (S7.B.4), and provides an evaluation of the effectiveness of the major monitoring programs. The *Cumulative Monitoring Summary and Analysis Report* contains a more detailed description and summary of each of the monitoring activities conducted during the first four years of the permit term.

Program Description

The City conducts a variety of monitoring activities, including receiving water quality assessments (S7.B.4.a), BMP effectiveness (S7.B.4.b), pollutant source control assessments (S7.B.4.c), and aquatic community assessments (S7.B.4.d). Additional details on each of the monitoring programs are contained in *Cumulative Monitoring Summary and Analysis Report.*

Program Goal

To collect data and information related to stormwater control actions in order to support the needs of decision makers responsible for stormwater runoff management.

Program Objectives and Program Effectiveness

The objectives of key monitoring activities, and the effectiveness of meeting the listed objectives, are summarized in the tables below for the following monitoring activities:

- Water Quality Assessment Monitoring (Table 18)
- Habitat Assessment Monitoring (Table 19)
- Aquatic Community Monitoring (Table 20)
- BMP Monitoring (Table 21)
- Sediment Monitoring (Table 22)
- King County Storm Basin Monitoring (Table 23)
- Pollutant Source Control--Lake Union Source Control Assessment Monitoring (Table 24)

Effectiveness at meeting the objectives is broadly evaluated as being "high," "medium," and "low." Remarks are provided to explain the rationale behind each measurement of effectiveness.

Table 18. Objectives and Level of Effectiveness of Water Quality Assessment Monitoring

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To detect any significant changes from previously determined water quality conditions	Low	Concentrations of pollutants in the water column are too variable and the number of samples obtained are too limited to determine, with any degree of statistical significance, any changes or trends in water quality conditions over time.
To detect the presence of illegal discharges or illicit connections	Low	Owing to the limited locations and frequency of sample collection the probability of collecting a sample at the precise time necessary to detect a one-time discharge of a pollutant is low. Because of the high variability of water quality chemistry, the ability to detect a long-term illicit connection is very limited.

Table 19. Objectives and Level of Effectiveness of Habitat Assessment Monitoring

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To characterize physical watershed conditions in the creeks	High	A significant volume of data and information has been gathered related to the physical characteristics and habitat conditions in the City's creek watersheds.
To prioritize short- and long-term objectives in the creek watersheds	Medium	A number of capital improvement projects were programmed into the City's CIP schedule as a direct result of Habitat Assessment Monitoring. However, it is difficult to accurately determine how many projects would have been identified independently of the monitoring program.
To evaluate changing conditions over time in the creeks	Low	The data and information have not been adequately entered into a database to facilitate retrieval and analysis.

Table 20. Objectives and Level of Effectiveness of Aquatic Community Monitoring

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To identify the biotic integrity at selected locations in urban creek watersheds	Medium	Raw data on benthic macroinvertebrate communities provide insight into the presence and relative numbers of tolerant/intolerant species. However, current measures of biotic integrity are not sensitive to relative health within heavily urbanized watersheds, and may not be appropriate for comparing conditions between these stations.
To detect any significant changes from previously determined biotic integrity in urban creek watersheds	Not determined	No significant changes have been noted to date, but this may be due to a relatively short time period over which data have been collected, and because of the relative insensitivity of current indices of biological integrity.

Table 21. Objectives and Level of Effectiveness of BMP Monitoring

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To measure the pollutant removal effectiveness of stormwater filtration in a tidally influenced basin	Low	Limitations in current state-of-the-practice of monitoring technologies frustrated efforts to evaluate BMPs located in a tidally influenced area.
To measure the effectiveness of stormwater pollution education	High	The study conducted in conjunction with the Water Quality Consortium reported gains in public awareness and positive changes in behavior as a result of education activities.
To measure the pollutant removal effectiveness for various structural BMPs	Not determined	Construction delays prevented completion of monitoring to evaluate the effectiveness of a wet pond, Stormceptor, Coalescing Plate Oil/Water Separator, and Downstream Defender. These monitoring activities will be carried over into the next permit term.

Table 22. Objectives and Level of Effectiveness of Sediment Monitoring

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To evaluate pollutant levels of concern in sediments of urban creeks	Medium	Analysis of data collected by King County indicated that metals in creek sediments were below levels of concern for benthic organisms. Data collected and analyzed by USGS may indicate pesticides, organochlorine compounds, and PAHs may be of long-term concern for Puget Sound streams.
To evaluate pollutant levels of concern in sediments of other receiving water bodies	Not determined	Data collected to investigate sediment conditions in Elliott Bay, Duwamish River, and Lake Union have not been assessed for usefulness in evaluating stormwater-related programs.

Table 23. Objectives and Level of Effectiveness of King County Storm Basin Monitoring

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To detect any significant changes from previously determined water quality conditions	Low	Concentrations of pollutants in the water column are too variable and the number of samples obtained are too limited to determine, with any degree of statistical significance, any changes or trends in water quality conditions over time.
To detect the presence of illegal discharges or illicit connections	Low	Owing to the limited frequency and location of sample collection the probability of collecting a sample at the precise time necessary to detect a one-time discharge of a pollutant is low. Because of the high variability of water quality chemistry, the ability to detect a long-term illicit connection is very limited.

Table 24. Objectives and Level of Effectiveness of Lake Union Source Control Project

Objectives	Level of Effectiveness (High/Medium/Low)	Remarks
To identify land use sources of stormwater pollutants	High	The study identified pollutants including metals, TPHs, PAHs and fecal coliform associated with industrial, residential, commercial and auto-related land uses.
To identify retrofit opportunities in several priority drainage basins	High	The study identified numerous retrofit opportunities, however recommended that small-scale, underground structural treatments would be a more cost-effective option.

Suggested Program Effectiveness Improvements

A number of general recommendations can be made regarding the monitoring conducted by the City under its NPDES stormwater permit as a result of evaluating the effectiveness of the various programs. A more detailed discussion on improvements planned for the monitoring is contained in the *Cumulative Monitoring Summary and Analysis Report.*

1. Use monitoring to evaluate the performance of capital projects conducted in urban creeks

Monitoring efforts should be expanded in such a manner that the data and information collected can be specifically related to changes caused by the construction of capital projects. The City is embarking on a major series of capital projects, which include creek bank stabilization, off-channel habitat creation, and stormwater detention. A pre- and post-construction monitoring program, properly designed and conducted, can provide information on the relative merits of various construction projects, provide feedback on engineering design and construction techniques, and identify any opportunities to return to the site for post-construction adjustments.

2. Continue and expand BMP effectiveness monitoring

BMP effectiveness monitoring assists in ongoing refinements to the Stormwater Management Program by providing valuable information on what activities or structures provide greater stormwater quality protection or improvement. Increasing the understanding the stormwater quality benefits gained from specific management actions, including inspections, enforcement and education, will assist Stormwater Management Programs in making incremental steps from measuring targeted outputs to measuring the benefits of specific actions. This information will refine stormwater management decisions and advance the benefits gained by strategically investing in the most effective activities and projects.

3. Consider dropping water quality assessment monitoring

In its current form, storm event and base flow sampling conducted in urban creeks (or end of pipe sampling) is not effective at evaluating trends or detecting illicit/illegal discharges. Therefore, this type of monitoring has essentially no influence on decisions made regarding stormwater control actions. To raise the level of effectiveness above its current low level would require a substantial increase in the number and frequency of samplings (by a factor of ten or more), and likely an expansion of the types of chemical analyses conducted. Even if substantial investments indicated trends, this data would not provide necessary causal analysis to direct future actions. In view of other monitoring activities that can be conducted (see below), and the implausibility that even with an increased level of effort the objectives would be met, serious consideration should be made by the City of Seattle (and King County) to discontinue water quality assessment monitoring.

4. Do not initiate City-sponsored monitoring of sediment contamination

Sediment contamination data collected by King County and USGS have thus far not directly influenced stormwater management decisions aside from reinforcing the need to continue conducting source control and public education programs aimed at reducing the use of fertilizers and pesticides. Currently, there are no stormwater management-related decisions pending that require additional sediment contamination data. Therefore, although collecting sediment contamination data may be necessary as part of a remediation project, or may be required in the

future as part of the City's combined sewer overflow program, there is no clear need at this point to conduct sediment monitoring under the City's stormwater management program.

SECTION III - RESOURCES (S7.B.3, S7.B.5, S7.B.6)

Introduction

This category contains the foundational resources that are both essential for conducting a stormwater management program and necessary for guiding decisions regarding stormwater control actions. This category includes:

- Legal Authority (S7.B.3)
- Fiscal Analysis (S7.B.5)
- Information Support (S7.B.6).

Description

The resource requirements contained in the City's NPDES stormwater permit are summarized below:

> ***Legal Authority (S7.B.3).*** Adequate legal authority to control discharges to and from municipal separate storm sewers owned or operated by the permittee.
>
> ***Fiscal Analysis (S7.B.5).*** A fiscal analysis of the capital and operation and maintenance expenditures necessary to implement the stormwater management program, including a description of the source of funds that are available to meet the necessary expenditures.
>
> ***Information Support (S7.B.6).*** A mechanism for gathering, maintaining and using adequate information to conduct planning, priority setting, and program evaluation activities.

Objectives

1. Maintain adequate resources as defined in the NPDES stormwater permit.
2. Maintain resources appropriate for planning and implementing the stormwater management program.
3. Integrate resources into stormwater management and planning.
4. Identify opportunities for improvement.

Evaluation of Effectiveness

Evaluating effectiveness of stormwater management program resources involves two processes. First a determination must be made as to whether the available resources meet the first objective as being adequate to conduct an effective stormwater management program. Table 25 provides a descriptive evaluation of how the City has adequate levels for each of the three resources of legal authority, budget and fiscal analysis, and information support. Next, a determination must be made as to whether or not the available resources are appropriate and effectively used, thereby meeting the remaining three objectives. Table 26 evaluates each of the resources according to the three remaining objectives.

Table 25. Adequacy of Resources

Resource	Adequacy
Legal Authority	Adequate legal authority is provided by several City ordinances, most particularly the Stormwater, Grading and Drainage Control Code (SMC 22.800), Side Sewer Ordinance (SMC 21.16), and Land Use Code (SMC 23.90).
Budget and Fiscal Analysis	Fiscal resources are ensured through the City's drainage fee, which has a rate structure based on the size and type of land use.
Information	Adequate information support is provided by retention of hard copy documentation, water quality and precipitation record data bases, and a comprehensive geographic information system (GIS).

Suggested Improvements

1. Develop protocols to ensure consistent enforcement of existing regulations.
2. Identify effective enforcement strategies to address priority problem areas. Determine situations where education and information are not effective at changing behavior.
3. Develop a method for tracking expenditures for a limited number of specific stormwater programs that will meet the information needs of Ecology and the management needs of the City.
4. Integrate GIS data structures with other programmatic databases to provide the ability to conduct spatial analysis of programmatic activities. Database information, such as water quality complaint responses, inspections, operations and maintenance, could be spatially displayed analyzed to assist in prioritizing stormwater management actions or needs.
5. Increase the integration of information from across programs and City departments for stormwater management decision making.

Table 26. Evaluating the Appropriateness and Effectiveness Use of Resources

Resource	Appropriateness	Effective Use	Opportunities for Improvement
Legal Authority	The City has adequate legal authority to enforce the requirements of its stormwater management program.	The City primarily uses education and information as opposed to drawing on the wider range of tools available such as Notice of Violations, Stop Work Orders and fines, to enforce codes.	There may be situations where current enforcement methods are not effective and other options should be considered. Develop strategies, protocols and training to ensure consistent enforcement of existing regulation.
Budget and Fiscal Analysis	The City's SWMP and CIP budget has been substantially increased during the permit term due to drainage rate increases.	The fact that multiple agencies and departments are responsible for SWMP implementation makes a detailed fiscal analysis organized according to permit component difficult.	Develop an expenditure tracking method that will meet the management needs of the City and the assessment needs of Ecology. Work with Ecology to identify a fiscal analysis format organized around specific stormwater programs.
Information: (includes infrastructure, land use, program effectiveness and CIP effectiveness	The City maintains excellent databases of land use, drainage infrastructure, stormwater facilities, inspections, water quality complaints and permit applications. Good water quality, habitat and aquatic health data has been collected during the term of the permit.	Currently information is collected very well for specific programs and City departments. However, this information could be better integrated and analyzed for use in stormwater management and planning.	Increase integration of information across City agencies and departments. Integrate where appropriate database information and GIS to increase spatial analysis in planning. Increase interpretation and analysis of information to assist in prioritizing stormwater management actions.

SECTION IV - PLANNING (S7.B.1, S7.B.2, S7.B.7)

Introduction

This category comprises those actions conducted by decision makers involved in stormwater management planning processes, and includes:

- Planning (S7.B.1)
- Prioritization (S7.B.2)
- Watershed-wide Coordination (S7.B.7)

Owing to the close interrelationships among these three components, the analysis of the decision making processes presented below does not attempt to segregate them.

Description

The category of Planning and Prioritization involves the process of planning, coordinating and making decisions affecting the City's stormwater management program. Within Seattle, planning processes related to stormwater management are conducted primarily within SPU, but also involve, for example, Department of Design, Construction and Land Use, and Seattle Transportation. Public involvement in stormwater management-related decisions is obtained through the participation of residents in a Citizen Advisory Committee, in various Watershed Action Plan Committees, and through a number of public meetings. Intergovernmental coordination is achieved as a result of the City's participation in a variety of joint assemblies, such as watershed forums, the NPDES Municipal Stormwater Interagency Work Group, several technical advisory committees, and a multitude of jurisdictional gatherings associated with the area's response to the listing of Puget Sound chinook salmon as "threatened" under the Endangered Species Act.

Goal

To conduct a comprehensive stormwater management program through effective prioritization, resource allocation, coordination and evaluation of stormwater quality control activities.

Program Objectives

1. Comply with all the conditions of the City's Municipal Stormwater NPDES discharge permit.
2. Build an integrated program involving both intra- and inter-governmental coordination.
3. Develop effective methods for evaluating and prioritizing stormwater management decisions.
4. Provide meaningful public participation in the City's ongoing, comprehensive stormwater management planning.

Program Effectiveness

Planning and prioritization are ongoing processes, and the "effectiveness" of these processes cannot be directly tied to either level of effort or adequacy of resources. Additionally, the level of success of a particular component of a stormwater management program may be entirely independent of the planning and prioritization process involved, owing to factors beyond the control of stormwater management decision makers. Table 26 describes areas of high

performance and suggests improvements. General evaluative comments related to the stated program objectives are summarized below.

1. Comply with all conditions of the City's Municipal Stormwater NPDES permit
The City has been in compliance with its NPDES Stormwater permit since it was issued. All the components of the permit have been implemented. The focus of Seattle's SWMP implementation since its formal approval has been on enhancing existing programs (such as public participation), responding to related regulatory requirements (such as ESA), and ensuring any permit items having a schedule for completion will be finished before the end of the current permit term. Therefore, the City has been effective at complying with its NPDES stormwater discharge permit.

2. Build an integrated stormwater management program
One of the challenges in stormwater runoff management is finding the correct balance between centralized planning and the need to allow for nearly autonomous initiatives to be developed and implemented at divisional, unit and individual levels. As a result of a reorganization of several City departments in 1997, responsibility for various stormwater program components is shared among at least three city departments (which have separate goals, prioritization methods and fiscal tracking systems) and several divisions within SPU (See Table 27).

Table 27. Permit Elements and Responsible Agencies and Departments

Responsible Agency or Department	Permit Category
SPU Community Services Division	Treatment and Source Control Education Monitoring
SPU Drainage Operations and Maintenance Division	Stormwater Facility O & M
SPU Resource Development Division	Water Quality in CIPs
Seattle Transportation	Street O & M
DCLU	Runoff Control
SPU with legal advice when requested from Seattle City Attorneys Office	Legal Authority
SPU Resource Planning Division *(Responsible for integrating planning resources and functions across departments and agencies.)*	Effectiveness and Monitoring Fiscal Analysis Information Analysis Planning Prioritization Coordination

Several effective initiatives have been taken to coordinate planning and prioritization among these departments and divisions. For example, within SPU there is a Drainage System Lateral Team, which is made up of senior decision makers in SPU who are involved in drainage and wastewater planning. Similarly, a Stormwater Technical Team has been formed to coordinate programs and initiatives specifically related to stormwater management. This team includes staff representatives from SPU, SEATRAN and DCLU. Evidence of the effectiveness of these integrative efforts include the Urban Creeks Legacy Project, which involves significant capital improvement projects, an ambitious CIP evaluation plan, and bold education and public

awareness programs. The Watershed Action Plans for Thornton, Longfellow and Pipers Creeks have all provided opportunities to integrate business inspections, private detention inspections, public education, public outreach, and storm drain stenciling efforts. Therefore, the City, as with any complex organization, is broadly effective at integrating and coordinating its stormwater management programs. But additional improvements can be made in clarifying roles and accountability, increasing communication and coordination among responsible parties, and developing shared methods for program evaluation and prioritization.

3. Develop effective means of program evaluation and re-prioritizing actions
Effective programmatic evaluation for stormwater management is still in development across the country. The City is currently developing an evaluation process for many of its stormwater control activities that includes program objectives, parameters defining the scope of activity, targets to be achieved, and qualitative or quantitative (as appropriate) measures of effectiveness. Evaluation methods and measures will be refined and incorporated into ongoing planning and prioritization. The goal of the effectiveness evaluation is to move from measures that count outputs to measures that emphasize outcomes. This continuum is represented in Table 28. When the permit components were first implemented, evaluation focused on the level of activity within each program component. Evaluation measures are now moving toward targeted programmatic outcomes. The next goal will be to develop program outcome measures for each activity. Given the nature of non-point pollution, stormwater quality outcomes are best understood through specific BMP and CIP effectiveness measures.

Table 28. Moving from Outputs to Outcomes in Effectiveness Measures.

	Outputs →			Outcomes
Focus	**Actions**	**Target Outcomes**	**Program Outcomes**	**SW Quality Outcomes**
Key questions	To what degree are we doing certain activities?	To what degree are we meeting targets within specified parameters?	To what degree is the activity having an indirect, but beneficial outcome?	To what degree does the activity improve stormwater quality?
Possible Examples of Measures	# of people attending a workshop	% of riparian corridor residents in watershed who attended workshop	% of public who improved stewardship	% increase in biotic integrity at outfall downstream of isolated activity

4. Effective Public Participation in Planning Processes
The City has developed a number of forums for incorporating public participation into stormwater management planning. These forums range in involvement level from public notification to formal on-going committees. Detailed descriptions and 1998 accomplishments of the Watershed Action Plans (WAPs) and the Drainage and Wastewater Citizen Advisory Committee (DWCAC) are included in the *1998 Update Report*. The City has identified five

main objectives for public participation in stormwater planning. The effectiveness of the various public participation forums is evaluated in Table 29.

Suggested Program Effectiveness Improvements

The following points summarize the recommended areas for improvements described above:

1. Continue to work to clarify roles and accountability, increasing communication and coordination among responsible parties, and developing shared methods for program evaluation and prioritization.
2. Continue to develop program outcome measures for stormwater program activities.

Table 29. Public Participation Effectiveness

Forum	Objectives				
	1. To notify the public regarding stormwater planning issues.	2. To gain localized planning information from residents.	3. To provide a forum for citizens to identify stormwater management issues, problems and opportunities.	4. To provide a forum for citizens to comment on proposed plans and projects.	5. To encourage informed participants through education efforts.
Watershed Action Plans • Monthly meetings • Geographically specific • Watershed coordinators facilitate planning and implementation • Addresses non-point pollution, habitat, public education	◗	●	●	●	●
DWCAC • Quarterly meetings • City-wide • Address drainage and wastewater policy issues	◗	◗	◗	◗	●
Neighborhood Planning • Neighborhood specific • Multiple infrastructure issues • Sector liaisons coordinate implementation	◗	●	●	◗	○
Public Meetings One time, project or topic-specific; examples include: • ECA review • CIP review • Drainage Policy Review	◗	●	◗	●	◗
Media Primarily notification; venues include: • Newspaper articles • Newsletters • Television • Bill inserts • City website	●	○	○	○	◗
Informal Comments, questions, complaints; venues include: • calls • letters • City staff	○	◗	◗	◗	○

○ = not effective; ◗ = moderately effective; ● = very effective

SECTION V - OVERALL PROGRAM EFFECTIVENESS

Introduction

The intent of the first four sections of this report on the effectiveness of the City of Seattle's Stormwater Management Program (SWMP) has been to provide measures of how well various components of the City's SWMP are being conducted. This final section discusses the City's program as a whole, and includes an assessment of the entire program and an evaluation of the success of the City's SWMP. It also contains general comments on the success of the NPDES Municipal Stormwater Permit and provides recommendations for Ecology to consider as it prepares for the next permit term.

At this point, it would be preferable to take the information contained in the previous four sections of this report, sum the totals, weigh the balances, and provide a quantitative assessment of the overall effectiveness of the City's stormwater management program on providing environmental benefits. Unfortunately, attempting to determine the overall effectiveness of a comprehensive stormwater management program cannot be accomplished in this manner because it is difficult, if not impossible, to evaluate which programmatic components are having what environmental effect. Furthermore, the science does not exist to precisely quantify the relationships between stormwater management programmatic activities and the overall effectiveness as measured by the anticipated positive results in the environment. The information available is too incomplete, the date are too variable, and there are too many other explanatory factors. Recognizing these difficulties in assessing the overall effectiveness of the City's stormwater program, the below evaluation is provide based on a combination of measured parameters, operational experience and best professional judgement.

Overall Assessment of the Effectiveness of Seattle's SWMP

The purpose of Seattle's stormwater management program, as set forth in the 1997 SWMP, is:

To protect life, property, and natural resources from loss or damage caused by uncontrolled stormwater runoff.

Although the focus of reporting under the NPDES stormwater permit is primarily focussed on protecting natural resources, it should be noted that the City's stormwater management program has been both effective and successful and protecting life and property from uncontrolled stormwater runoff.

The City of Seattle's stormwater management program has also been effective at protecting natural resources. There are three broad outcomes critical to the success of a SWMP:

1. Effectively conduct each of its various programmatic components (education, maintenance, inspections, etc.) defined by the permit.
2. Improve the actions of the public.
3. Achieve the long-term goals of the program.

Each of these three outcomes are examined in more detail below, and summarized in Table 30.

Table 30. Overall Measure of Stormwater Management Program Effectiveness

SWMP Outcome	Examples of Program Measurements	Ability to Measure Effectiveness	Overall Evaluation of Effectiveness	Remarks on Overall Evaluation of Effectiveness
Effectiveness related to programmatic performance	• Percent water quality complaints resolved. • Targeted maintenance standards achieved. • Percent of projects with properly maintained BMPs.	High Number performance measures typically exist in programmatic databases or can be obtained through records.	Highly Effective	City is generally effective in executing stormwater management programs, with areas available for improvement noted elsewhere in this report.
Effectiveness related to changing public behavior	• Percent unaided recall of educational content. • Percent surveyed stating they had changed behavior (for the better) as a result of education/outreach program(s).	Medium to Low Properly structured pre- and post-education surveys can examine the effectiveness of transmitting the message. Harder to obtain are data and information relating SWMP activities to overall environmental stewardship and individual actions. In general, other factors, independent of (or difficult to separate from) SWMP activities affecting individual actions.	Reasonably Effective	Estimation based on limited data, studies, and qualitative assessments of SPU staff. A survey conducted to evaluate success of Water Quality Consortium education program (see Monitoring Report) showed, for example, that 35% of respondents who recalled the ads had changed their behavior in some way.
Effectiveness related to benefits provided to the receiving aquatic environment	• Measures of biotic integrity. • Attainment of numeric water quality standards. • Achievement of properly functioning conditions necessary to support aquatic species.	Low or non-existent Current measures of biotic integrity may not be adequate for heavily urbanized watersheds. Water quality chemistry data are too variable to evaluate trends in relation to numeric standards.	Generally Effective	Estimation based on overall improvements in conditions of creeks, lakes and bays over the past 10 - 20 years. Science currently does not exist that can directly translate programmatic activities (e.g., education, maintenance, enforcement) to changes in receiving water environment.

Effectively conduct each programmatic activity

At its foundational level, the overall effectiveness of a stormwater management program is directly tied to the effectiveness of each of its component parts. Measures of effectiveness at this level vary, but numeric values are often available for many components. However, to use these values to assess effectiveness, all measures should be placed in context with either a target value or performance goal. For example, citing the total number of water quality complaints resolved during a given time period is insufficient to provide a measure of performance unless the total number of complaints is also known. Actual performance relative to a target, as in the maintaining a particular frequency of catch basin cleaning, for example, can also be used to evaluate the effectiveness of a stormwater maintenance component. In general, based on the information contained in Sections I through IV of this report, the City of Seattle is highly effectively conducting the various stormwater management program components, with potential areas for improvement cited elsewhere in this report.

Effectively improve public behavior

One of the objectives inherent in many stormwater management programs is to change the behavior of individuals so that they: (1) do not engage in actions harmful to the environment and, as a next step, (2) participate in activities that benefit the environment. An example of the former would include individuals who no longer dump contaminants into storm drains or use excess fertilizer on their lawns. An example of the latter would be increasing the number of individuals who properly maintain their private detention systems or actively participate in riparian planting activities. One method of measuring the effectiveness of programs which have as one of their objectives behavioral modification is possible by using pre- and post-program surveys. In one example, cited in the *Cumulative Monitoring Summary and Analysis Report*, a survey following public education efforts conducted by the Water Quality Consortium determined that there was a quantifiable change in the behavior of some individuals regarding water pollution issues. Based on this limited information, the City is likely generally effective at affecting individual behavior.

Effectively provide benefit to the receiving water environment

The ability to measure the overall effectiveness of a stormwater management program in benefiting the receiving water environment remains one of the greatest challenges for stormwater planners and regulators. Knowing the appropriate level of effort necessary to achieve specific environmental benefits would substantially aid in setting priorities among stormwater components and in ensuring resources are being invested in the most cost-effective manner. For the foreseeable future, however, the ability to translate programmatic performance measures (e.g., numbers of storm drains stenciled, fractions of inspections completed, or levels of maintenance targets achieved) into quantifiable benefits made manifest in the receiving water body cannot be done. Despite the inability to provide precise measures of effectiveness of the City's stormwater management program, the overall effectiveness of the City's programs at providing environmental benefits is estimated as being generally effective, based on the following factors:

- The City's overall stormwater management program, in its current form, reflects the current state-of-the-practice as it is conducted nationwide.

- The City is fully engaged in all aspects of stormwater runoff management, with resources appropriately allocated to its programmatic activities based on locally determined needs and priorities.

- Although affected by many other factors, the overall condition of the City's creeks, bays and lakes has either remained the same or, in most cases, improved. This qualitative assessment covers a time period spanning roughly ten to twenty years, to reflect when the City first began more focussed efforts at conducting stormwater management activities designed to benefit the environment. Improvements in water quality conditions occurred in spite of the significant growth in the region over the same time period.

Overall Assessment of the Success of Seattle's SWMP

From a broad, programmatic perspective, the City's SWMP has been, and continues to be, highly successful. Examples of success can be found in many of the individual programs, and across programmatic boundaries. Some examples are provided below, illustrating successes in policy and planning, jurisdictional leadership, educational programs, capital projects and maintenance programs.

1. Proactive Policy Development

SPU is in the final stages of an extensive Drainage Policy Review. This process has integrated active involvement from senior management, a citizen's advisory committee and public involvement workshops. One of the major policy considerations is defining an appropriate role for the drainage utility in the stewardship of the City's urban creeks. Additional issues being addressed include education and enforcement. Although this process is not yet finalized, feedback thus far indicates SPU will be continuing to take a leadership role in protecting and enhancing the City's aquatic resources.

2. Sound Watershed-Based Planning

The three Watershed Action Plans, whether in the development, implementation or revision phase, have all served as integrators of many water quality and aquatic habitat improvement strategies. Extensive planning, public participation, and coordination among shareholders have focused programs and activities on protecting the aquatic health of the City's three major creeks. This watershed-based approach layers the benefits of capital improvement projects on such source control measures such as inspections and education. Resulting in cumulative protection and enhancement strategies. In addition, focusing activities and projects around creek systems increases watershed identity for local residents.

2. Strong Leadership in Building Urban Creek Health and Identity

Commitment in the form of leadership and resources has accelerated the implementation of many of the recommendations and projects outlined in the Watershed Action Plans. The Urban Creeks Legacy Program has directed resources toward the development of such projects as the Thornton Creek Protection BMP project, the Piper's Creek Phase I Erosion and Sediment Control Project and the Longfellow Creek Enhancement Projects,

3. Strong individual education programs
Leveraging multiple agency resources, the City participates in many successful educational programs addressing watershed stewardship improvement. Education is an essential strategy for improving water quality, particularly in urban areas. These programs include:

- Salmon in the Classroom
- Natural Lawn Care
- Green Gardening Program
- Local Household Hazardous Waste Program
- Storm Drain Stenciling Program
- S.T.E.P. Program
- Watershed Educators

4. Water Quality in Capital Improvement Projects
The City has continually increased its commitment to aquatic health. Most recently, this commitment has been demonstrated by the strong emphasis on water quality in infrastructure development. Capital improvement resources have supported extensive riparian corridor baseline data collection, enhancement projects, and stormwater management research.

5. Stormwater Facility Maintenance Programs
An extensive database has been developed to track and evaluate city-owned stormwater facility maintenance. Specific objectives and targets have been established as part of an internal management tool to continually improve service. The City has committed to checking all catch basins once a year and updating maintenance best management practice manuals to ensure quality and consistency.

Overall Assessment of Success of Municipal Stormwater Permit

From the jurisdictional perspective, the NPDES municipal stormwater permit issued in 1995 has been successful for three key reasons.

1. Represents Current State-of-the-Practice
The permit contains a comprehensive description of all the components necessary to conduct a successful and effective stormwater runoff management program. The permit represents the state-of-the-practice of urban stormwater runoff management as it is conducted nationwide.

2. Allows Jurisdictions to Evaluate Local Needs and Set Local Priorities
The permit allows each local jurisdiction to *plan* its own SWMP around its own unique needs and priorities, while at the same time still meeting the specific requirements contained in the permit. This is in contrast to a state-wide prescriptive approach, dictating assumed needs and priorities that may not be reflective of the local conditions. Local planning contributes to successful implementation of the permit in that ensures those most familiar with the local conditions and needs are made responsible for addressing them in their SWMP.

3. Provides Flexibility in Conducting a Local Stormwater Management Program
The permit provides enough flexibility to allow each local jurisdiction to *conduct* its own unique stormwater management program within the broader framework provided by the permit. This allows stormwater program managers freedom to allocate resources and execute plans in accordance with their own, locally derived priorities. Because environmental conditions, plans, and available resources vary among permitted jurisdictions, the overall composition of each jurisdiction's stormwater management program should be allowed to vary.

Recommendations for Improving the NPDES Municipal Stormwater Permit

Based on the first four years of operation under the NPDES Stormwater permit, the following recommendations are made:

1. Reorganize listing of program components
The permit components are defined to include all the stormwater management program elements listed in Special Conditions S7.B.1 through S7.B.7, and S7.B.8.a through S7.B.8.i. Each of these components is necessary for any comprehensive stormwater management program. However, the listing as provided in the 1995 permit does not necessarily reflect how the components may relate to each other or to the overall conduct of a stormwater management program. It is recommended that Ecology consider restructuring the presentation of the components in a manner similar to that presented in this report, using categorical groupings such as: "Stormwater Control Actions," "Monitoring," "Resources," and "Planning and Prioritization."

2. Adjust Requirements to Report by Permit Components
All permit components do not need to be treated equally for reporting purposes. For example, the "stormwater control components" listed in S7.B.8.a through S7.B.8.g (O&M programs, illicit/illegal discharge prevention and removal programs, education programs, etc.) are programmatic activities that can vary in level of effort and priorities from year to year and, therefore, should be reported on a regular basis to Ecology. However, components such as "Adequate Legal Authority" (S7.b.3), "Fiscal Analysis" (S7.B.5), and "Information Support" (S7.B.6) are relatively stable once implemented and it is recommended, therefore, that reporting on these be required only as they change or as part of a one-time report (such as in the fourth-year report) during each permit term.

3. Eliminate Financial Reporting by Each Permit Component
In their current form, the permit components do not necessarily line up with the programmatic activities as conducted by the permittee. In many cases, there are individual jurisdictional programs that directly address more than one permit component, involving overlapping staff, resources, and levels of effort. To attempt to break down planned and actual numeric expenditures by component is extraordinarily resource-intensive, and the benefits, if any, obtained from this investment are not clear. Levels of effort cannot be judged by reviewing a component-by-component budget, owing to varying efficiencies and economies of scale. Neither can appropriateness of priorities be measured by component costs, because addressing a high priority need may require a relatively low expenditure of resources, and the opposite may be true for addressing a low priority need. It is recommended, therefore, that rather than requiring a component by component breakdown in planned and actual expenditures, Ecology require only

reporting on the overall stormwater management program budget, possibly with a breakout of maintenance costs..

4. Eliminate References to Representative Concentrations and Loads

Included in the listing of potential monitoring activities is a program, the purpose of which is to "estimate concentrations and loads from representative areas or basins to be used in evaluating overall program effectiveness" (S7.B.4.a). Based on all the currently available data and science, it is clear that even with an extraordinary investment of monitoring resources–to a degree detrimental to all other stormwater programs—the extreme variability of urban stormwater runoff pollutant concentrations would make such a determination of effectiveness implausible, if not impossible. It is recommended that this activity not be included in the next permit language.

City of Seattle
Fourth-year Report
Municipal Stormwater NPDES Permit

Part 3
Cumulative Monitoring Summary and Analysis Report

Providing a summary of monitoring activities conducted during the term of the permit through August 1999.

Submitted pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NDPES) and State Waste Discharge General Permit for discharges from municipal separate sewers for the Cedar/Green Water Quality Management Area.

Municipal Stormwater NPDES Permit No. WASM23003

Submitted by:
Seattle Public Utilities
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Seattle, Washington 98104

September 2, 1999

Preface

This report is submitted by the City of Seattle pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for discharges from municipal separate storm sewers for the Cedar/Green Water Quality Management Area. The report covers the 12-month period between January 1, 1998, and December 31, 1998, with additional information provided, as appropriate, for 1999.

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Combined Sewer Overflow Report, Seattle Public Utilities 1998.

Combined Sewer Overflows: Nine Minimum Controls Documentation, City of Seattle.

Lake Union Area Source Control: Stormwater Characterization and Treatment Options, Seattle Public Utilities, December 1998.

Lower Thornton Creek Evaluation of Salmonid Habitat Conditions and Opportunities, Task 1 Memorandum, Seattle Public Utilities, August 21, 1998.

Meadowbrook Pond Water Quality Monitoring Program, Phase 1 Report, Seattle Public Utilities, August 1999.

Review of Water and Sediment Quality Data: Longfellow Creek, September 1998.

Review of Water and Sediment Quality Data: Pipers and Venema Creeks, July 1998.

Review of Water and Sediment Quality Data: Thornton Creek, May 1998.

Sample Analysis Report for Thornton Creek Summer Base Flows, Seattle Public Utilities, 1998.

The Water Quality Consortium Public Awareness Study Summary Report, October 1996.

Urban Streams Biomonitoring: Benthic Invertebrate Communities, Seattle Public Utilities, 1994-1998.

Cumulative Monitoring Summary and Analysis Report

This report is submitted by the City of Seattle pursuant to Special Condition S10 of the National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for discharges from municipal separate storm sewers for the Cedar/Green Water Quality Management Area. Section S10.B.5 requires that for the fourth-year report, the permittee provide a summary and analysis of the cumulative monitoring data collected throughout the term of the permit. This report describes monitoring activities conducted during the permit term through August 1999. Attached are hard copies of associated reports and disks containing data in electronic form.

Introduction

This report summarizes the monitoring activity conducted during the permit term through August 1999. Detailed descriptions, data collection methods, QA/QC plans and conclusions are included in a series of attached reports. This summary report is organized according to the Monitoring Program outlined in the SWMP, Appendix WQ-1, and is categorized as follows:

- Monitoring Programs for Urban Creeks
- Monitoring Programs for Lakes, Rivers, Elliot Bay and Puget Sound
- Support Monitoring
- Additional Completed Monitoring
- Additional On-going Monitoring
- Future Monitoring

Within each category, monitoring projects are summarized according to the following format:

1. Project Description and Data Analysis Methods
2. Conclusions or Status of the Project
3. Recommendations

For appropriate projects, monitoring data is attached either in electronic or hard copy format, or both. Any additional data needed is available upon request.

Several projects address specific permit monitoring components. The relationship of the City's monitoring programs to the activities described in the permit is illustrated in Table 1.

Table 1. Equivalent Monitoring Programs

Permit Monitoring Activity	Equivalent SPU program(s)
Concentrations and loads evaluating overall program effectiveness	Deemed not applicable per "Clarifications" document dated March 1995.
BMP effectiveness	Water Quality Consortium Survey
Identify sources of pollution	Lake Union Area Source Control
Identify the degree to which stormwater is impacting receiving waters and sediment	Review of Water and Sediment Quality Data: Longfellow Creek Review of Water and Sediment Quality Data: Pipers and Venema Creeks Review of Water and Sediment Quality Data: Thornton Creek

MONITORING PROGRAMS FOR URBAN CREEKS

Water Quality Assessment

Program Description and Data Analysis Methods

SPU conducts storm event monitoring in Pipers and Longfellow Creeks, and base flow monitoring in Longfellow Creek. In addition, SPU obtains both storm event and base flow data from the King County Freshwater Assessment Program (Table 2). Combining monitoring data from both agency programs provides water quality data for each of the City's three major creeks. The water quality parameters monitored are summarized in Table 3. Data collection and analysis follows the QA plans outlined in SPU's SWMP (See *Appendix WQ-1 of SWMP*).

Table 2. Overview of Water Quality Monitoring

Station	Creek	Storm Event	Base Flow
P1	Pipers Creek	12 grab/year at 3 locations-KC	
P2	Pipers Creek	2/year-SPU	
P3	Pipers Creek		
P4	Pipers Creek	2/year-SPU	
P5	Pipers Creek	2/year-SPU	
L1	Longfellow Creek		1/month-SPU
L2	Longfellow Creek		1/month-SPU
L3	Longfellow Creek	2/year-SPU	
T1	Thornton Creek	12 grab/year-KC	

Conclusions

In 1998, SPU hired a consultant to review and analyze all available water and sediment quality data for each of the three creeks. The reports concluded that the water quality for all three creeks was generally excellent for urban creeks, with some exceptions. Summary of key findings:

- No trends were observed over time.
- The three creeks have generally similar water quality. However Thornton Creek had higher average bacteria concentrations.
- Dissolved oxygen and fecal coliform do not consistently meet standards set by Ecology. (These findings are consistent with King County's 1994 report, *Water Quality of Small Lakes and Streams, Western King County, 1990-1993*, which found bacteria exceed Ecology's standards in 90-percent of King County streams.)
- Zinc and copper were present in all three creeks.
- TSS and metals tended to increase dramatically with storm events.

Although temperatures consistently met Ecology standards, the consultant expressed concern that temperatures may exceed standards if taken during the hottest time of day. A follow up temperature study was conducted in Thornton Creek, where it was determined that temperatures can exceed standards throughout the watershed on hot summer days.

The analysis reports for Pipers, Longfellow and Thornton Creeks, included in the Appendices, provide additional detail. (Note: Sampling locations C370 and J370 indicated as King County in the *Longfellow Creek Water Quality Report* are actually SPU sampling points.)

Table 3. Water Quality Monitoring Parameters

Base Flow	Storm Event
Temperature	Base flow parameters, plus:
Dissolved Oxygen	
pH	Cadmium
Conductivity	Chromium
Flow	Copper
Turbidity	Lead
Suspended Solids	Nickel
Fecal coliform	Zinc
Enterococcus	Mercury
Nitrate + Nitrite	Hardness
Ammonia	
Ortho-phosphorus	
Total Phorphorus	

Recommendations

The stated objectives for collecting water quality data from Seattle's creeks are: to detect any significant changes from previously determined water quality conditions and to detect the presence of illegal discharges or illicit connections (See SWMP, Appendix WQ-1, Section MP 2.4). The data collected during the permit term indicate that the chemical quality in the water column is consistent with that which should be expected in creek systems located in heavily urbanized areas, with no perceptible changes during the permit term. It is difficult to use the data to detect intermittent illegal discharges because the sample must be drawn at the precise moment that the pollutant mass is traveling past the sampling location. It was expected that no trends in the water quality data would be discernable, as it would require many more samples (on the order of several hundreds) in order to make a determination that met the standards of statistical significance. The data collected under the Water Quality Assessment Program for creeks suggests that there may be concerns with respect to meeting Washington State Water Quality Standards for dissolved oxygen and fecal coliform. However, the cause of these levels is unknown.

Because of the limited utility in conducting baseflow and storm event sampling in creeks, particularly in light of the resources expended to collect and analyze the data, the City will be evaluating whether to continue this monitoring element. It may be determined that it would be more beneficial, in terms of information gained for the amount of resources invested, to redirect the monitoring resources from this form of creek sampling into monitoring activity such as CIP

and BMP effectiveness that provides useful information for improving stormwater management investments. (See "Future Projects" section of this report.)

Water Quantity Assessment

Program Description and Data Analysis Methods

Flow levels for selected streams and storm lines are measured at over forty sites by SPUs surface water quality team and consultants. The data collected are used to accurately size flood control/stormwater management structures.

Conclusions

Flow data collected under the Water Quantity Assessment program have been useful in evaluating options for capital projects and in determining design specifications for these projects. There may be more useful means for reporting on the impacts of the City's Stormwater Management Program, such as evaluating pre- and post-construction flow regimes.

Recommendations

The City will continue to monitor flow, however reporting the results of flow monitoring will be incorporated in the future into CIP evaluations to evaluate the performance of installed best management practices.

Habitat Assessment

Project Description and Data Analysis Methods

The Habitat Assessment Project provided a descriptive characterizations of a number of habitat parameters for major creeks within the city, including: Fauntleroy, Pipers, Puget Ridge, Schmitz, Taylor, Thornton and Longfellow. Surveys taken at the mouth of each creek and every 200 feet detail vegetation type and density, streambank physical measurements, in-channel characterization, and substrate structural analysis. The protocols used are outlined in SPU's SWMP (See *Appendix WQ-1 of SWMP*).

Conclusions

The information obtained by the Habitat Assessment program has had a direct influence on the SPU's capital project programs. The data include valuable photo documentation of urban riparian corridors. Many of the needs identified during the creek surveys have been translated into both large and small construction projects including bank stabilization, riparian planting, weir retrofits, culvert replacement, instream improvements and fish barrier removals.

Recommendations

The Habitat Assessment Program was valuable in identifying current watershed conditions, and to categorize short- and long-term needs. However, the data and information do not lend themselves easily to a database. Garnering further information from the assessments requires a careful review of hard copy forms, maps, and drawings. With future full-scale assessments, care

should be taken to consider how the data and information can be store, retrieved, interpreted and summarized to facilitate planning and management.

Aquatic Community Assessment

Program Description and Data Analysis Methods

SPU sponsors an ongoing aquatic community assessment program. SPU initiated the program in 1994 with five creeks. Seven sampling points have been added to the program for a total of nine creeks and twelve sample points. Once a year during the fall, SPU staff collect benthic invertebrate samples, which are submitted to a laboratory for analysis. Three samples are taken from each location. SPU staff have followed the protocol outlined in the QA plans outlined in SPU's SWMP (See *Appendix WQ-1 of SWMP*).

Conclusions

The attached report, *Urban Streams Biomonitoring: Benthic Invertebrate Communities*, contains summary tables of the laboratory analysis for data collected from 1994 through 1998. All data is attached in electronic form. (Note: Samples were collected in 1997, but they could not be analyzed owing to delays in shipping to the analysis laboratory.) Table 5 summarizes the Benthic Invertebrate Bioassessment scores for all the creeks in the program over the five year period listed in order of biotic health for 1998. Table 4 outlines the qualitative categories used by ABA to describe the relative health of the scores. These scores are percentages based on the Aquatic Biology Associates, or ABA, method developed by Aquatic Biology Associates, Inc, which analyzes SPU's samples. According to ABA's general biotic integrity and impact categories, the nine streams fall into low or severe biotic/habitat integrity categories. However, ABA cautions, "this bioassessment method is based on Pacific Northwest montane watersheds that have experienced minimum human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient." For the term of this permit, the scores are still too limited to distinguish definitive temporal trends. The scores do to indicate in a general way the biotic integrity of these nine creeks relative to each other.

Table 4. Qualitative Biotic Integrity Categories

Biotic Integrity Categories	
Very high	90-100%
High	80-89%
Moderate	60-79%
Low biotic	40-59%
Severe	< 40%

Table 5. Summary of Benthic Invertebrate Bioassessment Scores for 1994-98

Creek	Benthic Scores (%)			
	1994	1995	1996	1998
Venema: Lower	x	x	37.1	47.6
Venema: Rearing Pond	x	x	x	46.0
Fauntleroy Creek	46.3	56.5	41.1	44.4
Piper's Creek	x	x	37.9	44.4
Taylor Creek	36.6	37.1	33.1	42.7
Ravenna Creek	x	x	x	40.3
Thornton: North (golf course)	x	x	x	39.5
Schmidt's Creek	38.2	46.0	33.9	38.2
Thornton: Main	x	x	34.7	37.1
Thornton: South	36.6	34.7	34.7	X
Longfellow Creek	x	x	33.1	34.7
Thornton: Littles Creek	x	x	x	33.9
Puget Ridge Creek	32.5	33.9	31.5	29.0

Recommendations

Aquatic Biology Associates plans to develop an ABA bioassessment index appropriate for lowland streams for the upcoming 1999 analysis. Further interpretation of existing data could include 1) analyzing it in relation to King County's benthic data and 2) transforming scores into the B-IBI scale used at the University of Washington. In addition to refining bioassessments for urban areas, correlating specific parameters of stream bioassessments to upland characteristics or practices is an active area of research. Incorporating benthic analysis into BMP effectiveness monitoring in the future will assist stormwater managers in evaluating which measures will most efficiently improve the biotic integrity of the riparian ecosystem.

BMP Effectiveness - Longfellow Creek Oil/Water Separator

Project Description and Data Analysis Methods

The purpose of this project was to evaluate the effectiveness of an API-type oil/water separator. Unfortunately, owing to difficulties obtaining influent and effluent samples the project was abandoned in favor of pursuing other BMP effectiveness projects.

Stream Sediment Analysis

Project Description and Data Analysis Methods

As part of its Freshwater Assessment Program, King County DNR collects sediment samples at the mouths of Pipers, Longfellow, and Thornton Creeks once every year. The samples are analyzed for cadmium, copper, lead, nickel and zinc. These data were analyzed in 1998 and the summary is included in attached water and sediment quality reports for each of the three major creeks. (See Longfellow, page 16; Thornton, page 9; Pipers, page 14.) For additional analysis

see "Water-Quality Assessment of the Puget Sound Basin, Washington—Summary of Stream Biological Data Through 1995," USGS and "The Water Quality of Small Lakes and Streams," February 1994, Water Resources Section, Water Pollution Control Department, King County Department of Metropolitan Services.

Conclusions

The water quality and sediment analysis study concluded that metals in the sediment samples for Longfellow, Thornton and Pipers Creeks appear to be below the level at which minor or lowest effects occur for benthic organisms. These metals included arsenic, chromium, cadmium, copper, zinc, lead and nickel. However, according to studies conducted by the U.S. Geologic Survey in Puget Sound streams, "concentrations of arsenic, cadmium, lead, mercury, and zinc frequently exceed forest and reference conditions in streambed sediment and sculpin in urban streams" (Organic Compounds and Trace Elements in Freshwater Streambed Sediment and Fish from the Puget Sound Basin," September 1998, USGS.)

Recommendations

At this point, collecting additional sediment data from Seattle Creeks under a city-sponsored monitoring program is not warranted. No key stormwater management decisions are pending that require analysis of urban creek sediment data.

Visual Inspections

Pertinent information obtained during visual inspections may be reported as part of Water Quality Complaint, Private Detention Inspection, or Business Inspection programs (See *1998 Update Report* for additional details). For a discussion of results of visual inspections conducted as part of a grant-funded project, see "Urban Creeks - Habitat Assessment Study" in this report.

CSO Quantity Monitoring

See *CSO Monitoring* under Lakes, Rivers, Elliott Bay, Puget Sound.

Urban Creeks - King County Densmore and Landers Storm Basins

Electronic data is attached. King County will be submitting report separately. Contact Cynthia Hickey, King County, (206) 263-3006.

LAKES, RIVERS, ELLIOTT BAY, PUGET SOUND

CSO Monitoring

Project Description and Data Analysis

Seattle's combined sewer collection system has 113 outfalls and 138 overflow points (some outfalls have more than one overflow point.) Monitoring was in place for all pump station overflow points in 1998.

Conclusions

Table 6 summarizes the monitored overflows to receiving waters in 1998. Monitoring at pump stations is currently limited to the frequency and duration of the overflows. CSO monitoring is an on-going commitment by the City. In addition to NPDES reporting, monitoring results are used to assess capital improvement effectiveness, model drainages and prioritize future investments. The City of Seattle's 1997 and 1998 *Combined Sewer Overflow Annual Report* is are included in the Appendices. These reports provide the volume, duration and frequency of all monitored CSOs. A copy of the report describing implementation of CSO minimum controls (*Combined Sewer Overflows: Nine Minimum Controls Documentation*) is also attached.

Recommendations

Seattle is currently upgrading the monitoring system for the CSO pump stations, which will provide volume calculations in addition to flow and duration data. This upgrade is expected to be by the 2001.

Table 6. Monitored Overflows to Receiving Waters in 1998

RECEIVING WATER	FREQUENCY (CSO EVENTS)	VOLUME (gal)
Lake Washington	129	78,704,460
Union Bay	6	2,704,001
Salmon Bay	1	N/A
Elliott Bay	33	454,080
West Waterway	2	123,415
East Waterway	5	207,811
Duwamish River	34	1,609,608
Portage Bay	1	N/A
Longfellow Creek	5	2,304,785

Water Quality Assessment

Duwamish River/Elliott Bay Storm Drains

Project Description and Data Analysis Methods

The purpose of this project was to collect stormwater runoff concentration data in order to calibrate a model for use in evaluating stormwater pollutant loadings in the drainage basin. Details on the intended sampling protocols are contained in the *Elliott Bay/Duwamish River Drainage Basin: Stormwater Sampling Plan*, which is provided in Appendix WQ-1 of the SWMP. Unfortunately, tidal influences made it impossible to follow the sampling protocols.

Conclusion

Owing to the complexities of drawing storm event samples in a tidally influenced area, it was concluded that it was in the best interests of both Ecology (sponsoring a portion of the project through a grant from the Centennial Clean-Water Fund) and SPU to drop the project.

Recommendation
Until the state-of-the-practice in stormwater sampling becomes more advanced, one recommendation from this project was to avoid entering into stormwater sampling regimes that involved tidally influenced basins.

Lake Union Area Source Control

Project Description and Method of Analysis
The Lake Union Area Source Control Project was completed in December 1998 and summarized in the report, *Lake Union Area Source Control: Stormwater Characterization and Treatment Options* (Copy attached). The study focused on the immediate, highly urbanized Lake Union watershed. This 2,600 acre watershed contains nineteen separated urban stormwater drainage areas discharging into the Portage Bay/Lake Washington Ship Canal system. The study prioritized the drainage areas with a ranking system, and implemented a stormwater sediment monitoring program in the high priority drainage areas to identify pollutants of concern and probable sources. Stormwater sediment was monitored at 12 locations in the high priority basins from January to June 1997. In addition, sediments were collected from industrial, commercial, arterial roadway, single family residential, multifamily residential, and parking land uses. Sediment samples were passively collected over this 6-month period from catch basins using in-line sediment samplers designed to primarily sample the silt and clay fraction.

Conclusions
The relationship between pollutants and land use are summarized in Table 7. The highest concentrations of sediment metals are associated with industrial, multifamily and single family residential, and commercial land uses. Cadmium and lead concentrations are generally highest in residential land use areas, while copper and zinc are greatest in industrial land use areas. Parking, industrial and commercial land uses exhibit the highest mean sediment total petroleum hydrocarbon (TPH). Sediment fecal coliform bacteria concentrations are greatest for residential land uses. Sediment polynuclear aromatic hydrocarbon (PAH) concentrations, normalized for organic carbon content, are greatest for parking lot and arterial roadway land uses. The study concluded that small-scale underground structural treatment BMPs would be a more cost-effective option than above ground BMPs. The study concluded that nonstructural, source control BMPs were also needed to reduce pollutant discharge to the lake.

Recommendations

The study identified numerous retrofit opportunities in several priority drainage basins, however it cautioned that these retrofits would be relatively expensive due to the highly urbanized composition of the basins. The study rated sand filter vaults and leaf compost filters as optimal filter media in terms of pollutant removal efficiency, feasibility and costs. However, pollutant removal efficiencies of these two media for dissolved metals are still unknown. In addition, leaf compost filters export nutrients which could be an additional concern. The study recommended continuing existing business and residential education, inspection and source controls programs.

Table 7. Summary of relationship between pollutants and land use.

	Industrial	MF	SF	Comm	Park/Road
Metals	X	X	X	X	
Cadmium Lead		X	X		
Copper Zinc	X				
TPH*	X				X
PAH*					X
Fecal coliform		X	X		

BMP Effectiveness - Harbor Island Filter

The stormwater filter effectiveness portion of the Elliott Bay Source Control Grant was eliminated from the Elliott Bay/Duwamish River Drainage Basin Stormwater Sampling project per Ecology's approval. Sampling difficulties owing to the presence of tidal influences could not be resolved.

Visual Inspections

Visual inspections conducted as a form of source control or evaluation are reported as part of Water Quality Complaint, Private Detention Inspection, or Business Inspection programs (See *1998 Update Report* for additional details).

Sediment Analysis

Sediment Sampling in Elliott Bay

Project Description and Data Analysis Methods

In 1996, sampling was conducted in Seattle's Elliott Bay (in the Pier 53-55 remediation area) as part of a 10-year monitoring program to evaluate the effectiveness of a sand cap installed in March 1992. Cap thickness and settlement measurements taken in 1996 indicated that the cap and enhanced natural recovery (ENR) area were stable. Analysis of core samples showed that no chemicals had migrated into the cap form the underlying contaminated sediments. Seven sediment surface composite samples detected 4-Methylphenol and phenal exceeding Cleanup Screening Levels. Further study is needed to identify sources of both phenols. Benthic taxonomy samples revealed lower polychaete numbers and higher mollusks and crustaceans. These changes in benthic community appear to be linked to an expected change toward finer grain size.

Conclusions
The conclusions from the 1996 monitoring include:

- The 3-foot cap and ENR are stable.
- Contaminants are not migrating from the underlying sediments up into the cap or ENR.
- High levels of PAHs found in 1993 have decreased.
- The 1996 benthic taxonomy data indicated a re-colonization process of the cap.

For more information, see *Pier 53-55 Sediment Cap and Enhanced Natural Recovery Area Remediation Project, 1996 Data: Elliott Bay/Duwamish Restoration Program*, King County Water and Land Resources Division, October 1997.

SUPPORT MONITORING

CIP Water Quantity Monitoring

Water quantity monitoring is conducted to obtain flow data in order to support engineering design. A summary of CIP projects completed, in-process and planned is provided in *Report on Effectiveness*.

Rain Gauge Network

Seattle manages a network of 17 rain gauges for collecting and reporting on rainfall data in the Seattle area. Rainfall event, hourly/daily, daily/monthly, and monthly/annual summaries are generated and reported for each rain gauge. Data and summaries are available upon request. Contact Hirad Mousavi, SPU, 206-615-0826.

BMP Effectiveness

Effectiveness of Educational Media Campaign

Project Description and Data Analysis Methods
This study investigated the effectiveness of a one year stormwater pollution education campaign developed and launched by the Water Quality Consortium in 1995-96. The Water Quality Consortium was an intergovernmental group specifically organized to deliver a media campaign to the Puget Sound Region. The campaign was designed to raise awareness about the impacts of citizen behavior on water quality. The media campaign targeted four specific activities: fertilizing lawns, leaking oil from cars, disposal of pet waste and washing cars. Pre- and post-campaign market research evaluated the effectiveness of the media campaign at raising public awareness about the impact of certain behavioral activities on water quality.

Conclusions
The attached report, *The Water Quality Consortium Public Awareness Study Summary Report, October 1996*, includes the details of the results. The key findings of the study indicate that the

media campaign was successful in raising awareness regarding water pollution issues. Key results relevant to measuring the effectiveness of the media campaign include:

- A 15% increase in those citing water pollution as the most important environmental issue to our region.
- A 33% unaided recall of the fertilizer television ad (unaided recall is those respondents who with no prompting, described the ad when asked if they had seen or heard anything recently about protecting water quality.)
- 35% of the respondents recalling the advertisements stated that the ads had caused them to change their behaviors in some way.

Recommendations
When asked to identify causes of water pollution in their own neighborhoods, 19% of the respondents mentioned fertilizing lawns and 11% mentioned garden pesticides. These two lawn and garden care activities were the most frequently mentioned activities. Only 1% of the respondents mentioned pet waste in both the 1995 and the 1996 survey. These findings, together with the high fecal coliform levels found throughout streams in King County suggest that additional educational campaigns explaining the environmental and human health risks associated with pet waste might be a valuable regional investment. Additional research is needed to better understand how to effectively target education programs in the future.

Street Waste "Vactor" Sampling

Formerly titled "Effectiveness of Catch Basin Cleaning" in the City's 1997 SWMP, it was subsequently determined that data collected at street waste collection facilities cannot be used directly to evaluate the effectiveness of Catch Basin Cleaning. The City operates and maintains two street waste ("vactor") facilities that discharge to King County's sanitary sewer system. As part of the City's discharge permit with King County, the City takes quarterly samples at the discharge point of both facilities. King County regulates the discharges and requires correction and additional monitoring if samples fail to meet their required minimum standards. Electronic data are attached. For more information, contact Gary Lockwood, SPU, at (206) 684-7750.

Emergent Monitoring Requirements

Data collected on an emergent basis are maintained in the City's Surface Water Quality database.

ADDITIONAL COMPLETED MONITORING ACTIVITIES

Thornton Creek Summer Base Flow Study

Project Description and Data Analysis Methods

This study attempted to characterize temperature, dissolved oxygen and fecal coliform during hot summer afternoons throughout the Thornton Creek watershed. The study builds on the City's

on-going water quality monitoring program which gathers data at the base of the drainage, by providing an understanding of the spatial variability of these three parameters within the watershed. In addition, temperature samples have historically not been collected during the hottest part of the day. Ten sites were sampled on five hot summer afternoons in 1998. The final report, *Sample Analysis Report for Thornton Creek Summer Base Flows*, is included in the Appendices.

Conclusions

The study found that temperatures frequently exceed acceptable levels on hot afternoons, and dissolved oxygen levels are depressed throughout the creek system. Fecal coliform levels exceed state standards at nine of the ten stations. The study concluded that elevated fecal coliform levels are unlikely from illicit discharges.

Recommendations

The report outlines a number of recommendations based on the study findings including engaging in a public outreach effort to reduce animal waste pollution. In 1999, the City launched a Pet Waste Source Control Project (detailed in the *1998 Update Report*) targeted at veterinary and pet businesses throughout Seattle. The relationship between temperature and streamside canopy, upland characteristics and BMPs is currently an active area of research. Including temperature, dissolved oxygen and fecal coliform parameters in BMP effectiveness monitoring would provide valuable information for improving aquatic system health in urban areas. A number of these recommendations will be incorporated into future monitoring activities.

Evaluation of Salmonid Habitat Conditions and Opportunities

Project Description and Data Analysis Methods

This study summarized current habitat conditions and identified potential habitat improvement opportunities for salmonids in lower Thornton Creek.

Conclusions

A stream inventory revealed that lower Thornton Creek has very few pools and that existing pools are shallow; little woody debris of notable size exists, much of the channel bank is hardened by streamside property owners and; several large culverts may hinder fish. Electroshocking for fish presence/absence revealed sculpins, cutthroat and a few chinook smolt. Areas of large gravel, suitable for large fish spawning is found in very few low gradient riffles scattered throughout the creek. Few pools exist with minimum water depth acceptable for rearing of larger fish. Fish passage was not found to be a significant limiting factor. However the study found greater fish presence in areas with appropriate habitat.

Recommendations

The consultant recommended several vegetative, pool and debris enhancement opportunities. For more information, see the attached report, *Lower Thornton Creek Evaluation of Salmonid Habitat Conditions and Opportunities, Task I Memorandum.*

ADDITIONAL ON-GOING MONITORING ACTIVITIES

Urban Creek - Aquatic Community Assessment

Project Description and Data Analysis

The Aquatic Community Assessment Program was expanded in 1996 to include four new sites, and in 1998 to include four additional sites.

Status of Project

There are currently a total of 13 sites now being used for Aquatic Community Assessment. See "Aquatic Community Assessment" under "Urban Creeks" and the report, *Urban Streams Biomonitoring: Benthic Invertebrate Communities,* in the Appendices.

BMP Effectiveness - Meadowbrook Pond Evaluation

Project Description and Data Analysis Methods

Meadowbrook Pond, completed in 1998, is an off-channel detention pond and constructed wetland designed to both attenuate peak flows in Thornton Creek. An initial sample program was conducted during two weeks in July 1999 to evaluate the early performance of the pond. Because of the significant residence time in the system, a statistical sampling approach to characterize pollutants at the inlet and outlet was adopted. Only four samples were obtained before sampling equipment had to be removed to accommodate further construction activities at the site. Conclusions about the water quality treatment performance of the pond could not be made owing to the limited data collected during the sampling period. However, lessons learned in establishing the monitoring sites and collecting samples will be incorporated when the sampling regime recommences upon completion of the construction.

Status of Project

Monitoring should resume once construction has been completed at the site.

BMP Effectiveness—Stormwater Treatment Grant Study

Project Description and Data Analysis Methods

As part of a Centennial Grant, the City will be investigating the pollutant removal efficiency maintenance requirements of four structural BMPs: two stormceptors, a coalescing plate oil/water separator, and a filter media installed in a catch basin. The selected BMPs will be

evaluated using a modified time-composited sampling technique developed by SPU that attempts to compare influent and effluent samples that are collected at similar flow rates. By comparing inflow and outflow pollutant concentrations at similar flow rates, it is expected that a set of curves can be derived showing the relationship between pollutant removal efficiencies and flow rate. A set of curves is expected because in addition to flow rate, it is expected that removal efficiencies are also a function of inflow concentrations.

Status of Project

Construction at the structures has been completed and sampling equipment installed. A consultant contract is in place for samples to be collected.

BMP Effectiveness - *Downstream Defender* Oil/grit Separator

Project Description and Data Analysis Methods

In 1999, installation of an Oil/Grit Separator BMP *Downstream Defender* will be completed. This structure, constructed as a joint project between SPU and Washington State Department of Transportation (WSDOT) and located in WSDOT right-of-way, will filter highway runoff in the Northgate area north of downtown Seattle before it enters Thornton Creek. It is anticipated that a sampling plan will be used that is similar to that described earlier in the *Stormwater Treatment Grant Study.*

Status of Project

A monitoring program to evaluate the effectiveness of oil and grit removal is currently projected to begin in 2000.

BMP Effectiveness - Confined Space BMP Research

Project Description and Data Analysis Methods

The City is working closely with WSDOT in a project investigating the effectiveness of several structural BMPs in treating highway runoff. The project involves routing 25-30 acres of highway runoff to an area under Interstate 5 above the Ship Canal, where up to four different BMPs will be tested (e.g., swirl technology-based units, filtration-based units, oil water separators), with sampling ports located so that flow rates and chemical concentrations can be determined at entry and exit points in each BMP. After leaving the structure(s), flow will be collected again into a common pipe, routed through a permanently installed BMP to remove or reduce suspended particles, oils, grease and other potential contaminants, before being discharged into the Ship Canal. This is expected to be a long-term monitoring and research project partnership between WSDOT and the City of Seattle for evaluating BMP efficiencies, operating procedures, and maintenance costs. Other participants in the initial project include the Environmental Technology Evaluation Center (EvTEC) of the Civil Engineering Research Foundation (CERF), Concurrent Technologies Corporation (CTC), and the Center for Urban Water Resources Management (CUWRM) at the University of Washington. Sampling protocols

have been approved and research faculty at the University of Washington have been engaged on the project.

Status of Project

Seismic retrofit projects on the highway structures delayed construction of the BMP test facility. A monitoring program to evaluate the effectiveness of the BMPs is currently projected to begin late in 1999 or early in 2000.

FUTURE MONITORING ACTIVITIES

BMP Effectiveness - CIP Performance Evaluation

Project Description and Data Analysis Methods

In 1999, SPU launched an ambitious long-term CIP monitoring program that will lay a foundation for future water quality and creek health monitoring. High priority in-stream construction projects are targeted in the Piper's Creek, Thornton Creek, Longfellow Creek and Taylor Creek watersheds. Types of projects to be evaluated include bank stabilization, bed control structures, riparian replanting, weir retrofit, in-stream improvements, culvert replacement, off-channel habitat creation, wetland creation and stormwater detention. The intent of CIP effectiveness monitoring will be to provide information on the level of improvement or protection afforded a water body as a result of the constructed system or BMP. This information will refine stormwater management decisions and advance the benefits gained by strategically investing in the most effective activities and projects.

Status of Project

Baseline data and information have been completed for all high priority projects. Data and information are currently being gathered for all other planned CIP projects. Future steps include developing a long-term CIP monitoring program and expanding CIP project evaluation to the watershed level to monitor urban creek health.

Urban Creeks Limiting Factors Analysis

Project Description and Data Analysis Methods

A limiting factors analysis for fish health is currently being conducted under a consultant contract. The study includes Pipers, Thornton, Longfellow, Taylor, Fauntleroy, Puget Ridge, and Schmidt Creeks. The study will type the seven streams based on standard protocols, conduct fish presence/absence surveys, and identify natural barriers. The results of this study will assist in prioritizing future improvement projects within the City's urban streams.

Status of Project

Currently the consultant is surveying the extent and distribution of salmon and resident trout based upon stream habitat characteristics and electrofishing results.

CSO Water Quality Characterization Study

Project Description and Data Analysis Methods

The City is undertaking a CSO Water Quality Characterization study in order to provide appropriate decision support information for long-term CSO control planning. The objectives of the study include:

- Characterize the City's CSOs using existing CSO quality monitoring information.
- Propose options for followup.

Additional tasks include compiling both City and King County data into relational databases; assembling relevant GIS files; and categorizing, ranking and prioritizing CSOs.

Status of Project

A consultant has been retained and a report is being drafted detailing the data analysis results of existing CSO discharge quality data.

Built Environment Study

Project Description and Data Analysis Methods

The purpose of the Built Environment Study is to identify limiting factors for Puget Sound chinook salmon in the built environment of Seattle and outline a methodology for prioritizing improvements and proposing solutions.

Status of Project

The City is currently conducting the Limiting Factors portion of the study. This research will focus on Lake Washington, Portage Bay/Ship Canal/Lake Union, Duwamish River/Elliott Bay, Puget Sound, and to a lesser extent, urban streams. The limiting factors study seeks to characterize the salmon lifecycle, the history of salmon runs within the city's jurisdiction, urban limiting factors to salmon recovery, and relevant information gaps. Existing information on stormwater as a potential limiting factor will be included. This study will provide a valuable baseline of known information and help identify future areas of research and improvements.

BMP Effectiveness - Ultra-Urban CIP Evaluation Studies

Project Description and Data Analysis Methods

Beginning in September 1999 and continuing through July 2000, SPU will work with the University of Washington to investigate the effectiveness of four potential stormwater management techniques, all of which are intended to minimize the adverse effects of urban runoff. The four techniques include:

- **Residential Swale.** Viewlands Demonstration Swale will use a series of cells defined by log weirs to reduce flow velocities from approximately 30 acres of residential development and enhance stormwater quality prior to its discharge into Pipers Creek.
- **Modified Residential Street.** S. E. A. Street ("Street Edge Alternative"), is an innovative residential street design including narrower streets, a swale system, and appropriate landscaping, that will be installed to aid surface water management and minimize negative impacts to Pipers Creek.
- **Street Tree Impervious Surface Reduction.** A SPU/SEATRAN partnership will study the potential benefits of an on-going program to increase the size of tree pits throughout the city.
- **Landscaped Roofs.** A Roof Garden Demonstration will explore the potential stormwater benefits of roof-gardens in urban areas.

Status of Project

A research team at the University of Washington has been retained and a scope of work prepared that includes: (1) developing a long-term, systematic approach to ultra-urban stormwater management in Seattle stream catchments; (2) preparing an experimental design and a monitoring plan for testing initial projects; (3) collecting and analyzing data.

References

Elliott Bay Source Control Grant Final Report, Seattle Public Utilities.

King County Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliot Bay, February 1999.

Organic Compounds and Trace Elements in Freshwater Streambed Sediment and Fish from the Puget Sound Basin, September 1998, USGS.

Water-Quality Assessment of the Puget Sound Basin, Washington—Summary of Stream Biological Data Through 1995, USGS.

The Water Quality of Small Lakes and Streams, February 1994, Water Resources Section, Water Pollution Control Department, King County Department of Metropolitan Services.

LIST OF ATTACHED DATA

Water Quality Data for Major Creeks

City of Seattle

Electronic copy attached of storm sample data for Pipers and Longfellow Creeks and base flow sample data for Longfellow Creek.

King County

(See *The Water Quality of Small Lakes and Streams*, February 1994, Water Resources Section, Water Pollution Control Department, King County Department of Metropolitan Services.)

Water Quality Data for King County Storm Sewer Basins

Electronic copy attached of sample data for Lander and Densmore basins.

Aquatic Community Data

Electronic copy of 1998 data sheets attached. Hard copies of data summary tables included in the attached report, *Urban Streams Biomonitoring: Benthic Invertebrate Communities*, Seattle Public Utilities, 1994-1998.

"Vactor" Facility Data

Electronic copy of 1998-99 data attached.